Ass. Univ. Bull. Environ. Res. Vol. 7 No. 1, March 2004

AUCES

RESPONSE OF SUGAR BEET (*BETA VULGARIS,* L.) TO POTASSIUM APPLICATION AND IRRIGATION WITH SALINE WATER

S.E. Abdel-Mawly* and I. Zanouny**

***Soil and Water Dept., Fac. of Agric., Al-Azhar Univ., Assiut Campus.**
****Soil Sci. Dept., Fac. of Agric., Minia Univ., El-Minia.**

ABSTRACT :

A pot experiment was conducted during the winter growing seasons of 2001/2002 and 2002/2003 in the greenhouse of the Faculty of Agric., Al-Azhar Univ., Assiut campus. A complete randomized design with four replications was used in this study. A combination of four potassium levels (0, 24, 48, and 72 kg K_2O /fed) with four levels of saline irrigation water (tap water, 2000, 4000 and 6000 ppm) on root yield and some chemical composition of sugar beet.

The mean effects of these interactions confirmed depressing manner in sugar beet growth with increasing salt concentration in the irrigation water up to 6000. The same trend holds true regarding both refineable sugar and purity percentages of the root juice. On contrary, TSS% in roots was significantly increased under such prevailing unfavourable conditions. The sustainable results ascertained the significance effect of salinity levels in irrigation water on K, Na or K/Na ratio in roots of sugar beet. Total soluble solids, refineable sugar, purity percentages of root juice, total root yield and top yield of sugar beet plants increased as K fertilizer increased. Generally, sugar beet plants could tolerate saline water up to 2000 ppm without impaired effects on growth yield and quality. Moreover, K application resulted in improving the quality of sugar beet roots either irrigated with saline water or with tap water.

INTRODUCTION:

Accumulation of excessive amounts of soluble salts in soil is a characteristic in arid and sub-arid regions, although not entirely limited to such areas. The ability of plants to tolerate excess salts in the rhizosphere is of considerable importance in arid and semi-arid regions where salinization of soil usually prevails. A large number of studies have been devoted to investigate the hazard effects of salinity on growth and yield of sugar beet plants (Plaut and Heuer, 1985; shehata, 1989; Darwhish *et al.*, 1995; Higazy *et al.*, 1995; El-Noemami 1996; Khafagi *et al.*, 1996 and Kandil *et al.*, 1999).

The germination of sugar beet seed can be inhibited in soils with high salt concentration. Therefore, sugar beet plant must be well established in the soil to tolerate high salt concentrations (Bernstein, 1964).

Sugar beet which is considered to be the second source for sugar production in Egypt has the ability to grow in the new soils that usually suffer from salinity and poor quality of irrigation water. It tolerates soil salinity and soil water stress (Hills *et al.*, 1990). It is well known that salinity retards plant growth through its influence on the osmatic adjustmented, reducing nutrient uptake (Greenway and Munns, 1980). Recently, the use of salt tolerant crops has been recognized as a successful method to overcome salinity problem (Meiri and Plaut, 1985). Roades and Loveday (1990) indicated that sugar yield of sugar beet was not affected by salinity up to an electrical conductivity value of soil paste extract (ECe) of 7dSm^{-1}.

Sugar beet grown under saline conditions showed a change in the chemical composition of leaves and roots. Since saline water has been proposed as an alternative irrigation source for sugar beet, attention should be focused on its positive and negative effects on quality and quantity of sugar beet (El-Wakeel, 1993; and Kaffka *et al.*, 1999).

El-Etreiby (2000) indicated that water quality and nutrients are the major limiting factors for sugar beet production in most of soils. Sugar beet plants grown under salinity stress showed imbalanced nutrient contents in their tissues. The effect of salt stress on the nutrient concentration in the plant varies among elements. Increasing the salt concentration in growth media resulted in reducing K uptake by sugar beet plants (Shehata *et al.*, 2000) and in turn, K content in shoots (Reda *et al.*, 1980).

Potassium fertilization became an important factor for sugar beet production under Egyption soils. Potassium has been given a credit for several important roles in plant nutrition associated with the quality of the product. It increases sugar content of beets and has an important biochemical role for sugar transport in plants (Balba, 1968). Saxena (1985) stated that attention should be paid to the economics of potassium response under salinity conditions. Sarkar and Ghosh (1989) reported that K application to sugar beet plants increased root yield. Liu *et al.* (1992) stated that K enhanced tolerance of sugar beet treated. Several investigators studied the effect of K application and salinity on sugar beet chemical composition. El-Maghraby *et al.* (1998), Khalil *et al.* (2001) found that sucrose, total soluble solids and purity of sugar beet juice increased with increasing K level, but decreased with salinity stress. Further, it was found that quality and quantity of sugar in sugar beet roots, was enhanced by K fertilization (El-Harriri and Gobarh, 2001).

The objective of this study is to evaluate the effects of saline irrigation water and fertilizer application of K on yield and quality of sugar beet.

MATERIALS AND METHODS:

The present investigation was carried out during two successive winter seasons of 2001/2002 and 2002/2003 in greenhouse Experimen, Faculty of Agriculture Al. Azhar Univ., Assiut campus. A clay loam was used soil in order to assess the response of root yield and quality of sugar beet (*Beta vulgari*, L.) to saline water and application of potassium. Plastic pots of 35 cm diameter and 50 cm in depth were used, teach provided with outlet in the bottom and filled with 20 kg of soil. Table (1) shows some physical and chemical properties of the studied soil surface layer 0–30 cm was dried and the tap water analysis. Pots were arranged in a factorial complete randomize design with four replicats. Before planting phosphorus fertilizer was added at a level of 200 kg/fed., i.e, 4 g/pot, as Suerphosphate (15.5% P_2O_5/fed). Ten seeds

of sugar beet Maghribel variety, were sown on October, 23 and 26 in the first and second season, respectively. The plants were thinned once at 35 days leave two plants/pot. Nitrogen was added at a level of 90 kg N/fed supplied as Ammonium Nitrite (33.5% N) in three equal doses i.e, 1.79 g/pot (immediately after thinning, two and four weeks after thinning), respectively.

The experiment included 16 treatments, which were combination of four saline water levels and four potassium levels. Potassium levels were the control treatment, 24, 48 and 72 kg K_2O/fed. This means that the K rates were 0,1,2 and 3 g/pot of potassium sulfate (48% K_2O). Fertilizer amounts were divided into two equal portions and then added after thinning and four weeks after thinning). After 45 days from sowing, sugar beet plants were subjected to four levels of salt concentration till harvest. The four salinity levels were 2000, 4000 and 6000 ppm in addition to tap water as control. In both seasons, the irrigation whether with tap water or saline water must reach the level of 65% of total field capacity of the soil by weighting every pot daily and adding amounts. The salt types that were used in irrigation water was almost same a mixture, which was suggested by Strognov (1962), Table (2).

The experiments were harvested after 180 days of sowing in both seasons and root and top yield/plant were estimated. The determination of total soluble solids (TSS) concentration in roots were estimated by using hand refractometer according to Simon *et al.* (1980). Refineable sugar content in the root yield was measured according to the method adopted by Le-Docte (1927). Purity percentages (Refineable sugar%/TSS×100) were determined according to Poschenok (1976). Potassium (K) and Sodium (Na) were measured in the top dry weight at harvest time, by using the Flamephotometer.

The obtained data were subjected to statistical analysis of variance described by Snedecor and Cochran (1981), and the combined analysis of results of the two seasons were applied according to the method adopted by Steel and Torrie (1960).

Table (1): Characteristics of the soil and tap water used.

Soil property	Value	Tap water
Pratical size distribution		
Sand (%)	36.4	-
Silt (%)	27.8	-
Clay (%)	35.8	-
Texture grade	clay loam	-
EC_e (dS/m)	0.81	0.47
pH (1:1 suspension)	7.9	7.4
Total Ca CO_3 (%)	2.6	-
Field capacity (%)	34	-
Soluble cations meq/l (in soil paste extract)		
Ca^{+2}	1.82	1.55
Mg^{+2}	0.79	0.76
K^{+}	1.39	1.18
Na^{+}	3.1	1.44
Soluble anions meq/l (in soil paste extract)		
CO_3^{-2}	nil	nil
HCO_3^{-}	0.90	1.82
Cl^{-}	2.91	1.86
SO_4^{-2}	2.83	0.98
Na HCO_3 extractable P (ppm)	6.8	
Na OAC extractable K (ppm)	275	

Total nitrogen (%) **Organic matter (%)**	**0.16** **1.5**	

Table (2) Salt and ion components of the salt mixture used for salinization.

% of total salt content					**% of total millequivalent**					
Mg SO_4	**Ca SO_4**	**Na Cl**	**Mg Cl**	**Ca CO_3**	**Na^+**	**Mg^{+2}**	**Ca^{+2}**	**SO_4^{-2}**	**Cl^-**	**CO_3^{-2}**
10	**1**	**78**	**2**	**9**	**38**	**6**	**6**	**5**	**40**	**5**

RESULTS AND DISCUSSION:

1-Root and Top Yield:

Root and top yields were significantly affected by saline water and different levels of potassium fertilization and their interactions (Tables 3 and 4). Significant decreases of root and top yields were observed with increasing salinity level of irrigation water. Data indicate that the use of saline water for irrigation at concentration of 2000 ppm resulted in a small decreases in root and top weight.

On the other hand, lowest significant increments were noticed when sugar beet plants were subjected to the high a level of salinization (6000 ppm). For instance, the reduction in root yield (g/plant) were 44 and 41.4% in both seasons. In top yield the result were 43.3 and 43% in two seasons respectively.

These results are well supported by those published by several authors concerning the effect of salinity on root and top yields of sugar beet plants (Higazy *et al.*, 1995; Darwhish *et al.*, 1995; El-Noemani, 1996; Khafagi *et al.*, 1996; Kandil *et al.*, 1999; Mekki and El-Gazzar, 1999 and El-Etreiby, 2000). The depressive effect of salinity on root and top yield is probably due to osmatic inhibition of water absorption, accumulation of certain ions in high concentration in plant tissues and alteration of the mineral balance of plants (Khafagi and El-Lawandy, 1996), and/or due to the reduction in photosynthetic activity and carbohydrates metabolisum (Heuer and Plaut, 1989). The decrease in dry matter accumulation is mainly due to increase in Na^+ and Cl^- under high salt stress causing a reduction in the activity of CO_2 –fixation during photosynthesis and a decrease in the enzymatic activity of the metabolic processes (Ahmed, 1987).

Significant increases in root and top yields of sugar beet plants applied with K was also observed (Table 3 and 4). Sun *et al.* (1994) indicating that K application increases dry matter in sugar beet roots. Data presented in Table (1) indicate that amount of K in the soil is under the critical limits. So, applying sugar beet plants with K has a significant increase in the yield of root and top as a result of improving the physiological performance of the treated plants and increase the dry weight accompanied by an increase of these elements in the leaves. The application of K tends to accelerate photosynthetic activity, translocation of sucrose from the leaves and its accumulation in roots. The beneficial effects of K in improving sugar beet productivity may be attributed to its enhancement effects on increasing plant metabolic activity. The obtained increases with K application could be due to its role on carbohydrate and N-metabolism, water absorption and transpiration in plant. These results are in harmony with those obtained by El-Hawary (1994 a and b); Bondok (1996); El-Etreiby (2000) who noticed that fertilization with K had stimulatory effects on the hormonal blance, activiting physiological and biochemical processes in plant as well as their effect on nitrogen metablism (El-Kortoby, 1982).

Regarding, the interactions between salinity in irrigation water and different levels of K showed significant effect on root and top yields. Marked variations were observed with K application at the different levels of irrigation water salinity. As mentioned above, top yield of sugar beet plants behaved similarly as root yield with considerable variations among salinity treatments. These results are in agreement with those obtained by Shehata *et al.* (1994 b), Younes *et al.* (1997), El-Etreiby (2000). The results of root and top yields indicate that the root is more tolerant than the top to salinity. Also, the salinity caused a slighter decrease in top with fertilization with K compared with untreated one.

2-Refineable Sugar Yield and Quality:

The most important factors which affect the productivity and quality of sugar beet roots are the percentage of refineable sugar, purity and total soluble solids of root juice as shown in Tables (5,6 and 7). Data show that salinity with K application significantly affected refineable sugar level in sugar beet. The refineable sugar content tended to decrease slightly from 16.1 to 15.3% and from 17.0 to 16.0% in both season respectively, as salinity increased from 300 ppm (control) to 6000 ppm. Similar results were obtained by other researchers Yazdani *et al.* (1995). On the other hand, refineable sugar content significantly increased with increasing K level up to 72 kg K_2O/fed. Application of K with different levels increased refineable sugar content from 14.5 to 16.9% and from 15.2 to 17.8% in the 1^{st} and 2^{nd} seasons, respectively.

The data in the above Tables also show that purity of sugar beet roots was significantly decreased with increasing the level of salinity in irrigation water as compared with the normally-irrigated plants. The purity percentage of root juice tended to decrease from 76.2 to 70.2 in the first season and from 78.8 to 71.8 in the second season by increasing salt concentration of irrigation water. The reduction of juice purity in sugar beet plants runs mannerly with increasing salt concentration in irrigation water, i.e. low in using tap water, moderate at 2000 ppm and high at 4000 and/or 6000 ppm.

Concerning TSS of a sugar beet roots, the data sustained was significant increase with increasing the level of salinity in irrigation water Table (7). The increase in TSS may be attributed to more salt absorption by plants, as salinity level increases, which in turn decreases purity and negatively affects of refineable sugar percentage. The TSS tended to increase from 21.2 to 21.8% in the first season and from 21.4 to 22.3% in the second season as salinity increased from 300 ppm i.e, tap water (control) to 6000 ppm. The increase in TSS under high salinization is mainly due to high concentration of solutes. Such decreases in purity noticed under saline conditions in the present work are supported by the results obtained by Higazy *et al.* (1995) and Darwhish *et al.* (1995) who reported that the increase in soil salinity produced sugar juice of high ash (impurities) and, hence, leads to a reducing in quality. Kandil *et al.* (1999) found similar results.

Under saline irrigation condition, the uptake of Na and K increases and consequently, the impurities in root juice increases, resulting in low quality. Such decreases in juice purity were undesirable for sugar processing. These results are in harmony with those obtained by Mekki and El-Gazzar (1999) and El-Etreiby (2000).

The data reveal, further that, fertilization sugar beet plants with K resulted in significant increases in purity and total soluble solids TSS percentages as compared to the untreated ones. Data indicate that refineable sugar percentage was significantly affected by the interaction

between salinity levels and K fertilization treatments. Although such interaction did not significantly affect root quality i.e, purity% and TSS%, it can be clearly noticed that quality of K fertilizer treated sugar beet plants grown under different levels of saline conditions showed higher values than the corresponding ones of salt-stressed plants and untreated with K fertilizer. Such stimulating effect tended to depend upon salinity levels and K application used. These results may be due to counteracting effect of K fertilization on the inhibitory effect of salinity. Potassium fertilizer play an important role in photosynthetic activity, translocation of sucrose from the leaves and its accumulation in roots. Refineable sugar and purity percentages as well as root and sugar yield increased due to the use of K, Bondok (1996) have similar results.

3-Mineral Content in Sugar Beet:

The influence of salinity level of irrigation water and fertilizer application with K on potassium (K), sodium (Na) and K/Na ratio in root juice as well as K, Na, Ca and Mg contents in sugar beet tops is present in Tables (8 to 14).

K and Na contents in sugar beet differed significantly due to salinity levels of irrigation water and K application Tables (11 and 12). Increasing the salinity level of irrigation water increased K concentration in tops of sugar beet. Potassium in sugar beet tops tended to increase from 1.76 to 1.80, 2.13 and 1.87%, as the salinity level was raised from control to 2000. 4000 and 6000 ppm, respectively. Sodium tended to increase from 1.93 to 2.57, 2.78 and 3.04% respectively, with the respective salinity levels. At higher salinity level (4000 ppm) K and Na concentration were increased by 18.3% and 8.2% respectively, while at the highest salinity level (6000 ppm), the respective increases were 3.9 and 18.3%. Since Na is the dominant element of salts in saline irrigation water increased Na concentration in both top and root of sugar beet through using saline irrigation was quite expected.

In this respect, it is worth to mentioned that Na concentration in sugar beet juice extraction is consider one of the main impurities which decrease as Na concentration in juice increases. Both K and Na are impurities and their ratio interfers with the crystallization process, which causes a greater proportion of the sugars to be recovered as molasses with a reduction in refined sugar (Carter, 1986). High refineable sugar concentration in the wet roots was always obtained with low Na concentration, high K/Na ratio, and low water concentration, whereas lower refineable sugar concentration was obtained with higher Na concentration, lower K/Na ratio and higher water concentration in the roots (Carter, 1986). These results indicate that Na concentration and/or K/Na ratio in the roots in the primary cause of the differences in water concentration and can cause major changes in the refineable sugar concentration in the wet root. The reason for the increased water in the roots with an increase in the Na concentration and/or a decreased K/Na ratio in the root has not yet determined. However, it has been frequently reported in the literature that K has an effect on the water uptake, turgor pressure and water relation associated with the stomatal opening (Mengel and Kirkby, 1980). Sodium can substitute for K in sugar beets (Cooke and Scott, 1993). These results are in agreement with those obtained by Shehata (1989), Shehata *et al.* (1994a and b), Mekki and El-Gazzar (1999). They found that the salinity had a positive effect on Na concentration of sugar beet. On the other hand, salinity markedly increase K concentration in root and leaves of sugar beet. (Mekki and El-Gazzar, 1999). The increase in Na ion accumulation

under salt stress may be due to increased uptake, reduced the translocation or to disproportion changes in growth and uptake.

Table (3) : Root yield (g/plant) of sugar beet as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	451	472	543	563	507	463	496	548	553	515
2000	368	381	401	481	408	431	468	506	515	480
4000	270	298	370	377	329	283	316	437	448	371
6000	204	233	338	360	284	213	219	373	402	302
Mean	323	346	413	445	382	348	375	466	479	417
L.S.D. $_{0.05}$	Salinity (S) = 18					Salinity (S) = 18				
L.S.D. $_{0.05}$	k fertilization = 16					k fertilization = 16				
L.S.D. $_{0.05}$	S x k = 25					S x k = 25				

Table (4): Top yield (g/plant) of sugar beet as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	155	182	197	212	187	174	191	216	238	205
2000	126	155	167	187	159	140	183	190	209	181
4000	102	126	130	165	131	106	127	149	186	142
6000	84	99	110	131	106	91	104	117	155	117
Mean	117	141	151	174	146	128	151	168	197	161
L.S.D. $_{0.05}$	Salinity (S) = 15					Salinity (S) = 16				
L.S.D. $_{0.05}$	k fertilization = 17					k fertilization = 18				
L.S.D. $_{0.05}$	S x k = 22					S x k = 25				

Table (5) : Refineable sugar (%) of sugar beet root as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	15.3	15.6	16.6	16.9	16.1	16.2	16.5	17.5	17.9	17.0
2000	14.5	14.7	16.4	17.1	15.7	15.1	16.3	17.2	17.8	16.6
4000	14.2	14.5	16.3	16.8	15.5	14.8	15.3	17.0	17.8	16.2
6000	14.0	14.5	16.0	16.6	15.3	14.6	15.2	16.7	17.6	16.0
Mean	14.5	14.8	16.3	16.9	15.6	15.2	15.8	17.1	17.8	16.5
L.S.D. $_{0.05}$	Salinity (S) = 0.3					Salinity (S) = 0.4				
L.S.D. $_{0.05}$	k fertilization = 0.3					k fertilization = 0.5				
L.S.D. $_{0.05}$	S x k = 0.5					S x k = 0.7				

Table (6): Purity % of sugar beet root as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	74.6	75.0	77.2	77.9	76.2	77.1	78.6	79.5	79.9	78.8
2000	69.0	69.0	75.9	78.1	73.0	74.0	76.5	77.5	79.6	76.9
4000	67.6	67.8	74.8	75.0	71.3	71.2	71.5	75.2	78.4	74.1
6000	66.7	67.4	73.1	73.5	70.2	68.5	70.7	73.6	74.3	71.8
Mean	69.5	69.8	75.3	76.1	72.66	72.7	74.3	76.5	78.1	75.4

L.S.D. $_{0.05}$	**Salinity (S) = 1.5**	**Salinity (S) = 1.3**
L.S.D. $_{0.05}$	**k fertilization = 1.5**	**k fertilization = 1.3**
L.S.D. $_{0.05}$	**S x k = N.S**	**S x k = N.S**

Table (7): Total soluble solids (%) of sugar beet root as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	20.6	20.8	21.5	21.7	21.2	21.0	21.0	22.0	22.4	21.4
2000	21.0	21.3	21.6	21.9	21.5	20.4	21.3	22.2	22.5	21.6
4000	21.0	21.4	21.8	22.4	21.7	20.8	21.4	22.6	22.7	21.9
6000	21.0	21.5	21.9	22.6	21.8	21.3	21.5	22.7	23.7	22.3
Mean	20.9	21.3	21.7	22.2	21.5	20.7	21.3	22.4	22.8	21.8
L.S.D. $_{0.05}$	Salinity (S) = 0.4					Salinity (S) = 0.3				
L.S.D. $_{0.05}$	K fertilization = 0.4					k fertilization = 0.3				
L.S.D. $_{0.05}$	S x k = N.S					S x k = N.S				

Table (8) : Potassium (K) content (meq/100g) of sugar beet root as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	3.40	3.45	3.92	4.02	3.70	3.60	3.78	4.28	4.38	4.01
2000	5.01	5.05	5.64	5.99	5.42	5.12	5.18	5.81	6.09	5.55
4000	4.36	4.56	5.02	5.66	4.90	4.64	4.55	5.19	5.32	4.92
6000	3.12	3.25	3.73	4.50	3.65	3.75	4.12	4.36	4.29	4.13
Mean	3.97	4.08	4.58	5.04	4.42	4.28	4.41	4.91	5.02	4.65
L.S.D. $_{0.05}$	Salinity (S) = 0.12					Salinity (S) = 0.10				
L.S.D. $_{0.05}$	k fertilization = 0.12					k fertilization = 0.08				
L.S.D. $_{0.05}$	S x k = 0.24					S x k = 0.14				

Table (9): Sodium (Na) content (meq/loog) of sugar beet root as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	1.36	1.24	1.23	1.12	1.24	1.39	1.29	1.22	1.18	1.27
2000	1.79	1.76	1.67	1.56	1.70	1.74	1.64	1.57	1.53	1.62
4000	1.82	1.72	1.67	1.58	1.70	1.76	1.70	1.67	1.62	1.69
6000	1.95	1.85	1.83	1.68	1.82	1.87	1.85	1.74	1.70	1.79
Mean	1.73	1.64	1.60	1.49	1.82	1.69	1.62	1.55	1.51	1.59
L.S.D. $_{0.05}$	Salinity (S) = 0.07					Salinity (S) = 0.06				
L.S.D. $_{0.05}$	k fertilization = 0.07					k fertilization = 0.06				
L.S.D. $_{0.05}$	S x k = N.S					S x k = N.S				

Table (10): K/Na ratio of sugar beet root as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	2.50	2.78	3.17	3.59	3.01	2.59	2.93	3.51	3.71	3.19
2000	2.80	2.87	3.38	3.84	3.22	2.94	3.16	3.70	3.98	3.45
4000	2.40	2.65	3.01	3.58	2.91	2.64	2.68	3.11	3.28	3.93
6000	1.60	1.76	2.04	2.68	2.02	2.01	2.23	2.51	3.52	2.32
Mean	2.33	2.52	2.90	3.42	2.79	2.55	2.75	3.21	3.37	2.97

L.S.D. 0.05	Salinity (S) = 0.10	Salinity (S) = 0.12
L.S.D. 0.05	k fertilization = 0.11	k fertilization = 0.13
L.S.D. 0.05	S x k = 0.19	S x k = 0.25

Table (11) : Potassium (K) content (%) of sugar beet tops as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	1.56	1.74	1.81	1.91	1.76	1.66	1.81	1.83	1.89	1.80
2000	1.61	1.79	1.85	1.96	1.80	2.00	2.16	2.21	2.24	2.17
4000	1.98	2.11	2.18	2.26	2.13	2.06	2.18	2.26	2.33	2.21
6000	1.66	1.82	1.97	2.02	1.87	1.62	1.78	1.94	2.96	1.83
Mean	1.70	1.87	1.95	2.04	1.89	1.84	1.98	2.06	2.12	2.00
L.S.D. 0.05	Salinity (S) = 0.15					Salinity (S) = 0.11				
L.S.D. 0.05	k fertilization = 0.15					k fertilization = 0.13				
L.S.D. 0.05	S x k = N.S					S x k = N.S				

Table (12) : Sodium (Na) content (%) of sugar beet tops as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	2.16	1.99	1.87	1.71	1.93	2.13	1.96	1.85	1.68	1.91
2000	2.79	2.65	2.46	2.37	2.57	2.75	2.60	2.41	2.23	2.50
4000	3.03	2.84	2.75	2.51	2.78	2.97	2.78	2.70	2.46	2.73
6000	3.30	3.13	2.98	2.76	3.04	3.22	3.02	2.91	2.69	2.96
Mean	2.82	2.65	2.52	2.34	2.58	2.77	2.59	2.44	2.27	2.52
L.S.D. 0.05	Salinity (S) = 0.13					Salinity (S) = 0.14				
L.S.D. 0.05	k fertilization = N.S					k fertilization = N.S				
L.S.D. 0.05	S x k = N.S					S x k = N.S				

Table (13): Calcium (Ca) content (%) of sugar beet tops as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	0.50	0.50	0.49	0.49	0.50	0.47	0.46	0.46	0.49	0.47
2000	0.42	0.42	0.42	0.39	0.41	0.44	0.40	0.40	0.38	0.41
4000	0.40	0.38	0.38	0.39	0.39	0.41	0.38	0.38	0.38	0.39
6000	0.35	0.36	0.37	0.37	0.36	0.37	0.36	0.37	0.37	0.37
Mean	0.42	0.42	0.42	0.41	0.41	0.42	0.40	0.40	0.41	0.41
L.S.D. 0.05	Salinity (S) = 0.02					Salinity (S) = 0.04				
L.S.D. 0.05	k fertilization = N.S					K fertilization = N.S				
L.S.D. 0.05	S x k = N.S					S x k = N.S				

Table (14) : Magnesium (Mg) content (%) of sugar beet tops as affected by salinity of irrigation water with different levels of K fertilization during the winter seasons 2001/2002 and 2002/2003.

Salinity of irrigation water (ppm)	2001/2002 Season					2002/2003 Season				
	K level (kg/fed.)				Mean	K level (kg/fed.)				Mean
	0	24	48	72		0	24	48	72	
Control (tap water)	0.79	0.80	0.79	0.80	0.80	0.81	0.80	0.81	0.80	0.81
2000	0.78	0.78	0.79	0.80	0.79	0.79	0.79	0.80	0.79	0.79
4000	0.79	0.79	0.80	0.79	0.79	0.79	0.79	0.81	0.79	0.79
6000	0.76	0.75	0.77	0.78	0.76	0.77	0.76	0.76	0.77	0.77
Mean	0.78	0.78	0.79	0.79	0.78	0.79	0.79	0.80	0.79	0.79

L.S.D. $_{0.05}$	**Salinity (S) = 0.09**	**Salinity (S) = 0.08**
L.S.D. $_{0.05}$	**k fertilization = N.S**	**k fertilization = N.S**
L.S.D. $_{0.05}$	**S x k = N.S**	**S x k = N.S**

The salinity and K application significantly affected K/Na ratio in root juice (Table 10). Potassium/ Sodium (K/Na) ratio tended to be decreased from 3.01 to 2.02 (67.11%) in the first season and 3.19 to 2.32 (72.73%) in the second season respectively, as salinity increased from control to 6000 ppm. The K/Na ratio in juice root was increased from 2.33 to 3.42 (46.78%) and from 2.55 to 3.37 (32.1%) as K applying increased from control to 72 kg K_2O/fed. The decrease in Ca and Mg contents with increasing salinity level of irrigation water was significant. At higher salinity level (6000 ppm) Ca and Mg concentrations were decreased by 28% and 5% in the first season and 21.3% and 4.9% in the second season, respectively. The decrease in Ca and Mg ions under high salinization were supported by Mekki and El-Gazzar (1999).

The influences of fertilizer treatments in the mineral content in tops and roots of sugar beet at harvest time important and the correlation between yield and K content of roots is evident. The correlation between K in tops and K in roots is highly positive. Finally the analysis of roots serves for the determination of the needs corresponding to a maximum experimental yields.

Results also show that addition of K fertilization increased K content of tops. On the other side, Na, Ca and Mg contents of sugar beet leaves were not affected by K application. Beringer *et al.* (1986) indicated that K^+ content in leaf dry matter as 3.8% sprays at harvest was necessary to produce the rates of photosynthesis and sucrose translocation required for maximum root yield and sugar yield. Graham and Ulrich (1974) reported that levels of Ca^{+2}, Mg^{+2} were unaffected by K supply. These results are in agreement with those obtained by Mekki and El-Gazzar (1999).

From the abovementioned results, it is clear that increasing salt concentration of irrigation water results in a noticeable reduction in growth and consequently yield and yield quality of the sugar beet plants. This may be attributed to the fact that exposure to salinity during growth induces stunted growth and structural changes at various levels of organization. Moreover, such reduction in sugar beet growth, yield and quality may be due to different stresses such as water stress, salt stress and ion-imbalance stress. Salinity appears to affect growth, yield and quality through toxic effect of Na^+ and/or Cl^- ions and/or the osmotic potential of the soil solution. On the other hand, fertilizer application with K improved the growth and increased yield and quality of sugar beet under saline conditions. The positive action of fertilizer application with K might be related to its effect on water – plant relationship as well as metabolic and physiological activities of sugar beet plant. Moreover, increased salt concentration of irrigation water causes an imbalance in the chemical composition of the plant which greatly disturbs the metabolic and physiological activities. So, addition of K increases the water retaining capacity of cells, decreasing the transpiration rate of leaves through improving stomatal opening and closure and increasing photosynthesis rate and translocation of assimilates which, in turn, enhances yield and quality of sugar beet (Carter, 1986; El-Hawary, 1994 a, b, and Gobarh, 2001).

The study reveals the need to maintain low or moderate salinity levels in the soil or irrigation water which is necessary for

maximum sugar beet yield with satisfactory quality. Also further study is needed on the effects of potassium in relation to slat in field experiments under drivers agroclimatic conditions on soils deficient and sufficient in potassium. This study and similar researches will help to achieve the immediate objectives in order to realize the maximum possible rate of self sufficiency in the production of food stuff.

REFERENCES:

Ahmed, A.M. (1987). Effect of saline irrigation water, N-fertilization and supplemental foliar spraying with K and Mg on growth, nutritional status and yield of sugar beet in desert calcareous soil. Desert Inst. Bull. Egypt. 37 (2): 219-239.

Balba, A.M. (1968). "Soil Fertility" Dar El-Matboat El-Gadida, Alex., Egypt. (In Arabic).

Beringer, H., K. Koch and M.G. Lindhauer. (1986). Sucrose accumulation and osmotic potentials in sugar beet at increasing levels of potassium nutrition. J. Sci. Food Agric., 37: 211-218.

Bernstein, L. (1964) salt tolerance of plants. USDA Agricultural Bull. No. 283.

Bondok, M.A. (1996). The role of boron in regulating growth, yield and hormonal balance in sugar beet Annals Agric., Sci., Ain Shams Univ., Cairo, 41 (1): 15-33.

Carter, J. N. (1986). Potassium and sodium uptake effects on sucrose concentration and quality of sugar beet roots. J. Am. Soc. Sugar Beet Technol., 23 (3-4): 183-202.

Cooke, D.A. and R.K. Scott. (1993). The sugar beet crop. Chapman and Hall London, pp. 262-265.

Darwhish, Y. L, H. A. Attar, F.A. Askar and M. El-Harris (1995). Sugar beet response to soil salinity and sodicity at northern Nile Delta. Egypt J. of soil Sci. 35 (4):395 – 400.

El-Etreiby, F. (2000). Effect of saline irrigation water and micronutrient foliar application on sugar beet cultivars. Alex. Sci. Exch. Vol. 21 (4): 397 – 407.

El-Harriri, D.M. and M. E. Gobarh. (2001). Response of growth, yield and quality of sugar beet to nitrogen and potassium fertilizers under newly reclaimed sandy soil. J. Agric. Sci. Mansoura Unvi., 26 (10): 5895 – 5907.

El-Hawary, M.A. (1994a). Effect of boron and zinc fertilization on growth yield of sugar beet plants grown under different soil salinity levels. Al-Azhar J. Agric. Res., Vol. 20: 25-35.

El-Hawary, M.A. (1994b). Effect of phoshporus and potassium fertilization on salt tolerance of sugar beet plants. Proc. 6th Conf. Agron., Al-Azhar Univ., Cairo, Egypt, Vol. 11: 881-895.

El-Kortoby, A.O.I. (1982). Biochemical studies of some plants regulators and minor elements on the constituents of sugar beet. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ., Egypt.

El-Maghraby, S. S., M. M. Shehata and Y. H. Tawfik. (1998). Effect of soil and foliar application of nitrogen and potassium on sugar beet. Egypt. J. Agric. Res., 76 (2): 665 – 678.

El-Noemani, A.A. (1996). Influence of irrigation with saline water on growth, yield and chemical composition of five sugar beet (*Beta vulgaris*, L.) varieties. Egypt. J. Appl, Sci. 11 (2): 268 – 291.

El-Wakeel, A.F. (1993). Effect of some soil characteristic on root growth, juice quality and yield of sugar beet. Egyptian J. of Agric. Res., 71 (3): 609 – 620.

Graham, R.D. and A. Ulrich. (1974). Retranslocation of potassium in (*Beta vulgaris*, L.) under conditions of low sodium supply. Aust. J. Plant Physiology, 1: 387-396.

Gobarh, M.E. (2001). Effect of foliar application with some micronutrients on sugar beet grown in newly reclaimed sandy soil. J. Agric. Sci., Mansoura Univ., 26 (10): 5929-5937.

Greenway, H. and R. Munns. (1980). Mechanisms of salt tolerance in nonhalophytes. Ann. Rev. plant physiology, 31: 149–190.

Heuer, B and Z. Plaut (1989). Photosynthesis and osmotic adjustment of two sugar beet cultivars grown under saline conditions. J. Exper. Bot. 40 (213): 437 – 440.

Higazy, M. A., M. M. Shehata and A. Allam (1995). Free proline relation to salinity tolerance of three sugar beet varieties. Egypt. J.Agric. Res., 73 (1): 175 – 191.

Hills, F.S., S.S. Johnson and B.A. Godwin (1990). The sugar beet industry. California Univ., Exp. Stn. Bull. 1916. (C.F. irrigation of Agricltural Crops, 5613, 1742, 1990).

Kaffka, S., Dong-Daxue, G. Peterson and Dx. Dong. (1999). Saline water can be reused irrigate sugar beets but sugar may be low. California Agriculture, 53: 1. 11 – 15.

Kandil, S.A, M.S.A Abo El-Kheir and H.A. El-Zeiny (1999). Increasing salt tolerance of sugar beet (*Beta vulgaris*, L.) plants through application of uniconazole. J. Agric. Sci., Monsoura Univ., 24 (7): 3413 – 3425.

Khafagi, D.M.A., A.A Abdel Rahman and W.I. El-.Lawandy, (1996). Salt tolerance of sugar beet (*Beta vulgaris*, L.). I. Growth water relations and photosynthetic pigments. Annals of Agric. Sci., Monshtohor 34 (4): 1631 – 1646.

Khafagi, O. M. A. and W.I. El-Lawandy (1996). Salt tolerance of sugar beet (*Beta vulgaris*, L.). I I. Metabollic products and ion accumulation. Annals of Agric. Sci., Moshtohor products, 34 (4): 1947 – 1663.

Khalil, S. M., S. N. Mostafa and Z. R. Mostafa (2001). Influence of potassium fertilizer and soil salinity on chemical composition of sugar beet root. Minufiya J. Agric. Res., Vol. 26 No. 3: 583 – 594.

Le-Docte, A. (1927). Comerical determination of sugar in the beet root using the Saccharimeter. Le-Docte process. Int. Sugar J. 29 : 448 – 492.

Liu, Y., Tc-Zou., G. Geng., Xu-Fq and Yz-Wang (1992). Effect of potash on sugar beet quality and adversity resistance. China-Sugar beet, No. 4, 15 – 20.

Meiri, A. and Z. Plaut. (1985). Corp production and management under saline conditions. Plant and Soil, 98: 253 – 272.

Mekki, B.B. and M.M. El-Gazzar (1999). Response of root yield and quality of sugar beet (*Beta vulgaris*, L.) to irrigation with saline water and foliar potassium fertilization. Annals agric. Sci. Ain Shams Univ., Cairo, 44 (1): 213-225.

Mengel, K. and E.A. Kirkby (1980). Potassuim in crop production. Adv. Agron. 33: 59-110.

Plaut, Z. and B. Heuer (1985). Adjustment, growth, photosynthesis and transpiration of sugar beet plants exposed to saline conditions. Field crop Res., 10 (1) 1 –13.

Poschenok (1976). Biochemical Analysis of Fruit and Vegetable Products. TataMc graw-Hill publishing company limited, New Delhi pp, 634 – 650.

Reda, K.A., A.A. Shalaby, H.T. Kishk and A.M. Hegazi. (1980). Some effects of potassium

on growth yield and chemical composition of beet irrigated with saline water containing different levels of boron. Ain Shams Univ., Fac. Agric., Res. Bull. 12337: 16 pp.

Roades, J.D. and J. Loveday (1990). Salinity in Irrigated Agriculture. pp. 1089–1142. In stewart, B.A. and D.R Nielsen (eds.). Irrigation of Agricultural Crops. Agronomy No. 30, American Soc. of Agron. Inc., Madison.

Sarkar, A.K. and P.K. Ghosh (1989). Effect of decapitation and foliar application of KNO_3 solution of root enlargement stage on yield of sugar beet (*Beta vulgaris*, L.) Indian Agric. 33 (4): 259 – 261. (C.F. field crop Abst. 44 (8), 5708, 1991).

Saxena, N. P. (1985). The role of potassium in drought tolerance. Potash Review, Potash fertilizers and manuring 102nd suite, subject 16, N. 5/1985.

Shehata, M.M. (1989). Physiological studies on the tolerance of some sugar beet varieties to salinity. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Shehata, M.M., S.M. Abdel-Sayed and S. El-Hamshary (1994a). Response of sugar beet varieties to irrigation water salinity. Egypt. J. of Appl. Sci., Vol. 9 (10): 277-285.

Shehata, M. M., S.Y. Beheet and N. M. Taha (1994b). Chemical composition of six sugar beet varieties as affected by saline water irrigation. Egypt. J. Appl. Sci., Vol. 9 (11): 844-852.

Shehata, M. M., Shohair, A. A. and S. N. Mostafa (2000). The effect of soil moisture level on four sugar beet varieties. Egypt. J. Agric. Res., 78 (3): 1141 – 1160.

Simon, P.W.,C.E. Peterson and R.C. Lindsay (1980). Correlations between sensory and objective parameters of college flavor, J. Agric. Food chem. 28: 559 – 562.

Snedecor, G.W. and W.G. Cochran (1981). Statistical methods, seventh Ed. Iowa State Univ. Press Ames, lowa, USA.

Steel, A. and F. Torrie (1960). Principles and Procedures of Statistics Mc Grow-Hill Book Company Inc., New York, Toronto, London.

Strognov, B.P. (1962). Physiological basis of the salt tolerance of plants (under different types of soil salinization). Izd Akad. Nauk, USSR Moscow.

Sun, S.J., Li-Fs, Y. Wan and G.C Zheng (1994). Effect of zinc and potassium on dry matter accumulation of sugar beet in mid-late growing season. China-Sugar Beet No. 4, 26-29.

Yazdani, H., A. Tavassoli and Vali M.Fallah (1995). Management of soils irrigated with saline water for sugar beet and cotton production. Proceedings of the International Workshop on Integrated Soil Management for Sustainable Use of Salt Affected Soil November 6 – 10, 1995.

Younes, A.H., N.Z. Younan and N.M. Talkhawy (1997). The effect of saline water on sugar beet yield of three genotypes. Adv. Agric. Res. Vol. 2 (1): 45-54.

استجابة بنجر السكر لإضافة البوتاسيوم والرى بماء ملحى

صابر إمام عبد المولى*، إبراهيم ذنونى إبراهيم**

*قسم الأراضى والمياه – كلية الزراعة– جامعة الأزهر – أسيوط

** قسم الأراضى – جامعة المنيا – المنيا

أجريت هذه التجربة في صوبة بكلية الزراعة جامعة الأزهر أسيوط خلال موسمى النمو الشتوي ٢٠٠١/٢٠٠٢م ، ٢٠٠٢/٢٠٠٣م فى نظام قطاعات عشوائية لاختبار التداخلات بين مستويات مختلفة من السماد البوتاسي (صفر، ٢٤، ٤٨، ٧٢ كم بو$_2$ أ/فدان) مع ثلاث مستويات من الري بماء ملحى (٢٠٠٠ ، ٤٠٠٠ ، ٦٠٠٠ جزء فى المليون) مع استعمال ماء الصنبور للمقارنة علي محصول الجذور والتركيب الكيميائي لنبات بنجر السكر.

التأثير الرئيس لهذه التفاعلات أكدت انخفاض فى نمو نبات بنجر السكر مع زيادة تركيز الأملاح بماء الري إلي ٦٠٠٠ جزء في المليون. نفس الاتجاه كان يتحقق بخصوص كلا من نسبة صافي السكر والنقاوة فى العصير. وعلي العكس فإن النسبة المئوية للمواد الصلبة الكلية في الجذور قد زادت معنوياً تحت ظروف الري الملحي السائد. أكدت النتائج تحقيق التأثير المعنوى لمستويات الملوحة فى ماء الري على البوتاسيوم والصوديوم وكذلك النسبة بين البوتاسيوم إلي الصوديوم فى جذور نبات بنجر السكر. نسبة المواد الصلبة والسكر الصافى والسكروز في عصير الجذور وكذلك محصول الجذر والأوراق لكل نبات من بنجر السكر زادت مع إضافة السماد البوتاسي.

عامة، نبات بنجر السكر يستطيع تحمل الملوحة في ماء الري حتى ٢٠٠٠ جزء في المليون بدون تأثير يذكر علي النمو أو المحصول أو بعض صفات الجودة تحت الدراسة وكذلك إضافة سماد البوتاسيوم أدي لتحسين المحصول وصفات الجودة لنبات بنجر السكر سواء رويت بماء ملحي (مستوى ٤٠٠٠ جزء فى المليون) أو ماء عذب.