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RESPONSE OF TOMATO SEEDLINGS TO SOIL SALINITY

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ABSTRACT

A pot experiment was carried out to evaluate the effect of five levels of soil salinity (1.78 , 6.05, 7.44 , 9.62 and 11.85 dS m^{-1}) which achieved by using a mixture of 1:1 NaCl and $CaCl_2$ salts on the growth and ion composition of fifteen tomato varieties (Advantage, Alwasifi, Castle Rock O.P., Castle Rock Hy., Elots, Madeer, Nemathoda 1400, Crystal, Saria, Soufei, Supper Maramand, Supper Strain B, TO-897, Nora and Wadistar) . Shoot and root dry weights of tomato seedlings were generally reduced with increasing salinity levels .Based on relative shoot dry weights, tomato varieties were classified as moderately tolerant , moderately sensitive and sensitive to salinity. Sodium and chloride concentrations were increased in both shoots and roots by increasing levels of soil salinity while potassium concentration declined.. K/Na concentration ratio of both shoots and roots decreased with increasing levels of soil salinity. Salt moderately tolerant varieties exhibit higher K/Na concentration ratio in shoots compared to both salt moderately sensitive and salt sensitive varieties.

Keywords : Tomato varieties , Soil salinity, Na ,Cl ,K, Salt tolerance.

INTRODUCTION

Low rainfall, high evaporation, native rocks, saline irrigation water and poor water managements can cause salinity problems in agricultural areas (Dasgan *et al..*,2002). In Egypt, increasing salinity and rising ground water table level represent a serious problem which could face crop production (Hassan *et al..,* 1999). Where, saline soil reach about 2 million fed, which represents about 26% of the total cultivated area (which about 7.8 million fed).Salinity stress, which usually occurs in arid and semiarid regions, is a major environmental constraint to crop productivity. The progressive salinization of irrigated land limits the future of agriculture in most productive areas of the world (Santa-Cruz *et al..*,2002). Plants are stressed in three ways in saline soils; (1) low water potential of the root medium leads water deficit, (2) the toxic effects of the ions, (3) nutrient imbalance by depression in uptake and/or shoot transport (Dasgan *et al..*, 2002). Increasing the level of the soluble salts in the soil solution tends to cause individual ion toxicity. Of the irrigated land worldwide. (Caines and Shennan ,1999).They added that, once soil is lost from productivity because of salt accumulation, it takes large amounts of water,energy, and careful management to re-establish its viability.

The ability of plants to survive and maintain their growth under saline conditions is known as salt tolerance. Salt tolerance seems to be connected with the plant's ability to increase the concentration of solutes in its tissues. It is well known that most of the plant species accumulate solutes in the tissues for osmotic adjustment and try to maintain their water uptake under water stress conditions (Leidi and Saiz ,1997). This is a variable trait that is dependent on many factors, including the species of the plant .Attempts have been made to improve the salt tolerance of many crops, but commercial success has been limited so far (Santa-cruz *et al.*.,1999). Crops differ in their ability to grow successfully under saline conditions and to accumulate high concentration of salts in their tissues (Mohammad *et al.*.,1998)..

Tomato (*Lycopersicon esculentum* Mill.),is one of the most important and widespread vegetable crops in the world, is sensitive to moderate of soil salinity. So many authors have reported large variation among tomato genotypes in their response to salinity (Cuartero and Fernández-Muñoz, 1999 and Soloviev *et al.*., 2003). Cultivated tomato is generally classified as a moderately sensitive crop that can tolerate an electrical conductivity of the saturated soil extract up to 2.5 ds m^{-1} without any yield reduction (An *et al.*., 2005). However the response of tomato to salinity is variable according to lines and cultivars. Salt tolerance, have been identified among the related wild species and primitive cultivars of tomato (Foolad and Lin, 1997).Previous investigations to characterize the genetic control of salt tolerance in tomato were focused primarily on individual development stages such as germination and vegetative growth (Foolad and Lin, 1997). It was concluded that the differences in the ion transport at the beginning of the NaCl stress were closely related to the differences in the response of the plant species to NaCl stress (Baba and Fujiyama,2003).They added that, the significant differences in responses to salt stress by the different genotypes show that selections or tolerance to this stress within this germplasm is possible .

Salinity can alter nutrient uptake through antagonistic effects with essential nutrients (Mohammad *et al.*. ,1998) Nutrient imbalance resulting from both antagonistic and synergistic interaction in saline growth media can also affect nutrient uptake and reduce plant growth (Grattan and Grieve,1999) Significant reductions in fresh and dry weight of tomato shoots were reported in response to salinity stress (Mohammad *et al.*. ,1998 and Maggio *et al.*., 2007) .The effect of salinity on plants was expressed as reduced shoot dry weight because vegetative growth in the most widely used index in studies on salt tolerance in tomato (Tuna *et al.*.,2007). It was documented that, growth reduction was likely caused by the high salt level which increased the osmotic potential of the circulating saline solutions as well as by salt stress from excessive uptake of salt ions (El-Masry and Hassan ,2001). Moreover the ability of plants to reduce and survive at high level of salinity depends on its capacity to establish an equilibrated osmotic gradient between soil root and to exclude salt ions from active plants tissues (Caines and Shennan, 1999).The aim of this study was to classify 15 tomato varieties according to their salt tolerance and to follow up the effect of soil salinity on growth and some chemical composition of the plants.

MATERIALS AND METHODS

A green house experiment was conducted to evaluate the effect of soil salinity on growth and elemental concentration in fifteen tomato varieties. Soil used in this experiment was clay loam with initial soil salinity 1.78 dS m^{-1}, pH 7.8, and ions concentration were 4.9, 0.2, 6.5 and 10 $meqL^{-1}$ for Na, K, Ca and Cl respectively.

This experiment included 75 treatments which were the contribution of 15 tomato varieties: Advantage, Alwasifi, Castle Rock O.P., Castle Rock Hy., Elots, Madeer, Nemathoda 1400, Crystal, Saria, Soufei, Supper Maramand, Supper Strain B, TO-897, Nora and Wadistar and 5 salinity levels. The initial soil was artificially salinized using different amount of a mixture(NaCl +$CaCl_2$) in ratio (1:1) to reach salinity levels (1.78 , 6.05, 7.44 , 9.62 and 11.85 dS m^{-1}).

Seeds of each varieties were planted in pots containing 4 kg clay loam soil. There were 5 plants per pot.. Each pot received a basal application of 0.43 gm urea and 0.42 gm potassium sulphate and 0.40 gm super phosphate (corresponding 50 kg N, 50 kg K_2O and 15 kg P_2O_5/ fed.). Pots were frequently watered to maintain moisture at approximate filed capacity. Plants were harvested after 60 days from sowing. Plants were washed with distilled water and separated to shoots and roots, oven dried at 70 C° and dry weights of both shoots and roots were recorded. Plants were grounded and digested with mixture of sulfuric and perchloric acids according to Jackson (1974). Sodium and potassium were determined using perkin flam photometer (Page *et al.*, 1982). Phosphorous was determined calorimetrically according to Chapman and Pratt (1961). Calcium was determined by atomic absorption spectro photometer. Chloride was extracted from the ashes samples with hot water and titrated with standard silver nitrate solution according to Page *et al.* (1982). Analysis of variance was performed with the SAS statistical package (SAS ,1991)

RESULTS AND DISCUSSIONS

1- Effect of different salinity levels on plant growth of various tomato varieties:

1 – 1 Shoot and root dry weights:

The average shoots and roots dry weight (across various tomato varieties) were significantly decreased by increasing soil salinity levels as it could be noticed from the data presented in Table 1. Irrespective of soil salinity levels, it was observed that tomato varieties differ in their shoots and roots dry weight. Generally, Soufie recorded the highest shoot and rootdry weights (8.17 and 1.69 gpot^{-1}) respectively. While Wadistar recorded the lowest values (3.04 and 0.58 gpot^{-1}) for shoots and roots respectively.

Concerning the interaction effect of soil salinity levels and tomato varieties on shoot and root dry weights, the obtained data revealed a great fluctuation in shoot and root dry weights between tomato varieties, where at low salinity level (2 dS m^{-1}) shoot dry weights ranged between (14.85 and 6.76 gpot^{-1}), and rcot dry weights ranged between (2.38 and 1.12 gpot^{-1}). It could be noticed also that, for each variety, increasing soil salinity decreased dry weight of both shoots and roots. However this adverse effect becomes more pronounced at higher salinity levels (higher than 6 dS m^{-1}) for some varieties such as Advantage, Soufei and Castle Rock O.P., while for the rest of the studied varieties the harmful effect of soil salinity appears even at low salinity levels (above 2 dS m^{-1}).

Table 1: Effect of different salinity levels on shoot and root dry weights (gpot^{-1}) of various tomato varieties

	Shoots						Roots					
Tomato varieties	Soil salinity levels (dS m^{-1})											
	1.78	6.05	7.44	9.62	11.85	mean	1.78	6.05	7.44	9.62	11.85	mean
Advantage	8.73	8.36	2.80	2.77	1.76	**4.88**	1.49	1.45	0.82	0.81	0.55	**1.02**
Soufei	14.85	12.64	6.40	4.03	2.92	**8.17**	2.38	2.22	1.89	1.00	0.97	**1.69**
Castel Rock O.P.	8.64	7.37	3.43	1.28	1.26	**4.40**	1.40	1.32	0.88	0.36	0.35	**0.86**
Alwasifi	13.61	9.42	4.17	3.43	2.40	**6.61**	2.06	1.66	1.05	0.90	0.67	**1.27**
To -897	10.37	6.62	5.75	2.09	1.53	**5.27**	1.75	1.17	1.05	0.52	0.39	**0.98**
Saria	12.46	7.51	4.29	2.58	1.51	**5.67**	1.95	1.19	1.08	0.69	0.41	**1.06**
Crystal	8.90	5.12	3.81	3.36	2.16	**4.67**	1.48	0.98	0.88	0.80	0.61	**0.95**
Nemathoda 1400	11.54	6.48	4.90	3.35	1.49	**5.55**	1.86	1.11	1.00	0.90	0.42	**1.06**
Madeer	7.87	5.74	2.69	1.57	0.75	**3.72**	1.28	0.95	0.61	0.42	0.22	**0.70**
Supper Marmaned	11.39	5.59	3.44	1.15	0.61	**4.44**	1.89	1.03	0.74	0.31	0.17	**0.83**
Elots	12.60	6.11	3.00	2.37	1.52	**5.12**	2.21	1.14	0.70	0.57	0.43	**1.01**
Nora	14.53	5.64	5.04	3.83	2.21	**6.25**	2.48	1.14	1.06	0.92	0.60	**1.24**
Castel Rock Hy.	11.29	4.57	4.09	1.94	0.75	**4.53**	1.75	0.94	0.88	0.50	0.21	**0.86**
Supper Strain B	10.47	3.99	3.36	1.48	1.31	**4.12**	1.70	0.74	0.65	0.39	0.37	**0.77**
Wadistar	6.76	3.90	2.57	1.25	0.71	**3.04**	1.12	0.75	0.55	0.30	0.18	**0.58**
Mean	**10.93**	**6.60**	**3.98**	**2.43**	**1.53**		**1.79**	**1.19**	**0.92**	**0.63**	**0.44**	
L.S.D at 5% for	Varieties (v)	Salinity levels (s)	(V)*(S)				Varieties (v)	Salinity levels (s)	(V)*(S)			
	0.122	0.070	0.273				0.065	0.037	0.145			

The reduction in plant growth may be attributed to the effect of salinity on many metabolic processes including enzyme activity, protein synthesis and the activity of the mitochondria and chloroplasts (Marchner, 1998).

1-2 Classification of tomato varieties according to their salinity tolerance:

Relative dry weights (dry weight of the treated plants, expressed as a percentage of the dry weights of the control plants) was used as an index of salinity tolerance for tomato varieties (Shannon *et al.*., 1983). Where shoots is a sensitive parameter to salt that could be used to evaluate salt tolerance in tomato as it was documented by Cruz *et al.*., (1990), varieties could be divided into two groups according to their relative shoot dry weights as it was illustrated in Fig.1

It could be noticed that for varieties (Advantage, Castle Rock O.P. and Soufei) the relative shoot dry weights versus EC response function defined two linear regions with a sharp slope change at approximately 6 dS m^{-1}. which could be considers a threshold value for these varieties, where at soil salinity lower than 6 dS $m^{-1}$the relative shoot dry weights decrement were only 0.93, 3.5, and 3.45 per 1 dS $m^{-1}$for Soufei, Advantage and Castle Rock O.P. respectively. Moreover, every 1 dS m^{-1} increase in soil salinity higher than this value induced 10.77, 10.42 and 11.5 reduction in relative shoot dry weights for each of these varieties respectively (Fig.1a). These varieties could be considered moderately tolerant to salt stress, as it was demonstrated by Maggio *et al.*. (2004) who classified tomato varieties that could tolerate salinity up to 6 dS m^{-1}as moderately salt tolerant. In this respect Al-Rwahy (1989) attributed the reduction in dry weights due to increased salinity as a result of a combination of osmotic and specific ion effects .

On the other hand, Fig.1b and c revealed that the rest of the studied varieties could tolerate soil salinity up to 2 dS m^{-1}only could be (considered sensitive to salinity). However these varieties could be divided into two sup group, the first one exhibit a gradual significant reduction in relative shoot dry weights by increasing soil salinity (Fig.1b), the relative shoot dry weights reduced by an average of about 8.5% for each unit increase in soil salinity above 1.78 dS m^{-1}, and could be considered moderately sensitive to salinity, this group include (Alwasifi, TO- 897, Saria, Crystal, Nemathoda 1400 and Madeer), while for the second one, which includes (Supper Marmaned, Elots, Nora, Castle Rock Hy., Supper Strain B and Wadistare) increasing soil salinity up to 6 dS m^{-1}induced a sharp significant reduction in relative shoot dry weights, while over this salinity level the decrement in shoot dry weights becomes gradual (Fig.1 c) this group could be considered highly sensitive to salinity.

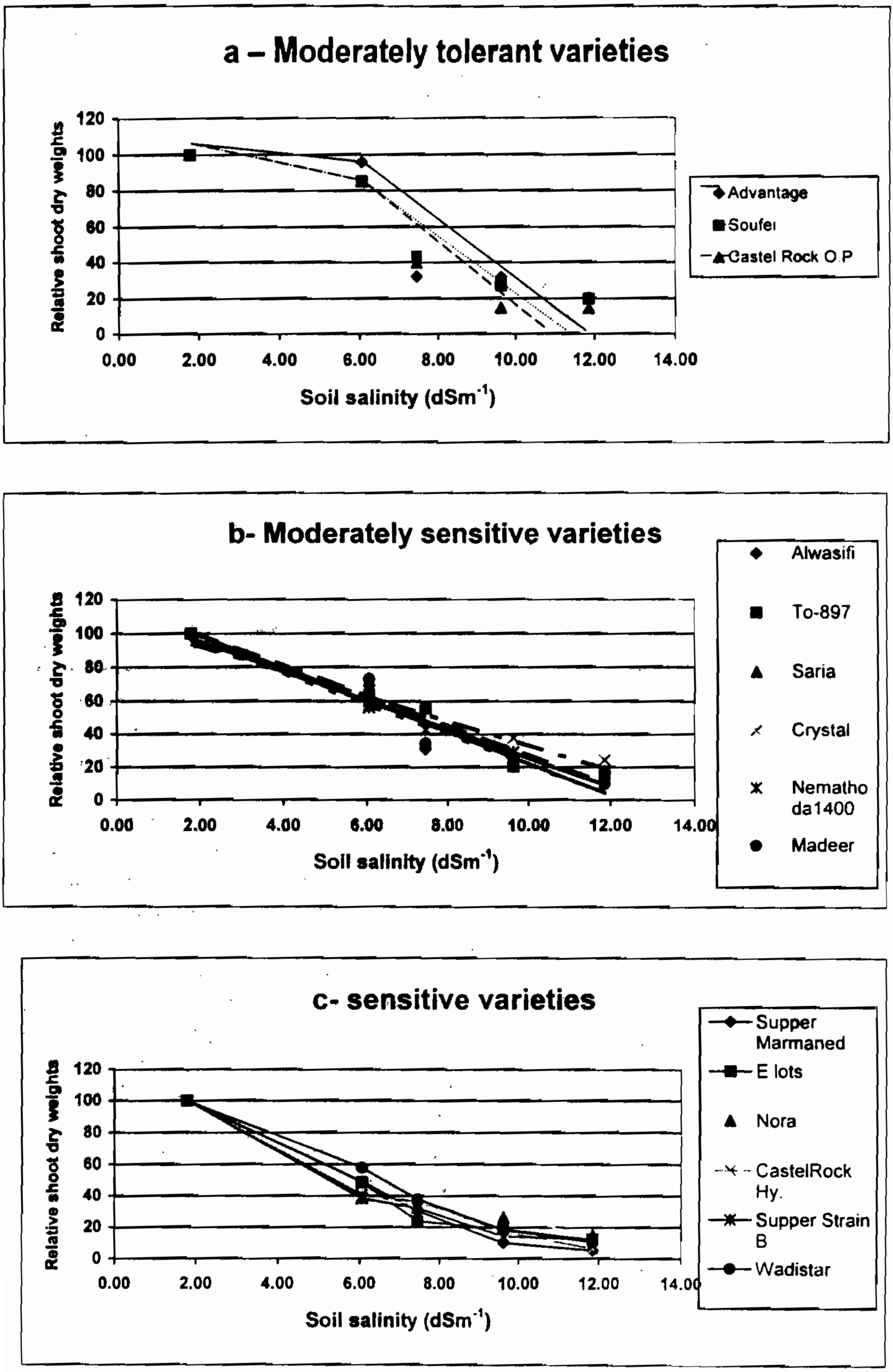

Fig. 1: Effect of salinity levels on relative shoot dry weights of various tomato varieties

2- Ion concentration of various tomato varieties:

2-1 Sodium concentration:

The distribution of ions in the different parts of the plant is an essential factor of the mechanism of salt tolerance (Greenway and Munns, 1980), because the specific accumulation of Na and/or Cl in plant is toxic and may be one of the main causes for growth inhibition under high salinity.

The data presented in Table 2 revealed that Na concentration was increased in both shoots and roots by increasing soil salinity, regardless tomato varieties. This was in accordance with Maggio *et al.*. (2007) who stated that, the accumulation of Na was proportional to the EC of the soil.

The average values of Na% in various tomato varieties (across soil salinity) ranged between 0.58 and 1.01 and between 0.61 and 0.87 for shoots and roots respectively, revealing a great variation between varieties. The lowest Na% in shoots was recorded for Castel Rock O.P. while the highest one was obtained with Wadistar, while for roots the lowest Na% was recorded in variety Crystal and the highest one was found in Castel Rock O.P.. Moreover, it could be noticed that the varieties that classified as moderately tolerance to salinity recorded the lowest Na concentration values in their shoots and the highest values of Na% in their roots, while the reverse was true for sensitive varieties.

Concerning the interaction effect of soil salinity levels and tomato varieties, it was observed that, for each variety, increasing soil salinity levels increased Na% in both shoots and roots. This effect becomes more pronounced in salt sensitive varieties particularly at higher salinity levels (11.85 dS m^{-1}).

Moreover, it was noticed that, the varieties which considered moderately tolerant to salinity (Advantage, Soufei and Castel Rock O.P.) accumulated Na in the roots more than that found in the shoots. On the other hand, the rest of the examined varieties had higher Na% in the shoots compared to that present in the roots. In general, Na% in both shoots and roots for the varieties which classified as sensitive to salinity were lower than Na % in that considered as highly sensitive to salinity. This indicated that the capacity of Na exclusion from shoots is well correlated to salt tolerance degree, as it was demonstrated by Gorham *et al.*. (1990) and Foolad (1997). In this respect, Hassan *et al.* (1999) stated that the large variation in response of different plants and crops to salinity can be related to their ability to exclude salt from sensitive tissues cells and organs. It is worth to mention here that, there was a highly significant negative relation between shoots dry weight and Na% in the shoots (r^2 = 0.6) (Fig.2). On the other hand the relation between Na% in roots and their dry weight was not significant. This was in harmony with the finding of Perez-Alfocea *et al.* (1996) who found negative relation between the accumulation of toxic ions (Na and Cl) in the plants and shoots growth of tomato plants growing under salinity.

Table 2: Effect of salinity levels on sodium concentration (%) in shoots and roots of various tomato varieties.

Tomato varieties	Shoots						Roots					
	Soil salinity levels (dS m^{-1})											
	1.78	6.05	7.44	9.62	11.85	mean	1.78	6.05	7.44	9.62	11.85	mean
1-Moderately tolerant varieties												
Advantage	0.54	0.56	0.76	0.81	0.85	**0.70**	0.50	0.63	0.72	0.80	0.85	**0.70**
Soufei	0.46	0.47	0.70	0.76	0.83	**0.64**	0.47	0.53	0.85	0.95	0.97	**0.75**
Castel Rock O.P.	0.40	0.43	0.65	0.69	0.73	**0.58**	0.56	0.75	0.78	0.96	1.29	**0.87**
mean	**0.47**	**0.49**	**0.70**	**0.75**	**0.80**		**0.51**	**0.64**	**0.78**	**0.90**	**1.04**	
2-Moderately sensitive varieties												
Alwasifi	0.50	0.71	0.85	0.99	1.10	**0.83**	0.48	0.54	0.60	0.69	0.80	**0.62**
To -897	0.45	0.66	0.80	0.81	1.33	**0.81**	0.53	0.63	0.79	0.84	1.11	**0.78**
Saria	0.56	0.69	0.75	0.89	1.23	**0.82**	0.55	0.56	0.60	0.70	0.90	**0.66**
Crystal	0.56	0.65	0.70	0.90	1.08	**0.78**	0.46	0.51	0.60	0.63	0.83	**0.61**
Nemathoda 1400	0.45	0.64	0.75	0.93	1.21	**0.80**	0.54	0.60	0.70	0.78	0.89	**0.70**
Madeer	0.61	0.66	0.85	0.95	1.13	**0.84**	0.41	0.55	0.63	0.71	0.90	**0.64**
Mean	**0.52**	**0.67**	**0.78**	**0.91**	**1.18**		**0.50**	**0.57**	**0.65**	**0.73**	**0.91**	
3-Sensitive varieties												
Supper Marmaned	0.54	0.61	0.76	0.86	1.14	**0.78**	0.53	0.55	0.67	0.79	0.87	**0.68**
Elots	0.45	0.75	0.86	0.98	1.33	**0.87**	0.53	0.54	0.66	0.76	0.90	**0.68**
Nora	0.54	0.75	0.84	0.89	1.14	**0.83**	0.48	0.60	0.69	0.72	0.75	**0.65**
Castel Rock Hy.	0.49	0.71	0.84	0.93	1.43	**0.88**	0.41	0.53	0.64	0.70	0.88	**0.63**
Supper Strain B	0.70	0.75	0.86	0.92	0.94	**0.83**	0.43	0.61	0.65	0.81	0.82	**0.66**
Wadistar	0.54	0.74	0.98	1.30	1.50	**1.01**	0.50	0.58	0.61	1.23	1.40	**0.86**
Mean	**0.54**	**0.72**	**0.86**	**0.98**	**1.25**		**0.48**	**0.57**	**0.65**	**0.84**	**0.94**	
Grand mean	**0.52**	**0.65**	**0.80**	**0.91**	**1.13**		**0.49**	**0.58**	**0.68**	**0.80**	**0.94**	
L.S.D at 5% for	**Varieties (v)**	**Salinity levels (s)**	**(V)*(S)**				**Varieties (v)**	**Salinity levels (s)**	**(V)*(S)**			
	0.037	0.020	0.079				0.044	0.025	0.098			

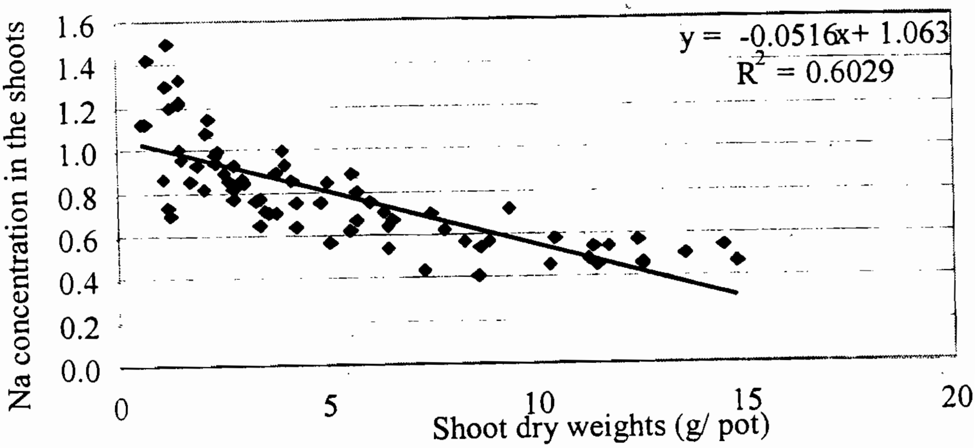

Fig. 2: Relation between shoot dry weights and Na concentration in the shoots of various tomato varieties.

2-2 Chloride concentration:

Since chloride was the dominant anion in the saline soil used in this experiment, it accumulates in both roots and shoots, and increased by increasing salinity levels, irrespective of tomato varieties (Table 3).

It was noticed also that, Cl concentration in shoots reached about 2 fold that found in the roots which was true for all varieties (as an average across soil salinity), where it ranged between 2.92% and 3.41 % in shoots and between 1.28 and 1.63% in roots of various tomato varieties. Concerning the interaction effect of soil salinity levels and various tomato varieties, the obtained data revealed that for each varieties Cl concentration increased by increasing soil salinity.

However, there was some fluctuation between varieties in their response to salinity, where at lower salinity level (1.78 dS m^{-1}) Cl % in shoots ranged between 1.31 and 1.78%, and between 0.5 and 0.86 in roots, while at higher salinity levels it ranged between 3.93 and 6.28%. in shoots and between and 1.73 and 2.84% in roots .Moreover, it could be noticed that, Cl was accumulated in proportion to soil salt levels and in greater amounts than Na, which was in accordance with Perez-Alfocea *et al.* (1996) who stated that Cl % in shoots was 3-6 times higher than Na%., and attributed the great Cl accumulation in shoots to maintain an osmotic gradient at moderately salinity.

2-3 Potassium concentration:

Concerning K concentration, the data presented in Table 4 showed that K% in both shoots and roots declined as soil salinity increased (as an average across varieties). However, there was little variation between varieties, regardless salinity effects, where average values of K% ranged between 2.47 and 3.7 % in shoots and between 1.81 and 2.3 % in roots.

Table 3 :Effect of salinity levels on chloride concentration (%) in shoots and roots of various tomato varieties

	Shoots						Roots					
Tomato varieties	Soil salinity levels (dS m^{-1})											
	1.78	6.05	7.44	9.62	11.85	mean	1.78	6.05	7.44	9.62	11.85	mean
1-Moderately tolerant varieties												
Advantage	1.31	2.55	3.26	3.79	3.99	**2.98**	0.60	1.66	1.83	1.84	2.20	**1.63**
Soufei	1.78	2.31	3.20	3.37	3.93	**2.92**	0.70	1.29	1.41	1.59	1.99	**1.40**
Castel Rock O.P.	1.49	2.91	3.08	4.50	4.68	**3.33**	0.50	1.13	1.48	2.14	2.55	**1.56**
mean	**1.53**	**2.59**	**3.18**	**3.89**	**4.20**		**0.60**	**1.36**	**1.57**	**1.86**	**2.25**	
2-Moderately sensitive varieties												
Alwasifi	1.71	2.77	2.95	3.31	4.04	**2.96**	0.60	1.22	1.58	1.92	1.98	**1.46**
To -897	1.66	2.37	2.55	3.61	5.05	**3.05**	0.50	1.24	1.43	1.50	1.73	**1.28**
Saria	1.49	2.37	2.55	3.97	6.28	**3.33**	0.49	0.78	1.49	1.64	2.02	**1.28**
Crystal	1.66	2.73	3.44	3.62	4.62	**3.21**	0.69	1.31	1.51	1.64	1.87	**1.40**
Nemathoda 1400	1.31	2.55	2.73	3.62	5.92	**3.23**	0.81	0.93	1.35	1.88	2.01	**1.40**
Madeer	1.66	2.91	3.64	3.79	5.04	**3.41**	0.79	0.81	1.48	2.05	2.44	**1.51**
mean	**1.58**	**2.62**	**2.98**	**3.65**	**5.16**		**0.65**	**1.05**	**1.47**	**1.77**	**2.01**	
3-Sensitive varieties												
Supper Marmaned	1.78	2.51	3.39	3.57	4.12	**3.07**	0.50	0.75	0.93	1.97	2.79	**1.39**
Elots	1.31	2.02	3.26	3.63	5.38	**3.12**	0.50	1.22	1.35	1.56	2.41	**1.41**
Nora	1.67	2.40	2.93	3.47	4.16	**2.93**	0.50	0.93	1.35	1.65	2.61	**1.41**
Castel Rock Hy.	1.59	2.77	2.95	3.66	4.01	**3.00**	0.50	0.79	0.82	1.51	2.84	**1.29**
Supper Strain B	1.31	2.37	3.44	3.79	5.73	**3.33**	0.86	1.01	1.39	1.82	2.78	**1.57**
Wadistar	1.77	2.83	3.35	3.39	5.47	**3.36**	0.50	1.13	1.51	1.90	2.49	**1.51**
mean	**1.57**	**2.48**	**3.22**	**3.59**	**4.81**		**0.56**	**0.97**	**1.23**	**1.74**	**2.65**	
Grand mean	**1.57**	**2.56**	**3.11**	**3.67**	**4.83**		**0.60**	**1.08**	**1.39**	**1.77**	**2.31**	
L.S.D at 5% for	varieties (v)	Salinity levels (s)	(V)*(S)				varieties (v)	Salinity levels (s)	(V)*(S)			
	0.140	0.081	0.314				0.091	0.053	0.205			

Table 4 :Effect of salinity levels on potassium concentration (%) in shoots and roots of various tomato varieties

	Shoots						Roots					
Tomato varieties	Soil salinity levels (dS m^{-1})											
	1.78	6.05	7.44	9.62	11.85	mean	1.78	6.05	7.44	9.62	11.85	mean
1-Moderately tolerant varieties												
Advantage	4.13	3.90	3.23	2.48	2.44	**3.24**	2.57	2.49	2.31	1.88	1.59	**2.17**
Soufei	4.69	4.34	3.60	3.19	2.70	**3.70**	2.98	2.61	2.22	1.97	1.70	**2.30**
Castel Rock O.P.	5.03	4.16	3.41	2.70	2.14	**3.49**	2.32	2.12	2.07	1.93	1.99	**2.09**
mean	**4.62**	**4.13**	**3.41**	**2.79**	**2.43**		**2.62**	**2.41**	**2.20**	**1.93**	**1.76**	
2-Moderately sensitive varieties												
Alwasifi	4.44	3.90	3.51	2.90	2.07	**3.36**	2.42	2.30	2.23	2.19	1.90	**2.21**
To -897	3.90	3.86	3.60	2.85	1.95	**3.23**	2.46	2.13	2.01	1.77	1.45	**1.96**
Saria	4.43	4.24	4.01	3.11	2.06	**3.57**	2.31	2.30	2.16	1.94	1.77	**2.10**
Crystal	4.23	4.12	3.39	2.92	2.28	**3.39**	2.09	2.02	1.98	1.71	1.45	**1.85**
Nemathoda 1400	4.94	3.88	3.79	3.00	2.59	**3.64**	2.47	2.34	2.21	2.12	1.77	**2.18**
Madeer	4.84	4.01	3.85	3.69	1.88	**3.65**	2.61	2.58	2.15	1.92	1.86	**2.22**
mean	**4.46**	**4.00**	**3.69**	**3.08**	**2.14**		**2.39**	**2.28**	**2.12**	**1.94**	**1.70**	
3-Sensitive varieties												
Supper Marmaned	4.46	4.20	3.19	2.63	1.29	**3.15**	2.62	2.47	1.68	1.47	1.26	**1.90**
Elots	4.16	3.41	2.85	2.44	2.21	**3.01**	2.64	2.02	1.70	1.63	1.44	**1.89**
Nora	4.43	3.99	3.79	3.19	2.93	**3.67**	2.31	2.18	2.01	1.79	1.58	**1.97**
Castel Rrock Hy.	3.56	3.45	2.63	2.48	2.10	**2.84**	2.38	2.30	1.67	1.40	1.29	**1.81**
Supper Strain B	4.24	3.94	3.86	2.02	0.79	**2.97**	2.38	2.32	1.66	1.42	1.32	**1.82**
Wadistar	3.34	2.85	2.29	2.14	1.73	**2.47**	2.23	2.11	2.01	1.46	1.40	**1.84**
mean	**4.03**	**3.64**	**3.10**	**2.48**	**1.84**		**2.43**	**2.23**	**1.79**	**1.53**	**1.38**	
Grand mean	**4.32**	**3.88**	**3.40**	**2.78**	**2.08**		**2.45**	**2.29**	**2.00**	**1.77**	**1.58**	
L.S.D at 5% for	varieties (v)	Salinity levels (s)	(V)*(S)				varieties (v)	Salinity levels (s)	(V)*(S)			
	0.103	0.059	0.230				0.123	0.071	0.276			

Concerning the interaction effect of salinity and varieties, the data revealed that, for each variety, increasing soil salinity levels decreased K% in both roots and shoots. Moreover, the adverse effect becomes more pronounced at higher salinity levels particularly in sensitive varieties.

The inhibition effect of salinity on potassium concentration may be attributed to the antagonism between excess of sodium as well as calcium and potassium

2 – 4 Potassium/ sodium ratio:

As discussed in the previous section soil salinity induced an increase in sodium concentration and decrease in K concentration, consequently K/Na ratio decreased by increasing soil salinity (Table 5) the reduction was more pronounced at high salinity levels. Which was in accordance with the finding of Cachorro (1993) and Grattan and Grieve (1999). In this respect Song and Fujiyama (1996) stated that sodium induced K deficiency has been implicated in growth and yield reduction of tomato. However, the varieties that could tolerate salinity up to 6 dS m^{-1} (Advantage, Castle Rock O.P. and Soufei) exhibit higher K/Na ratio in the shoots compared to the salt sensitive varieties. The basic differences between varieties was in their ability to discriminate between Na and K in uptake and translocation, it appears that in salt sensitive varieties Na was utilized more readily, possibly also substituting for K in metabolic sites causing adverse effects on plant growth. While salt tolerance varieties prevent Na translocation to the tops and K uptake was less depressed than in salt sensitive varieties (Marschner, 1998).

In this respect, Dasgan *et al.*. (2002) found that the degree to which plants tolerate salt stress was correlated with their capacity to maintain a high K/Na ratio in young leaves of tomato

Table 5: Effect of salinity levels on potassium/sodium concentration ratio (%) in shoots and roots of various tomato varieties

Tomato varieties	Shoots						Roots					
	Soil salinity levels (dS m^{-1})											
	1.78	6.05	7.44	9.62	11.85	mean	1.78	6.05	7.44	9.62	11.85	mean
1-Moderately tolerant varieties												
Advantage	7.65	6.96	4.25	3.06	2.87	**4.96**	5.14	3.95	3.21	2.35	1.87	**3.30**
Soufei	10.20	9.43	5.14	4.20	3.25	**6.44**	6.34	4.92	2.61	2.07	1.75	**3.54**
Castel Rock O.P.	12.58	9.67	5.25	3.91	2.93	**6.87**	4.14	2.83	2.65	2.01	1.54	**2.63**
Mean	**10.14**	**8.69**	**4.88**	**3.72**	**3.02**		**5.21**	**3.90**	**2.82**	**2.14**	**1.72**	
2-Moderately sensitive varieties												
Alwasifi	8.88	5.49	4.13	2.93	1.88	**4.66**	5.04	4.26	3.72	3.17	2.38	**3.71**
To -897	8.67	5.85	4.50	3.52	1.47	**4.80**	4.64	3.38	2.54	2.11	1.31	**2.80**
Saria	7.91	6.14	5.35	3.49	1.67	**4.91**	4.20	4.11	3.60	2.77	1.97	**3.33**
Crystal	7.55	6.34	4.84	3.24	2.11	**4.82**	4.54	3.96	3.30	2.71	1.75	**3.25**
Nemathoda 1400	10.98	6.06	5.05	3.23	2.14	**5.49**	4.57	3.90	3.16	2.72	1.99	**3.27**
Madeer	7.93	6.08	4.53	3.88	1.66	**4.82**	6.37	4.69	3.41	2.70	2.07	**3.85**
Mean	**8.65**	**5.99**	**4.73**	**3.38**	**1.82**		**4.89**	**4.05**	**3.29**	**2.70**	**1.91**	
3-Sensitive varieties												
Supper Marmaned	8.26	6.89	4.20	3.06	1.13	**4.71**	4.94	4.49	2.51	1.86	1.45	**3.05**
Elots	9.24	4.55	3.31	2.49	1.66	**4.25**	4.98	3.74	2.58	2.14	1.60	**3.01**
Nora	8.20	5.32	4.51	3.58	2.57	**4.84**	4.81	3.63	2.91	2.49	2.11	**3.19**
Castel Rock Hy.	7.27	4.86	3.13	2.67	1.47	**3.88**	5.80	4.34	2.61	2.00	1.47	**3.24**
Supper Strain B	6.06	5.25	4.49	2.20	0.84	**3.77**	5.53	3.80	2.55	1.75	1.61	**3.05**
Wadistar	6.19	3.85	2.34	1.65	1.15	**3.04**	4.46	3.64	3.30	1.19	1.00	**2.72**
Mean	**7.54**	**5.12**	**3.66**	**2.61**	**1.47**		**5.09**	**3.94**	**2.74**	**1.91**	**1.54**	
Grand mean	**8.50**	**6.18**	**4.33**	**3.14**	**1.92**		**5.03**	**3.98**	**2.98**	**2.27**	**1.72**	
L.S.D at 5% for	varieties (v)	Salinity levels (s)	(V)*(S)				varieties (v)	Salinity levels (s)	(V)*(S)			
	0.053	0.031	0.120				0.013	0.008	0.030			

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استجابة بادرات الطماطم لملوحة التربة

يوسف على عبد العال ، سيد طه أبوزيد وشيماء حافظ نصر الصباغ
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نفذت تجربة أصص لتقييم أثر خمسة مستويات من ملوحة التربة (١,٧٨، ٦,٠٥، ٧,٤٤، ٩,٦٢، ١١,٨٥ ديسيمنز/م) وذلك باستخدام خليط مكون من ملحي ص كل ، كا كل$_2$ بنسبة ١:١ على النمو والتركيب الايونى لخمسة عشر صنف من أصناف الطماطم (أدفا نتج ، الوصيفى ، كاسل روك مفتوح التلقيح ، ، كاسل روك هجين ،الأوتس ،مادير ، نيماتودا ١٤٠٠ ،كريستال ،ساريا ،صوفي ، سوبر مارمند ،سوبر سترين بى، تو-٨٩٧، نورا و وادي ستار).

أدت زيادة مستويات الملوحة إلى نقص الوزن الجاف لكل من الأجزاء الخضرية والجذور لبادرات الطماطم بشكل عام. وأنه بناء على الوزن الجاف النسبي للأجزاء الخضرية ، قسمت أصناف الطماطم إلى أصناف متوسطة التحمل للملوحة وأصناف متوسطة الحساسية للملوحة وأصناف حساسة للملوحة . أدت زيادة مستويات ملوحة التربة إلى زيادة تركيز كل من الصوديوم والكلوريد في كلا من الأجزاء الخضرية والجذور بينما انخفضت تركيزات البوتاسيوم كما أدت زيادة مستويات الملوحة إلى انخفاض النسبة بين تركيز البوتاسيوم إلى تركيز الصوديوم في كل من الأجزاء الخضرية والجذور لبادرات الطماطم .أظهرت الأصناف متوسطة التحمل للأملاح نسبة عالية بين تركيز البوتاسيوم إلى تركيز الصوديوم في الأجزاء الخضرية بالمقارنة بالأصناف متوسطة الحساسية والحساسة للملوحة.