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INCREASING PRODUCTIVITY OF TOMATO PLANTS BY USING SEEDLING HARDENING UNDER SAHLE –ELTINA CONDITIONS

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ABSTRACT: *These experiments were carried out on tomato plants (Lycopersicon esculentum Mill) hybrid VT765 at two subsequent locations. The first experiment (nursery experiment) was performed in the nursery under green- house conditions covered with plastic shading at Sahle Eltina, North Sinai Governorate on the 10th February during the two growing seasons of 2008 and 2009. Tomato seeds were sown in foam trays filled with a mixture of vermiculite and peatmoss 1:1(v/v) and mixed it with macro and micro nutrients. After germination seedlings were exposed to salinity hardening treatments using four levels of saline irrigation in order to increase its adaptation to salinity stress; 2000, 4000, 6000 ppm, and the control which irrigated with tap water (200 ppm) during nursery period.; 45 days after sowing. The second experiment (open field experiment) was conducted at Sahle Eltina, North of Sinai Governorate, Egypt to evaluate the salt tolerance of tomato plants during the two summer seasons of 2008 and 2009 .Seedlings obtained from nursery experimental treatments were grown. 12 treatments i.e. the combination of three different foliar application treatments; Trafos k, Phostrade- Mg. and control X four hardening seedlings obtained from nursery experimental salinity treatments (2000, 4000, 6000 and control as tap water 200 ppm). Such treatments were arranged in a split plot design with three replicates. The obtained results could be summarized as follows.*

All vegetative and productive parameters responded positively to the individual effect of salinity hardening and fertilization as foliar application treatments and their interactions. The salinity hardening level of 4000 ppm showed the best effect followed by the 2000 ppm level and the least for 6000 ppm level. Meanwhile, the Trafos k was better than phostrade Mg as a foliar application.The interaction effect of the treatments appeared to be cumulative on plant response. However, Trafos k and the medium level of salinity (4000 ppm) recorded the high osmotic pressure followed by phostrade Mg with the medium level. Meanwhile, Stomatal conductance detected the lowest significant value under the treatments of medium level of salinity hardening and the Trafos k as a foliar application. Also, hardening medium level treatment with the Trafos k showed the lowest value of transpiration rate compared with the control. Trafos k treatment with the

medium level of salinity hardening showed the highest value of K, K/Na , Ca and protein content .
Keywords: *tomato, salinity, hardening, Trafos k, Phostrade Mg*

INTRODUCTION

Tomato is a widely distributed annual vegetable crops which is consumed fresh, cooked or after processing: by canning, making into juice, pulp, paste, or as a variety of sauces. More than 30% of world production comes from countries around the Mediterranean sea and about 20% from California FAO, (1995).

Globally, no resource can be considered to be more strategic than water. There are growing competitions from other sectors than agriculture such as the industrial and urban sectors for fresh water. In addition to the rapid increase in population, agriculture will have to do less with fresh water and do more with marginal quality water. For these reasons, the availability of water resources of marginal quality such as drainage water, saline groundwater and treated wastewater has become an important consideration. For water saving, recycling agricultural drainage water is a new policy that is applied either as a mean of rationalizing water use in countries such as Egypt (Abu-Zied, 1989) and/or for environmental reasons in other developed countries such as the Netherlands (Ammerlaan, 1993). This lead to salinity built up in the root zone. Salinity stress is a common consequence of insufficient water supply and/or using poor quality water (Li, 2000). Soil and/or water salinity may be naturally exist particularly in arid and semi arid regions such as Egypt. This problem is usually facing the expansion in reclaimed lands. Salinity is a well known factor affecting negatively growth and total yield of many crops such as tomato (Malash *et al.* 2002; Yurtseven *et al.* 2002, Flawers *et al.* 2005). The main negative effect of salinity comes from the osmotic effect on plant water uptake which eventually affects growth and yield. This negative effect is common in the new reclaimed lands where most of the high cash crops are usually cultivated there. The result is the well-known yield reduction because of salinity. Many trials have been conducted to alleviate salinity effects with partial success or non-applied results.

Tomato (Lycopersicon esculentum Mill) is one of the major and the most important vegetable crops in the world. There is a high demand on this crop either for local market or export. In 2007 year, the cultivated area with tomato was 595481 faddan, its productivity was 8391223 ton, with an average of 16.94 ton per faddan*. Particularly in Egypt, tomato has received great attention to increase its productivity parallel to market demand.

The aim of this investigation is to increase salinity hardening of tomato seedlings by irrigation with different saline levels in nursery in order to produce highly adapted transplants with high survival and more tolerant to salinity stress in the open field under desert conditions of Sahle Eltina , Egypt. Furthermore, trails were assessed for increasing salt resistance and improving growth and productivity of tomato plants by using the Trafos k and Phostrade Mg as a Fertilization foliar application. The success of such treatments will be essential for increasing the cultivated area of such crop grown under salinity stress.

MATERIALS AND METHODS

The present investigation consisted of two subsequent experiments, the first at nursery and the other at open field as follows:-

1- Nursery Experiment:-

In this experiment seeds were sowing under green house conditions at Sahle Eltina, North Sinai Governorate on the 10th February during the two growing seasons of 2008 and 2009. Tomato genotype used in the present study was VT765 hybrid which produced by G.S.I Company from England and imported by TECNOGREEN Co. The main characters of this tomato genotype are shown in Table (1).

Table (1): The main characters of tomato VT765 hybrid .

Characteristics	*V.T. 765"hybrid"*
Growth habit	Determinant
Vegetative growth	Very strong with good cover for fruits.
Cultivation date	Autumn and winter seasons.
Ripening date	95-110 days after transplanting
Fruit characteristics	Round shape – very good firmness – good red color – avg. fruit weight 160 g.
Tolerance	- Good fruit setting in high temperature. - Tolerant to infection with tomato leaf yellow virus. - Tolerant to infection with fusarium and verticilium.

The nursery experiment was conducted to increase seedlings tolerance after transplanting it in open field under high water salinity. Seeds of the used tomato genotype was sown in foam trays having 209 holes filled with a growing media containing 60% moisture. The growing media was prepared by mixing the following materials:-300 liters peatmoss, 100 kg vermiculite, 500g ammonium phosphate, 400 g ammonium nitrate, 300 g potassium sulfate, 100 g micro nutrients mixture (Tradecorp A-Z), 100 cm^3 fungicide (Maximum) and 4 kg Calcium Carbonate. Trays were irrigated with tap water for 15 days, then, salinity treatments were applied for inducing hardening. Four salinity levels of irrigation with saline water were applied i.e, control (tap water200), low (2000), medium (4000) and high (6000) ppm. Each week for five weeks, irrigation with the above mentioned salinity levels were applied shown in Table (2) according to Salama (2009), on tomato cultivar .

Table (2): Clarifies the salinity hardening system for tomato seedling during the nursery period

Days after sowing	Treatment			
	control	2000 ppm	4000 ppm	6000 ppm
1-15	Tap water			
16		2000	4000	6000
17		Without irrigation		
18		Tap water		
19		2000	4000	6000
20		Without irrigation		
21		Tap water		
22		2000	4000	6000
23		Without irrigation		
24		Tap water		
25		2000	4000	6000
26		Without irrigation		
27		Tap water		
28		2000	4000	6000
29		Without irrigation		
30		Tap water		
31		2000	4000	6000
32		Without irrigation		
33		Tap water		
34		2000	4000	6000
35		Without irrigation		
36		Tap water		
37		2000	4000	6000
38		Without irrigation		
39		Tap water		
40		2000	4000	6000
41		Without irrigation		
42		Tap water		
43		2000	4000	6000
44		Without irrigation		
45		Tap water		

2- Field Experiment:-

In this experiment, the seedlings which treated before with salinity hardening in the nursery were transplanted under the open field conditions of Sahle Eltina North of Sinai Governorate on 25[th] March during the two growing seasons in 2008 and 2009. This study was conducted to investigate the effect of different foliar application treatments, i.e, Trafos k (30% P_2O_5 and 20% K_2O) at rat 3L/300 L water/ fad., phostrade magnesium(29.7% P_2O_5, 5% K_2O and 6.8 %M g) at rat 3L/300L water / fad. and tap water (control) as well as salinity hardening and its effect on plant vegetative growth characters, physiological characters, yield and its components as well as chemical composition of tomato plants.. Plants were irrigated using brackish water from El-Salam canal.

Physical and chemical analysis of field soil were determined according to Piper (1950), Jackson (1958) and Chapman and Pratt (1961), (Table,3).

Table 3. Physical and chemical properties of the experimental soil and chemical analysis of irrigation water at Sahle El-Tina.

Physical analysis of the experimental soil

Coarse Sand	FineSand	Clay	Silt	Soil texture
0.7	8.0	54.8	36.7	Clay

Chemical analysis of the experimental soil

EC dS/m	pH	Cations (meq/L)				Anions (meq/L)			
		Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$
9.75	8.10	30.11	15.99	55.34	0.61	----	3.37	41.75	56.65

Chemical analysis of irrigation water

EC dS/m	pH	Cations (meq/L)				Anions (meq/L)			
		Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$
3.975	8.04	7.08	4.6 2	20.5 3	0.22	----	1.89	20.54	11.90

The experiment included 12 treatments, which were the combination of four salinity hardening for seedling tomato treatments x three foliar application treatments were arranged in split- plot design with three replicates. Foliar application treatments were placed in the main plot, and salinity hardening treatments arranging in the sub plots. All Plants were irrigated using brackish water from El-Salam canal.

Cattle manure at a rate of 20m^3/faddan, calcium super phosphate (15.5% P_2O_5) was added at a rate of 200 kg/faddan. Ammonium sulfate (20.5% N) and potassium sulfate (48% k_2O) were added at the rate of 150 and 100 kg/faddan respectively and it's were added to all treatments of the experiment before transplanting. The experimental unit included three ridges 60 cm in width and 3.5m in lengh (i.e. 10.5 m^2 = 1/400 fad.). Homogenous plants were transplanted in hills distanced 30cm apart on 25th March in 2008 and 2009 growing seasons, respectively. Trafos k and phostrade magnesium as foliar fertilizers application treatments were applied twice after 60 and 75 days from transplanting using tween 20 as wetting agent.

Tow samples were randomly taken at 75 and 90 days after transplanting to determine Plant height (cm), number of leaves/plant, number of branches/plant, leaf area/plant (cm), stem diameter (cm), shoot fresh and dry weights/plant (g) at 75 days from transplanting, fruit number/plant, total yield/plant (g) ,total yield (ton/fad.) and TSS% for fruit were recorded at 90 days from transplanting. Shoot samples were dried in an oven at 75 C^O. The dried materials for the 1st sample was ground to a fine powder and kept for mineral analysis. Plant materials were exposed to acid digestion using the wet aching procedure as described by (Johnson and Ulrich 1959) to determine sodium, potassium and calcium content by flame photometer according to the method of (Brown and Lilleland 1964) using Jenway PFP7 flame Photometer model. Mg content was estimated using atomic absorption spectrophotometer Pye Unicium Sp 1900. Proline content was determined in fresh leaves according to the method outlined by (Bates *et al*., 1973). Crud protein content was calculated by multiplying the total nitrogen by 6.25 (Pregl 1945). Meanwhile physiological measurements were determine as follow. Stomatal conductance(stom. Cond.) , leaf temperature (leaf temp.), transpiration rate (trans.) using (Porometer machine model LI-COR., USA). Osmotic pressure of cell sap at 75 days after transplanting was estimated with relationship between total soluble solids and osmotic pressure according to (Gosev 1960). Total Soluble Solids (T.S.S. %) in leaves at 75 days after transplanting was determined by using hand referactometer according to (A.O.A.C.1990).

Data were subjected to statistical analysis according to (Snedecor and Cochran 1967). Combined analysis over growing seasons for salinity hardening and foliar application treatments were carried out when the homogeneity test was insignificant according to (Gomez and Gomez 1984).

L S D was used to detect significant differences between means at 0.05 level.

RESULTS AND DISCUSSION

1-Growth characters:-

1-1Effect of foliar fertilization treatments:-

Data presented in Table (4) show the effect of foliar application treatments on vegetative growth parameters.) The effect of foliar treatments were clear. Trafos-k recorded the highest significant mean values of plant height (cm), number of leaves/ plant, number of branches/plant, leaf area/plant (cm), stem diameter (cm) fresh and dry weights g/plant of tomato shoots as compared with the other foliar application treatments. The percentages of increments reached 50.8% and 60.08% for leaf area and dry weights/plant respectively. The superior effects of phostarade magnesium was followed by Trafos k treatment. These differences were significant compared to control treatment through the two seasons (2008 and 2009). These finding were agreement with the results of Eata (2001) and Achilea (2002), they found that the presence of potassium can alleviate the negative effect of salinity and this explanation is what can be used in the case of the application of fertilizers such as Trafos k, and phostrade Mg. Leaf area reduction was overcome by K application under saline conditions Al-Karaki, (2000), Eata, (2001) & Ahmed (2003). This may be due to the competition between potassium and sodium for absorption and/or the regulation of K to plant water relation which reflects on cell elongation. The same explanation can be held true for the effect of K on a higher leaf area of the plant under saline conditions. Using K by Trafos k as a foliar application under saline conditions was reported to alleviate saline effect and improve plant fresh and dry weights Soubeih, (1998); Hassan, (1999) and this what has been observed in this study.

As the fresh weight depends mainly on plant water status and K has a major role in controlling this status, therefore this can be the explanation for the role of K in improving this parameter. The presence of phostrade Mg also contributed to the effect of alleviation since phostrade was reported to increase plant vegetative growth Turkmen *et al.*, (2004), Dursun *et al.*, (2002), & Arancon *et al.*, (2003). Meanwhile, the application of K may contribute to the osmo-regularty of the plant (Treichel, 1975) which may be the reason of the alleviation of salinity negative impact on plant growth.

Also, these results are in agreement with those recorded by Satti *et al* (1994), Raafat *et al*, (2000) & Salama, (2009) which noticed that growth of tomato plants was enhanced when K was added to the nutrient solution. In the same regard, Satti and Lopez (1994) affirmed the same results on tomato leaf count, stem fresh and dry weights. However, the positive response of growth parameters resulting from KCl treatments could be due to the role of K in the osmotic adjustment of plants under saline conditions, and consequently its importance of being required in the external medium to maintain the selectivity and integrity of cell membrane (Satti *et al* 1994).

Table (4): Effect of foliar fertilizer treatments on growth parameters of tomato plant at 75 days after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons).

Foliar fertilization	Plant height /cm	No. of leaves/plant	No. of branches/ plant	Leaf area/ plant / cm	Stem diameter /cm	Shoot fresh wt. /plant / g	Shoot dry wt / plant /g
Control	67.71	88.68	9.8	10.77	0.676	260.4	128.0
Trafos K 3L/fad	80.76	137.2	13.10	16.24	0.845	465.7	204.9
Phostrade Mg 3L/fad	75.89	120.7	12.58	15.54	0.789	405.5	188.2
L.S.D (0.05)	1.46	11.06	1.18	1.41	0.037	19.16	8.09

1-2 Effect of salinity hardening treatments:-

Effects of salinity hardening treatments on tomato vegetative growth are shown in Table (5). Hardening treatments using saline water showed a gradual increase in all vegetative growth parameters i.e plant height, number of leaves/ plant, number of branches/plant, leaf area/plant, stem diameter, shoot fresh and dry weights /plant until medium level of salinity hardening. The highest effect of salinity hardening occurred with the medium level (4000 ppm) of salinity hardening. The percentage of increments for leaf area and dry weight/plant with the same level reached 47.4 % and 44.6%as compared with the control. However, that effect started to decline with the highest level (6000 ppm) of salinity hardening but still significantly higher than the control. These responses were consistent with the two seasons (2008 and 2009). The response to salinity hardening can be arranged in the order: medium, low, high level of hardening compared with control treatment. The same results were obtained with mung bean due to the application of hardening on the plants Ahmed, (2003) and Salama (2009) on tomato plants. This effect of hardening may come from the effect of hardening on plant osmotic adjustment to higher osmotic pressure in the root zone. This adjustment can be brought about by accumulating nutrients in the plant as hardening was found to increase P and K content Taha, (1978) and Ahmed (2003). Also Moghaieb *et al.*, (2001) who found that salinity reduced plant growth in all cultivar of tomato plants and the reduction was more pronounced. In addition to who found that shoot showed a much higher concentration of sodium ion and proline due to its higher ability of maintaining the root function for the uptake and supply of water to shoot under salinity conditions but not due to the adjustment of transpiration from stomata. Snoussi *et al.*, (2004) reported that the water absorption was decreased at natural salted treatment levels, this probably due to ionic imbalance of the treated water.

Table (5): Effect of salinity hardening treatments on growth parameters of tomato plants at 75 days after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons).

Salinity hardening	Plant height /cm	No. of leaves/plant	No. of branches /plant	Leaf area/ plant / cm2	Stem diameter/cm	Shoot fresh wt. / plant /g	Shoot dry wt / plant /g
Control	66.06	90.34	10.68	11.27	0.691	278.7	142.8
2000 ppm	76.82	119.7	11.74	13.18	0.791	383.6	176.4
4000 ppm	84.13	140.15	13.67	16.61	0.834	500.1	206.5
6000 ppm	72.11	111.9	11.22	15.67	0.765	346.5	169.1
L.S.D (0.05)	2.06	11.35	1.36	1.65	0.052	19.46	8.15

1-3 Effect of the interaction between foliar fertilizer application and salinity hardening treatments:

Table (6) present the interaction effect of foliar fertilizer application and salinity hardening treatments on tomato vegetative growth. The effect of the interaction between any foliar application treatment and hardening level seemed to be cumulative of the individual effects of the treatments. Medium level of salinity hardening (4000 ppm) was always significantly higher compared with all other hardening levels regardless of foliar application treatments. Meanwhile the treatment of Trafos-k along with the medium hardening level gave the highest mean values for all growth traits i.e. plant height, number of leaves/plant, number of branches/plant, leaf area /plant, stem diameter, shoot fresh and dry weights/plant compared with all other combinations. All combinations of salinity hardening and foliar application treatments resulted in significant positive effect on all growth traits compared with control treatment.

A clear effect of salinity hardening levels was noticed specially with the medium hardening level under all foliar application treatments. The 2nd effect of the interaction of treatments was recorded for the medium level of salinity hardening under the foliar application of phostrade Mg followed by the high level of salinity hardening under the same foliar application treatment.

These findings can be explained on the basis that all foliar application treatments have positive effect on reducing salinity effects due to the presence of K and P Soubeih (1998),Cuartero and Fernandez-Munoz, (1999), Hassan, (1999) and Salama (2009). Moreover Malash *et al.*, (2002) showed that salinity at 4 and 6 dsm-1 decreased growth and total yield of tomato cultivars. Also these results were harmony with that reported by Moghaieb *et al.*, (2001) on tomato cultivars.

Table (6): Effect of the interaction between foliar application & salinity hardening treatments on growth parameters of tomato plants at 75 days after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons).

Treatments		Plant height /cm	No. of leaves /plant	No. of branches / plant	Leaf area/ plant / cm2	Stem diameter/ cm	Shoot fresh wt. /plant / g	Shoot dry wt / plant /g
Foliar fertilization	Salinity hardening							
Control	Control	60.50	76.18	9.68	9.26	0.665	212.8	89.5
	2000 ppm	68.72	89.75	9.92	10.91	0.676	269.6	131.2
	4000 ppm	75.45	105.65	10.20	11.68	0.691	309.6	163.6
	6000 ppm	66.16	83.15	9.40	11.21	0.670	249.6	127.8
Trafos K 3L/fad	Control	71.50	101.35	10.60	12.50	0.726	331.5	179.2
	2000 ppm	82.60	141.8	13.20	15.22	0.865	475.6	205.5
	4000 ppm	93.25	169.20	16.36	19.56	0.965	665.2	236.5
	6000 ppm	75.68	136.4	12.25	17.67	0.824	390.6	198.6
Phostrade Mg 3L/fad	Control	66.19	93.5	11.75	12.05	0.682	291.6	159.8
	2000 ppm	79.15	127.5	12.10	13.40	0.831	405.7	192.6
	4000 ppm	83.70	145.6	14.45	18.60	0.845	525.5	219.5
	6000 ppm	74.50	116.2	12.00	18.12	0.801	399.2	180.8
L.S.D (0.05)		1.81	8.63	1.29	1.17	3.076	20.16	9.18

2- Yield and its components

2-1-Effect of foliar fertilizer application:-

Foliar fertilizer application treatments showed significant differences in fruit number/plant, total yield /plant, total yield (ton/fad.) and TSS% for fruit (Table, 7). Yield and its components significantly increased with all foliar fertilizer application treatments as compared with control treatment. Trafos-K as a foliar application treatment achieved the highest significant mean values for yield and its components. The percentage of increments of fruit number/plant, total yield/plant (g), total yield (ton/fad). and TSS% for fruit reached 58.4%, 60.1%, 45.7% and 11.3% respectively as compared with the control. Phostrade Mg treatment recorded the 2nd on yield and its components. Also, control treatment detected the lowest significant mean values for yield and its components.

Foliar fertilization treatments increased total yield under salinity conditions Soubeih, (1998), Eata, (2001), and Economakis and Daskalaki, (2003). Also K and Amino acids were found to increase number of flowers, fruit setting and fruit yield Neeraja *et al.*, (2005). Application of amino acids (proline) and k was reported to improve plant growth and production under saline conditions Hafez, (2001). The positive effects of K and amino acids application may be due to its effect on cell-internal function as osmo-regulatory Treichel, (1975) since it is very soluble in water therefore increase the concentration of cellular osmotic components. Potassium fertilization was found to affect TSS % of tomato fruits under salinity Eata, (2001), soubeih, (1998), and Satti *et al.*, (1995).

Table (7): Effect of foliar fertilizer treatments on yield and its components of tomato plants at 90 days after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons).

Foliar fertilization	No. of fruits/ plant	Total yield / plant (g)	Total yield/ ton fad	TSS % for fruit
Control	32.14	872.43	9.23	8.23
Trafos K 3L/fad	50.91	1396.9	13.45	9.16
Phostrade Mg 3L/fad	40.33	1211.1	11.28	8.40
L.S.D (0.05)	2.18	123.06	0.06	1.15

2-2 - Effect of salinity hardening on yield and its components :-

Effect of salinity hardening on yield and its components were shown in Table (8). Salinity hardening treatments with 4000 ppm gave the highest significant effect on the fruit number/plant, total yield /plant, total yield (ton/fad.) and TSS% for fruit as compared with the other treatments, then it began to decline with the high level of salinity hardening i.e 6000 ppm. Despite of this decline with the high level of salinity hardening, it was still significantly higher than control. The percentage of increments of fruit number/plant, total yield /plant, total yield (ton/fad.) and TSS% reached 57.41% , 51.5% , 56.2% and 21,7%, respectively as compared with the control. Salinity hardening treatments also increased the total yield per plant which also was a reflection to its effect on the total number of fruits that was observed above. Total yield per plant increased as the salinity hardening level increased, however it started to decline with the high level of salinity hardening. Despit this decline, all salinity hardening treatments were significantly higher compared with control. The highest effect of salinity hardening was recorded with the medium level (4000 ppm)of salinity hardening followed by the low level (2000 ppm) then the high level (6000 ppm) of salinity hardening as compared with control treatment.

Table (8): Effect of salinity hardening treatments on yield and its components of tomato plants at 90 days after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons).

Salinity hardening	No. of fruits/ plant	Total yield / plant (g)	Total yield/ (ton/fad)	TSS % for fruit
Control	32.26	946.7	9.20	7.65
2000 ppm	43.51	1192.3	11.62	8.62
4000 ppm	50.78	1434.2	14.37	9.31
6000 ppm	37.95	1067.4	10.08	8.80
L.S.D (0.05)	2.70	125.20	1.29	0.42

The improvement in yield under salinity condition may be brought about by osmotic adjustment due to salinity hardening. This adjustment due to the accumulating of nutrients in the plant as hardening was found to increase Na, K, Ca and Mg content as shown later in Table (11) as well as the decrease in Na content of leaves (Table, 11). This explanation are harmony with Taha (1978), Ahmed (2003) and Salama (2009). Moreover, the higher vegetative growth (Table, 5) of plants which treated before in nursery with the medium concentration of salts (4000 ppm) may also explain the high total yield /plant and total yield / faddan as compared with all other salinity hardening treatments, at both seasons. Also Malash *et al.,* (2002) and Flowers (2005) they found that salinity reduced tomato commercial yield, mainly due to a decrease in fruit weight and to a lasser extent by a reduction in fruit number and by increasing blossom and rot in fruits.

2-3-Effect of the interaction between foliar fertilizer application and salinity hardening treatments levels:-

Data in Table (9) show the interaction effect between foliar fertilizer application treatments and salinity hardening. Generally, the effect of salinity hardening levels is consistent with all foliar application treatments. However, the foliar application treatments affected the degree of response to the salinity hardening treatments.

In all recorded data of yield components such as fruit number/plant, total yield/plant, total yield/fad. and TSS % in tomato fruits. The results showed that the three salinity hardening levels interacted with the foliar application of Trafos-K produced the highest significant effect on the previous characters as compared with all other combinations of treatments with superiority to the medium level of salinity hardening (4000 ppm) which was significantly higher compared to all treatments. However, Phostrade Mg combined with 4000 ppm salinity hardening recorded the 2nd best result for No. of fruits /plant, total yield/plant and total yield /ton fad. Generally, tap water as a control with all seed hardening treatments gave the lowest means value for yield and its components. The reported positive effects of foliar fertilizer application was observed by Satti *et al.*, (1994) and salinity hardening Taha, (1978). Also, these finding was agreements with that obtained by Raafat *et al*, (2000) and Salama, (2009) on tomato plants. On the other hand Sarg *et al.*, (1993) found that osmotic pressure in the cell sap in leaves was higher with Nacl salt up to 150 mM. Which reflect on yield and its components. Moreover, Flowers (2005) showed that salinity reduced tomato yield, mainly due to a decrease in fruit weight and to a lasser extent by a reduction in fruit number and by increasing blossom and rot in fruits.

Table (9): Effect of the interaction between foliar fertilizer application & Salinity hardening treatments on yield and its components of tomato plants at 90 after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons).

Treatments		No. of fruits/ plant	Total yield / plant /g	Total yield/ ton fad	TSS % for fruit
Foliar fertilization	Salinity hardening				
Control	Control	26.15	706.2	8.26	7.21
	2000 ppm	37.11	876.5	9.35	8.35
	4000 ppm	36.14	1106.5	10.56	8.85
	6000 ppm	29.15	800.5	8.75	8.5
Trafos K 3L/fad	Control	37.12	1161.3	9.70	8.06
	2000 ppm	51.25	1448.6	13.66	9.26
	4000 ppm	68.10	1696.5	18.85	9.92
	6000 ppm	47.16	1281.2	11.57	9.40
Phostrade Mg 3L/fad	Control	33.50	972.5	9.65	7.69
	2000 ppm	42.16	1251.8	11.85	8.25
	4000 ppm	48.09	1499.5	13.70	9.16
	6000 ppm	37.55	1120.6	9.92	8.50
L.S.D (0.05)		3.02	128.11	1.18	0.16

3-1- Physiological response :-

Effect of the interaction between foliar fertilizer application and salinity hardening treatments:-

Data presented in Table (10) show the interaction effect of foliar fertilizer application and salinity hardening treatments on some physiological parameters i.e . TSS% Of leaves, osmotic pressure, stom. cond., transpiration and leaf temp. There were a tendency for higher values of

TSS% of the leaves of tomato plants with the medium and high levels of salinity hardening i.e 4000 and 6000 ppm under all treatments of foliar application with each of Trafos k and phostrade Mg.

Table (10): Effect of the interaction between foliar fertilizer application & Salinity hardening treatments on some physiological characters of tomato plants at 75 days after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons).

Treatments: Foliar fertilizer	Treatments: Salinity hardening	Tss% Of leaves	Osmotic pressure	Stom. Cond. (cms^{-1})	Trans. ($mg\ cm^{-2}\ s^{-1}$)	Leaf temp (C°)
Control	Control	10.25	7.85	30.12	31.51	36.55
	2000 ppm	10.62	8.90	28.40	26.35	34.70
	4000 ppm	10.85	9.06	24.11	22.65	34.25
	6000 ppm	10.32	8.15	20.66	26.80	35.20
Trafos K 3L/fad	Control	10.38	8.55	24.70	24.25	35.60
	2000 ppm	11.26	9.20	20.05	22.50	32.20
	4000 ppm	12.75	10.85	18.92	20.15	31.85
	6000 ppm	10.66	8.76	21.15	23.70	33.20
Phostrade Mg 3L/fad	Control	10.30	8.35	22.45	28.42	36.10
	2000 ppm	10.90	8.92	21.25	25.60	33.50
	4000 ppm	11.55	9.75	19.06	21.90	32.70
	6000 ppm	11.05	8.50	22.05	25.75	35.20
L.S.D (0.05)		0.19	0.17	0.54	0.39	0.15

As for leaf osmotic pressure, data in Table (10) show that all salinity hardening levels under all foliar application treatments were significantly higher than the control. In the present study, Trafos-k and the medium level of salinity hardening resulted the high osmotic pressure followed by Phostrade Mg with the same level. The control gave the lowest values. This result was agreement with that obtained by Sarg *et al.*, (1993) which found that osmotic pressure in the cell sap in leaves was higher with Nacl salt up to 150 mM. Also, Salama, (2009) showed that Osmotic pressure, showed significant effects under all fertilization treatments, the medium level of salinity hardening (3000ppm) recorded the highest effect on that parameter followed by the high level of hardening (4500ppm).

Stomatal conductance as affected by the interaction between foliar fertilizer application and salinity hardening levels was presented in Table (10). Stomatal conductance recorded the lowest value under the treatment of medium level of salinity hardening with the Trafos-k as a foliar fertilizer. In general, the medium level of hardening with each of Trafos-k or Phostrade-Mg resulted in the lowest stomatal conductance, respectively. Regarding transpiration rate, all foliar fertilizer application with salinity hardening treatments had a positive response. Medium level of salinity hardening with the Trafos-k fertilization recorded the lowest value of transpiration rate compared to all other treatments. These resultes were harmony with that obtend by Salama (2009) who, reported that transpiration rate increased where as stomata resistance decreased, with lower level of salinity and higher water supply. Also Malash *et al.,* (2005) found that irrigated tomato plant, with saline water decreased transpiration rate but increased stomata resistance and leaf temperature compared with irrigation by fresh water. In contrast the lowest value of leaf temperature was recorded with the medium level of salinity hardening under the fertilization treatment of trafos-K (Table 8). These finding was agrementes with that obtained by Salama, (2009) on tomato plants. Also, who showed that Stomatal conductance recorded the lowest significant value under the treatments of medium level of salinity hardening and the mono potassium phosphate fertilization.

3.2. Chemical composition :

Effect of the interaction between foliar fertilizer application & Salinity hardening levels :-

Table (11) showed the interaction effect between foliar fertilizer application and salinity hardening on chemical composition.

The values of nutrional parameters i.e Na, K, K/Na, Ca, Mg, proline and total protein in shoot of tomato plants are shown in Table (11). The previous characters were positively and significantly affected by the interaction, between salinity hardening levels and foliar fertilizer application treatments. Shoots of the tomato plants receiving the medium level of salinity hardening and foliar fertilizer application with Trafos-k treatment showed the highest value of each K,K/Na and Ca nutrional parameters except Mg and proline content had the same by the interaction treatment (6000 ppm) of salinity with Phostrade-Mg. On the reverse, the treatment of Trafos-k with the medium level (4000 ppm) of salinity hardening recorded the lowest value of Na in the shoot of tomato plants followed by the same foliar application treatment with the low level (2000 ppm) of salinity hardening. Also medium level of salinity X trafos k gave the highest value for protein content compared with trafos k X control. On the other hand, proline content recorded the lowest significant mean values by Trafos K as a foliar application under medium salinity hardening interaction. The revers was true for protein content.

These results are in agreement with those obtained by Taha (1978). The presence of K and humate in the fertilization treatments, David *et al*, (1994) and Adani *et al.,* (1998). In addition the effect of hardening treatments, Taha

(1978) gave a cumulative effect on Ca content in shoot of tomato plant. Na content was reported to be decreased in response to K as a foliar application Sattie *et al.*, (1995). As the presence of K increased by the fertilization treatment, the translocation of assimilates increase to the plant Koning, (1995). Moreover salinity hardening treatments enable the plants to produce more assimilates (Taha, 1978 and Ahmed, 2003), the combination of these two factors increase the assimilates going to the plant hence increasing protein content.

Table (11): Effect of interaction between foliar application & Salinity hardening treatments on chemical composition of tomato plant at 75 days after transplanting under saline conditions. (Combined analysis of 2008 and 2009 growing seasons)

Treatments		Na+ mg/g (D.W.)	K+ mg/g (D.W.)	K+/Na+ ratio mg/g (D.W.)	Ca++ mg/g (D.W.)	Mg++ mg/g (D.W.)	Proline mg/g (F.W.)	Total protein %
Foliar fertilizer	Salinity hardening							
Control	Control	6.23	5.60	0.583	23.40	17.50	0.084	21.35
	2000 ppm	5.43	5.96	0.622	25.20	20.16	0.066	22.80
	4000 ppm	5.26	6.01	0.739	25.70	22.35	0.061	23.65
	6000 ppm	6.19	5.30	0.562	23.80	21.30	0.063	22.00
Trafos- K 3 L/fad	Control	5.32	6.20	0.666	26.10	23.30	0.092	23.70
	2000 ppm	5.03	6.85	0.893	31.55	26.50	0.051	28.50
	4000 ppm	5.01	7.15	1.079	35.70	29.20	0.044	29.60
	6000 ppm	5.25	6.40	0.788	31.15	30.05	0.055	26.50
Phostrade-Mg 3 L/fad	Control	5.61	6.01	0.645	25.60	21.13	0.085	23.20
	2000 ppm	5.19	6.08	0.840	28.75	28.20	0.091	28.00
	4000 ppm	5.12	6.25	0.882	30.80	32.50	0.083	28.80
	6000 ppm	5.36	6.05	0.666	26.50	32.70	0.096	25.50
L.S.D (0.05)		0.42	0.90	0.226	3.74	5.22	0.031	5.81

Also, Cayuela *et al.*, (2001) they found that K concentration increased in the young leaves of the adapted plants. These results indicate that the changes in growth and physiological responses induced by NaCl pretreatment at the seedling stage maintained throughout the plant life cycle. In the same regard Parra *et al.*, (2007) found that improved tolerance in most pre-treated plants was related to lower Na and Cl- concentrations in the leaves and increases in leaf K+ contents and K+ /Na+ ratio. However, Malash *et al.*, (2008a) who found that N and P in leaves of tomato plants decreased gradually with increasing salinity of irrigation water. On the other hand Xuexia *et al.*, (2006) found that at 100 m mol NaCl/L the seedling growth proline contents in tomato leaves were significantly increased.

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زيادة انتاجية نباتات الطماطم باستخدام الشتلات المقساة تحت ظروف سهل الطينة

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الملخص العربي

أجريت هذه الدراسةعلى فترتين الفترة الاولى أجريت بمشتل تم إعداده بمنطقة سهل الطينة شمال سيناء خلال موسمى ٢٠٠٨ ، ٢٠٠٩ حيث زرعت بذور نبات الطماطم فى صوانى فوم مجهزة بمخلوط الفيرموكيوليت والبيتموس بنسبه (١:١ حجم) والمخصب بالعناصر الغذائية الصغرى والكبرى . حيث هدفت الدراسة إلى بحث أساليب زراعية مختلفة لتخفيف التأثيرات السلبية للملوحة على نمو وإنتاج نباتات الطماطم. تم استخدام هجين VT 765.

أولا : فترة المشتل:

أثناء فترة المشتل تم تسميد الشتلات بمعدلات التسميد الموصى بها وتم تطبيق معاملات التقسية بالملوحة بعد ١٥ يوم من الزراعة. معاملات التقسية الملحية كانت الرى باستعمال أربعة معدلات وهى (٢٠٠٠ ، ٤٠٠٠، ٦٠٠٠ جزء فى المليون)بجانب معاملة المقارنة وهى الرى بماء الصنبور (٢٠٠ جزء فى المليون) أسبوعيا ولمدة ٥ أسابيع. تم الرى بمستويات الملوحة السابق ذكرها كما يلى: اليوم الاول: الرى بمستوى الملوحة المقترح ، اليوم الثانى: تصويم ، اليوم الثالث: غسيل بماء صنبور ، اليوم الرابع: الرى بمستوى الملوحة المقترح ، اليوم الخامس: تصويم ، اليوم السادس: غسيل بماء الصنبور اليوم السابع: الرى بمستوى الملوحة المقترح. ولم يتم تطبيق اية معاملات أخرى فى هذه المرحلة حتى عمر ٤٥ يوم .

ثانيا فترة الحقل المستديم :

فى هذه الفترة أجريت بمنطقة سهل الطينة شمال سيناء خلال موسمى ٢٠٠٨ ، ٢٠٠٩ لتقييم عدد ١٢ معاملة هى محصلة التداخل بين ثلاث معاملات للرش الورقى باستخدام سماد الترافوس بوتاسيوم٣لتر/ ٣٠٠ لتر ماء/ فدان, فوستريد مغنسيوم ٣لتر/ ٣٠٠ لتر ماء/ فدان ، معاملة المقارنة (بدون رش) مع ٤ معاملات للتقسية الملحية للبادرات بالمشتل (المستوى

المنخفض– المستوى المتوسط – المستوى العالى – بالاضافة إلى معاملة الكنترول) ، وذلــك على صفات النمو والانتاجية وبعض الصفات الفسيولوجية والمركبات الكيميائية لنباتات الطماطم تحت الظروف الملحية ، وتم اتباع نظام القطع المنشقة مرة واحدة فى تصميم التجربــة حيــث شملت معاملات الرش بالاسمدة الورقية القطع الرئيسية ومعاملات التقسية الملحيــة بالمــشتل بالقطع الفرعية.

أدت معاملات الرش جميعها الى خفض التأثير السلبى للملوحة من خلال تحسن نمو النباتات متمثلة فى (طول النبات ، المساحة الورقية، الوزن الغض والوزن الجاف للنبات) والقياسات الفسيولوجية (الضغط الاسموزى للاوراق والمواد الصلبة الذائبة الكلية لعصير الاوراق والتوصيل الثغرى ومعدل النتح و درجة حرارة الورقة) والمحصول (محصول النبات الواحد – محصول الفدان وعدد ثمار النبات الواحد) وجودة الثمار (المواد الصلبة الذائبةالكلية) وكذلك المحتوى الكيماوى بالمجموع الخضرى (البروتين الكلى والبوتاسيوم والكالسيوم والمغنسيوم) وانخفاض (الصوديوم والبرولين) واختلفت درجة تأثير كل معاملة رش عن الآخر وامكن ترتيبهم حسب درجة التأثير كالاتى: ترافوس بوتاسيوم٣لتر/فدان, فوستريد مغنسيوم (٣لتر/فدان) ثم معاملة المقارنة.

ادت معاملات التقسية بالملوحة الى تحسن واضح فى النمو الخضرى (طول النبات ، مساحة الورقة، الوزن الغض والوزن الجاف) والقياسات الفسيولوجية (الضغط الاسموزى للاوراق و المواد الصلبة الذائبة الكلية لعصير الاوراق والتوصيل الثغرى ومعدل النتح و درجة حرارة الورقة) والمحصول (محصول النبات الواحد – محصول الفدان وعدد ثمار النبات الواحد) وجودة الثمار (المواد الصلبة الذائبةالكلية) وكذلك المحتوى الكيماوى بالمجموع الخضرى (البروتين الكلى والبوتاسيوم والكالسيوم والمغنسيوم) وانخفاض (الصوديوم والبرولين) وكان المستوى المتوسط ٤٠٠٠ جزء فى المليون هو احسن المستويات تأثيرا يليه المستوى المنخفض من التقسية واخيرا المستوى المرتفع.

سجل التداخل بين معاملات التقسية الملحية والرش الى تحسن ملحوظ فى النمو الخضرى والمحصول والقياسات الفسيولوجية وكذلك المحتوى الكيماوى. حقق التداخل بين معاملة الرش ترافوس بوتاسيوم٣لتر مع التقسية الملحية بالمستوى المتوسط ٤٠٠٠ جزء فى المليون أفضل النتائج.