The Impacts of Silicon and Salicylic Acid Amendments on Yield and Fruit Quality of Salinity Stressed Tomato Plants

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ABSTRACT

Two pot experiments were conducted during the two successive seasons of 2015 and 2016 at the Experimental Farm; Faculty of Agriculture; Damanhour University. The aim of this study was to monitor the alleviating effects of silicon (Si) as a soil application in concentrations of (0, 200and 400 mg kg^{-1} soil) and salicylic acid (SA) as a foliar application in concentrations of 0, 50 and 100 ppm in addition to their combinations on yield and fruit quality of tomato plants (cv. El-Basha 1077) irrigated with saline water at different salinity levels (0, 4, 8 and 12 ds m^{-1} using NaCl). The results of the two seasons revealed that the salinity treatments resulted in decreasing in the mean values of all yield traits. However, the mean values of all fruit quality parameters, in both seasons. Application of either Si or SA gave higher mean values for yield and its components as well as the quality traits, in both seasons. Moreover, the results revealed that the combined treatment of Si at the rate of 400 mg kg^{-1} soil with SA (50 ppm) gave the best ameliorative effect for all the studied characters of tomato plants grown under the highest salinity level of 12 dsm^{-1}, in both seasons. The average increment percentages of such treatment over the control under the highest salinity level of both seasons were 121.98, 32.69, 42.71, 192.71, 22.35, 24.83, 39.17 and 66.50% for number of fruits plant^{-1}, fresh fruit weight, dry fruit weight, fruits yield plant^{-1}, fruits TSS, Acidity, vitamin C and lycopene contents, respectively.

Keywords: salinity, tomato, silicon, salicylic acid, fruit quality

INTRODUCTION

Egypt is a country with about 5000 years of experience in irrigation. Nevertheless, the country‘s economy suffers from severe salinity problems due to irrigation with low quality water and poor drainage systems.About 33% of the cultivated land are already salinized (Mohamed *et al.*, 2007).Over coming salt stress becomes the main issue in these regions to secure adequate crop productivity.Among the various compounds which employed for regulating plant growth and productivity, silicon (Si) and salicylic acid (SA) are, also, involved in establishing plants defense mechanisms to confronting various abiotic and biotic stresses (Ma, 2004 and Liang *et al.*, 2005).

The ability of (Si) to mitigate stresses that associated with salinity in plants is well documented(Ma, 2003 ; Malhotra et al., 2016); it could be physiologically by controlling many enzymes activities, inhibiting H_2O_2 activity and enhancing photosynthetic rate (Al-Aghabary et al., 2005)or controlling each of K^+ and Na^+ uptake and balance (Yeo et al., 1999 and Liang et al., 2005) as well as increasing the plant cell walls components i.e., lignin, cellulose and pectin (Emam*et al*., 2014). Hence, Si has vital importance for better plant growth under salinity (Tahir et al., 2006).

Salicylic acid (SA) is considered as multiple abiotic stress tolerance agent (Senaratna et al., 2000). Exogenous application of (SA)to plants can affect their salt tolerance through participating in the regulation of many plant physiological processes such as ion uptake,cell membranes permeability and photosynthetic rate and content(Barkosky and Einhellig, 1993; Khan et al., 2003;Gunes *et al*., 2005; Stevens et al., 2006 and Mimouni et al., 2016) as well as increasing the total antioxidant enzymes activity (Eraslan et al., 2007).Concerning tomato crop, the SA application resulted in enhancement of quantity and quality characters of tomato yield (Javaheri et al., 2012). However, Mady (2009) reported that the foliar application of SA at 50 ppm with vitamin E has significant and favorable effect on early, total yield and fruits quality parameters of tomato compared with using 100 ppm of SA.Such favorable effects on plants growth and yield could be due to the role of SA in influencing the balances of plant hormones such as auxin, cytokinin and ABA under both normal and saline conditions (Shakirova, 2007)

The aim of this study was to monitoring the alleviating effects of silicon (Si) salicylic acid (SA) in addition to their combination on tomato plants cv. El-Basha 1077 irrigated with different water salinity levels.

MATERIALS AND METHODS

Two pot experiments were carried out at the Experimental Farm, Faculty of Agriculture, Damanhour University. Tomato cv. El-basha 1077 was transplanted on 7th of June and 26th of May in 2015 and 2016 seasons, respectively. The experimental layout was RCBD in a split-plot arrangementwith three replications. Randomly, salinity treatments (control, 4, 8 and 12 ds/m; using NaCl) were randomly distributed in the main plots; whereas, the foliar application of salicylic acid at three levels; 0, 50, 100 ppm namely; control, SA_1 and SA_2, they applied three times with 10-

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days interval one week after transplanting, soil application of silicon at three levels applied before transplanting; 0, 200, 400 mg/kg soil; as K_2SiO_3 namely; control, Si_1 and Si_2 and the combined treatments were distributed in the sub-plots. Four weeks old tomato seedlings were transplanted in plastic pots of 35 cm inner diameter filled with 15 kg of sandy loam soil. Fertilization and other agricultural practices were applied as commonly recommended in commercial tomato production.

The measured yield characters were fruits number plant^{-1}, average fruit fresh and dry weights (gm) and fruits yield plant^{-1}. While the tomato fruits quality traits were TSS (°Brix) using hand refractometer, fruits titratable acidity (%), vitamin C (mg/100 g f.w.) and fruit lycopene (mg/100 g f.w.) that were estimated as described by Ranganna (1986). Statistical analysis of the obtained data and comparing means were done using CoStat program (Version 6.4, CoHort, USA, 1998–2008).

RERSULTS AND DISCUSSION

Irrigation with saline water resulted in significant negative effects on the traits of Table 1, in both seasons. The mean values of the studied traits were decreased generally in a stepwise fashion with increasing salinity level. As an average of the two experimental seasons, the highest salinity level (12dsm^{-1}) gave the most reduction percentage offruits No. plant^{-1}by 47.16%,average fruit fresh weight by 34.80%, average fruit dry weight by 51.18% and fruits yield plant^{-1} by 65.08%, compared with control treatment.These findings, generally, are coincided with those reported by Del Amor *et al.*(2001); Magan *et al.*(2008); Ali and Ismail(2014) and Rodriguez-Ortega *et al*. (2017) who stated that negative reduction in tomato yield and its components due to salinity stress. The general reduction in tomato yield and its components could be derived from the negative relationship between salinity and each of growth and photosynthetic rate (Mozafariyan *et al*., 2013). Suchdecline in tomato yield probably wasconsequential result of the reduction of average fruit weight and fruits No. plant^{-1} (Cuartero and Fernandez-Munoz, 1999).

In the contrary, water salinity treatments reflected significant effects on tomato fruits quality traits. Comparisons among the means in Table 2 showed that increasing salinity was associated with increasing TSS, acidity, V.C. and lycopene contents of tomato fruits in both seasons. Application of the highest saline water level (12 dsm^{-1}) caused in 38.46%, 35.01%, 32.51% and 78.50%, increments relative to the control, in TSS, acidity, V.C. and lycopene content of tomato fruits, respectively, as an average of both seasons. These increments in quality characters of tomato fruits that irrigated with saline waster could be interpreted as plant defense mechanisms for confronting the resulted oxidative stress and counterbalancing the cells osmotic pressure (Türkan and Demiral, 2009). These findings could explain the positive relationship between salinity levels and tomato quality parameters which was found by Del Amor et al. (2001); Magan et al. (2008) and Ali and Ismail (2014).

The results in Tables 1 and 2, also, clarified favorable effect of the amendment treatments of Si andSA on tomato yield and fruit quality traits regardless the used salinity level. The results revealed that the treatment of Si_2+SA_1 showed significant superiority effect on yield and quality of tomato fruit comparing with the other amendment treatments including the control, in both seasons.As an average of both seasons in Table 1, the Si_2+SA_1 treatment gave increment percentages over the control estimated by 84.69, 33.98, 45.66 and 145.44% for number of fruits plant^{-1}, average fruit fresh weight, average fruit dry weight and fruits yield plant^{-1}, respectively.Also, Irrespective of the salinity level, the average of two seasons increment percentages of Si_2+SA_1 treatment over the control were 23.70, 28.80, 36.07 and 56.08% for TSS, acidity, V.C. and lycopene content, respectively (Table 2).

Concerning the interaction effect between salinity levels and amendment treatments (Tables 1 and 2), the results showed significant interaction between the two factors of study for all the studied characters, in both seasons. Moreover, the interaction means comparisons showed that Si_2+SA_1 treatment gave the highest significant mean values comparing with the other interaction combinations, in both seasons.

When tomato plants irrigated with the highest salinity level (12 dsm^{-1}),the average fruits yield plant^{-1} (192.71%) and number of fruits plant^{-1} (121.98%) were more pronounced in Si_2+SA_1 treatment over the control. However, the increment average fruit fresh weight and average fruit dry weight were lesser as 32.69% and 42.70%, respectively. Whereas, under the same interaction combination (Si_2+SA_1 with 12 dsm^{-1} salinity level, the average increment percentages were estimated by 22.35, 24.83, 39.17 and 66.50% for TSS, acidity, V.C. and lycopene content, respectively.

The superiority of this combined treatment might be derived from the existence of some kind of synergistic relation between Si_2 and SA_1 that resulted in increasing the components of tomato yield and fruit quality. Stamatakis et al. (2003); Yildirim and Dursun (2008),Toresano-Sanchez et al. (2012), Jarosz (2014)Baninaiem et al. (2016);Korkmaz et al. (2017)

Table 1.Effect of salinity withSi and SA and their interactions on fruits No. plant^{-1}, average fruit fresh and dry weights and fruits yield plant^{-1} of tomato, c.v.El-Basha1077, during 2015 and 2016 seasons

Amendments applications	Salinity levels (ds/m)									
	First season				Mean	Second season				Mean
	0	4	8	12		0	4	8	12	
					Fruits number plant^{-1}					
Control	6.00 h-j	5.33 j-l	4.33mn	3.00 o	4.67 E	6.33 i-k	5.33 l-n	4.33 o-q	2.67 t	4.67 G
Si_1	6.67 gh	6.33 hi	5.33j-l	3.67 no	5.50 D	7.33 f-h	6.00 j-l	5.00 m-o	3.00 st	5.33 F
Si_2	9.33 bc	8.33 de	7.67ef	6.33 hi	7.92 B	9.67 b	8.33 c-e	6.33 i-k	4.33 o-q	7.17 B
SA_1	9.33 bc	8.00 d-f	7.33 fg	5.67 i-k	7.58 B	8.67 cd	7.67 e-g	6.00 j-l	4.00 p-r	6.58 C
SA_2	6.33 hi	5.67 i-k	4.67 lm	3.33 o	5.00 E	6.67 h-j	5.67 k-m	4.67 n-p	2.67 t	4.92 G
Si_1+SA_1	7.67 ef	7.33 fg	6.33 hi	4.67 lm	6.50 C	8.00 d-f	7.00 g-i	5.67 k-m	3.67 q-s	6.08 D
Si_1+SA_2	6.67 gh	6.33 hi	5.33 j-l	3.67 no	5.50 D	7.33 f-h	6.33 i-k	4.67 n-p	3.33 r-t	5.42 EF
Si_2+SA_1	11.00 a	9.67 b	8.67 cd	7.33 fg	9.17 A	10.67 a	9.00 bc	7.33 f-h	5.33 l-n	8.08 A
Si_2+SA_2	7.33 fg	7.33 fg	6.33 hi	5.00 k-m	6.50 C	8.00 d-f	6.33 i-k	5.00 m-o	3.67 q-s	5.75 DE
Mean	7.81 A	7.15 B	6.22 C	4.74 D		8.07 A	6.85 AB	5.44 B	3.63 C	
					Average fruit fresh weight (gm)					
Control	43.29 f-i	40.79 j	34.54 n	29.15 p	36.94 G	47.89 gh	41.93 kl	36.18 pq	29.84 t	38.96 F
Si_1	45.34 de	42.92 g-i	37.78 kl	30.37 op	39.10 E	50.27 ef	44.94 ij	38.65 m-o	32.18 rs	41.51 D
Si_2	52.46 b	48.90 c	42.51 hi	36.17 lm	45.01 B	57.87 b	53.55 cd	43.80 jk	37.53 n-p	48.19 B
SA_1	51.85 b	48.34 c	41.81 ij	35.59 mn	44.40 B	58.65 b	54.16 c	43.26 jk	37.41 n-p	48.37 B
SA_2	44.19 efg	41.81 ij	36.00 mn	29.75 p	37.94 F	48.85 f-h	42.64 k	36.73 op	30.55 st	39.69 EF
Si_1+SA_1	46.28 d	44.06 e-h	38.87 k	31.81 o	40.26 D	53.68 cd	47.36 h	40.16 lm	33.99 qr	43.80 C
Si_1+SA_2	44.90 d-f	42.31 ij	37.80 k	30.49 op	38.88 E	49.85 e-d	42.79 jk	37.15 op	31.37 st	40.29 E
Si_2+SA_1	57.61 a	52.93 b	46.00 d	38.83 k	48.84 A	66.44 a	58.73 b	46.94 hi	39.44 mn	52.89 A
Si_2+SA_2	49.11 c	45.46 de	38.99 k	31.63 o	41.30 C	51.74 de	46.62 hi	40.04 lm	32.75 rs	42.79 C
Mean	48.34 A	45.28 B	39.37 C	32.64 D		53.92 A	48.08 B	40.32 C	33.90 D	
					Average fruit dry weight (gm)					
Control	5.17 ij	4.56 lm	3.56 p-r	2.71 s	4.00 F	5.55 e	4.57 h	3.65 lm	2.70 o	4.12 F
Si_1	5.95 ef	4.96 jk	3.81 n-p	2.81 s	4.38 D	5.92 d	4.87 g	3.86 j-l	2.83 no	4.37 D
Si_2	6.78 b	6.02 de	4.53 lm	3.53 qr	5.22 B	7.08 b	6.32 c	4.73 gh	3.58 m	5.43 B
SA_1	6.63 b	5.92 ef	4.45 m	3.46 r	5.11 B	7.14 b	6.23 c	4.68 gh	3.54 m	5.40 B
SA_2	5.47 h	4.78 kl	3.69 o-r	2.74 s	4.17 E	5.75 de	4.77 gh	3.74 k-m	2.73 no	4.25 E
Si_1+SA_1	6.23 cd	5.28 hi	3.97 n	2.93 s	4.60 C	6.34 c	5.26 f	4.06 ij	2.92 n	4.64 C
Si_1+SA_2	5.73 fg	5.04 ij	3.79 n-p	2.78 s	4.34 D	5.83 d	4.76 gh	3.80 kl	2.81 no	4.30 DE
Si_2+SA_1	7.66 a	6.63 b	4.93 jk	3.78 n-q	5.75 A	8.07 a	7.06 b	5.25 f	3.94 i-k	6.08 A
Si_2+SA_2	6.30 c	5.52 gh	3.90 no	2.82 s	4.63 C	6.23 c	5.13 f	4.11 i	2.92 no	4.60 C
Mean	6.21 A	5.41 B	4.07 C	3.06 D		6.43A	5.44 B	4.21 C	3.11 D	
					Fruits yield plant^{-1} (gm)					
Control	260.06 i-l	217.63 mn	149.90 p	88.23 r	178.96 E	301.72 gh	222.66 klm	157.05 p-r	80.14 t	190.39 G
Si_1	302.36 f-h	271.91 g-k	201.62 no	111.68 qr	221.89 D	367.42 e	269.83 hij	193.48 m-p	96.94 st	231.92 F
Si_2	489.88 b	407.65 c	326.05 ef	229.22 l-n	363.20 B	558.90 b	447.04 d	277.01 h-j	162.28 pq	361.31B
SA_1	485.75 b	386.72 cd	306.50 fg	201.78 no	345.19 B	508.01 c	416.08 d	259.58 i-k	149.65qr	333.33C
SA_2	280.14 g-j	236.88 k-n	167.96 op	99.41 r	196.10 E	324.95 fg	241.36 jkl	171.23 o-q	81.89 t	204.86G
Si_1+SA_1	354.69 de	323.16 ef	246.30 j-m	148.68 pq	268.21 C	427.88 d	331.22 e-g	227.56 k-m	124.49 rs	277.79D
Si_1+SA_2	299.10 f-h	267.96 h-k	201.55 no	112.34 qr	220.24 D	364.13 e	270.39 h-j	173.38 n-q	104.82st	228.18F
Si_2+SA_1	635.35 a	512.00 b	398.54 c	284.91 g-i	457.70 A	707.94 a	528.24 bc	344.03 ef	210.37 l-n	447.65A
Si_2+SA_2	360.17 de	333.13 ef	247.03 j-m	158.49 p	274.70 C	413.08 d	295.78 g-i	200.49 m-o	120.29 rs	257.41E
Mean	385.28 A	328.56 B	249.50 C	159.42 D		441.56 A	335.84 B	222.65 B	125.65 C	

* The mean values have the same letters are not significant at significance level of 5%

Table 2.Effect of salinity with Si and SA and their interactions on TSS, Acidity, V.C. and Lycopene of tomato fruits, c.v. El-Basha1077, during 2015 and 2016 seasons

Amendments applications	Salinity levels (ds/m)									Mean
	First season				Mean	Second season				
	0	4	8	12		0	4	8	12	
TSS (°Brix)										
Control	5.20 p	6.13 kl	7.00 g	7.40 f	6.43 G	5.40 t	6.80 mn	7.20 kl	7.93 e	6.83 F
Si_1	5.73 n	6.47 i	7.40 f	7.80 d	6.85 E	6.00 q-s	7.00 lm	7.60 f-i	8.53 cd	7.28 D
Si_2	6.33 ij	7.13 g	8.13 c	8.67 b	7.57 B	6.40 op	7.67 e-h	8.67 c	9.00 b	7.93 B
SA_1	6.27 jk	7.07 g	8.00 c	8.53 b	7.47 C	6.27 pq	7.47 h-k	8.33 d	8.60 cd	7.67 C
SA_2	5.40 o	6.27 jk	7.13 g	7.60 e	6.60 F	5.80 s	6.73 mn	7.33 i-k	7.67 e-h	6.88 F
Si_1+SA_1	6.00 lm	6.67 h	7.60 e	8.07 c	7.08 D	6.13 p-r	7.27 j-l	7.87 ef	8.40 cd	7.42 D
Si_1+SA_2	5.67 n	6.47 i	7.33 f	7.73 de	6.80 E	5.87 rs	7.00 lm	7.53 g-j	7.87 ef	7.07 E
Si_2+SA_1	6.47 i	7.60 e	8.67 b	9.27 a	8.00 A	6.67 no	8.33 d	9.13 b	9.47 a	8.40 A
Si_2+SA_2	5.93 m	6.67 h	7.60 e	8.13 c	7.08 D	6.13 p-r	7.20 kl	7.80 e-g	8.40 cd	7.38 D
Mean	5.89 D	6.72 C	7.65 B	8.13 A		6.07 D	7.27 C	7.94 B	8.43 A	
Acidity (%)										
Control	0.52 tu	0.61 qr	0.63 pq	0.72 g-k	0.62 E	0.53 r	0.61 o	0.67 lm	0.73 ij	0.63 G
Si_1	0.53 tu	0.67 l-o	0.71 h-l	0.77 ef	0.67 D	0.57 pq	0.65 mn	0.72 j	0.79 fg	0.68 E
Si_2	0.64 o-q	0.73 f-j	0.80 de	0.88 ab	0.76 B	0.67 lm	0.73 ij	0.79 fg	0.87 bc	0.76 B
SA_1	0.69 j-m	0.74 f-h	0.79 de	0.87 ab	0.77 B	0.66 lm	0.73 ij	0.81 ef	0.88 b	0.77 B
SA_2	0.50 u	0.63 pq	0.67 l-o	0.73 f-j	0.64 E	0.56 q	0.61 o	0.68 kl	0.77 gh	0.66 F
Si_1+SA_1	0.59 rs	0.68 k-n	0.73 f-j	0.83 cd	0.71 C	0.62 no	0.67 lm	0.73 ij	0.84 cd	0.72 C
Si_1+SA_2	0.55 st	0.65 n-q	0.70 i-m	0.75 fg	0.66 D	0.57 pq	0.62 no	0.70 jk	0.79 fg	0.67 EF
Si_2+SA_1	0.69 j-m	0.74 f-h	0.85 bc	0.90 a	0.80 A	0.72 j	0.75 hi	0.84 cd	0.91 a	0.81 A
Si_2+SA_2	0.58 rs	0.67 l-o	0.73 f-j	0.80 de	0.70 C	0.60 o	0.65 mn	0.73 ij	0.81 ef	0.70 D
Mean	0.59 D	0.68 C	0.73 B	0.80 A		0.61 D	0.67 C	0.74 B	0.82 A	
V.C. (mg/100 g f.w.)										
Control	10.00 m	10.61 lm	12.12 ij	13.03 gh	11.44 G	10.00 l	11.21 jk	12.12 hi	13.33 d-f	11.67 F
Si_1	10.61 lm	12.12 ij	13.03 gh	13.94 ef	12.42 E	10.91 jk	12.12 hi	13.03 e-g	14.85 c	12.73 D
Si_2	12.42 hi	13.94 ef	15.15 d	16.97 b	14.62 B	12.73 f-h	13.94 d	15.45 c	16.97 b	14.77 B
SA_1	12.12 ij	13.64 fg	14.85 d	16.06 c	14.17 C	12.73 f-h	13.64 de	15.15 c	16.36 b	14.47 B
SA_2	10.61 lm	11.21 kl	12.42 hi	13.33 fg	11.89 F	10.61 kl	11.52 ij	12.42 gh	13.03 e-g	11.89 EF
Si_1+SA_1	11.52 jk	12.42 hi	13.94 ef	15.15 d	13.26 D	11.52 ij	12.42 gh	13.94 d	15.15c	13.26 C
Si_1+SA_2	10.61 lm	11.52 jk	13.03 gh	13.94 ef	12.27 EF	10.61 kl	11.52 ij	12.73 f-h	13.64 de	12.12 E
Si_2+SA_1	13.33 fg	14.85 d	16.36 bc	18.79 a	15.83 A	12.73 f-h	15.15 c	16.67 b	17.88 a	15.61 A
Si_2+SA_2	11.21 kl	12.42 hi	13.64 fg	14.55 de	12.95 D	10.91 jk	11.52 ij	13.33 d-f	14.85 c	12.65 D
Mean	11.38 D	12.53 C	13.84 B	15.08 A		11.41 D	12.56 C	13.87 B	15.12 A	
Lycopene (mg/100 g f.w.)										
Control	3.52 w	4.06 rs	5.07 m	5.92 h	4.65 G	3.65 u	4.24 rs	5.25 n	6.13 j	4.82 F
Si_1	3.71 uv	4.30 pq	5.56 j	6.34 fg	4.98 E	3.92 t	4.52 pq	5.70 k	6.58 gh	5.18 D
Si_2	4.40 op	5.58 ij	6.57 e	8.52 b	6.27 C	4.61 p	5.83 k	6.79 f	8.66 b	6.47 B
SA_1	4.47 n-p	5.62 ij	6.83 d	8.64 b	6.39 B	4.65 p	5.86 k	6.84 ef	8.77 b	6.53 B
SA_2	3.61 vw	4.21 qr	5.29 kl	6.27 g	4.85 F	3.75 tu	4.41 qr	5.48 lm	6.38 i	5.01 E
Si_1+SA_1	3.83 tu	4.54 no	5.76 hi	6.84 d	5.24 D	4.17 s	4.88 o	6.09 j	7.04 de	5.55 C
Si_1+SA_2	3.74 uv	4.29 pq	5.45 jk	6.50 ef	5.00 E	3.94 t	4.56 pq	5.66k l	6.70 fg	5.21 D
Si_2+SA_1	5.17 lm	6.26 g	7.77 c	9.95 a	7.29 A	5.42 mn	6.42 hi	8.02 c	10.11 a	7.49 A
Si_2+SA_2	3.94 st	4.63 n	5.84 h	6.85 d	5.32 D	4.21 rs	4.99 o	6.13 j	7.05 d	5.59 C
Mean	4.04 D	4.83 C	6.02 B	7.32 A		4.26 D	5.08 C	6.22 B	7.49 A	

* The mean values have the same letters are not significant at significance level of 5%

and Wasti et al. (2017) reported the enhancement effects of both of Si and/or SA on tomato yield and fruits quality traits under normal or salinity stressed conditions. Salehi et al. (2011) stated that the SA application with high level could cause inhibitory effect of treated tomato plants even if under non saline conditions. Moreover, Mady (2009) revealed that the SA foliar treatment at 50 ppm with vitamin E has significant and better effect on tomato yield and fruits quality parameters comparing with using 100 ppm of SA.This enhancement effects of Si and SA could be the sum of increasing the activity of many antioxidant enzymes, inhibiting H_2O_2 activity in addition to enhancement of chlorophyll content and photochemical efficiency andgoverning uptake and balance of K and Na (Al-Aghabary et al., 2005 and Liang et al., 2005) as a result of using Si application, or due to enhancing of water relations, membrane stabilization and altering the plant hormones such as auxin, cytokinin and ABA as with SA application (Gunes et al., 2005; Stevens et al., 2006 and Shakirova et al., 2007).

It could be concluded that the application of Si in concentration of 400 mg kg^{-1} soil with foliar application of SA at 50 ppm level may be considered a favorable treatment for the salinity stressed tomato plants cv. El-Basha 1077 to achieve the highest yield with high quality characteristics.

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الملخص العربي

تأثيرا إضافة كل من السيليكون و حامض الساليسيليك على تحسين المحصول و جودة ثمار نباتات الطماطم تحت ظروف الإجهاد الملحي

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تم إجراء تجربتي أُصص خلال موسمين متعاقبين لعامي ٢٠١٥-٢٠١٦ في المزرعة البحثية لكلية الزراعة - جامعة دمنهور. أهدف هذه الدراسة هو ملاحظة التأثير المُحسِن لكل منالسيليكون كمعاملة أرضية (٠، ٢٠٠ و ٤٠٠ جم كجم⁻١ تربة) وحامض الساليسيلك كمعاملة رش ورقي (٠، ٥٠ و١٠٠ جزء في المليون) إضافة إلى تداخلاتهما على نباتات محصول الطماطم صنف (الباشا-١٠٧٧) وذلك تحت مستويات مختلفة من ملوحة مياة الري (٠، ٤، ٨ و١٢ ديسي سيمنز م⁻١). أظهرتالنتائج المتحصل عليها من الموسمين أن مختلف مستويات الملوحة قد أدت إلى خفض متوسطات قيم كل من عدد الثمار بالنبات، متوسطي وزن الثمرة الطازج و الجاف إضافة إلى محصول الثمار للنبات. على النقيض من ذلك، فنجد أن جميع الصفات المُقدرة لجودة ثمار الطماطم(حموضة الثمار، فيتامين جـــ، المواد الذائبة الكلية والمحتوى من الليكوبين) قد زادت متوسطاتها نتيجة لزيادة الملوحة، في كلا موسمي الزراعة. بالنسبة للمعاملات المُحسنة فقد وجد أن تطبيق كلاً من الساليسيلك أوالسيليكون قد أدى لارتفاع متوسط قيم المحصول ومكوناته إضافة إلى جميع صفات الجودة لثمار الطماطم، ذلك في كلا موسمي الدراسة. إضافة لما سبق، فإنه اتضح من النتائج أن أفضل معاملة مشتركة كانت السيليكون(٤٠٠ جم كجم⁻١ تربة) مع الساليسيلك (٥٠ جزء في المليون)حيث كان لهما تأثير مُحسن بصورة معنوية على جميع الصفات المدروسة لنبات الطماطم النامية تحت أعلى مستوى ملوحةو الذي هو ١٢ ديسي سيمنز م⁻١،في كلا موسمي الدراسة. النسبة المئوية للزيادة التي تسببت فيها هذه المعاملة مقارنة بالكنترول تحت أعلى مستوى ملوحة كمتوسط لكلا موسمي الزراعة كانت ١٢١,٩٨، ٣٢,٦٩، ٤٢,٧١، ١٩٢,٧١، ٢٢,٣٥، ٢٤,٨٣، ٣٩,١٧ و ٦٦,٥% و ذلك لكل من عدد الثمار للنبات، متوسط وزن الثمرة الطازج، متوسط وزن الثمرة الجاف، محصول الثمار للنبات، المواد الصلبة الذائبة، الحموضة، فيتامين جـــ و الليكوبين، على التوالي.

وتوصي هذه الدراسة بأن أفضل معاملة لنباتات الطماطم المُعرضة لإجهاد الملوحة هي إضافة كل من السيليكون بتركيز ٤٠٠ جم كجم⁻١ تربة مع الرش الورقي لحامض للسايسيليك بتركيز ٥٠ جزء في المليون و ذلك من أجل الحصول على محصول وكذلك أفضل صفات جودة للثمار.