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Effect of Salicylic Acid Foliar Application and Saline Irrigation Water on Soil Salinity and Productivity of Maize *(Zea mays L.)*

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ABSTRACT

Greenhouse experiment was conducted to study the effect of foliar spray of salicylic acid under irrigation with saline water on soil salinity; growth and production of maize (*Zea mays L.)* variety single-cross 10. It comprised three salicylic acid were foliar applied to maize plants in rates of 0,100 and 200 mg kg^{-1}. Three level of irrigation water salinity, (EC_w) were 390 (tap water as control), 1750 and 3500 mg kg^{-1}. Some soil properties were determined. The yield of Maize (*Zea Mayes L.*), some yield component and the chlorophyll content were recorded and statistically analyzed.

The results indicated that the saline irrigation water having EC_w of 390, 1750, and 3500 mg kg^{-1} significantly increased the ECe of sandy soil to 1152, 2144 and 3680 mg kg^{-1}, respectively. The ECe increase was almost proportional to the EC_w of irrigation.

The result revealed that the irrigation water salinity, (EC_w) were significantly decreased maize grain yield, weight of 100 kernels, the ear weight and the plant height. While, fresh and dry weight as well as the chlorophyll content were not significantly affected.

However, foliar spray of salicylic acid was significantly increased the grain yield. The salicylic acid at rates of 100 and 200 mg kg^{-1} increased the grain yield by 28.8% and more than 50% of the maximum yield, respectively. Application of salicylic acid demonstrated a gradually positive effect on the grain yield, chlorophyll content and ear weight. But it did not significantly affected on the other crop parameters like the weight of 100 kernels, plant height, fresh and dry weight. The highest grain yield was obtained by application of salicylic acid with control of irrigation water salinity, (866.49 g/plot). Moreover, the statistical analysis indicated that there was interaction between the salinity of irrigation water and foliar application of salicylic acid.

It is evident that foliar application of salicylic acid not only induced grain yield but also played an role in controlled salinity tolerance in maize plants.

Key words: Chlorophyll content, irrigation of saline water, maize, salicylic acid, soil salinity and *Zea mays L.*,

INTRODUCTION

Ionic stress is the creator of ion toxicity causes a large amount of salt enter the plant and it will be damaged. Na^+ stress, disrupt K^+ uptake by the root cells. Salinity has a negative effect on nutrient balance in the cell (hasegava *et al.,* 2000). Water deficiency and salinity are the two main environmental factors reduce crop production. Soil and water salinity is the major factors may limit the crop production (jamil *et al.*, 2006). Soil salinity inhibits the plant growth and yields. It may cause plant death in hot and dry regions. (Melony *et al., 2004*). Salinity is one of the environmental factors limiting soil fertility and plant production in arid and semiarid regions (Ghassemi *et al.*, 1995; Silveira *et al.*, 2001; More *et al.*, 2004; Khan and Panda, 2008). Salinity-specific effects on plants are accelerated over time and by the extent of ions accumulation, which eventually rise to toxic level and impose an additional stress on physiological and biochemical processes in plant cells (Munns, 2002). Under stress conditions such as salinity, drought and low and high temperatures, plants produce reactive oxygen species (free radical), which are harmful to plant growth and productivity. Reactive oxygen species deteriorates membrane function (Mishra and Choudhuri, 1999). Reactive oxygen limits NO_3^- uptake, damages membrane lipids, proteins and nucleic acids under saline conditions (Silveira *et al.*, 2001). Salicylic acid as an internal regulator hormone has significant effects on different aspects of plant life such as plant growth, photosynthesis, absorption and ion transfer. Salinity increased sodium in leaf and root, SA increased sodium in leaf and reduced it in root .Salinity reduced root and leaf potassium but, SA increased it.

The chlorophyll plays a very important role in building the plant. Chlorophyll absorbs light energy used in biosynthesis. The chlorophyll content reflects the biochemical reaction intensity and the formation of all substances especially the carbohydrates. Storage of starch in grains relates directly to the chlorophyll content. Shoot dry weight, stem length, number of

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leaves, leaf area and chlorophyll content of maize were affected negatively and significantly by increasing salinity gradually up to 12 dS/m. The Increase of SA concentration up to 200 ppm improved the perviofus maize parameters (Farahbakhsh and Shamsaddin Saiid 2010).

Abd-El Baki *et al.*, (2000) reported that nitrate reductase (NR) activity and NR-mRNA were both reduced by salt stress in maize seedlings. Salicylic acid (SA) plays an important role in abiotic stress tolerance, and more interests have been focused on SA due to its ability to induce a protective effect on plants under adverse environmental conditions. Salicylic acid controls salinity tolerance in wheat (Shakirova and Bezrukova, 1997; Sakhabutdinova *et al.*, 2003), osmotic stress (Singh and Usha, 2003), mineral nutrition and oxidative stress (Gunes *et al.*, 2007). Salicylic acid appears as a signal molecule or chemical messenger and its role in defense mechanism has been well established in plants (Klessing and Malamy, 1994; Gunes *et al.*, 2007). Shruti and Singh (2009) showed that salt induced deleterious effects in maize seedlings were significantly eliminated by the pretreatment of SA. It is concluded that 0.5 mM salicylic acid improves the adaptability of maize plants to NaCl stress. Gunes et al., (2007) reported that SA could be used as a potential growth regulator to improve plant salinity tolerance.

Salt tolerance has been found to be positively associated with a more efficient antioxidant system (Mittler, 2002). SA has a role in abiotic stress tolerance such as drought tolerance in wheat (Singh and Usha, 2003), and salt tolerance in wheat (Sakhabutdinova *et al.*, 2003; Shakirova et al.,2003). Németh et al. (2002) reported that exogenously applied SA through the rooting medium caused growth inhibition of maize.

Salicylic acid (SA) is an endogenous growth regulator of phenolic nature, which participates in the regulation of physiological processes in plants. The SA, for example, plays a role of natural inductor of thermogenesis in Arum lily, induces flowering in a range of plants, controls ion uptake by roots and stomata conductivity (Raskin, 1992).

The objective of the current study is to specify the optimum salicylic acid rate that maximize the maize production and ameliorate adverse effects of saline irrigation water.

MATERIALS AND METHODS

The study was conducted at the Soil Salinity Lab., Alex., on an sandy loam soil with maize grown to maturity. Grain of maize cultivar (single-cross 10) was obtained from Crops Research Institute, Agricultural Research Center, Egypt.The experiments were set up at the summer seasons of 2011 and 2012 to investigate the effect of three levels of salicylic acid (SA) (0, 100 and 200 mg kg^{-1}) and water salinity levels (S) (390,1750 and 3500 mg kg^{-1}) on maize yield and yield components.

Soil samples were taken, air-dried and sieved < 2 mm before chemical analysis. The soil paste extract was analyzed for pH, ECe, soluble cations and anions and mechanical analysis was carried out according to Richards, (1954) and Chapman and Pratt, (1978). Total Ca CO_3 was determined as mentioned by Black (1965). The soil used is sandy loam in texture with particles size distribution is 74.0% sand, 10.4 % silt and 15.6% clay. The chemical properties of the used soil are presented in Table (1).

The experimental design was split plot design with four replicates. The experimental unit was a cemented plot with a dimension of 150 x 75 with an area of 1.125 m^2 each. The grain were sowing in first of May, 2011. Each plot received calcium super phosphate 15.5% P_2O_5 at a rate of 100 kg/faddan, potassium sulfate 48% K_2O_4 at a rate of 50 kg/feddan and three doses of ammonium sulfate 20.5% at the rate of 150 kg N/ feddan of N. The first dose of N was added at sowing, the second at the first irrigation, and the third at the second irrigation.

The SA was initially dissolved in a few drops of Dimethylsulfoxide and the final volume was reached by adding distilled water, then the pH was adjusted at 6-7 by Na OH (1.0N). SA solutions were sprayed twice on the leaves in the early morning when the plants had their fourth leaf and two weeks later. The saline water treatments were initiated in amount approximately equal to field capacity plus that required achieving leaching fraction of 40 % to avoid salt accumulation in the plot. The grain yield (g/plot), the weight of 100 kernels (g) and yield component were determined at the end of the experiment. The chlorophyll content was determined according to Daughtry *et al* (2000).

The data was subjected to statistical analysis using SAS computer software, (SAS 1985). The mean values were compared with the least significant difference test (LSD).

Table 1. Main characteristics of the studied soil at surface layer, (0 - 30 cm)

pH	EC	Soluble cations (meqll)				Soluble anions (meqll)				Ca Co_3 %
	dS/m	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	
7.53	1.82	3.5	1.5	12.5	0.34	-	2.80	14.50	3.30	2.3

Table 2. Chemical parameters of the used water samples

Water	pH	EC dS/m	Soluble cations (meqll)				Soluble anions (meqll)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Tap water	7.6	0.62	2.20	1.73	2.75	0.18	-	3.55	2.11	1.2
Well water	7.8	5.44	1.8	2.4	48.0	3.9	-	2.9	32.0	13.9

RESULTS AND DISCUSSION

Soil Salinity:

Table (3) and Fig. (1) illustrate the effect of saline irrigation water on the ECe of used soil. The results indicated that the saline irrigation water having EC_w of 390, 1750, and 3500 mg kg^{-1} significantly increased the ECe of sandy soil to 1152, 2144 and 3680 mg kg^{-1}, respectively. This increase was almost proportional to the EC_w of irrigation water, These results agree with the values obtained by Sobh *et al*.(1997) and El Etreiby (2002). The relative cations composition of the saturation paste extract, which is indicative of soil solution, was altered by saline irrigation water application. Moreover, the excess salts associated with irrigation saline water have a confounding influence on the K, Na and their balance in the soil. The dominant cation was sodium and the sodium adsorption ratio (SAR) increased from 7.57 to 11.31 for sand loamy soil by increasing EC_w from 390 to 3500 mg kg^{-1}.

The Grain Yield:

The results indicated that salinity of irrigation water strongly and significantly affected the grain yield (Table 4). Increasing the salinity of irrigation water to 1750 mg kg^{-1} decreased the grain yield one third of that maximum yield obtained with the tap water as control (320 mg kg^{-1}). Moreover, with the higher salinity3500 mg kg^{-1} the yield decreased to less than the half of the maximum yield (Table 4). These results were in agreement with that reported by Hasegava *et al.* (2000) and Jamil *et al.* (2006).

On the other hand, foliar application of salicylic acid at rates of 100 and 200 mg kg^{-1} increased the grain yield 28.8% and more than 50% of the maximum yield values, respectively. Statistical analysis (ANOVA) demonstrated the high significant effect of factors, salinity of irrigation water as main factor and the salicylic acid as sub main factor, where there was no interaction as presented in Table (5). Figure (1) cleared the negative effect of irrigation water salinity and the positive effect of added salicylic acid concentration on the grain yield of maize. This result coincided with the result reported by Shruti and Singh (2009).

The Weight of 100 Kernels:

The weight of 100 kernels was a good parameter reflected the degree of the activity of the biological processes create different substances, in other words it expressed the quality of the production. Table (6) and Fig. (2) illustrate the effect of saline irrigation water at different addition of salicylic acid treatments expressed in mg kg^{-1} and tap water as a control on the weight of 100 kernels.

The obtained results demonstrated significantly reduced the weight of 100 kernels as affected by increasing salinity of irrigation water. The increasing of salinity level to 1750 and 3500 mg kg^{-1} decreased the weight of 100 kernels by 15% and 21% of the maximum yield, respectively. The addition of salicylic acid increased slightly the weight of 100 kernels with the tap water as control. With the saline water 1750 and with highest 3500 mg kg^{-1} the effect fluctuated and did not show a certain trend. In general, addition of salicylic acid was not effective. Statistical analysis as shown in table (7) supported those results. Moreover, the statistical analysis showed that there was no interaction between the salinity of irrigation water as a main factor and the salicylic acid foliar sprayed.

The Total Chlorophyll Content:

Effects of the irrigation water salinity and salicylic acid treatments on the chlorophyll content were shown in Table (8). Salinity of irrigation water did not show a significant effect on the chlorophyll content. This results disagree with that reported by (Farahbakhsh and Shamsaddin Saiid 2010). This may be due to they used higher salinity levels up to 12.0 dS m^{-1}. Agreement was obvious with the addition of salicylic acid. Salicylic acid showed a strong positive significant effect on the chlorophyll content. There was no interaction between salinity of irrigation water and salicylic acid as shown in table (9).The application of 100 mg kg^{-1} of SA showed more positive effect with the lower salinity of irrigation water 1760 than the higher salinity 3500 mg kg^{-1}, (Table 8 and Figure 3).

The Ear Weight:

Ear is considered as the fruit of the maize plant, and the weight of it as a crop parameter is too important because it is so closed to the quantity and quality of grains. The statistical analysis cleared that the two studied factors, salinity of irrigation water and foliar spray of salicylic acid significantly affected the ear weight (Table 10). While the salinity of irrigation water decreased the ear weight, the salicylic acid increased it and there was no interaction between them. Increasing of the salinity of irrigation water to 1750 and 3500 mg kg^{-1} decreased the ear weight to 47.3 and 60.8 % of the maximum grain yield recorded by the tap water as control, respectively (Table 10). On the other hand, the foliar spray of 100 and 200 mg kg^{-1} of salicylic acid increased the ear weight by 15.6 and 72.5 % of the maximum yield recorded by the tap water, respectively (Table 10 and figure 4).

The Plant Height (cm), Fresh and Dry Weight, (g):

The crop parameters like plant height, fresh and dry weight were measured and listed in Tables (12), (14) and (16), respectively. The statistical analysis (ANOVA) for the previous parameters were listed in Tables (13),(15) and (17), respectively. The two studied factors salinity of irrigation water and salicylic acid addition did not show any effect on those parameters except for the plant height that was significantly affected by the salinity of irrigation water only. It can be concluded that the use of saline water EC_w 3500 mg kg^{-1} or more in irrigated agriculture cannot be sustained. The soil salinity status on the long run might increase to undesirable levels as a result of high salt waters. But saline water EC_w 1750 mg kg^{-1} that had SAR 8.23 can be sustained under the study conditions. The excess salts associated with irrigation saline water have a confounding influence on the K, Na and their balance in the soil. It is evident that foliar spray salicylic acid not only induced physiological and biochemical changes but also played an important role in a biotic stress tolerance, and controlled salinity tolerance in maize plants.

Table 3. Main characteristics of the studied soil at end of experiments,(surface layer, (0 - 30 cm)

EC_w	pH	EC dS/m kg^{-1}	Soluble cations (meqll)				Soluble anions (meqll)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
S0	7.53	1.82	3.95	1.50	12.50	0.3 4	-	2.80	10.50	4.99
S1	7.66	3.35	5.67	5.00	19.00	0.37	-	3.55	14.50	11.99
S2	7.80	5.75	10.09	12.50	38.00	0.39	-	2.90	15.00	13.90

Table 4. Effect of the irrigation water salinity and salicylic acid treatments on the grain yield of maize (g/plot)

	Salicylic aced treatents				
Salinity treat.	SA0	SA1	SA2	Mean	L.S.D.
S0	630.10	816.97	866.49	771.19	
S1	427.65	474.72	632.40	511.59	
S2	243.78	384.88	463.63	364.10	60.84
MEAN	433.84	558.86	654.17		
L.S,D,		52.71			

Table 5. Analysis of variance for the grain yield data

S.O.V	df	SS	MS	F
Rep.	3	125914.71		
Salinity	2	1019467.43	509733.71	52.00 **
Error (salinity)	6	58595.49	9765.92	
SA	2	293031.56	146515.78	40.48 **
Salinity x SA	4	22564.38	5641.09	1.56
Error (b)	18	65154.15	3619.67	
Total	35	1584727.72		

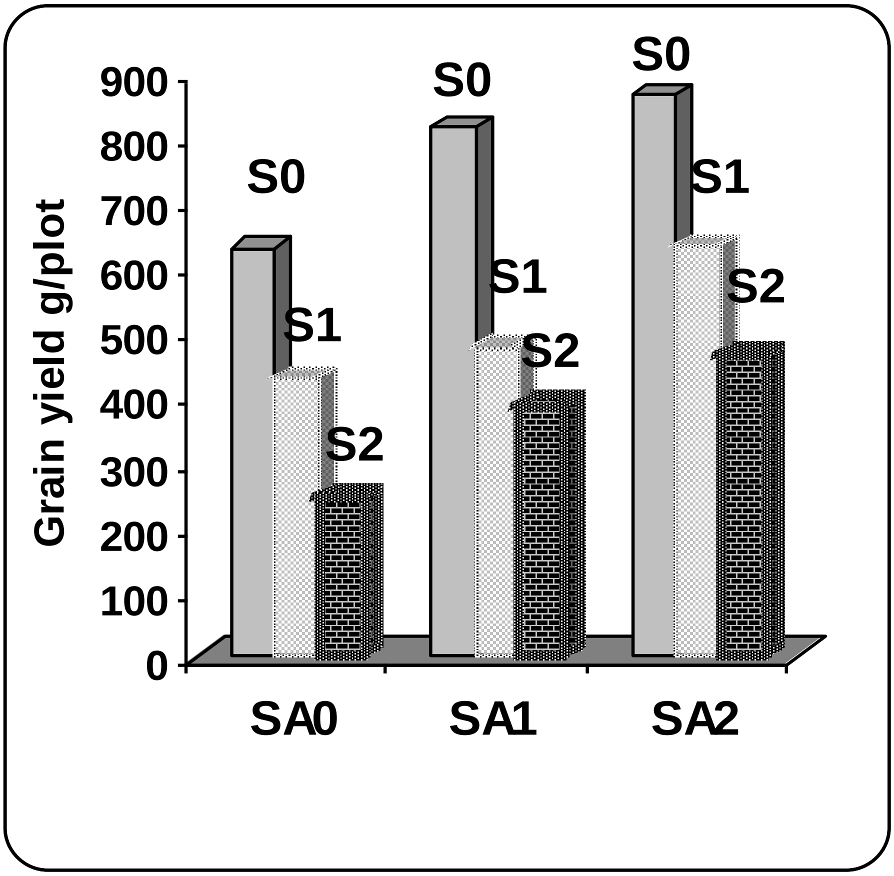

Figure 1. Effect of the irrigation water salinity (S0, S1 and S2) and salicylic acid treatments (SA0, SA1 and SA2) on the grain yield of maize (g/plot)

Table 6. Effect of the irrigation water salinity and salicylic acid treatments on the weight of 100 kernels of maize (g)

	Salicylic aced treatents				
Salinity treat.	**SA0**	**SA1**	**SA2**	**Mean**	**L.S.D.**
S0	25.48	26.52	28.76	771.19	4.72
S1	23.99	22.03	22.91	511.59	
S2	18.09	22.92	21.92	364.10	
MEAN	22.52	23.82	24.53		
L.S,D,		4.037			

Table 7. Analysis of variance for the data of 100 kernels weight

S.O.V	df	SS	MS	F
Rep.	3	57.35		
Salinity	2	219.39	109.69	38.12 **
Error (salinity)	6	17.26	2.88	
SA	2	25.04	15.52	0.58
Salinity x SA	4	27.40	14.30	0.66
Error (b)	18	391.33	21.74	
Total	35	737.77		

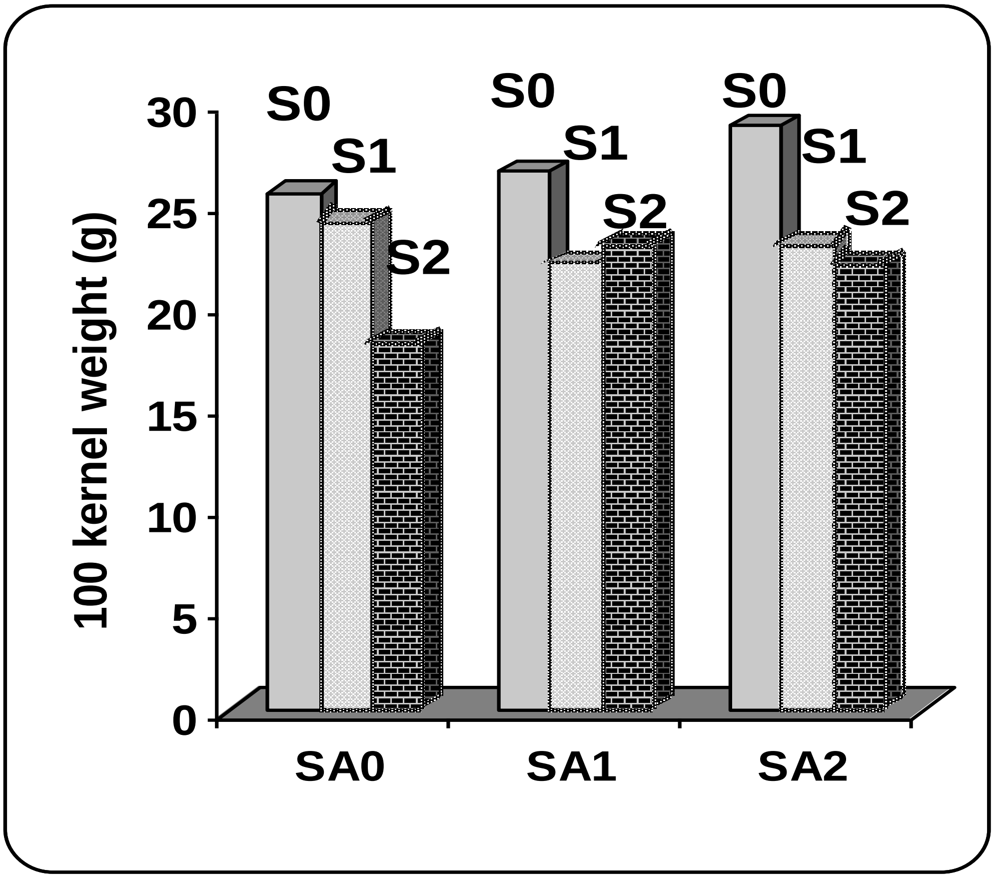

Figure 2. Effect of the irrigation water salinity (S0, S1 and S2) and salicylic acid treatments (SA0, SA1 and SA2) on the weight of 100 kernels of maize (g)

Table 8. Effect of the irrigation water salinity and salicylic acid treatments on the total chlorophyll content (mg/100g)

	Salicylic aced treatents				
Salinity treat.	**SA0**	**SA1**	**SA2**	**Mean**	**L.S.D.**
S0	235.38	308.00	342.84	295.41	
S1	249.49	320.32	339.95	303.25	
S2	281.78	293.16	309.94	294.96	23.53
MEAN	255.55	307.16	330.91		
L.S,D,		20.14			

Table 9. Analysis of variance for the total chlorophyll content data

S.O.V	df	SS	MS	F
Rep.	2	22.18		
Salinity	2	391.28	195.64	0.08
Error (salinity)	4	9583.24	2395.81	
SA	2	26723.24	13361.86	32.9 **
Salinity x SA	4	6105.04	1526.26	3.67 *
Error (b)	12	4874.24	406.19	
Total	26	47699.22		

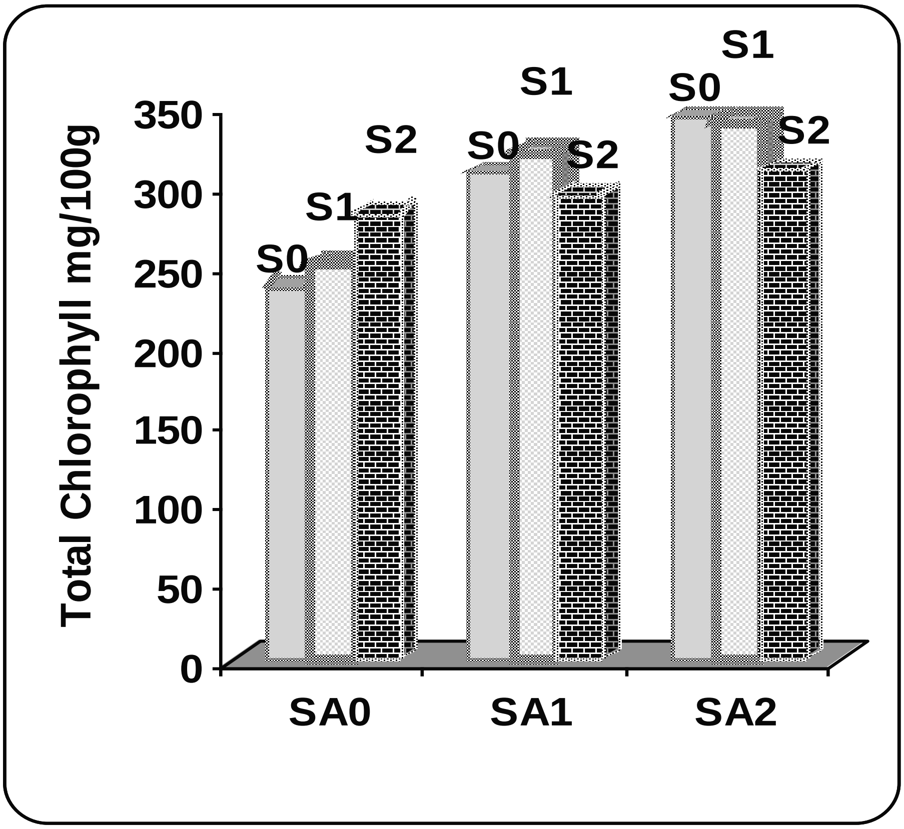

Figure 3. Effect of the irrigation water salinity (S0, S1 and S2) and salicylic acid treatments (SA0, SA1 and SA2) on the total chlorophyll content (mg/100g)

Table 10. Effect of the irrigation water salinity and salicylic acid treatments on the Ear weight of maize, (g)

	Salicylic aced treatents			
Salinity treat.	**SA0**	**SA1**	**SA2**	**Mean**
S0	128.34	151.17	193.06	157.52
S1	75.89	86.67	127.35	96.64
S2	55.21	63.37	110.00	76.19
MEAN	86.48	100.40	143.47	
L.S,D,		21.9		

Table 11. Analysis of variance for the ear weight data

S.O.V	df	SS	MS	F
Rep.	3	5299.16	1766.4	
Salinity	2	42956.53	21478.27	129.71**
Error (salinity)	6	993.55	165.59	
SA	2	21187.89	10593.92	16.54**
Salinity x SA	4	316.97	79.24	0.12
Error (b)	18	11529.45	640.52	
Total	35	82283.51		

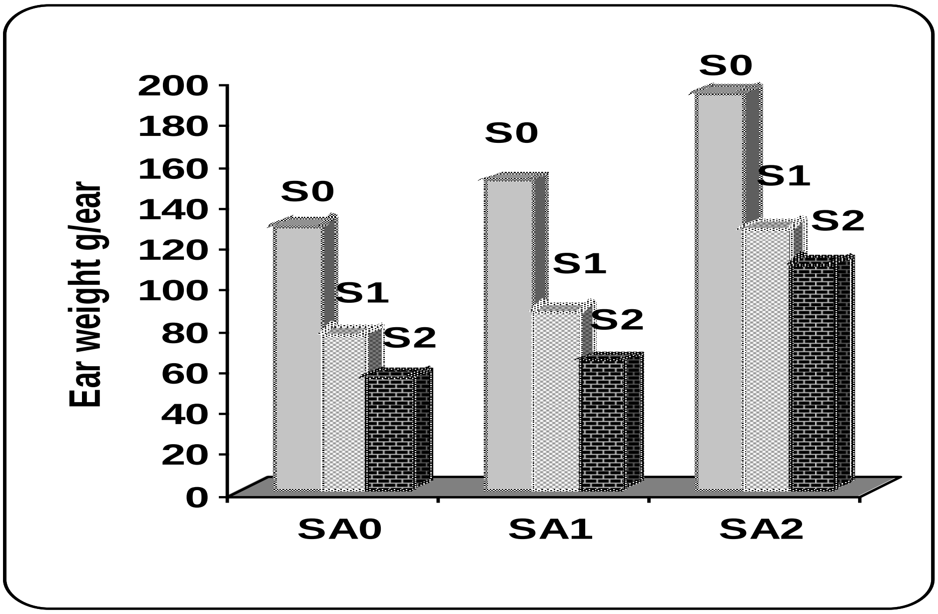

Figure 4. Effect of the irrigation water salinity (S0, S1 and S2) and salicylic acid treatments (SA0, SA1 and SA2) on the ear weight, (g)

Table 12. Effect of the irrigation water salinity and salicylic acid treatments on the maize plant height (cm)

	Salicylic aced treatents				
Salinity treat.	**SA0**	**SA1**	**SA2**	**Mean**	**L.S.D.**
S0	176.50	194.75	187.75	186.33	
S1	164.50	182.50	176.75	174.58	
S2	164.00	168.25	160.00	164.08	15.22
MEAN	168.33	181.83	174.83		
L.S,D,		13.02			

Table 13. Analysis of variance for the plant height data

S.O.V	df	SS	MS	F
Rep.	3	2489.67	1432.9	
Salinity	2	2973.50	1485.75	11.31*
Error (salinity)	6	788.50	131.42	
SA	2	1094.00	547.00	2.42
Salinity x SA	4	396.5	99.13	0.44
Error (b)	18	4074.83	226.38	
Total	35	13626.00		

Table 14. Effect of the irrigation water salinity and salicylic acid treatments on the fresh weight of maize, (g)

	Salicylic aced treatents				
Salinity treat.	**SA0**	**SA1**	**SA2**	**Mean**	**L.S.D.**
S0	435.00	555.00	573.75	521.25	
S1	440.00	490.00	515.00	481.67	
S2	438.75	452.50	435.00	442.08	67.43
MEAN	437.92	499.17	507.92		
L.S,D,		65.417			

Table 15. Analysis of variance for the fresh weight data

S.O.V	df	SS	MS	F
Rep.	3	114866.67		
Salinity	2	37604.17	18802.02	3.62
Error (salinity)	6	31162.50	5193.75	
SA	2	34912.5	17456.25	3.06
Salinity x SA	4	22770.83	5692.71	1.00
Error (b)	18	102833.33	5712.96	
Total	35	344150.00		

Table 16. Effect of the irrigation water salinity and salicylic acid treatments on the dry weight of maize (g)

	Salicylic aced treatents				
Salinity treat.	**SA0**	**SA1**	**SA2**	**Mean**	**L.S.D.**
S0	77.73	98.00	100.99	92.24	21.24
S1	72.35	84.83	85.70	80.96	
S2	81.16	81.67	73.41	78.75	
MEAN	77.08	88.17	86.70		
L.S,D,		18.18			

Table 17. Analysis of variance for the dry weight data

S.O.V	df	SS	MS	F
Rep.	3	1679.34		
Salinity	2	1256.70	628.35	2.01
Error (salinity)	6	1878.00	313.00	
SA	2	870.66	435.33	0.99
Salinity x SA	4	1027.82	256.95	0.58
Error (b)	18	7943.30	441.29	
Total	35	14655.82		

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الملخص العربي

تأثير معاملات الرش بحامض السلسليك والرى بمياه ملحية على ملوحة الارض وإنتاجية نبات الذرة

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تم تنفيذ التجربة تحت الصوبة الزجاجية بمعمل بحوث الأراضى الملحية والقلوية بالإسكندري لدراسة تاثير الرش بحمض السلسليك على انتاجية نبات الذرة(صنف هجين فردى 10) تحت الرى بمياة ملحية.

واشتملت الدراسة على ثلاث تركيزات من حمض سلسليك هى صفرو100و200 مليجرام/كجم وثلاث تركيزات مياة ملحية (EC_w) هى1750و3500ملليجرام/كيلوجرام حيث تم تخفيف مياة بئر ملحية بماء الصنبور للحصول على التركيزات السابقة إلى جانب ماء الصنبور للمقارنة. قدرت بعض خواص الارض ومحصول الذرة وبعض مكوناتة ومحتوى الكلوروفيل وتم تحليل النتائج احصائيا.

أوضحت النتائج ان تاثير الرى بالمياة الملحية(EC_w) 1750و3500 ملليجرام/كجم ادى الى زيادة التوصيل الكهربائى النهائى للارض الطميية الرملية(EC) الى 2144 و3680 ملليجرام/كجم على التوالى مقارنة مع القيمة الاصلية 1152 ملليجرام /كجم. حيث ان التوصيل الكهربائى للارض(EC) كان دائما متناسب طرديا مع التوصيل الكهربائى لمياة الرى(EC_w).

أوضحت النتائج ايضا ان الرى بالمياة الملحية(EC_w) خفض معنويا محصول الحبوب ووزن المائة حبة وأيضا وزن كوز الذرة وارتفاع النبات بينماالوزن الرطب والجاف بالاضافة الى المحتوى من الكلوروفيل لم تتاثر معنويا.

اوضحت النتائج التأثير الإيجابى المعنوى لمعاملات الرش بمحاليل حمض السلسليك على محصول الحبوب حيث اضافتة بمعدلات 100و200 مليجرام/كجم زادت محصول الحبوب 28.8وزيادة عن50% من المحصول الرئيسى على التوالى. الاضافة ادت الى تأثير تدريجي موجب على محصول الحبوب ومحتوى الأوراق من الكلوروفيل وكذلك وزن الكوز بينما لم تؤثر معنويا على وزن المائة حبة ووزن النبات الكلى والجاف وارتفاع النبات. وتم الحصول على اعلى محصول للحبوب باضافة حامض السلسليك مع معاملة الكنترول لملوحة مياة الرى(866.49جرام/حوض).على الرغم من أن التأثير السلبى للملوحة(EC_w) على محتوى الكلوروفيل لم يكن معنوياً إلا أن النتائج أظهرت تفاعلاً معنوياً بين ملوحة مياه الرى والرش بحمض السلسيلك, فى حين لم يظهر هذا التفاعل فى أى من الخصائص المقاسة. ويمكن القول ان معاملات الرش بحمض السلسليك لم تحفز محصول الحبوب فقط ولكن ايضا تلعب دورا فى التحكم فى مقاومة نبات الذرة للملوحة.