J. Agric. Sci. Mansoura Univ., 31 (12): 8119 - 8130, 2006

EFFECT OF ALTERNATIVE IRRIGATION WITH FRESH AND DRAINAGE WATER ON SUGAR BEET YIELD, SOIL SALINITY AND SOME WATER RELATIONS AT NORTH NILE DELTA, EGYPT

Omar, E.H.; M.A. Abd El-Aziz ; M.M. Ragab and M.A.A. Abd Allah
Soil, Water & Environment Research Institute, A.R.C, Egypt

ABSTRACT

Two field experiments were conducted at Sidi Salim District , Kafr El-Sheikh Governorate. North Delta, Egypt to study the effect of the alternative use of high saline drainage water with fresh water for irrigation on sugar beet yield, yield components, soil salinity and some water relations during 2004/2005 and 2005/2006 seasons. The soil was saline and clayey in texture. Fresh water salinity and SAR values were 0.5 dS/m and 1.53 ,respectively, while drainage water salinity and SAR values were 7.21 dS/m and 14.4, respectively. Seven irrigation treatments were arranged in randomize complete block design with four replicates as follows:

(A)100% fresh water.(B) 75% fresh water + 25 % drainage water. (C) 62.5% fresh water + 37.5 % drainage water.(D) 50% fresh water + 50 % drainage water.(E) 37.5% fresh water + 62.5 % drainage water. (F) 25% fresh water + 75 % drainage water.(G) 100% drainage water. The important findings could be summarized as follows :-

- Using the alternative irrigation of drainage water with fresh water increased seeds emergency percentage compared to full irrigation with drainage water.
- Reduction of root yield was 18.93 and 26.24 % when drainage water was used by 50% with fresh water during the two successive seasons, respectively.
- Applying 25 to 50 % drainage water alternatively with fresh water resulted in a significant increase in sucrose percentage compared to control treatment in the 1st season while in the 2nd season sucrose percentage significantly was decreased with increasing the number of irrigations with drainage water.
- There were no significant differences in extracted sugar yield between the control and treatments B and C which received 25 and 37.5 % drainage water. While in the second season all drainage water treatments caused high significant reduction in sugar yield.
- The highest values of applied water and water consumptive use were obtained under irrigation with fresh water but decreased with increasing drainage water usage for irrigation.
- Irrigation with fresh water achieved the highest values of field water use and crop water use efficiencies for root and extracted sugar yields.
- Continues irrigation with drainage water increased soil salinity and alkalinity, while the cyclic irrigation by drainage and fresh water decreased them.

It could be concluded that the saline drainage water(4416 ppm) could be used at non sensitive plant growth stages in percentage 50 % with fresh water for irrigating sugar beet with expected yield reduction percentage 25 %.

Keywords: Drainage water, Alternative Irrigation ,Sugar beet, Soil salinity, Water consumptive use

INTRODUCTION

The increased need in food production to support the acceleration of population growth in Egypt (2.7%)compels the country to use all of water sources i.e. drainage water, ground water and treated waste water, FAO, (1992). Farmers at the tail of irrigation canals unofficially reuse about 2 billion m3 /year of drainage water, directly for irrigation; whenever they suffer from limited canal fresh water supply, (El-Hessy and El-Kady, 1997).The problem of crop yield losses resulted from the low quality of drainage water and when and how much drainage water to be apply .

Rhoades *et al.* (1988) found that there were insignificant differences in yield or crop quality occurred in any of the 5 crops wheat, cotton, sugar beet, cantaloupe and Medicago sativa grown when brackish water was substituted for fresh water for up to 25-50% of the irrigation requirements. Soil salinity levels were higher at the end of the experimental period . Ayars et al(1990) stated that using saline water to supply part of the crop water requirement resulted in a 20% yield reduction in the wheat crop. While the cotton and sugar beet yields weren't affected during the initial five years.. Abo Soliman *et al.* (1992) found that wheat grain yield decreased by 38.9, 43.72, 47.0, 48.1 and 57.92 %when drainage water applied in two, four irrigations, (at late season), two, four, and six irrigations)at the beginning of growing season), respectively as compared with continuous irrigation with fresh water. El-Henawy (2000) pointed out that using of drainage water or drainage water mixed with wastewater in irrigation at North Delta ,Egypt resulted in a reduction in yield of cotton, rice and wheat ranged from 24.8 to 52.1 %, from 14.1 to 47.7% and from 21.7 to 73.3 %, respectively. Malash *et al.*(2005) found that the highest yield of tomato obtained (3.2 kg/plant) was the result of the combination of drip system and mixed management practice using a ratio of 60% fresh water(EC= 0.55dS/m) with 40% saline water (EC= 4.2-4.8 dS/m). Hamdy *et al.*(2005) showed the possibility of securing high yields, with mean reductions of only 21% in barley and 25% in wheat compared to the fully, fresh-water irrigated control, through the application of limited amounts of brackish water having EC 3-9 dS/m.

Kaffka *et al.*(1999) found that fresh water did not affect overall water use, plant density or clean root yield, but use of saline water decreased percentage sugar and hence sugar yield. This decrease was associated with the higher N levels in saline water. Katerji *et al.*(2000) stated that the higher the salinity, the lower the yield, evapotranspiration, pre-dawn leaf water potential and stomatal resistance. Reina-Sánchez *et al.* (2005) revealed that tomato Plants grown under the most saline conditions consumed, on average, 40% less water than control plants. The relationship between total plant water uptake and salinity was linear. Yurtseven *et al.*(2005) showed that tomato yield decreased with increasing salinity of irrigation water starting at salinity level of 2.5 dS m−1 and continued to 10 dS m−1 treatment. Water consumption and water use efficiency (WUE) decreased with increasing salinity. Ragab *et al.* (2005) indicated that a 7 dS/m irrigation water only reduced the yield of tomato by 50%.The relation between both yield and water uptake as a function of irrigation water salinity is non linear and is better described by a polynomial function of the fourth order.

Theillier *et al.*(1990) concluded that both soil salinity and sodicity increased with decreasing applied water quality. Sobh *et al.*(1997) found that the increase of either salinity or SAR of drainage water used for irrigation caused a significant increase in soil salinity and SAR values. Tedeschi and Dell'Aquila (2005) stated that irrigation with saline water led to an increase in ESP and a degradation of the soil physical properties. Murtaza *et al.*(2005) stated that cyclic use of fresh and saline-sodic water (EC = 3.32 dS m−1, SAR = 16.29) through alternate irrigations increased soil ECe and SAR levels, but this increase was only significant in SSW treatment. Moreno *et al.*(2005) found that cyclic use of two irrigations saline water (5.9–7.0 dS m−1) with fresh water (1.7 dS m−1) to sugar beet resulted in increased soil salinity but root yield did not affected. Almodares and Sharif (2005) studied the effect of four irrigation water salinities (2, 5, 8 and 11 dS m-1) on two sugar crops ,sugar beet and sweet sorghum. The results showed that as the quality of irrigation water decreased, the soil salinity and exchangeable sodium percentage increased which caused yield reduction for both plants.

MATERIALS AND METHODS

Two field experiments were carried out at Sidi Salim District, Kafr El-Sheikh Governorate, North Delta ,Egypt on sugar beet crop variety Rasboly during two successive seasons 2004 / 2005and 2005/ 2006.A randomize complete block design with four replicates was used. The plot area was 210 m^2 (10 x 21 m) and included 20 ridges, 50 cm apart.

Experimental treatments were designed as follows :

A. 100 % fresh water (8 irrigations from fresh water)

B. 75% fresh water + 25 % drainage water (6 irrigations from fresh water+ 2 irrigations from drainage water)

C. 62.5% fresh water + 37.5 % drainage water (5 irrigations from fresh water + 3 irrigations from drainage water)

D. 50% fresh water + 50 % drainage water (4 irrigations from fresh water+4 irrigations from drainage water)

E.37.5% fresh water + 62.25 % drainage water (3 irrigations from fresh water+ 5 irrigations from drainage water)

F. 25% fresh water + 75 % drainage water (2 irrigations from fresh water+ 6 irrigations from drainage water)

G.100% drainage water (8 irrigations from drainage water)

Irrigation treatments were applied according to the scheme in Table (1):

Table (1):Irrigation sequence of sugar beet crop.

Treatments	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth
A	Fresh water	Fresh water	Fresh water	Fresh water	Fresh water	Fresh water	Fresh water	Fresh water
B	Fresh water	Fresh water	Drainage water	Fresh water	Fresh water	Drainage water	Fresh water	Fresh water
C	Fresh water	Fresh water	Drainage water	Fresh water	Drainage water	Fresh water	Drainage water	Fresh water
D	Fresh water	Drainage water	Fresh water	Drainage water	Fresh water	Drainage water	Fresh water	Drainage water
E	Drainage water	Fresh water	Drainage water	Drainage water	Drainage water	Fresh water	Drainage water	Fresh water
F	Drainage water	Drainage water	Fresh water	Drainage water	Drainage water	Fresh water	Drainage water	Drainage water
G	Drainage water	Drainage water	Drainage water	Drainage water	Drainage water	Drainage water	Drainage water	Drainage water

Water Sources :

The source of fresh irrigation water is the end of Meet Yazied canal where water quantity not sufficient for full irrigation. The drainage water used for the alternative irrigation was from drain NO. 8 near its downstream. The chemical analysis of water sources are presented in Table (2) according to Richards (1954).

Table (2): Chemical analysis of irrigation water sources:

Water source	TSS (PPM)	EC, dS/m	SAR	Soluble anions (meq/L)				Soluble cations (meq/L)			
				$CO_3^{=}$	HCO_3^-	Cl^-	$SO_4^{=}$	Ca^{2+}	Mg^{2+}	Na^+	K^+
Fresh water	320	0.73	2.03	0.0	3.0	2.9	1.3	2.7	1.4	2.9	0.2
Drainage water	4614	7.21	14.4	0.33	5.15	47.0	21.65	7.04	16.47	49.22	1.07

Sugar beet was sown on the first of Sept. , in both seasons. The harvesting date was after 210 days from planting in both seasons. Fertilization requirements of sugar beet were added to the soil according to the recommended doses: Nitrogen was added in the form of urea by the rate of 70 kg N/fed. Applied as 10 kg activated dose before cultivation and the rest was splited into two doses, the first one was before post irrigation and the second one was before the second irrigation. Phosphorous was added as calcium super phosphate by the rate of 22.5 kg P_2O_5/fed. during soil preparation. Potassium was added in the form of potassium sulfate by the rate of 24 kg K_2O/fed. before the second irrigation. The experimental field was clayey in texture and non - saline non – alkaline soil. Some chemical , physical and hydrological properties of the experimental site illustrated in Table (3a and 3b) determined according to Page (1982).

Table (3a) Chemical analysis of soil profile before cultivation

Soil depth (cm)	ECe, dS/m	ESP	SAR	pH	Soluble anions (meq/L)				Soluble cations (meq/L)			
					CO_3^{-}	$HCO3^{-}$	Cl^{-}	SO_4^{-}	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}
0-30	5.64	10.61	8.3	7.75	---	2.5	34.3	20.8	15.3	11.4	30.3	0.6
30-60	4.93	9.12	7.4	7.9	---	3	30.7	18.2	13.9	11.2	26.2	0.6

Table (3b) Some physical properties of the experimental site:

Soil depth, cm	Particle size distribution%			Texture class	Bulk density, gm/cm^3	Field capacity .%	Witling point%	Available water%
	Sand	Silt	Clay					
0-30	18.87	32.73	48.4	clayey	1.22	43.28	23.36	19.92
30-60	16.66	33.14	50.2	clayey	1.31	40.82	23.08	17.74

The studied parameters :

1- Sugar beet yield and its components:

At harvesting time, 10.5 m2 from the central ridges of each plot was selected to determine root yield, sucrose percentage, juice purity, sugar yield and alpha amino nitrogen. Root quality parameters were determined according to Sach Le Docte by Mc Ginnus (1971) and Page (1982).

2- Water relations:

2.1- Seasonal water applied:

After depletion of 50-55 % from soil available water, irrigation water was applied using cut throat flume according to Michael (1979). Seasonal applied water included the effective rainfall.

2.2- Actual water consumptive use:

Actual water consumptive use was calculated by the following equation according to Israelsen and Hansen (1962).

$$CU = \frac{\theta 2 - \theta 1}{100} \times Db \times D$$

Where :

CU = Actual water consumptive use (cm).
Θ2 =Soil moisture after irrigation (%).
Θ1 =Soil moisture before the next irrigation (%).
Db = Bulk density for each layer (kg/cm^3).
D = Depth of each layer (m).

2.3- Water use efficiencies:

A- Field water use efficiency (FWUE).

It was calculated according to Doorenbos and Pruitt (1975) as follows :

$$F.W.U.E. = \frac{\text{Yield of roots or sugar (kg/fed.)}}{\text{Water applied (m3/fed.)}}$$

B- Crop water use efficiency C.W.U.E.):

It was calculated according to Doorenbos and Pruitt (1975) as follows :

$$C.W.U.E. = \frac{\text{Yield of roots or sugar (kg/fed.)}}{\text{Water consumptive use (m3-fed.)}}$$

3- Soil chemical analysis :

Soil samples representing each treatment were taken after harvesting from the surface layer 0-30 cm to determine soil salinity (ECe) and ESP according to Page (1982).

The collected data were statistically analyzed according to Snedecor and Cochran (1974).

RESULTS AND DISCUSSIONS

(I) Effect of alternative irrigation with fresh and drainage water on sugar beet yield and its quality:

Emergency percentage:

The obtained results in Table (4) revealed that continuous irrigation of sugar beet with fresh water achieved the highest emergency percentage values 96.50 and 95.68 % in the 1^{st} and 2^{nd} seasons, respectively. While continuous irrigation with saline drainage water decreased seed emergency percentage. Using the alternative irrigation of drainage water with fresh water increased seeds emergency percentage comparing with continuous irrigation with drainage water during the two growing seasons. Increasing the percent or the number of irrigations with drainage water encouraged the reduction of seeds emergency percentage . The reduction was more pronounced in the second season due to the higher salinity and alkalinity build up. Treatment (G) that irrigated with drainage water all the season resulted in the lowest values 68.80 and 59.57 % of emergency percentage in the 1^{st} and 2^{nd} seasons, respectively. The obtained data are in accordance with those of Kaffka *et al.*(1999).

Sugar beet root yield (ton/fed.):

Data in Table (4) showed that, a high significant reduction in root yield of sugar beet irrigated with different ratios of drainage water compared to full irrigation with fresh water during the two successive seasons. The highest yields of sugar beet (25.31 and 24.47 ton/fed.) for the first and second seasons respectively were obtained under control treatment (A). The lowest yields (19.11 and 12.25 ton/fed.) for the first and second seasons, respectively were obtained with treatment (G) that irrigated 100% with drainage water along the season. The root yield reduction was 24.49 and 49.93 % comparing with control treatment in the 1st and 2nd seasons, respectively.

There was an observed difference in the extent by which irrigation with fresh water alternated with drainage water and the number of irrigations with the different water qualities could affect the yield. Increasing the percent of applied drainage irrigation water from 25 to 100 % resulted in high significant decrease in the root yield, the reduction was more pronounced in the second season due to the accumulation of salinity and sodicity in the soil profile. Data in the same Table (4) also indicated that, the highest yield reduction were observed with treatments that started with drainage water in the first irrigation and this indicate the extent of sugar beet sensitivity to salinity during the first stages of growth specially the emergence stage, in spite of its tolerance to salinity during the other growth stages. The obtained results are in agreement with those of Abo Soliman *et al.* (1992) ; Malash *et al.* (2005) ; Hamdy *et al.*(2005 and Moreno *et al.*(2005).

Sucrose percentage (%):

Data in Table (4) showed that in the first season applying 25 or 37.5 % drainage water alternatively with fresh water (treatments B and C) resulted in a significant increase in sucrose percentage (18.95 and 18.9 %) ,respectively compared to17.4 % for the control treatment.Wlile in the second season there are a significant reduction in sucrose percentage with treatments C and D and a significant increase with treatments F and G comparing with the control treatment A. The obtained data also clear the sucrose percentage values were higher in the first season than in the second one. The reduction in the second season may be due to the adverse effect of accumulated salts in the soil specially sodium salts.The obtained data are in harmony with those of El-Rammady (1997)v and Omar *et al.* (2001)

Table (4): Average yield of sugar beet and its quality and the percent reduction in the yield under effect of different irrigation treatments (first and second seasons)

Season	Treatment	Emergency percentage	Root yield (ton/fed.)	Sucrose %	Purity %	Sugar yield (ton/ fed.)	Amino Nitrogen, %	Yield reduction
First season	A	96.50	25.31	17.40	83.6	3.68	3.30	0.00
	B	93.70 **	21.76**	18.95 *	82.8 ns	3.41 ns	3.43 ns	14.03
	C	92.28 **	21.35**	18.90 *	82.7 ns	3.34 ns	3.35 ns	15.65
	D	90.47 **	20.52**	18.75 *	82.3 ns	3.17 *	3.48 ns	18.93
	E	72.30 **	20.25**	18.70 ns	79.9 ns	3.03 **	3.38 ns	20.00
	F	70.78 **	19.45**	17.70 ns	78.5 **	2.70 **	3.53 ns	23.15
	G	68.80 **	19.11**	17.60 ns	78.0 **	2.62**	3.64 ns	24.49
	LSD	0.265	1.16	1.34	3.79	0.39	0.53	
		0.361	1.56	1.81	5.10	0.53	0.72	
Second season	A	95.68	24.47	16.45	76.9	3.11	5.17	0.00
	B	72.60 **	19.61 **	15.75 *	71.1 **	2.19 **	5.43 ns	19.86
	C	70.73 **	18.36 **	15.55 *	69.2 **	1.92 **	5.48 ns	24.96
	D	66.40 **	18.05 **	15.35 *	69.1 **	1.91 **	5.64 ns	26.24
	E	64.27 **	17.63 **	15.25 **	68.8 **	1.84 **	5.62 ns	27.95
	F	61.38 **	15.92 **	15.05 **	67.7 **	1.62 **	5.74 ns	34.94
	G	59.57 **	12.25 **	14.91 **	65.2 **	1.19 **	5.91 ns	49.93
	LSD	0.301	0.048	0.3	2.1	0.028	1.1	
		0.409	0.065	1.14	4.7	0.038	1.7	

Juice purity (%):

The obtained results in Table (4)indicated that increasing the amount of drainage irrigation water for sugar beet decreased juice purity during the two studied seasons. The magnitude of purity decrement was high in the second season compared to the first one. In the first season there were insignificant differences between the control treatment A and the treatments B, C and D. While in the second season all drainage water treatments recorded a high significant reduction compared to the fresh (A) treatment. The lowest value of purity percentage 78.0 and 65.2 % was obtained under treatment (G) in the first and second seasons ,respectively . These results are in agreement with those of Ayars et al(1990) ; Kaffka *et al.*(1999); El-Rammady (1997) and Omar *et al.* (2001)

Sugar yield (ton/fed.):

Data in Table (4) showed that increasing the applied percent of drainage irrigation water to sugar beet plants resulted in decreasing sugar yield during the two studied seasons. For the first season data showed that there were no significant differences in sugar yield between the control and treatments B and C which received 25 and 37.5 % drainage water. While in the second season the sugar yield reduction was highly significant under all drainage water treatments compared to control treatment. The highest sugar yields were 3.68 and 3.11 ton/fed. obtained under fresh water (A) treatment in the first and second seasons, respectively. While the lowest extracted sugar yields were 2.62 and 1.19 ton/fed. resulted from full irrigation with drainage water (G). These results are in agreement with those of Rhoades *et al.* (1988); Ayars *et al*(1990) and Kaffka *et al.*(1999).

Alpha amino nitrogen:

The obtained results in Table (4) for the two seasons indicated that using the alternative irrigation by drainage with fresh waters led to insignificant increase in amino nitrogen concentration compared to control treatment (A).Data also showed that the treatment (G) which received drainage water all the season recorded the maximum values (3.64 and 5.91 %) of alpha amino nitrogen while the lowest values (3.3 and 5.17 %) were obtained with (A) treatment in the 1st and 2nd seasons , respectively.

(II) Effect of alternative irrigation with fresh and drainage water on water relations and water use efficiencies of sugar beet crop:

Water applied and water consumptive use :

Data in Table (5) revealed that the highest values of applied water (2916.48 and 2740.08 m^3 /fed.) for the 1st and 2nd seasons, respectively were obtained with control treatment that irrigated only with fresh water. While the lowest values (2464.14 and 2128.14 m^3 /fed.) in the 1st and 2nd seasons, respectively were obtained under irrigation with drainage water all the season. The obtained results showed that the highest values of water consumptive use (2324.70 and 2253.72 m^3 /fed.) for first and second seasons, respectively were obtained with control treatment that irrigated only with fresh water. While the lowest values (2000.04 and 1885.38 m^3 /fed.) were obtained under irrigation with drainage water all the season.

From these results it could be concluded that, applied water and water consumptive use of sugar beet were decreased with increasing drainage water usage for irrigation and this could be attributed to decrease of water absorption by plants as a result of increasing of osmotic pressure of soil solution. It is clear from the obtained data that applied water and water consumptive use were higher in the first season than in the second one due to salinity build up by using drainage water alternatively with fresh water .These results are in agreement with those of Katerji *et al.*(2000) ; Reina-Sánchez *et al.* (2005) ; Yurtseven *et al.*(2005) and Ragab *et al.* (2005).

Water use efficiencies for root and sugar yields of sugar beet crop:

The obtained results in Table (5) indicated that treatment (A) achieved the maximum values of field water use efficiency (8.68 and 1.26 kg/ m^3) for root and extracted sugar yields respectively in the first season The corresponding values in the second season were 8.93 and 1.13 kg/ m^3 for root and sugar yields , respectively. While treatment (G) recorded the minimum values (7.76 and 1.06 kg/ m^3) in the first season and (5.75 and 0..56 kg/ m^3) in the second season for root and sugar yields, respectively.

The maximum values of crop water use efficiency of sugar beet root and extracted sugar is obtained under control treatment (10.89 & 1.58 kg/ m^3) for the first season and (10.86 & 1.38 kg/ m^3) for the second season. On the other hand the minimum values of crop water use efficiency of sugar beet root and extracted sugar (9.55 &1.33 kg/ m^3) in the first season and (6.49 and 0.63 kg/ m^3) in the second season were observed under full irrigation with drainage water, treatment (G).It could be concluded that water use efficiency for sugar beet decreased with increasing the usage of drainage water for irrigation . These results are in agreement with those of Katerji *et al.*(2000) ; Reina-Sánchez *et al.* (2005) ; Yurtseven *et al.*(2005) and Ragab *et al.* (2005).

Table (5): Applied water ,water consumptive use, field water use efficiency and crop water use efficiency (kg/m³) of sugar beet crop:

Season	Treat-ments	Fresh applied water, m3/fed.	Drainage applied water, m3/fed.	Total applied water, m3/fed.	Water consumptive use,m3/fed.	Field water use efficiency,kg/m3		Crop water use efficiency,kg/m3	
						Root	Sugar	Root	Sugar
First season	A	2916.48	0.00	2916.48	2324.70	8.68	1.26	10.89	1.58
	B	2056.64	685.55	2742.18	2236.08	7.94	1.24	9.73	1.52
	C	1671.34	1002.80	2674.14	2208.78	7.98	1.25	9.67	1.51
	D	1289.61	1289.61	2579.22	2144.52	7.96	1.23	9.57	1.48
	E	959.49	1599.15	2558.64	2109.24	7.91	1.18	9.60	1.44
	F	625.07	1875.20	2500.26	2020.62	7.78	1.08	9.63	1.33
	G	0.00	2464.14	2464.14	2000.04	7.76	1.06	9.55	1.31
Second season	A	2740.08	0.00	2740.08	2253.72	8.93	1.13	10.86	1.38
	B	1903.23	634.41	2537.64	2035.32	7.71	0.86	9.62	1.08
	C	1452.68	871.61	2324.28	2009.70	7.90	0.85	9.13	0.98
	D	1141.77	1141.77	2283.54	1972.32	7.90	0.84	9.15	0.97
	E	848.93	1414.88	2263.80	1953.00	7.78	0.82	9.02	0.95
	F	539.07	1617.21	2156.28	1894.62	7.38	0.75	8.40	0.86
	G	0.00	2128.14	2128.14	1885.38	5.75	0.56	6.49	0.63

(III) Effect of alternative irrigation with fresh and drainage waters on soil salinity and alkalinity:

The obtained results in Table (6) indicated that the continuous irrigation with drainage water increased soil ECe and ESP during the two studied seasons. Using the alternative irrigation of fresh water with drainage water decreased both soil salinity and exchangeable sodium percentage. Increasing the percent or the number of irrigations with drainage water resulted in increasing both ECe and ESP during the two growing seasons due to the higher salt content of drainage water. The lowest values of soil ECe 5.68 and 5.55 dS/m were obtained under full irrigation with fresh water(A) after the 1st and 2nd seasons, respectively. while the highest values of soil ECe 13.5 and 16.34 dS/m and ESP 22.68 and 24.7 % were resulted under (G) treatment in the 1st and 2nd seasons, respectively. The rate of change in soil salinity and alkalinity was positive and more pronounced after harvesting the second season of sugar beet crop. These results are in agreement with those of Sobh *et al.*(1997) ; Moreno *et al.*(2005) and Almodares and Sharif (2005).

Table (6): Soil salinity (ECe) and exchangeable sodium percentage as affected by alternative irrigation of sugar beet with fresh and drainage waters.

Treatments	Before experiment		After first season		Rate of change		After second season		Rate of change	
	ECe,dS/m	ESP	ECe,dS/m	ESP	ECe,dS/m	ESP	ECe,dS/m	ESP	ECe,dS/m	ESP
A	5.64	10.61	5.68	10.36	- 0.05	- 0.25	5.55	10.12	- 0.13	- 0.49
B	5.64	10.61	6.7	13.49	+ 1.08	+ 2.88	9.15	17.06	+ 3.51	+ 6.45
C	5.64	10.61	7.2	13.79	+ 1.56	+ 3.18	9.75	17.81	+ 4.11	+ 7.2
D	5.64	10.61	8.3	16.8	+ 2.66	+ 6.19	10.63	18.75	+ 4.99	+ 8.14
E	5.64	10.61	9.3	17.31	+ 3.66	+ 6.74	12.25	19.32	+ 5.61	+ 8.71
F	5.64	10.61	11.6	19.1	+ 5.96	+ 8.49	13.45	20.01	+ 6.81	+ 9.4
G	5.64	10.61	13.5	22.68	+ 7.86	+12.07	16.34	24.7	+ 10.7	+14.09

REFERENCES

Abo Soliman,M.S. ; M.R. Khalifa ; W.S. El-Sabry and K.M. Sayed (1992). Use of drainage water in irrigation at North Nile Delta, its effect on soil salinity and wheat production. J. Agric. Res. Tanta Univ., 18 (2):425-435.

Almodares, A.and M.E. Sharif ((2005). Effect of water quality on yield of sugar beet and sweet sorghum. Journal of Environmental Biology., 26(3): 487-493.

Ayars, J.E.; R.B. Hutmacher ; R.A. Schoneman and S.S.Vail (1990). Long term use of saline water for irrigation. : Visions of the future Proceedings of the 3rd National Irrigation Symposium ASAE-Pub.4-90. pp: 368-373.

Doorinbos, J. and W. O. Pruitt(1975). Crop Water Requirments. Irrigation and Drainage Papers , No. 24, F.A.O., Rome.

El-Rammady, H.R. (1997). Response of sugar beet to nitrogen and potassium dressing at different levels of soil salinity. M.Sc. Thesis, Fac. Agric., Tanta Univ.

El-Henawy, A.S.E. (2000). Impact of available water sources at North Delta on soil and some field crops. M.Sc. Thesis, Faculty of Agric., Tanta Univ.

El-Hessy Farida and Mona El-Kady (1997). Interventions of water saving for Egypt,s Nile irrigation system. Second International Water Technology Conference, TWTC, Alexandria.

FAO (1992). The use of saline waters for crop production. FAO Irrigation and drainage paper 48, FAO, Rome.

Hamdy,A., V. Sardo and K.A. Farrag Ghanem (2005). Saline water in supplemental irrigation of wheat and barley under rainfed agriculture. Agricultural Water Management, 78(1-2):122-127.

Israelsen, O.W. and V.E. Hansen (1962). Irrigation principles and practices, 3rd Edit., John Willey and Sons , Inc. New York.

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

Katerji, N ; J.W.van Hoom; A.Hamdy and M.Mastrorilli (2000). Salt tolerance classification of crops according to soil salinity and to water stress day index. Agricultural Water Management, 43(1): 99-109.

Malash,N.; T.J. Flowers and R.Ragab (2005). Effect of irrigation systems and water management practices using saline and non-saline water on tomato production. Agricultural Water Management, 78(1-2):25-38.

McGinnus, R.A. (1971). Sugar beet Technology,2nd Ed. Sugar beet Development Foundation Fot. Coollinos, , Colo., USA.

Michael, A.M. (1978). Irrigation theory and practice.Vikas Publishing House, New Delhi , Bombay.

Moreno, F.; F. Cabrera ; E.Fernandez-Boy ; I.F. Giron ; J.E. Fernandez and B. Bellido (2001). Irrigation with saline water in the reclaimed marsh soils of south-west Spain: impact on soil properties and cotton and sugar beet crops .Agricultural Water Management, 48(2): 133-150.

Murtaza, G. ; A. Ghafoor and M. Qadi (2006). Irrigation and soil management strategies for using saline-sodic water in a cotton–wheat rotation. Agricultural Water Management, 81(1-2): 98-114.

Omar, E.H.; E.A.E. Gazia ; M.A. Ghazy and M.A.A. Abd Allah (2001). Effect of irrigaton water quality and sludge application on soil salinity , sugar beet and canola yield and irrigation efficiencies . Minufiya J. Agric. Res., 26:1651-1665.

Page, A.L. (Ed) (1982). Methods of Soil Analysis, Part 2 : Chemical and Microbiological Properties , (2nd Ed.). Am. Soc. At Agron. Inc. Soilo Sci. Soc. Of Am Inc., Madison, Wisconsin, USA.

Ragab,R. ; N. Malash ; G. Abdel Gawad ; A. Arslan and A. Ghaibeh (2005).A holistic generic integrated approach for irrigation, crop and field management .2. The SALTMED model validation using field data of five growing seasons from Egypt and Syria. Agricultural Water Management, 78(1-2):89-107.

Reina-Sánchez, A. ; R. Romero-Aranda and J. Cuartero (2005). Plant water uptake and water use efficiency of greenhouse tomato cultivars irrigated with saline water. Agricultural Water Management, 78(1-2): 54-66.

Rhoades, J.D.; F.T. Bingham; J. Letey; P.J.Jr. Pinter; R.D.Lemert; W.J. Alves ; G.J.Hoffman; J.A.Replogle; R.V. Swain; and P.G.Pacheco (1988). Reuse of drainage water for irrigation: results of Imperial Valley study. II. Soil salinity and water balance. Hilgardia, 56(5): 17-44.

Richard,L.A. (1954).The diagnosis and improvement of saline and alkali soils. USda, Handbook 60.

Snedecor,G.W. and W.G. Cochran (1974).Statistical Methods. 6th Edition Ioaw State Univ., Press. Ames. Iowa, P. 593.

Sobh, M.M.; E.H.A. Mashaly and M.H. Amer (1997). Effect of diluted sea water on some soil chemical properties of some calcareous and non-calcareous soils and mineral composition and yield of wheat plants. Zagazig J. Agric. Res. , 24(5):915-925.

Tedeschi, A. and R. Dell'Aquila (2005). Effects of irrigation with saline waters, at different concentrations, on soil physical and chemical characteristics. Agricultural Water Management, 77(1-3):308-322.

Theillier, C.; K.M.Holtzclaw ; J.D.Rhoades and G.Sposito (1990). Chemical effects of saline imigation water on a San Joaquin Valley soil: II. Field soil samples. Joumal of Environmental Quality, 19(1): 56-60.

Yurtseven,E.,G.D.Kesmez and A.Unlukara (2005). The effects of water salinity and potassium levels on yield, fruit quality and water consumption of a native central anatolian tomato species (Lycopersicon esculantum). Agricultural Water Management, 78(1-2):128-135.

تأثير الري التبادلي بالمياه العذبة مع مياه الصرف على إنتـــاج بنجــر الســكر و نوعيته ، ملوحة التربة وبعض العلاقات المائية بشمال دلتا النيل

السعيد حماد عمر، محمد احمد عبد العزيز، محمد مصطفى رجب و محمد عبد الله
معهد بحوث الاراضى والمياه والبيئة، مركز البحوث الزراعية

أقيمت تجربتان حقليتان في شمال دلتا مصر لدراسة تأثير الري التبادلي بمياه الصرف مع المياه العذبـــة علـــى محصول بنجر السكر و نوعيته، ملوحة وقلوية التربة وبعض العلاقات المائية خلال موســـمي النمـــو ٢٠٠٤/٢٠٠٥ ، ٢٠٠٥/٢٠٠٦

قبل زراعة البنجر كانت التربة ملحية وذات قوام طيني. وقد اختيرت سبعة معاملات ري في تصميم قطاعـــات كاملـــة العشوائية في أربعة مكررات كالاتى:

A) الري ١٠٠% مياه عذبة.
B) الري ٧٥% مياه عذبة +٢٥ % مياه صرف.
C) الري ٦٢,٥% مياه عذبة +٣٧,٥ % مياه صرف.
D) الري ٥٠% مياه عذبة +٥٠ % مياه صرف.
E) الري ٣٧,٥% مياه عذبة +٦٢,٥% مياه صرف.
F) الري ٢٥% مياه عذبة +٧٥ % مياه صرف.
G) الري ١٠٠ % مياه بمياه الصرف صرف .

ويمكن تلخيص أهم النتائج كما يلي:

- استخدام الري التبادلي بمياه الصرف مع مياه الري العذبة أدى إلى زيادة نسبة الإنبات مقارنة بها تحت ظـــروف الري المستمر بمياه الصرف طوال الموسم.
- كان النقص في إنتاج الجذور ١٨,٩٣و ٢٦,٢٤% في الموسم الأول و الثاني على الترتيب عندما استخدمت ميـــاه الصرف في الري بنسبة ٥٠ % بالتبادل مع المياه العذبة.
- إضافة ٢٥ إلى ٥٠% مياه صرف بالتبادل مع مياه الري العذبة قد نتج عنه زيادة معنوية في النسبة المئوية للسكر مقارنة بمعاملة الكنترول خلال موسم النمو الأول. بينما في الموسم الثاني قد نقصت النسبة نقصا معنويا وذلك مع زيادة استخدام مياه الصرف في الري.
- لم يكن هناك فروق معنوية في إنتاج السكر المستخلص في الموسم الأول بين معاملة الكنترول والمعاملات C, B والتي رويت بنسبة ٢٥ و ٣٧,٥ % مياه صرف. بينما في الموسم الثاني للنمو فان كل المعاملات التـــي رويـــت بنسب مختلفة من مياه الصرف قد أدت إلى نقص عالي المعنوية في إنتاج السكر المستخلص.
- وتشير النتائج إلى أن أعلى القيم لمياه الري المضاف والاستهلاك المائي قد تم الحصول عليها تحت معاملة الري بالمياه العذبة طوال الموسم بينما انخفضت تلك القيم بزيادة استخدام مياه الصرف بالتبادل في الري مـــع الميـــاه العذبة.
- أدى الري المستمر بالمياه العذبة إلى الحصول على أعلى كفاءة لاســـتخدام الميـــاه بالنســـبة للجـــذور والســـكر المستخلص.
- أدى الري المستمر بمياه الصرف إلى زيادة ملوحة وقلوية التربة بينما أدى الري التبادلي بمياه الصرف مع المياه العذبة إلى خفض قيم هذه الصفات.

ويمكن أن نستخلص من هذه الدراسة انه يمكن استخدام مياه صرف مالحة (٤٦١٤ جزء في المليون) بنسبة ٥٠% بالتبادل مع مياه الري العذبة في ري بنجر السكر وذلك في مراحل النمو الغير حساسة للملوحة مع حدوث نقص في الإنتاج بنسبة تقارب ٢٥ % في منطقة شمال الدلتا التي تعانى من نقص في مياه الري العذبة خاصة في نهايات الترع أو المساقى الخصوصية..