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Effect Of Spraying With Nano Selenium And Salicylic Acid In Reducing Salt Stress And Growth And Yield Of Corn (Zea Mays L.)

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Abstract

The experiment was conducted during the spring season 2019-2020 in the Al-Babara area of Al-Imam sub-district in Al-Mahaweel District, Babylon province in clay loam soil by designing Randomized Complete Block Design RCBD according to the split-plot system to study the effect of irrigation water salinity and spraying with nano-selenium and salicylic acid on some soil trait, growth and yield of corn. Three levels of salinity of irrigation water were used (8, 4, 1.8) DS. m^{-1} and spraying with three concentrations of nano-selenium (0, 30 and 60) $mg.L^{-1}$ and two concentrations of salicylic acid (0 and 100) $mg.L^{-1}$ and three replicate, bringing the number of experimental units to 54 experimental units. Increasing the salinity of the irrigation water led to a decrease in most of the studied plant traits, as well as the concentrations of selenium, nitrogen, phosphorous and potassium in the plant.

Keywords: nano selenium, salicylic acid, salt stress, Corn, Zea mays L.

Introduction:

Selenium is considered one of the essential elements for humans, animals and many plants, and there is evidence indicating that the use of selenium in low concentrations leads to the creation of resistance in plants against environmental stresses (6). Recently, selenium nanoparticles (Se-NPs) have been used as alternatives to selenium compounds and many studies have concentrated on the good properties of Se-NPs such as higher antioxidant effect, lower toxicity and bioactivity (20).Salicylic acid (SA) is a phenolic plant hormone. It plays an important role in organizing many functional activities, including syphilitic induction and organizing Ion absorption and hormonal balance, and also its effect on the process of opening and closing stomata and construction optical. It also highlights its role by regulating the process of plant response to environmental stress conditions, where it was noted that salicylic acid works to provide protection against types of environmental stress such as salt stress, drought stress, heat stress, and stress that results from heavy metals (8). Salt stress is one of the important problems that reduce the area of lands cultivated in field crops and their poor quality. Salt stress is accompanied by many stresses such as osmotic stress [drought stress]. It represents the indirect effect of salts on plants, and there is also a direct effect of salts represented by the specific effect of some ions, such as sodium ion toxicity, and chlorine. Plants are constantly exposed to biotic and abiotic

stresses and salt stress (NaCl) is one of the most severe abiotic stresses that reduce plant productivity. where the large amounts of salt enter the plant, it eventually rises to levels that are toxic in older transpirational leaves, causing premature aging and reducing the photosynthetic leaf area of the plant to a level that it cannot sustain growth (13).Salt stress can affect many physiological processes during plant growth stages from seed germination to production and yield. Salinity may promote stomata closure which subsequently stops photosynthesis and enhances the generation of reactive oxygen species (ROS) leading to oxidation of various cellular components which are expressed in lipid oxidation, Protein degradation, enzyme inactivation and DNA damage (17).Yellow corn(Zea mays L.) is one of the most important grain crops, as it ranks third in importance after wheat and rice in terms of its productivity and the cultivated area. Its importance comes due to its multiple uses as it enters into human and animal nutrition as well as its entry into various industrial fields (14) .

2- Materials and methods:

A field experiment was conducted in Al-Abbara area of Al-Imam sub-district, Al-Mahaweel district, where yellow corn - spring season cultivars (DKC6589) were planted for the agricultural season 2019/2020 in a clay loam soil . Samples were taken from the soil before planting for the purpose of analysis, and the field was divided into three equal sectors, leaving an interval of 2 m between the sectors for the purpose of controlling the movement of water. Each replicate was divided into 18 experimental units in the form of the plot with dimensions of 1.5 m x 2, leaving an interval of 0.5 m between the experimental units. Yellow corn seeds (Zea mays L.) were cultivated on 10/3/2020 in a pit with 3 seeds in each pit, which later subsided after germination to one plant. 25 cm between one plant and another Three levels of irrigation water were used (8, 4, 1.8) DS. m^{-1}. Which is symbolized by (W3, W2, W1), respectively, and three concentrations of nanoselenium (0, 30, 60) mg. L^{-1} and is symbolized by (Se1, Se2, Se3) respectively, and two concentrations of salicylic acid are (0,100) mg. L^{-1} and are symbolized by the symbol Sa1, Sa2)) and with three repetitions, bringing the number of experimental units to 54.The experiment was conducted by designing randomized complete blocks (RCBD) according to the split-plot system. The analysis of variance method was used to determine the statistical differences between the arithmetic means using the program (Genstat, 2007). The means were compared with the least significant difference (L.SD) test with a significant level (0.05). The field was fertilized with diammonium phosphate fertilizer DAP (21%P) before planting 100 kg P. ha $^{-1}$ and urea fertilizer N 46 % was added at an amount of 240 kg N. hectare-1 in two batches. All experimental units were irrigated with river water (1.8 ds.m-1) in the first irrigation to allow the seeds to germinate.

Table 1: Some chemical and physical properties of soil

values	**Units**	Traits
4.96	$Ds.m^{-1}$	ECe . electrical conductivity
7.63		pH
dissolved ions		
12.43	mmol.L^{-1}	Sodium
0.65		potassium
10.34		Calcium
8.27		magnesium
19.36		chloride
12.58		sulfate

3.87		bicarbonate
0.00		carbonate
2.88	$(mmol.L^{-1})^{1/2}$	Sodium adsorption ratio (SAR))
24.61	$centimol.kg^{-1}$	Cation Exchange Capacity (CEC)
1.34	$Mg.g^{-3}$	bulk density
48.52	%	group stability
6.25	$g.kg^{-1}$	Organic matter
38	$mg.kg^{-1}$	availability Nitrogen
13		availability phosphorous
171		availability potassium
15	$g.kg^{-1}$	sand
500		Clay
485		silt
Silty Clay		texture

Table 2: Some chemical and physical properties of the irrigation water used in the experiment

treatments			**units**	**Traits**
W3	**W2**	**W1**		
7.18	7.34	7.45	----	**pH**
8	4	1.8	$Ds.m^{-1}$	**electrical conductivity**
26.96	18.9	3.79	$mmol.L^{-1}$	**Sodium**
0.33	0.24	0.11		**potassium**
6.4	4.2	2.3		**Calcium**
15.7	7	2.5		**magnesium**
61.83	24.7	7.33		**chloride**
6.38	4.87	3.42		**sulfate**
4.2	4.6	2.4		**bicarbonate**
5.73	5.65	1.73	$)mmol.L^{-1}(^{1/2}$	Sodium adsorption ratio (SAR)
C_5S_1	C_4S_1	C_3S_1	----	Classify water according to the American classification

Results and discussion:

Electrical conductivity:

The results of the statistical analysis in Table (3) indicated that the increase in the salinity of the irrigation water had a significant effect on the increase in soil salinity, Where its highest value in treatment W3 was 13.27 $DS.m^{-1}$ and the lowest value in treatment W1.Where it reached 5.55 $DS.m^{-1}$ These results are in agreement with (1) which indicated an increase in soil salinity by 191% as a result of using well water with a salinity of 4 $DS.m^{-1}$

compared to river water whose salinity is 1.2 DS.m^{-1}.The results showed that spraying with selenium led to a reduction in soil salinity, where the lowest value for Se3 treatment was 9.26 DS.m^{-1} and the highest value for Se1 was 9.88 dS m-1 with a decrease of 6.27%. Through the results, it was found that spraying with salicylic had a significant effect in reducing soil salinity, where the highest value of Sa1 was 9.77 DS.m^{-1} and the lowest value at Sa2 DS.m^{-1}.Where it was 9.26, a decrease of 5.22%. As for the bi-interaction between the salinity of irrigation water and spraying with selenium, it had a significant effect in reducing soil salinity, where the highest value at W3Se1 was 13.88 DS.m^{-1} compared to the lowest value in treatment W1Se3 whose value was 5.37 DS.m^{-1}, at an average of 61.31%. The bi-interaction between the salinity of irrigation water and salicylic spray had a significant effect in reducing soil salinity, where the highest value for the W3Sa1 treatment was 13.75 DS.m^{-1}, and the lowest value in the treatments W1Sa2, whose value was 5.44 DS.m^{-1}.It is noticed through the results of the statistical analysis that the interaction between selenium and salicylic had a significant effect in reducing soil salinity, where the highest value when the treatment Se1Sa1 was 10.22 DS.m^{-1}, and the lowest value was with Se3Sa2, where its value was 9.02 DS.m^{-1}, with a decrease of 11.74%. The results of the triple interaction between the salinity of irrigation water and spraying with selenium and salicylic indicated that there were significant differences, where the highest value was when the treatment W3Se1Sa1 had a value of 14.45 DS.m^{-1} and the minimum value for W1Se3Sa2 is 5.28 DS.m^{-1}, with an average of 63.46%. The spraying between nano selenium and salicylic acid and the interaction between them had a significant effect in reducing soil salinity. The reason for this is that spraying with both leads to improving plant growth as well as increasing the density of roots, and this, in turn, improves the composition of the soil and increases the washing process of salts in the grain.

Soil Reaction (PH)

The results in Table (4) indicate that the salinity of irrigation water increased from 1.8 to 4 and 8 DS.m^{-1} led to a decrease in pH from 7.58 to 7.46 and 7.32, respectively. This may be due to the saline effect that puts pressure on the values of the degree of interaction towards neutrality, as he (2) indicated that the accumulation of neutral salts of chlorides and sulfates of sodium, magnesium and calcium will press on the values of the degree of soil interaction of the soil solution towards neutrality. The results of the bi-interaction between the salinity of irrigation water and selenium indicate that the highest value was at W1Se2, which was 7.60 compared to the lowest value was at treatment W3Se3 which was 7.30. As for the bi-interaction between the salinity of irrigation water and salicylic acid, the highest value was in the treatment W1Sa2, which amounted to 7.64, while it was the lowest value in the treatment W3Sa2 and its value. 7.32.While the results of the statistical analysis showed that there were no significant differences between the treatments for the bi-interaction between selenium and salicylic.As for the results of the triple interaction between the salinity of irrigation water, selenium and salicylic, it indicated that the highest value was at W1Se2Sa2 compared to the lowest value in the treatment W3Se3Sa1.

Table 3: Effect of spraying with nano selenium and salicylic acid on the electrical conductivity values of soil DS.m^{-1} after harvest under saline stress.

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
5.86	5.67	6.06	0	
5.43	5.39	5.47	30	1.8
5.37	5.28	5.46	60	
9.88	9.61	10.16	0	
9.69	9.57	9.81	30	4
9.61	9.45	9.77	60	
13.88	13.32	14.45	0	
13.13	12.73	13.52	30	8
12.81	12.35	13.27	60	
0.25	0.37		L.S.D0.05	
Salinity average	Interaction S*SA		Salinity	
5.55	5.44	5.66	1.8	
9.72	9.54	9.91	4	
13.27	12.80	13.75	8	
0.16	0.21		L.S.D0.05	
Se average	Interaction Se* SA		Selenium	
9.88	9.53	10.22	0	
9.41	9.23	9.60	30	
9.26	9.02	9.50	60	
0.15	0.22		L.S.D0.05	
	9.26	9.77	SA average	
	0.14		L.S.D0.05	

Table 4: Effect of spraying with nano selenium and salicylic acid on pH after harvest under saline stress

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
7.57	7.62	7.52	0	
7.60	7.63	7.56	30	1.8
7.59	7.62	7.52	60	
7.48	7.52	7.44	0	
7.45	7.49	7.41	30	4
7.46	7.43	7.50	60	
7.33	7.28	7.37	0	

7.34	**7.30**	**7.38**	**30**	**8**
7.30	**7.36**	**7.24**	**60**	
0.09	**0.13**		**L.S.D0.05**	
Salinity average	**Interaction S*SA**		**Salinity**	
7.58	**7.64**	**7.53**	**1.8**	
7.46	**7.48**	**7.45**	**4**	
7.32	**7.32**	**7.33**	**8**	
0.09	**0.10**		**L.S.D0.05**	
Se average	**Interaction Se* SA**		**Selenium**	
7.46	**7.47**	**7.44**	**0**	
7.46	**7.48**	**7.45**	**30**	
7.45	**7.49**	**7.42**	**60**	
NS	**NS**		**L.S.D0.05**	
	7.48	**7.44**	**SA average**	
	NS		**L.S.D0.05**	

Selenium concentration in leaves (mg kg^{-1}):

It is noted through the results of the statistical analysis in Table (5) that the increase in the salinity of the irrigation water led to a decrease in the concentration of selenium in the leaves, where treatment W1 which gave an average of 17.94 mg kg^{-1} compared to treatment W3 which amounted to 6.65 mg kg^{-1} with a decrease rate of 62.93 %.As for the spraying with selenium, it had a significant effect in increasing the concentration of selenium in the leaves, where the highest value of the treatment Se3 was 18.97 mg kg^{-1}, while the lowest value at Se1 was 3.35 mg kg^{-1}. The spraying with selenium led to the saturation of the leaves with it, which is the medium that is concentrated In it, selenium stimulates the plant to represent selenium compounds.(5) Spraying with salicylic had a significant effect in increasing the concentration of selenium in the leaves, and the treatment of Sa2 was excelled on a value of 13.94 mg kg^{-1}, while the lowest value was when the treatment Sa1 at an average of 9.25 mg kg^{-1} and an increase of 50.70%.The results of the bi-interaction between the salinity of irrigation water and spraying with selenium indicated that the highest value was in the treatment W1Se3 and its amount was 27.72 mg kg^{-1}, while the treatment W3Se1 gave the lowest average of 1.26 mg kg^{-1}.The results of the bi-interaction between the salinity of irrigation water and salicylic spray showed a significant effect, where the treatment W1Sa2 was excelled at an average of 22.12 mg kg^{-1} compared to the treatment W3Se1 which reached a value of 5.12 mg kg^{-1}.Significant differences were found for the bi-interaction when spraying with selenium and salicylic, and the Se3Sa2 treatment gave the highest value of 22.42 mg kg^{-1} compared to the control treatment Se1Sa1, which had a value of 1.83 mg kg^{-1}. The results of the triple interaction between the salinity of irrigation water and spraying with selenium and salicylic acid indicated that the highest value was at the treatment W1Se3Sa2 and its amount was 33.92 mg kg^{-1} and the lowest value was at W3Se1Sa1 which was 0.48 mg kg$^{-1.}$

Table 5: Effect of spraying with nano selenium and salicylic acid on the concentration of selenium in leaves mg kg-1 under saline stress

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
5.95	8.37	3.53	0	
20.14	24.08	16.19	30	1.8
27.72	33.92	21.52	60	
2.85	4.21	1.49	0	
11.40	12.14	10.66	30	4
16.35	18.16	14.55	60	
1.26	2.04	0.48	0	
5.87	7.32	4.41	30	8
12.83	15.19	10.46	60	
2.18	2.66		L.S.D0.05	
Salinity average	Interaction S*SA		Salinity	
17.94	22.12	13.75	1.8	
10.20	11.50	8.90	4	
6.65	8.18	5.12	8	
1.08	1.28		L.S.D0.05	
Se average	Interaction Se* SA		Selenium	
3.35	4.87	1.83	0	
12.47	14.51	10.42	30	
18.97	22.42	15.51	60	
1.46	1.69		L.S.D0.05	
	13.94	9.25	SA average	
	0.79		L.S.D0.05	

Nitrogen concentration in leaves (%):

The results in Table (6) indicate that the percentage of nitrogen decreased with an increase in the salinity levels of the irrigation water. The highest value was found at W1 which is 1.85% and the lowest value for treatment W3 where its value reached 1.46% and with a decrease average of 21.08%.This is due to its negative effect on nitrogen absorption due to direct competition between Cl- and -No3 and the displacement of nitrate adsorption or through indirect competition through changing the permeability properties of plasma membranes by affecting membrane proteins (12)).As for spraying with selenium, it had a significant effect in increasing the percentage of nitrogen in the leaves, as it reached the highest value when treatment Se3 was 1.71% compared to treatment Se1 which amounted to 1.59% and an increase of 7.54%. Significant differences were found when spraying with salicylic in the percentage of nitrogen, as the Sa2 treatment reached an

average of 1.71% and the lowest value at Sa1 was 1.59%, and the percentage increase was 7.54%, due to the role of salicylic acid in increasing the absorption of nitrogen ions and increasing the activity of the enzyme Nitrate reductase (19).The bi-interaction between the salinity of irrigation water and spraying with selenium had a significant effect on the percentage of nitrogen, where the treatment W1Se3 gave an average of 2% compared to the treatment W3Se1 where its value was 1.42%. It is also evident from the bilateral interaction between the salinity of irrigation water and salicylic spray that the highest value was at treatment W1Sa2 and its value was 1.94% compared to the lowest value at W3Sa1 which is 1.39%. The results of the binary interaction between spraying with selenium and salicylic acid showed a significant increase, where the highest value was reached when the interaction Se3Sa2 was treated with an amount of 1.80%, while the lowest value was when the treatment Se1Sa1 gave an average of 1.56% with an increase of 15.38%.The results of the triple interaction between the salinity of irrigation water and spraying with selenium and salicylic acid indicated that the highest value of the percentage of nitrogen in the leaves was when treatment W1Se3Sa2 amounted to 2.20% and the lowest value was at W3Se1Sa1 which amounted to 1.38% with an increase of 59.42%.

Table 6: Effect of spraying with nano selenium and salicylic acid on the percentage of nitrogen in leaves under saline stress.

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
1.69	1.71	1.67	0	
1.85	1.92	1.78	30	1.8
2.00	2.20	1.81	60	
1.65	1.68	1.63	0	
1.67	1.71	1.64	30	4
1.64	1.62	1.66	60	
1.42	1.46	1.38	0	
1.46	1.54	1.39	30	8
1.49	1.59	1.40	60	
0.16	0.25		L.S.D0.05	
Salinity average	Interaction S*SA		Salinity	
1.85	1.94	1.75	1.8	
1.65	1.67	1.64	4	
1.46	1.53	1.39	8	
0.10	0.14		L.S.D0.05	
Se average	Interaction Se* SA		Selenium	
1.59	1.61	1.56	0	
1.66	1.72	1.60	30	
1.71	1.80	1.62	60	
0.10	0.15		L.S.D0.05	
	1.71	1.59	SA average	
	0.09		L.S.D0.05	

Phosphorous concentration in leaves (%):

The results in Table (7) indicated that increasing the salinity levels of irrigation water from 1.8 to 8 DS.m^{-1} reduced the phosphorous concentration in the leaves by 43.90%, due to the competition between Cl- and H2Po4- as Cl- reduces the absorption of H2Po4- by the plant (15)). Spraying with selenium had a significant effect in increasing the concentration of phosphorous in the leaves, as the highest value was in the treatment Se3 which was 0.36% compared to the treatment Se1 which had a value of 0.29% and an increase of 24.13%.It is clear from the results that spraying with salicylic significantly increased the percentage of phosphorous, where the treatment Sa2 reached an average of 0.35%, and the lowest value at Sa1 was 0.30%, and the percentage of increase was 16.66%. The plant is under conditions of salt stress, by stimulating the antioxidant system due to the production of oxidized oxygen radicals and reducing its oxidative action, as well as its role in

increasing chlorophyll in the plant and thus reflecting positively on the absorption of nitrogen, potassium and phosphorous (3), 9). The bi-interaction between the salinity of irrigation water and spraying with selenium had a significant effect on the percentage of phosphorous, whereby treatment W1Se3 gave an average of 0.45% compared to treatment W3Se1 whose value was 0.22%. The results of the bi-interaction between salinity of irrigation water and salicylic spray showed that the highest value of phosphorous in leaves was at treatment W1Sa2 and its value was 0.44% compared to the lowest value at W3Sa1 which is 0.21%. The bi-interaction between spraying with selenium and salicylic acid had a significant effect, as it reached the highest value for the interaction Se3Sa2 and its amount was 0.39%, while it reached the lowest value for the Se1Sa1 treatment, which gave an average of 0.27% with an increase of 44.44%. The results of the triple interaction between the salinity of irrigation water and spraying with selenium and salicylic acid indicated that the highest value of phosphorous in the leaves was at treatment W1Se3Sa2 and its amount was 0.50% and the lowest value was at W3Se1Sa1 which amounted to 0.20%.

Table 7: Effect of spraying with nano selenium and salicylic acid on the percentage of phosphorous in leaves under saline stress.

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
0.35	0.36	0.34	0	
0.42	0.47	0.38	30	1.8
0.45	0.50	0.41	60	
0.30	0.33	0.27	0	
0.33	0.36	0.31	30	4
0.37	0.41	0.34	60	
0.22	0.23	0.20	0	
0.23	0.24	0.21	30	8
0.25	0.26	0.23	60	
0.05	0.09		L.S.D0.05	
Salinity average	Interaction S*SA		Salinity	
0.41	0.44	0.37	1.8	
0.34	0.36	0.31	4	
0.23	0.25	0.21	8	
0.03	0.05		L.S.D0.05	
Se average	Interaction Se* SA		Selenium	
0.29	0.31	0.27	0	
0.33	0.36	0.30	30	
0.36	0.39	0.33	60	
0.03	0.05		L.S.D0.05	
	0.35	0.30	SA average	
	0.03		L.S.D0.05	

Potassium concentration in leaves (%):

It is noted from the results of the statistical analysis in Table (8) that the increase in the salinity of the irrigation water led to a decrease in the concentration of potassium in the leaves. The highest value at W1 was 1.87%, and the lowest value when treated W3 reached 1.49%, with a decrease of 20.32%.This may be due to the inverse relationship between it and the concentration of sodium, where irrigation with saline water led to an increase in sodium in the soil, which led to the displacement of potassium from the absorption area in the roots, as well as an imbalance in the nutrient balance and a decrease in its absorption (11).Spraying with selenium had a significant effect in increasing the potassium concentration in the leaves, where the highest value of the treatment Se3 was 1.74% compared to the treatment Se1 which amounted to 1.57% and an increase of 10.82%. It was found that spraying with salicylic had a significant effect on increasing the percentage of potassium, as the Sa2 treatment reached an average of 1.75%, and the lowest value at Sa1 was 1.57%, and the percentage increase was 11.46%.Spraying with salicylic acid led to an increase in potassium in

the leaves and the reason for this is due to its role in the division of the apical meristem cells of the roots and thus increasing the growth and development of the roots. This process leads to an increase in the efficiency of the roots in absorbing nutrients, including potassium ions (19). The results showed that the bilateral interaction between the salinity of irrigation water and spraying with selenium led to a significant increase in the percentage of potassium, where the treatment W1Se3 gave an average of 1.94% compared to the treatment W3Se1 where its value was 1.38% and an increase of 40.57%.It is also evident from the bi-interaction between the salinity of irrigation water and salicylic spray that the highest value was at treatment W1Sa2 and its value was 1.97% compared to the lowest value at W3Sa1 which is 1.42% with an increased average of 38.73%. The results of the bi-interaction between spraying with selenium and salicylic acid indicated that there were significant differences, where the highest value was at Se3Sa2 and its amount was 1.85%Whereas, the lowest value was reached with the treatments Se1Sa1, which gave an average of 1.50%, with an increase of 23.33%. The results of the triple interaction between the salinity of irrigation water and spraying with selenium and salicylic acid showed that there were significant differences, where the highest value of the percentage of potassium in the leaves was at treatment W1Se3Sa2 and its amount was 2.08% and the lowest value was at W3Se1Sa1 which amounted to 1.35% with an increase of 54.07%.

Table 8: Effect of spraying with nano selenium and salicylic acid on the percentage of potassium in leaves under saline stress.

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
1.81	1.89	1.73	0	
1.87	1.95	1.78	30	1.8
1.94	2.08	1.80	60	
1.52	1.61	1.44	0	
1.66	1.74	1.57	30	4
1.70	1.81	1.59	60	
1.38	1.42	1.35	0	
1.50	1.59	1.41	30	8
1.57	1.66	1.49	60	
0.11	0.14		L.S.D0.05	
Salinity average	Interaction S*SA		Salinity	
1.87	1.97	1.77	1.8	
1.62	1.72	1.53	4	
1.49	1.56	1.42	8	
0.10	0.11		L.S.D0.05	
Se average	Interaction Se* SA		Selenium	
1.57	1.64	1.50	0	
1.67	1.76	1.59	30	
1.74	1.85	1.63	60	
0.05	0.07		L.S.D0.05	
	1.75	1.57	SA average	
	0.04		L.S.D0.05	

Leaf area of the plant (cm^2):

It is noted from the results of the statistical analysis in Table (9) that the increase in the salinity of irrigation water from 1.8 to 4 and 8 DS.m^{-1} led to a decrease in the leaf area of corn plant from 473.5 cm2 to 397.4 cm^2 and 383.8 cm^2 respectively, at an average of 16% and 19%, respectively. Spraying with selenium led to a significant increase in the leaf area of the plant, where the Se3 treatment, which gave an average of 434.7 cm2, excelled on the treatment of Se1 with a value of 396.7 cm2, with an increase of 9.57%.This is due to its role in removing the toxic effect of free radicals from the active oxygen group through the enzyme glutathione peroxidase and works to increase the absorption of the elements and nutrients necessary for building the cellular system of plants such as potassium, phosphorous and nitrogen (16). lettuce plant;It was found that spraying with salicylic gave the highest value when treatment Sa2 was 425.6 cm2 compared to treatment Sa1 where its value was 410.9 cm2 and an increase of 3.57%. The plant from (ROS) generated due to stress, which is responsible for the disruption of most cellular components and also is responsible for the suppression of

some enzymatic activities and the breakdown of proteins (4). The bi-interaction between the salinity of irrigation water and spraying with selenium also had a significant effect, where the highest value for treatment W1Se3 was 485.9 cm^2.Whereas, treatment W3Se0 gave the lowest value of 359.3 cm2 with an increase of 35.23%. As for the bi-interaction between the salinity of irrigation water and salicylic spraying, the treatment W1Sa2 was excelled with a value of 480.1 cm^2 and the treatment W3Sa1 gave an average of 376.3 cm^2 with a percentage of 27.58%. The results of the bi-interaction between spraying with selenium and salicylic showed significant differences, where the highest value for Se3Sa2 was 445.6 cm^2 and the lowest value for Se1Sa1 was 391.7 cm^2 with an increase of 13.76%.The results of the triple interaction between the salinity of irrigation water and spraying with selenium and salicylic indicated that there were significant differences, where the treatment W1Se3Sa2 excelled by giving it an average of 495.2 cm^2, while the treatment W3Se1Sa1 gave the lowest mean of 352.8 cm2 40.36%.

Table 9: Effect of spraying with nano selenium and salicylic acid on the leaf area (cm2)under saline stress.

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
455	461.8	448.2	0	
479.6	483.3	476	30	1.8
485.9	495.2	476.6	60	
375.7	377.3	374.2	0	
400.4	407.3	393.5	30	4
416	431.4	400.6	60	
359.3	365.8	352.8	0	
389.9	379.9	381.9	30	8
402	410	394.1	60	
14.28	21.84		L.S.D0.05	
Salinity average	Interaction S*SA		Salinity	
473.5	480.1	466.9	1.8	
397.4	405.4	389.4	4	
383.8	391.2	376.3	8	
13.58	14.96		L.S.D0.05	
Se average	Interaction Se* SA		Selenium	
396.7	401.6	391.7	0	
423.3	429.5	417.1	30	
434.7	445.6	423.8	60	
6.39	11.73		L.S.D0.05	
	425.6	410.9	SA average	
	8.43		L.S.D0.05	

Grain yield (ton ha^{-1}):

Through the results of the statistical analysis in Table (10), it is clear that the increase in the salinity of the irrigation water from 1.8 to 8 DS m^{-1} led to a decrease in the yield, where the highest value was found for treatment W1 of 6.42 tons ha^{-1} and the lowest value at W3 is 3.71 tons ha -1, with a decrease of 42.21%, This is due to the accumulation of salts in the soil solution, which leads to high osmosis and low water stress, as well as the difficulty of moving water through the roots and the accumulation of sodium and chloride ions to the limits of toxicity and the lack of absorption of nitrogen, phosphorous and potassium elements, causing weak activity of meristematic tissues as well as inhibition of cell division and cell elongation and thus lead to weakness of the growth of the vegetative and root system, thus affecting the amount of yield (18).Spraying with selenium had a significant effect in increasing the yield, as the treatment Se3 gave the highest average of 5.65 tons ha^{-1} compared to the treatment Se1 where its value was 4.76 tons ha-1 and the increase amounted to 18.69%, because it led to an improvement in the vegetative growth traits of the plant.It is also noted from the same table that spraying with salicylic gave significant differences, where the highest value of the treatment Sa2 was 5.71 tons ha^{-1} compared to the lowest value of the control treatment Sa1 where its value amounted to 4.74 tons ha^{-1}, with an increase of 20.46%,This is due to its role in improving the growth characteristics of plants under saline stress conditions by stimulating the photosynthesis process and maintaining the enzymes involved in this process, as well as increasing the photosynthetic pigments (7).It is noticed from the bilateral interaction between the salinity of irrigation water and spraying with selenium a significant effect where the treatment W1Se3 gave an average of 6.83 tons ha-1 compared to the treatment W3Se1 which was 3.37 tons ha-1.From the results of the binary interaction between salinity of irrigation water and salicylic spray, the highest value was found for treatment W1Sa2 which is 6.89 tons ha-1 and the lowest value for W3Sa1 is 3.23 tons ha^{-1}.It is also noted from the results of the binary interaction between selenium and salicylic that the highest value was at Se3Sa2 treatment 6.25 tons ha^{-1}, while the lowest value was found at Se1Sa1 4.32 tons ha^{-1}, an increase of 44.67%.The results of the triple interaction between the salinity of irrigation water and spraying with selenium and salicylic showed significant differences, and the treatment W1Se3Sa2 gave the highest average yield of 7.23 tons ha^{-1}, while the lowest value was when the treatment W3Se1Sa1 was 3.02 tons ha^{-1}, with an increase of 139.40%.

Table 10: Effect of spraying with nano selenium and salicylic acid on the yield of maize grains, ton ha^{-1}, under saline stress.

Interaction W*Se	Salicylic acid SA (mg. L^{-1}) 100	0	Selenium Se)( )mg.L^{-1}(	Salinity ds.m^{-1})(W
5.92	6.49	5.36	0	
6.52	6.96	6.09	30	1.8
6.83	7.23	6.43	60	
4.99	5.41	4.58	0	
5.57	5.91	5.24	30	4
6.09	6.89	5.29	60	
3.37	3.72	3.02	0	
3.70	4.20	3.21	30	8
4.05	4.63	3.48	60	
0.20	0.38		L.S.D0.05	
Salinity average	Interaction S*SA		Salinity	
6.42	6.89	5.96	1.8	
5.55	6.07	5.03	4	
3.71	4.18	3.23	8	
0.07	0.20		L.S.D0.05	
Se average	Interaction Se* SA		Selenium	
4.76	5.20	4.32	0	
5.26	5.69	4.84	30	
5.65	6.25	5.06	60	
0.14	0.23		L.S.D0.05	
	5.71	4.74	SA average	
	0.15		L.S.D0.05	

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