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Response of Sunflower (*Helianthus annuus* L.) to Plants Salt Stress under Different Water Table Depths

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Abstract: Field plot study was initiated to determine the effects of different soil types, i.e. different salt affected soil and soil water depth on growth of sunflower (*Helianthus annuus L.*) through the first 30 days. A field plots experiment were conducted in senores El-Fayoum governorate, through 12 soil profile in Four plots represented four different soil types i.e., Non saline, Saline, Saline Alkali and Alkaline soil with three different profile depth i.e. 110, 100 and 80 cm during the summer season of 2004-2005. The obtained results revealed that sunflower seeds of fedok cultivar could germinate under different salt affected soils. Salinity and/or alkalinity has both osmotic and specific ion effects as well as soil depth (water table depth) on plant growth. In present study, salt stress caused a significant decreases in the studied growth parameters as well as macro and micronutrients concentration. The negative effect of salinity and alkalinity on plant was due to osmotic potential by salt in the soil solution which reduced cell water required from soil solution. Therefore, in plants, the uptake of some nutrients dissolved in water were also restricted. Thus, growth and development of plants are inhibited due to occurring defect in metabolism. Proline accumulation in response to different salt stresses was significantly increased in leaf tissues. High levels of Na^+ inhibited the K^+ concentration and as a result of this, it caused an increase in Na^+/K^+ ratio. This may be causes a disturbance in the ion balance in plant by an increase in the Na^+ uptake, reflecting enhanced ion concentration in the leaves. In the light of the obtained results in this study, it could be said that the further studies by using new techniques should be carried out to reach more certain realistic results for its remediation the effect of salt stress in the soils.

Key word: Soil quality, Soil depth, Salinity levels, Sunflower vegetative stage, chlorophyll and praline content.

INTRODUCTION

Salt affected soils occupy wide regions scattered all over the world [about 954 millions of hectares,[46]]. About 23% of the world's cultivated lands saline and 37 % is sodic[22]. Salinity and / or alkalinity are serious problem throughout the world particularly in newly reclaimed areas in Egypt and the plants differ in their ability to grow under these conditions.

The resistance of alkali stress of sunflowers [*Helianthus annuus* L] is stronger than that of other crops. Some sunflower breeds are able to grow on alkalinized soil however, there are very few reports about sunflower resistance to salt stress or alkali stress[24]. In different plant species it was found that salinity stress caused accumulation of soluble sugars, free proline and soluble proteins in germinating seed and leaf growth is most inhibited under drought and salinity[53,52].

Many of the studies in the area of plant nutrition and salinity and / or alkalinity interactions have been conducted in sand or solution cultures. A major difficulty in understanding plant nutrition as it is effected by soil salinity is reconciling results obtained in experiments conducted in the field and in solution cultures[2]. In the field,the concentrations of some nutrients in the soil solution, particularly P, K and the micronutrients, are controlled by the solid phase and concentrations are much lower than those in nutrient solutions. In addition, certain nutrients in soil system undergo transformations such as nitrification [ammonium to nitrate] which may be affected by salinity[21]. To complicate matters further, field studies must content with extreme variability in salinity, soil moisture, soil texture and soil nutritional status. The factors vary in location, depth and time.

The objective of the present study was to evaluate the response of sunflower [*Helianthus annuus* L] to grow on different salt affected soils [non saline, saline, saline alkaline and alkaline soils] under different water table.

MATERIALS AND METHODS

Two field experiments were conducted in Senores El-Fayoum governorate. The excremental area bounded by Bahr Tandud irrigation canal on western side and

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Table 1: Some physical and chemical properties of the studied soils

a- some physical properties

Soil types	Sand > 200 µ -20µ %	Silt 20 – 2 µ %	Clay ‹2 µ %	Soil texture class	S.P
Non -Saline	24.55	30.46	44.83	Clay	76.53
Saline	18.18	31.05	50.63	Clay	100.53
Saline alkali	24.21	28.45	47.45	Clay	101.01
Alkali	24.92	30.78	44.31	Clay	89.33

b- Chemical properties for studied soils and irrigation water

					Soluble Cations meq/l				Soluble anions meq/l				
Soil types	pH 01:02.5	E.C Cdm^{-1}	OM %	CaCO3 %	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	ESP
Non -Saline	7.9	2.04	0.92	1.58	11.87	6.83	11.01	0.41	--	2.62	6.82	20.63	5.91
Saline	7.7	7.79	2.37	1.66	6.13	9.75	57.23	0.39	--	2.62	38.34	36.31	9.68
Saline alkali	8.17	7.8	0.43	0.67	22.03	15.17	32.22	0.75	--	2.26	34.42	34.1	21.01
Alkali	8.01	3.69	1.51	0.93	3.38	3.87	36.31	0.35	--	3.04	16.79	16.68	19.51
Irrigation Water													
	8.6	3.49	--	--	9.15	4.92	20.45	0.36	--	20.38	4.41	10.08	--

Abo-Tarfaia main drain on the eastern one, which facilitates the disposal water of drainage system. Four plots represented four different salt affected soils [non saline, saline, saline alkali, alkali soils] under each soil type, three water table depth were chosen [110, 100 and 80 cm]. The used treatments were 12. [4 soil type x3 water table depth]. The experiment was setup in a complete randomized design with three replicates for each treatment as follows: 1) non saline soil with water table depth of 110 cm 2) saline soil with water table depth of 110 cm, 3) saline alkali soil with water table depth of 110 cm, 4) Alkali soil with water table depth of 110 cm. 5) non saline soil with water table depth of 100 cm, 6) saline soil with water table depth of 100 cm, , 7) saline alkali soil with water table depth of 100 cm, 8) Alkali soil with water table depth of 100 cm., 9) non saline soil with water table depth of 80 cm, 10) saline soil with water table depth of 80 cm , 11) saline alkali soil with water table depth of 80 cm ,12) Alkali soil with water table depth of 80 cm. The main analytical data were determined according Page *et al.*,[33] to the selected soils are presented in Table1 a and b. Sunflower seeds (*Helianthus annuus* L) Fedok variety as imported cultivar, were cultivated during the two successive season of 2004-2005.

Farmyard manure, super phosphate (15.5 % P_2O_5) and potassium sulphate (48 – 52 % K_2O) were incorporated into the soil during management practices i.e. at the rates of 20 m^3, 30 kg and 24 kg/ fed., respectively. Ammonium sulphate (20.5 % N) at the rate of 60 kg / fed for the 1st season and 60 kg / fed for the second one, as recommended in sunflower fields. Micro nutrients were sprayed three times as chelates at the rate of 100, 100 and 200 g/fed. from Mn (EDTA) 13 % ; Zn and Fe (EDTA) 14 % respectively.

Representative plant samples from three replicates of each treatment were randomly taken after 30 days from sowing and the following data were recorded during the two successive seasons:

1- Growth parameters: Dry weight g/ plant ; plant height (cm) was measured from the cotyledon node to the uppermost point of the plant, steam diameter, leaves number, leaf area index (cm^2).

2- Chemical analysis of leaf: photosynthetic pigments, i.e. chlorophyll a, chlorophyll b, (mg/g fresh leaves) were determined according to the methods described by Welburn and lichtenthaler[51]. Macro and micronutrients were determined according to the method described by Page *et al.*[33]. Free proline amino acid was estimated using the method of Botes[9].

3-Statistical analysis: Data of growth parameters as well as on chemical analysis of the leaf of the two growing seasons were subjected to conventional methods of analysis of variance. The combined data of both experimental seasons were used for results presentation. The least significant difference (L. S. D.) at 0.05 level of probability was calculated for each determined character under different used treatments and regression analysis for chlorophill and praline content in relation to soil EC..

RESULTS AND DISCUSSIONS

1-Effect of soil type:

1.1.Growth parameters: Data presented in Table (2) showed the effect of different soil types [non-saline, saline, saline alkali and alkaline] and three different depths of water table [110, 100 and 80 cm] on some growth parameters and nutrients content of sunflower grown for two seasons.

Table 2: Effect of soil type and water table depth on some growth parameters, chl. a and b and praline content in sunflower plants grown for two successive seasons after 30 days of planting.

Treatment		Growth parameters					photochemical parameters		
							Chloro-phyll a	Chloro phyll b	
Soil depth cm	SoilTypes	Plant height(cm)	Steam diameter (mm)	Leaves number	Leaf area index (cm^2)	Dry Weight g/plant	mg/g fresh weight		Praline mg/g dry weight
110	Non- Saline	49.67	7.63	17	57.68	1.41	0.36	0.73	0.2
	Saline	39.65	5.63	13	54.18	1.09	0.7	1	2.41
	Saline alkali	33.63	4.67	9	31.05	0.92	0.62	0.94	2.14
	alkali	26.61	3.67	7	19.88	0.75	0.54	0.88	2.02
Mean		37.39	5.41	11.5	40.7	1.04	0.56	0.89	1.69
100	Non-saline	49.33	7.33	17	55	1.34	0.48	0.7	0.2
	Saline	38.67	5.36	12	50.5	1.02	0.73	1.01	2.2
	Saline alkali	30.67	4.2	8	26.63	0.86	0.62	0.94	1.88
	alkali	24.06	3.36	6	17.71	0.71	0.55	0.91	1.38
Mean		35.67	5.06	10.75	37.46	0.98	0.59	0.89	1.42
80	Non-saline	47	7.3	16	52.83	1.42	0.45	0.75	0.1
	Saline	38.33	5.3	11	41.33	0.94	0.72	1.02	2.31
	Saline alkali	29	4	8	24.09	0.8	0.63	0.96	1.98
	alkali	22	3.33	6	13.33	0.7	0.57	0.93	1.4
Mean		34.08	4.98	10.25	32.9	0.97	0.59	0.92	1.45
Mean of soil type	Non-saline	48.67	7.42	16.67	55.17	1.39	0.44	0.71	0.19
	Saline	38.88	5.44	12	48.67	1.02	0.71	1	2.31
	Saline alkali	31.1	4.29	8.33	27.26	0.86	0.63	0.91	1.96
	alkali	24.2	3.45	6.33	16.97	0.72	0.55	0.88	1.64
LSD at level 0.05	Soil depth	1.69	0.54	0.74	2.12	0.02	0.02	0.06	0.11
	Soil quality	1.95	0.62	0.85	2.45	0.03	0.03	0.07	0.13
	interaction	NS	NS	NS	4.24	0.05	NS	NS	0.22

Data reveal that dry weight of plant, plant height, stem diameter, leaves number per plant of sunflower plants grown on saline, saline alkali and alkaline soils significantly decreased as compared with those grown on non-saline soil.

The highest values of the previous parameters were obtained from plants grown on non- saline soil followed by saline, saline alkali and alkaline soils in decreasing order. The obtained results indicate that alkalinity has more hazardous effect on the studied parameters of sunflower plants than salinity alone or salinity alkalinity together. The effects might be due to salinity which generally inhibits the growth of plants, through reduced water absorption, reduced metabolic activities due to Na^+ and Cl^- toxicity and nutrients deficiency caused by ionic interference[29].

Data, in general show that the studied growth parameters of sunflower plants grown on non- saline soil were better than those grown on saline, saline alkali and alkaline soils. This mean that salt stress inhibits plant growth by water deficiency and ion toxicity among other factors[17,13]. The obtained results in the current research are in good agreement with previous ones reported by Aziz,[4], who reported that salinity at all concentration ranges caused a significant decrease in plant height, number of branches, leaf area, fresh and dry weight of leaves as well as decreased fresh and dry weights of calyces and epicalyces of rosella plants.

1.2. Leaf area: Data in Table [2] show that leaf area index of sunflower plants grown on saline, saline alkali and alkaline soils significantly decreased as compared with those obtained from plants grown on non saline soil. This mean that the growth of sunflower seedling were inhibited by salinity and alkalinity and both salinity and alkalinity together and this effect tended to be more serious in plants grown on alkaline soil relative to that grown on saline and saline alkali soils and mean also that the inhibition effects on growth by salinity were increased with increasing alkalinity. Under the previous condition, the plasma membranes are injured more seriously with intensifying stress. In this concern Patakas *et al*,[34] stated that under severe water stress conditions caused by high salinity or drought plant growth sharply decreased and accumulate solutes in cells in order to maintain the cell volume and larger against dehydration. This phenomenon is known as osmotic adjustment, which has been observed in stem, leaves and fruits. Confirm the obtained results Sanchez Blanco *et al*,[39], Serpil *et al*.[40] and Shi and sheng[42] who reported that the effect of salinity and alkalinity on leaf area were significant and they recommended that the effects of salinity and alkalinity on electrolyte leakage rate were insignificant [$P < 0.001$) and the effect of alkalinity was greeter than that of salinity. They added that stressed plants had a significantly lower [$P < 0.05$] leaf area than that of the control treatment and the most important effect of stress reduced leaf area and decreased growth rate.

1.3.Chl. a and b: The results in Table [2] show that photosynthetic pigments [chlorophyll a and b] content in sunflower seedlings were significantly affected with different soil types. Chlorophyll a and chlorophyll b were significantly increased when sunflower was grown on saline, saline alkali and alkaline soils as compared with those grown on non-saline soil. The highest values of both chlorophyll a and b were found in plants grown on saline soil followed by saline alkaline, alkaline and non-saline soils in decreasing order. Confirm these results Robert and Roloyn[38] who stated that it was noteworthy that the rate of quenching of chlorophyll fluorescence was markedly increased in the salt-stressed sunflower leaves and at the steady state value quenching was slightly greater than in the control leaves. They added that changes in parameters of chl. fluorescence in response to salinity are less specific and not as dramatic. Although further study is necessary to evaluate fully the feasibility of chlorophyll fluorescence measurements for screening for salt tolerance, the results obtained are sufficiently encouraging suggest that it is worthwhile to that the method on verities or closely related species that are known to differ in salt tolerance. Data in Table (2) also show that the chlorophyll a and b content in the sunflower plants grown on alkaline soil were significantly decreased as compared with those obtained in plants grown on saline alkali or saline soils.

1.4.Proline content: Data in Table (2) show that praline content mg/g dry weight of sunflower plants grown on saline, saline alkali and alkali soils significantly increased as compared with those plants grown on non-saline soil. This means that proline contents increased with rising salinity, the degree of increase also tended to be higher with upsurges in salinity. Similarly, the extent of proline accumulation also increased with increasing alkalinity. Furthermore, the proline content increased most steeply when both salinity and alkalinity were high. These results demonstrate that alkali stress also can cause heavy accumulation of proline and that the physiological functions of the proline accumulated in sunflower, under salt and alkali mixed stress may not be just behave as an osmolyte and protectant but may also have other roles related to alkali stress. The highest values of proline content were found in plants grown on saline soil followed by saline alkali, alkali and non-saline soils in decreasing order. In this experiment, it is evident that proline content increased not only with salinity, but also when saline alkali and alkali soils were used for growing sunflower. The principal role of proline probably is not to reduce the osmotic potential, but to protect enzymes against dehydration and salt accumulation. Also, the ability of exogenous proline to maintain higher water content in severely stressed seedlings might be attributed to its contribution to osmotic adjustment both directly by increasing the internal proline content and indirectly by increasing the internal contents of other amino acids[1].

The previous results of proline content in sunflower plants are in good agreement with those obtained by Nuran and Cakirlar[31], Abdel-Hamid *et al.,*[1] and Shi and Sheng[42] who stated that proline improve the salt-tolerance by protecting the protein turnover machinery against stress-damage and up-regulating stress protective proteins.

Data in Fig. 1 and 2 Considerable increases in both total chlorophyll (a and b) and proline were noticed compared with non –saline soil in positively correlation with soil EC. Johnston, *et al.*[21] concluded that the increase of the chlorophyll a*l*b ratio occurred at an early stage during recovery from sodium deficiency preceding the increase in chlorophyll concentration and the growth response. It is therefore likely that the low chlorophyll alb ratio may be intrinsically associated with the condition of sodium deficiency.

Changes in proline content in several crops had been correlated with their capacity to tolerate and adapt to salinity conditions. However, the role of proline in promoting tolerance to salt stress is a polemic theme. Some researchers admit that the increase in proline content is merely a salt stress effect, rather than a cause of tolerance. Nevertheless, there are other researchers that did not find any increase in proline content as result of salt stress possibly because it is a genetic feature to adapt to stress conditions.

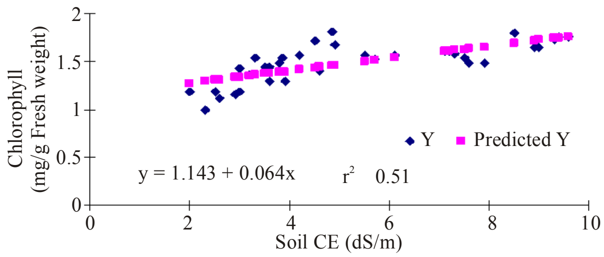

Fig. 1: Effect of soil EC on total chlorophyll content (mg/g fresh weight) in sunflower leaves after 30 days.

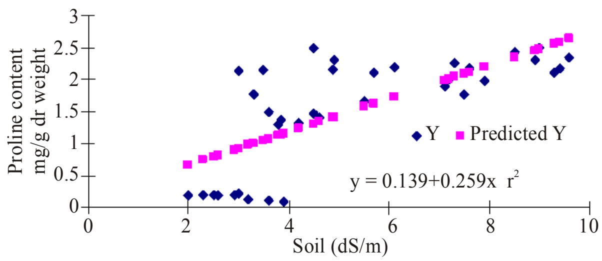

Fig. 2: Effect of soil EC on proline content (mg/g dry weight) in sunflower leaves.

1.5.Macronutrients (N, P, K, Na and Cl): Data in Table (3) show that Na concentration in sunflower seedling grown on saline, saline alkali and alkali soils significantly increased as compared with plants grown on non saline soil. The highest Na values were obtained in seedlings grown on alkali soil followed by those grown on saline alkali, saline and non-saline soils in decreasing order. This mean that the degree of Na^+ was significantly higher in plants grown on alkali soil as compared with those obtained from plants grown on saline alkali and/or saline soils. In this concern, some reports clearly demonstrated the existence of alkali stress and showed that it is more severe than salt stress[44,47]. The obtained results of Na concentration in sunflower seedlings are in good agreement with those obtained by Francois[16], Bareett-Lennard[7] and Shi and Cheng[42].

Generally, data show that K^+ concentration in seedling of sunflower grown on saline, saline alkali and alkali soils significantly decreased when compared with K^+ content in sunflower seedlings grown on non-saline soil. The highest K^+ values were attained in sunflower seedling grown on non-saline soil followed by those seedlings grown on saline, saline alkali and alkali soil in decreasing order. Confirm these results Grattan and Grieve[18] who reported that under saline-sodic or sodic conditions, high levels of external Na not only interfere with K^+ acquisition by the roots, but also may disrupt the integrity of root membranes and alter selectivity.

Results in Table (3) show that Na^+ increased and K^+ decreased not only with increasing salinity but also with rising alkalinity, a phenomenon perhaps related to plasma membrane being destroyed more severely by alkaline stress. These changes in Na^+ and K^+ are reflection of a reciprocal enhancement between salt stress and alkali stress, which was the peculiar feature of salt-alkaline mixed stress. Moreover, Na^+ and K^+ changes also reflected the effect of salt-alkali mixed stress on the metabolism of Na^+ and K^+ and indicate that the physiological responses of plant to salt-alkali mixed stress were more complex than that of salt stress alone. Confirm the previous results Weimberg[13] and de Lacerda *et al*.[50] who reported that Na^+ increased and K^+ decreased in plants stressed by salt and they added that high levels of Na^+ inhibited the K^+ concentration in sunflower plants and as a results of this it caused an increase in the Na^+/K^+ ratio.

Data presented in Table (3) show that Cl^- concentration in sunflower seedling which grown on saline, saline alkali and alkali soils was significantly increased as compared with those obtained in seedlings grown on non-saline soil. The highest Cl^- values were attained in seedling grown on saline alkali soil followed by those obtained from saline alkali an alkali soils in decreasing order. Came to the same results Francois[16] and Barrett-Lennard[7] who stated that as soil salinity increased Cl^- in both the petiole and blade tissue increased.

Data in Table (3) reveal that N concentration in the sunflower seedlings grown on saline, saline alkali and alkali soils significantly decreased as compared with those obtained in seedlings grown on non saline soil. The lowest N concentrations in sunflower seedlings were obtained when plants grown on alkali soil followed by saline alkali, saline and non-saline soils in increasing order. Confirm these results Pessarakli[35] and Al-Rawahy *et al.*[3] who stated that salinity can reduce N accumulation in plants. This is not surprising since an increase in Cl^- uptake and accumulation is often accompanied by a decrease in shoot-NO_3 concentration. Many scientists attributed this reduction of N conc. to Cl^- antagonism of NO_3^- uptake[5], while others attributed the response to salinity's effect on reduced water uptake[23]. Generally, the salinity-N relations of horticultural crops are obviously complex. The bulk of the studies indicate the N uptake or accumulation in the shoot may be reduced under saline conditions, although these are studies that found the opposite or no-effect[15].

Data in Table (3) show that the interaction between salinity and phosphorus (P) content of plants is equally as complex as that between salinity and N i.e. the P conc. in sunflower seedlings took the same trend of N conc. In most cases, salinity decreases the concentration of P in plant tissue, but the results of same studies indicate salinity either increased or had no-effect on P uptake. Phosphate availability is reduced in saline soils not only because of ionic strength effect that reduce the activity of

Table 3: Effect of soil types and water table depth on the concentration of some macro and micronutrients in sunflower plants grown for two successive seasons after 30 days of planting.

Treatment		Concentration of macro- nutrients in leaves				Concentration of micro -nutrients in leaves			
Soil depth Cm	Soil types	N %	P %	K %	Na %	Cl %	Fe ppm	Zn ppm	Mn ppm
110	Non-saline	3.79	0.33	2.7	0.48	0.23	248	72	92
	Saline	3.18	0.28	2.57	1.24	2.85	215	67	72
	Saline alkali	2.78	0.17	2.13	2.09	1.97	155	42	38
	alkali	2.65	0.16	1.73	2.94	1.44	116	32	22
Mean		3.1	0.24	2.28	1.69	1.62	183.5	53.3	56
100	Non-saline	3.34	0.31	2.63	0.4	0.18	233	70	85
	Saline	3.08	0.25	2.42	1.01	2.71	193	62	57
	Saline alkali	2.94	0.16	2.06	1.73	1.88	144	40	32
	alkali	1.91	0.14	1.48	2.51	1.18	106	30	20
Mean		2.82	0.22	2.15	1.41	1.49	169	50.5	48.5
80	Non-saline	3.19	0.28	2.53	0.36	0.13	218	68	80
	Saline	3	0.21	2.34	0.9	2.48	182	57	51
	Saline alkali	2.39	0.17	2.04	1.42	1.7	134	35	28
	alkali	1.81	0.13	1.4	2.14	1.07	93	28	20
Mean		2.6	0.2	2.02	1.21	1.35	156.8	47	44.8
Mean of soil type	Non-saline	3.44	0.31	2.62	0.41	0.18	233	70	85.7
	Saline	3.09	0.25	2.44	1.05	2.68	197	62	60
	Saline alkali	2.7	0.17	2.08	1.75	1.85	149	39	32.7
	alkali	2.12	0.14	1.54	2.53	1.23	105	30	20.7
Mean of soil depth Cm	110	3.1	0.24	2.28	1.69	1.62	183.5	53.3	56
	100	2.82	0.22	2.15	1.81	1.49	169	50.5	48.5
	80	2.6	0.2	2.08	1.21	1.35	156.8	47	44.8
LSD at 0.05 level	Soil depth	0.16	0.01	0.12	0.02	0.02	6.06	2.61	2.57
	Soil quality	0.19	0.01	0.14	0.02	0.02	6.99	3.02	2.96
	interaction	NS	0.02	NS	0.04	0.04	NS	NS	N.S

%: g/100 gram dry weight ppm: mg/ kg dry weight

phosphate but also because phosphate concentrations in soil solution are tightly controlled by sorption processes and by the low-solubility of Ca-P minerals. Therefore, it is understandable that phosphate concentrations in field-grown agronomic crops decreased as salinity ($NaCl+CaCl_2$) increased.

1.6.Micronutrients (Fe, Zn and Mn): It was observed from the presented data in Table (3) that the concentrations of Fe, Zn and Mn in the sunflower seedlings grown on saline, saline alkali and alkali soils were significantly decreased when they compared with their corresponding elements in the seedling grown on non-saline soil. The highest values of Fe, Zn and Mn concentration in sunflower seedlings were obtained when plants grown on non-saline soil followed by those grown on saline, saline alkali and alkali soils in decreasing order. In saline and sodic soils, the solubility of micronutrients (e.g. Fe, Zn and Mn) is particularly low and plants grown in these soils often experience deficiencies in these elements[32], but not in all cases. Most studies on horticultural crops, regardless of whether they were conducted in soils or in solution culture, indicate that salinity reduces Mn concentration in shoot tissue. Example include bean[37]. Confirm the previous results Shukla and Mukhi,[45] who stated that Zn conc. in shoot tissue has been found to decrease with increasing sodicity. Furthermore, Hassan *et al.*[20] stated that salinity decreased the Fe conc. in the shoots of barely and corn. Generally, the relationship between salinity and/or alkalinity and trace element nutrition is complex and salinity may increase, decrease or have no effect on the micronutrient concentration in plant shoots[18]. The obtained results in this investigation are in line with those obtained by Vieira Santos *et al.*[49] who reported that KCl decreased NO_3^-, Mn, Fe, P and B in whole sunflower plant.

2- Effect of water table depth: Data in Table (2) show that all the growth parameters of sunflower seedlings decreased gradually with decreasing the depth of water table from 110 to 80 cm. Regardless the effect of soil types the dry weight per plant, plant height, stem diameter and leaves number of seedlings grown under water table depth of 100 cm were significantly higher as they compared with those of seedlings grown on soils with water table depth of 100 and 80 cm. However, the previous parameters of the seedlings grown under water table depth of 100 cm did not reach the level of significance of 0.05 as compared with those attained under water table depth of 80 cm.

Data in Table (2) also show that, regardless of the soil types effect, the leaf area index as well as chl. a and b significantly decreased by decreasing the water table depth from 110 to 80 cm. The highest values were attained when the seedlings of sunflower were grown under water table depth of 110 cm followed by those under 100 and 80 cm in decreasing order.

Proline content also significantly decreased in sunflower seedlings grown under water table depth of 100 and 80 cm as compared with those grown under water table depth of 110 cm. Proline content in seedling grown under water table depth of 100 cm did not show any significant differences as compared with those grown on soil with water table depth of 80 cm. The highest values of proline content were found under water table depth of 110 cm followed by those under 100 and 80 cm in decreasing order. Saline and/or alkali soils is subjected to waterlogging (saturation of the soil) because of the present of shallow water tables sodcity[36]. This waterlogging has a range of effect on plants. Firstly, it rapidly decreases growth, initially of roots and subsequently of shoots[6] and it increases the senescence of roots, leginning at the tips[6]. Secondly, it affects processes associated with solute movement across membranes, such as the uptake of inorganic nutrients[10], the regulation of cytoplasmic pH and membrane potentials[19] and the efflux of internal cell constituents such as K^+, Cl^-, organic and amino acids and "basic and acidic metabolites"[11]. Thirdly, it can decrease stomatal conductance and/or leaf water potential[14].

Data presented in Table (3) reveal that the concentrations of macro (N, P and K) and micronutrients (Fe, Zn and Mn) in sunflower seedlings grown under water table depth of 100 cm were significantly higher than those obtained in seedlings grown under water table depth of 100 and 80 cm. Also, the concentration of all studied nutrients were significantly higher in sunflower seedlings grown under water table depth of 100 when compare with 80 cm. Generally the highest values of all macro and micronutrients were attained under water table depth of 100 cm followed by 100 and 80 cm in decreasing order. The presented data here (Table 3) suggest a potentially over-looked role of soil depth (water table depth) on nutrient uptake. For such nutrients to be available to plants, these must be sufficient water in soil for diffusion or mass flow of the nutrients to occur. The hydraulic redistribution may provide that water, potentially mobilizing nutrients at water table depth. This effect at water table depth of 80 cm was higher as compared with those water table depths of 100 and 100 cm. In this concern, Mc Culley *et al.,*[27] stated that the possible role for hydraulic redistribution may help reconcile discrepancies with forehole data showing mineral changes in soil moisture contents at depth, hydraulic redistribution would mobilize nutrients directly around roots where nutrient uptake occurs.

3- Interaction between soil types and water table depths: Data in Tables (2 and 3) show the interaction effect of the soil types under different water table depths on growth parameters, chl. a and b, proline content and concentrations of macro and micronutrients in sunflower seedlings. The interaction between soil types and water table depths did not significantly affect dry weight/plant, plant length, stem diameter and leave number/plant, while it significantly affected the leaf area index. The highest values of the leaf area index were attained in seedling grown on non-saline soil with water table depth of 100 cm, while the lowest values were found when the seedlings of sunflower were grown on alkali soil with water table depth of 80 cm.

Proline content was significantly affected with the interaction between soil types and water table depths. The highest values of the proline content was obtained in sunflower seedlings grown on saline soil with water table depth of 110, while the lowest ones were found when seedlings were grown on non-saline soil with water table depth of 80 cm.

Nitrogen, K, Fe, Zn and Mn concentrations (Table (3) in sunflower seedlings did not affect with the interaction between the soil types and the water table depths. On the other hand, P, Na^+ and Cl^- concentrations were significantly affected with the interaction between the soil types and the water table depths. Where the highest values of P were found in seedlings grown on non-saline soil with water table depth of 110 cm, while the lowest values were attained when the seedlings were grown on alkali soil with water table depth of 80 cm. Concerning Na^+ concentration, the highest values were obtained when seedlings were grown on alkali soil with water table depth of 100 cm, while the lowest ones were attained when seedlings were grown on non-saline soil with water table depth of 80 cm. Furthermore, data show that the highest Cl^- values were found in seedlings grown on saline soil with water table depth of 100 and the lowest values were obtained in seedlings grown in non-saline soil with 80 cm water table depth. Generally, the highest values of P, Na^+ and Cl^- were obtained when the water table depths were at 110 cm, while the lowest values were found when the water table depths were 80 cm. These results are in good agreement with those obtained under the effect of water table depths on nutrients concentration in this investigation.

Conclusion: The sunflower seeds of fedex cultivar could germinate under different salt affected soils. Salinity and/or alkalinity has both osmotic and specific ion effects as well as soil depth (water table depth) on plant growth. In present study, salt stress caused a significant decreases in the studied growth parameters as well as macro and micronutrients concentration. The negative effect of salinity and alkalinity on plant was due to osmotic potential by salt in the soil solution which reduced cell water required from soil solution. Therefore, in plants, the uptake of some nutrients dissolved in water were also restricted. Thus, growth and development of plants are inhibited due to occurring defect in metabolism. Proline accumulation in response to different salt stresses was significantly increased in leaf tissues. High levels of Na^+ inhibited the K^+ concentration and as a result of this, it caused an increase in Na^+/K^+ ratio. This may be causes a disturbance in the ion balance in plant by an increase in the Na^+ uptake, reflecting enhanced ion concentration in the leaves.

In the light of the obtained results in this study, it could be said that the further studies by using new techniques should be carried out to reach more certain realistic results for its remediation the effect of salt stress in the soils.

REFERENCES

1. Abdel-Hamid, A. Khaedr, Mohammad, A. Abbas, Amal, A. Abdel-Wahid, W. Paul Quick and Gaber, M. Abogadallah, 2003. Proline induces the expression of salt-stress-responsive proteins and may improve the adoption of *Pancratium maritimum* L. to salt stress. J. of Experimental Botany, Vol.54, No.392, pp: 2553-2562.
2. Adam, J.F. and T.A. Doerge, 1987. Soil salinity and soil acidity as factors in plant nutrition. In: Boersma, L.L. (Ed.), Future Developments in Soil Science Research. Soil Sci. Soc. Am., Madison, WI., pp: 193-203.
3. Al-Rawahy, S.A., J.L. Stroehlein and M. Passarakli, 1992. Dry matter yield and nitrogen. 15, Na^+, Cl^- and K^+ content of tomatoes under sodium chloride stress. J. Plant Nutr., 15: 341-358.
4. Aziz, Eman, E., 1992. Effect of soil types and salinity on roselle plant (*Hibiscus safdariffa* L.). M. Sc. Thesis, Fac. Agric. Cairo Univ., Egypt.
5. Bar, Y., A. Apelbaum, U. Kafkafi and R. Goren, 1997. Relationship between chloride and nitrate and its effect on growth and mineral composition of avocado and citrus plants. J. Plant Nutr., 20: 715-731.
6. Barrett-Lennard, E.G., 1988. Effects of waterlogging on the growth and NaCl uptake by vascular plants under saline conditions. Reclam. Reveg. Res., 5: 245-261.
7. Barrett-Lennard, E.G., 2003. Interaction between waterlogging and salinity in higher plants: causes, consequences and implications. Plant and Soil, 253: 35-54.
8. Barrett-Lennard, E.G., P.D. Leighton, F. Buwalda, J. Gibbs, W.S. Armstrong, C.J. Thomson and H. Greenway, 1988. Effects of growing wheat in hypoxic nutrient solutions and of subsequent transfer to aerated solutions. I. growth and carbohydrate status of shoots and roots. Aust. J. Plant Physiol. 15: 585-598.
9. Bates, L.S., R.P. Waldren and I.D. Tear, 1973. Rapid determination of free proline for water-stress studies. Plant and Soil, 39: 205-207.
10. Buwalda, F., E.G. Barrett-Lennard, H. Greenway and B.A. Davies, 1988a. Effects of growing wheat in hypoxic nutrient solutions and of subsequent transfer to aerated solutions. II. Concentrations and uptake of nutrients and sodium in shoots and roots. Aust. J. Plant Physiol. 15: 599-612.
11. Buwalda, F., C.J. Thomson, W. Steigner, E.G. Barrett-Lennard, J. Gibbs and H. Greenway, 1988b. Hypoxia induces membrane depolarization and potassium loss from wheat roots but does not increase their permeability to sorbitol. J. Exp. Bot., 39: 1169-1183.
12. Cheeseman, J.M., 1988. Mechanisms of salinity tolerance in plants. Plant Physiol., 87: 547-550.
13. De Lacerda, C.F., J. Cambraia, M.A. Oliva, H.A. Ruiz and J.T. Prisco, 2003. Solute accumulation and distribution during shoot and leaf development in two sorghum genotypes under salt stress. Environ. Exp. Bot., 49: 107-120.

14. Else, M.A., D. Coupland, L. Dutton and M.B. Jackson, 2001. Decreased root hydraulic conductivity reduces leaf water potential, initiates stomatal closes and slow leaf expansion in flooded plants of castor oil (*Ricinus cmmunis*) despite diminished delivery of ABA from the roots to shoots in xylem sap. Physiol. Plant III, 46-54.
15. Feigin, A., 1985. Fertilization management of crops irrigated with saline water. Plant & Soil 89: 285-299.
16. Francois, L.E., 1996. Salinity effects on four sunflower hybrids. Agron. Journal, 88: 215-219.
17. Ghoulam, C., A. Foursy and K. Fares, 2002. Effect of saltstress on growth, inorganic ions and praline accumulation in relation to osmotic adjustment in fuie sugar beet cultivars. Environ. Exp. Bot., 47: 39-50.
18. Grattan, S.R. and C.M. Grieve, 1999. Salinity-mineral nutrient relations in horticultural crops. Scientia Horticulturae, 78: 127-157.
19. Greenway, H. and J. Gibbs, 2003. Mechanisms of anoxia tolerance in plants. II. Energy requirements for maintenance energy distribution to essential processes. Functional Plant Biol. (in press).
20. Hassan, N.A.K., J.V. Drew, D. Knudsen and R.A. Olson, 1970. Influence of soil salinity on production of dry matter, uptake and distribution of nutrients in barley and corn. II. Corn (*Zea mays* L.) Agron. J., 62: 46-48.
21. Jurinak, J.J. and R.J. Wagenet, 1981. Fertilization and salinity. In: Yoron, D. (Ed.), Salinity in irrigation and water Resources. Marcel Dekker, New York, pp: 103-119.
22. Khan, M.A. and N.C. Duke, 2001. Halophytes resources for future. Wetland Ecology and Management, 6: 455-456.
23. Lea-Cox, J.D. and J.P. Syvertsen, 1993. Salinity reduces water use and nitrate-N use efficiency of citrus. Ann. Bot., 72: 47-54.
24. Lui, X. and W.V. Baird, 2003. Differential expression of genes regulated in response to drought or salinity stress in sunflower. Crop Sci., 43: 678-687.
25. Marc, J. and J.H. Palmer, 1976. Relationship between water potential and leaf an inflorescence initiation in *Helianthus annuus*.
26. Marcum, K.B., 1999. Salinity tolerance mechanisms of grasses in the subfamily chloridoideae. Crop Sci., 39: 1153-1160.
27. Mc-Culley, R.L., E.G. Jobbagy, W.T. Pockman and R.B. Jackson, 2004. Nutrient uptake as a contribution explanation for deep rooting in arid and semi-arid ecosystems. Ocologia (2004) 141: 620-628.
28. Mchrota, N.K., V.K. Khanna and S.C. Agarwala, 1986. Soil-sodicity induced zinc deficiency in maize. Plant & Soil, 92: 63-71.
29. Mengel, K. and E.A. Kirkby, 1982. Principles of plant nutrition (3rd ed.). International Potash Institute. Worblaufen- Bern Switzerland, pp: 228-235.
30. Nonami, H., 1998. Plant water relations and control of cell elongation at low water potentials. J. Plant Res., 111: 373-382.
31. Nuran Cice and Hűsnű Cakirlar, 2002. The effect of salinity on some physiological parameters in two maize cultivars. Bulg. J. Plant Physiol., 2002, 28 (1-2), 66-74.
32. Page, A.L., A.C. Chang and D.C. Adriano, 1990. Deficiencies and toxicities of trace elements. Agricultural Salinity assessment and Management, Chapter 7, ASCE Manuals and Reports on Eng. Practice No. 71, ASCE, pp: 138-160.
33. Page, A.L., R.H. Miller and D.R. Keeney, 1982. Methods of soil analysis. Chemical and Microbiological Properties. Agronomy, Part 2, A.S.A, SSSA, Madison, Wisconsin, USA.
34. Patakas, A., N. Nikolaou, E. Zioziou, K. Radoglou and B. Noitsakis, 2002. The role of organic solute and ion accumulation in osmotic adjustment in drought- stressed grapevines. Plant Science, 163: 361-367.
35. Pessarakli, M., 1991. Dry matter yield, nitrogen-15 absorption and water uptake by green bean under sodium chloride stress. Crop Sci., 31: 1633-1640.
36. Qureshi, R.H. and E.G. Barrett-Lennard, 1998. Saline agriculture for irrigated land in Pakistan; A Handbook. Monograph No.50, Australian Center for International Agricultural Research, Canberra, pp: 142.
37. Rahman, S., G.F. Vance and L.C. Munn, 1993. Salinity induced effects on the nutrient status of soil, corn leaves and kernels. Comm. Soil Sci., Plant Anal. 24: 2251-2269.
38. Robert, M.S. and N. Robyn, 1982. Salt tolerance in crop plants monitored by chlorophyll fluorescence *in vivo*. Plant Physiol., 70: 1049-1054.
39. Sanchez-Blanco, M.J., P. Rodriguez, M.A. Morales, M.F. Ortuco and A. Torrecillas, 2002. Comparative growth and water relation of cistus albidus and cistus monspelensis plants during water deficit conditions and recovery. Plant Science, 162: 107-113.
40. Serpil űnyayer; Yűksel Keles and Elif űnal, 2004. Proline and ABA levels in two sunflower genotypes subjected to water stress. Bulg. J. Plant Physiol., 2004, 30: 34-47.
41. Sharpley, A.N., J.J. Meisinger, J.F. Power and D.L. Suarez, 1992. Root extraction of nutrients associated with long-term soil management. In: Stewart, B. (Ed.), Advances in Soil Science, Vol.19, Pringer, pp: 151-217.

42. Shi, D. and Y. Sheng, 2005. Effect of various salt-alkaline mixed stern conditions on sunflower seedlings and analysis of their stress factors. Environmental and Experimental Botany, 54: 8-21.
43. Shi, D.C. and L.J. Yin, 1992. Strain responses in Na_2CO_3- stressed *Leymus chinehsis* seedlings and their mathematical analysis. Acta Bot. sin. 34: 386-393 (in Chinese with English abstract)
44. Shi, D.C. and L.J. Yin, 1993. Differences between salt (NaCl) and alkaline (Na_2CO_3) stresses on *Puccinella lenuiflora* (Griseb) Scribn et Merr. Plants. Acta Bot. Sin. 35, 144-149 (in Chinese with English abstract)
45. Shukla, U.C. and A.K. Mukhi, 1985. Ameliorative role of zinc on maize growth (*Zea mays* L.) under salt affected soil conditions. Plant & Soil. 87: 423-432.
46. Szaboles, I., 1989. Salt affected soils. Ph.D.C. Sci. CRC Press, Inc. Boca Raton, Florida, 247P.
47. Tang, C. and N.C. Turner, 1999. The influence of alkalinity and water stress on the stomatal conductance, Photosynthetic rate and growth of *Lupinus angustifolius* L. and *Lupinus pilosus murr.* Aust. J. Exp. Agric., 39: 457-464.
48. Thomas, H., 1990. Osmotic adjustment in *Lolium pernne*; its heritability and nature of solute accumulation. Annals of Botany, 66: 521-530.
49. Vieira, Santos, C.L., A. Campos, H. Azevedo and G. Caldeira, 2001. In situ and in vitro senescence included by KCl stress Nutritional imbalance, lipid peroxidation and antioxidant metabolism. Journal of Experimental Botany, Vol. 52, No. 355, pp: 351-360.
50. Weinberg, R., 91987. Solute adjustments in leaves of two species of wheat at two different stages of growth in response to salinity. Physiol. Plant, 70: 381-388.
51. Wellburn, A.R. and H. Lichtenthaler, 1984. Formula and program to determine total carotenoide and chlorophyll a and b of leaf extract different solvents. In: Advances of photosynthesis research (Sybesma, C. ed.), Vol. II, 9-12.
52. Zdunek, E. and Sh. Lips, 2001. Transport and accumulation rates of abscisic acid and aldehyde oxidase activity in *Pisum sativum* L. in response to suboptimal growth conditions. Journal of Experimental Botany, 52: 301-308.
53. Zidan, M.A. and M.A. Elewa, 1995. Effect of salinity on germination, seedling growth and some metabolic changes in four plant species (umbelliferae) Indian J. Plant Physiol., 38: 57-61.