J. Agric. Sci. Mansoura Univ., 33 (12): 9091 - 9104, 2008

EFFECT OF DIFFERENT WATER SOURCES UNDER DIFFERENT SOIL MOISTURE DEPLETIONS ON SOIL SALINITY, ALKALINITY AND SUGAR BEET AND SUNFLOWER YIELDS

Gazia, E. A. E.; M.A.A. Abd Allah; M. A. Abd El-Aziz and B.A. Zamil
Soil, Water and Environment Research Institute, A.R.C. EGYPT

ABSTRACT

Lysimeter experiments were carried out at Sakha Agric. Research Station in two growing seasons (2007 and 2008) to assess a new technique of irrigation using different water sources: fresh (Nile) water – drainage water – wastewater – well water. This technique is alternating irrigation between those different water sources and fresh water under soil moistures depletion (50% and 70%). Crop yield, water Use efficiency (WUE), soil salinity (ECe) and alkalinity (ESP) were recorded.

Sugar beet yield significantly influenced by Water sources, soil moisture depletion and application technique. Elemental content (macro nutrients and heavy metals) was increased as a result of irrigation by sewage water either directly or blended with well water. The alternative technique increased the WUE and frustrated the saline effect of sewage water as compared to continuous one. The lowest values of soil salinity and alkalinity were achieved under the irrigation with fresh water and blending sewage water with well water under alternative irrigation technique.

Regarding sunflower, seeds yield was significantly affected by the three factors (water source, application technique and soil moisture depletion). Fresh water with soil moisture depletion at 50% of available soil moisture induced the highest value of seed yield. The highest values of WUE were subjected to the treatment irrigated with sewage water alternated with fresh water and depletion at 70%. Using fresh water and well water induced the lowest and the highest values of ECe respectively. Blending sewage water with well water decreased soil alkalinity (ESP) under alternative technique compared with irrigation by well water or sewage water separately.

INTRODUCTION

Agricultural expansion in addition to increasing population in Egypt requires incrementally more amount of irrigation water. The annual Nile water supply is 55.5 milliard cubic meters of fresh water, while the annual demand is estimated to be 71.5 milliard cubic meters of water in 2000(Abd El-Dayem, 1994). This circumstance makes that increasing water a source is tremendously needed. This gap could be accomplished through two means: namely, increasing the usable supply of water and improving the efficiency of water utilization. Reusing of drainage, sewage and/or well water is an attractive solution that hopefully helps in facing this gap between demand and supply of water.

It was recommended in Dublin Conference (ICWE, 1992) that the scarcity and misuse of fresh water pose a serious and growing threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development and the ecosystem are all in risk, unless water and land sources are managed more efficiently and effectively in the present decade. That is echoed in the "Agenda 21 of the United Nations Conference on Environment and Development", (UNCED, 1992). That conference called for political commitment and involvement from the highest level of government to the smallest community to protect the quality and quantity of water resources. So Egypt put that commitment as a main task and switch to find out another resources of water, that are environmentally safe and do not lead to negative effects on the soil, plant, animal and human matter.

Pescod (1992) stated that alternating treated wastewater with canal water or ground water was superior to blending from the point of view of salinity control. However, an alternating application strategy will require duel conveyance system and availability of the effluent dictated by the alternate schedule of application. Balba (1960) and Hamdi *et. al*. (1968), stated that applying saline water increased the soil salinity, and almost doubled the initial soil salinity. Also, Hamdi et al. (1966), and El-Gamal (1966) stated that applying saline irrigation water with different Na: Ca ratios increased the soil alkalinity. On the other hand, Amer *et al*. (1997) found that the continuous irrigation (three years) with drainage water (1.6 dS/m) increased the salinity of clay soil.

The objectives of the present study are to assess a new technique for reusing the available sources of irrigation water (such as: drainage, secondary treated sewage and well water). This technique is alternating the irrigation using these sources of water with fresh (Nile) water, i.e. one irrigation with fresh (Nile) water and the next irrigation with different sources. Also, blending some of these sources (S, W water by different ratios) combined with different soil moisture depletions (50% and 70% of the available soil moisture) were applied to study the effect of these factors on some economical field crops (such as: sugar beet and sunflower) as well as water use efficiency and some soil properties.

MATERIALS AND METHODS

A factorial experiment with four replicates was carried out in circle Lysimeters (80 cm diameter and 120 cm height) at Sakha Agricultural Research Station on two successive growing seasons (2007 and 2008). Sugar beet (var. Top) was cultivated in the first season and sunflower (var. Vidoic) was cultivated in the next season. Four sources of water were used, namely: fresh (F), secondary treated sewage (S), drainage (D) and well water (W). S and W were blended with two ratios 1:1 (S1:W1) and 2:1 (S2:W1).

Experimental Treatments:

A- Main treatments(Water sources : 4)

F: fresh water
D: drainage water
W: well water
S: secondary treated sewage water

B-Sub - treatments (Application technique: 2)

* Continuous irrigation (irrigation using the above mentioned four sources of water all seasons time)
* Alternative irrigation (alternating the irrigation using the four sources of water with fresh (Nile) water, i.e., one irrigation with fresh (Nile) water and the next irrigation with different sources).

C – Sub- Sub treatments (Soil moisture depletions: 2)

* 50% D
* 70% D

The common agricultural practices of growing sugar beet and sunflower plants were carried out according to local recommendations of the Ministry of Agriculture, Egypt.

Soil chemical and physical properties were done according to Jackson (1970), and Page (1982), while water measurements were done using Israelson and Hansen (1962). Statistical analysis was done according to Cochran and Cox (1960). The chemical analysis of the soil and the used water sources are stated in tables (1, 2 and 3).

Table (1a): Some physical and chemical properties of tested soil before sugar beet planting.

SOIL DEPTH, CM	PARTICAL SIZE DISTRIBUTION,% SAND SILT CLAY			TEXTURE CLASS	BULK DENSITY,	SOIL MOISTURE CHARACTERISTICS,%		P^H	EC dsm^{-1}	ESP
	SAND	SILT	CLAY			F.C	W.P			
0-60	21.67	27.93	50.40	CLAY	1.22	40.44	22.88	7.85	5.30	10.53

Table (1b): Average soil elemental content ($mgKg^{-1}$) before sugar beet planting, extracted by DTPA (Cottenie et al., 1982).

N	P	K	Fe	Zn	Mn	Cu	B	Pb	Co	Ni	Cd	Cr
29.0	8.0	220.0	26.1	6.0	18.1	3.5	3.0	3.3	0.21	1.0	0.15	0.4

Table (2): Chemical and biological properties of different water sources according to Jackson (1970) and Greenberg et al. (1985).

Water sources	EC, dS/m	SAR	COD, Mg/l	BOD , Mg/l	NH_4, Mg/l	NO_3, Mg/l	Suspended solids, mg/l	Dissolved solids, Mg/l
F	0.53	1.45	23	9	1.3	5.5	240	530
S	1.25	4.65	127	75	17	38	920	1250
D	1.55	3.95	45	23	12	29	410	1540
W	3.10	10.10	0	0	1.9	3.5	25	3000

Table (3): Elemental content (ppm) of different water sources, according to Greenberg et al. (1985).

Water sources	N	P	K	Zn	Mn	Fe	Cu	Cd	Pb	Co	Ni	B	Cr
F	1.36	0.315	6.34	0.00	0.028	0.025	0.005	0.0023	0.032	0.004	0	0.06	0.03
S	7.85	4.850	32.6	0.09	0.094	0.331	0.019	0.0084	0.084	0.025	0	0.03	0.06
D	5.4	0.418	17.3	0.01	0.045	0.213	0.009	0.0040	0.041	0.016	0	0.02	0.03
W	0.42	0.235	1.02	0.02	0.020	0.110	0.004	0.0018	0.025	0.001	0	0.00	0.02

The quantities of water for each irrigation was calculated according to the following equation (Israelson and Hansen, 1962):

$$Q = R \times D \times Bd \times (F.C - S.M.I) / 100$$

Where:

Q : The quantity of water, m^3

R : Area that would be irrigated,m^2

D : The soil depth required to be irrigated, m

Bd : Soil bulk density, g/ cm^3

F.C : Field capacity %

S.M.I: Soil moisture percentage just before irrigation

Water utilization efficiency (W.U.E) was computed according to Michael, 1978.

W.U.E = yield (kg / fed.) / Amount of water applied (cubic meter /fed.)

RESULTS AND DISSCUSSION

Sugar beet crop:

1 – Yield and its components:

1.1 – Sugar beet yield (kg/Lysimeter):

Data in Table (4) elucidated that the sugar beet yield was highly significantly affected by water source and was significantly affected by soil moisture depletion and application technique. Also, data indicated that sugar beet yield with irrigation at 50% depletion surpassed that at 70% depletion. Concerning water sources, it could be observed that irrigation with fresh water induced the highest value of sugar beet yield, followed by treated sewage; drainage and then well water.

Blending sewage water and well water at ratio of 1:1 or 2:1 decreased the harmful effect of high salinity and alkalinity of well water. These results may be attributed to the high salinity of well water as well as sugar beet plant is very low tolerant to salinity at the germination stage and medium salt tolerant of established plants. (Franzen *et al*, 1994). These results are in good agreement with Pescod (1992).

1.2) Average root weight:

Data in Table (4) indicated that, the water application technique insignificantly affected the root yield, while the irrigation at 70% depletion increased the average root weight of sugar beet compared to irrigation at 50% depletion. Concerning water sources, it could be observed that continuous irrigation using treated sewage water gave the highest values of root weight. This result may be due to the high content of macro and micro nutrients of sewage water. On the other hand well water gave the lowest values of root weight; this result may be attributed to the high salinity of well water as it is shown in Table (2).

1.3) Sucrose percentage:

Data in Table (4) elucidated that the highest value of sucrose (%) was obtained under irrigation with fresh water while the lowest value was obtained under treated sewage water irrigation. This result may be attributed to the high content of sewage water with nitrogen which increase amino nitrogen concentration in roots plant and consequently decrease sugar percentage because plant divert more energy from sucrose storage to metabolism in growth of roots. The same conclusion was obtained by (Buorac et al., 1995 and Abd Allah 1998).

Alternative irrigation technique increased sugar percentage compared to the continuous irrigation, while soil moisture depletion showed a significant effect on sucrose %. Since 50% depletion surpassed that of 70%. This result may be due to that the more depletion the more root weight and hence decrease the percentage of sucrose.

Table (4): Average yield, root weight, sugar yield and sucrose % as affected by water source, application technique and soil moisture depletion.

Water sources	Average yield (kg/Lysim.)	Average root weight kg/Lysim.	Sugar yield (kg/Lysim.)	Sucrose %
Water source (W)				
F	2.25	1.02	0.192	18.85
D	2.46	1.40	0.261	18.65
W	2.12	1.01	0.189	18.75
S	2.60	1.55	0.275	17.73
S1:W1	2.27	1.10	0.199	18.10
S2:W1	2.56	1.45	0.260	17.93
F-test	**	*	*	Ns
LSD0.05	0.18	0.23	0.05	-
0.01	0.39	-	-	-
Application technique (P)				
Continuous	2.34	1.22	0.220	18.02
Alternative	2.42	1.29	0.241	18.66
F-test	*	Ns	ns	Ns
Depletion (D)				
50% D	2.42	1.19	0.220	18.50
70% D	2.36	1.32	0.240	18.20
F-test	*	*	ns	*
Interaction				
WxP	*	*	*	*
WxD	*	*	Ns	Ns
PxD	*	*	Ns	Ns
WxPxD	*	*	*	*

1.4) Sugar yield:

The presented data in Table (4) show that the water sources significantly affected sugar yield. The continuous irrigation by treated sewage water induced the highest yield (0.275kg/Lysimeter), while the lowest values were achieved with well water (0.189 kg / Lysimeter). Data also revealed that there is insignificant effect due to application water technique and soil moisture depletion.

1.5) Elemental content of sugar beet root:

Data in Table (5) showed that the concentration of elements was within the normal limits and less than the recorded critical limits found in plants as given by Mengel and Kirkby, (1987). Elemental content was increased as a result of irrigation by sewage water and blending sewage water with well water at ratio of 2:1. The lowest concentration was achieved with irrigation by fresh water. The effect of water sources on the elemental content could be arranged in descending order as follows: S > S2:W1 > S1:W1 > D > F> W

5

The alternative technique of different water sources with fresh water decreased the contents of heavy metals. On the other hand, irrigation with different water sources at 70% depletion increased the concentration of macronutrients as well as heavy metals as compared to 50% depletion. The increase of the elemental contents in sugar beet roots may be attributed to that the high content of sewage water with different nutrients and heavy metals consequently increase the amount of heavy metals taken up by the plants from the more dried soils. These results stood in similar interpretation with those obtained by Marshner, (1998).

2 .Water measurements:

2.1 – Water applied depth:

Data in Table (6) indicated that the irrigation at 50% depletion received higher depth of irrigation water than 70%. Regarding the water sources, data revealed that the irrigation by fresh water recorded the highest value of water depth, while the lowest one was obtained when sewage water was used in irrigation at depletion 70%. Also, the alternative irrigation technique received higher depth of water than the continuous one. This result may be due to the irrigation with sewage water decreased the permeability of the soil and hence decreased the water depth.

Table (6): Applied Water depth, cm as affected by application technique, water sources and soil moisture depletion under sugar beet crop.

Water source	Continuous			Alternative		
	50%	70%	Mean	50%	70%	mean
F	85.7	82.7	84.2	85.7	82.7	84.2
D	80.1	75.9	78.0	82.0	79.5	80.8
W	81.5	77.2	79.4	83.9	79.9	81.9
S	77.0	72.9	74.9	80.7	78.6	79.7
S1:W1	79.8	77.0	78.4	80.9	77.3	79.1
S2:W1	79.4	77.1	78.3	83.2	80.5	81.9
mean	80.6	77.1	78.9	82.7	79.8	81.3

2.2 – Water Utilization Efficiency (WUE):

Data in Table (7) showed that the alternative technique increased the water utilization efficiency as compared to continuous one, however the irrigation at 50% depletion surpassed the irrigation at 70% in increasing water utilization efficiency.

Table (7): Water utilization efficiency (kg/m^3) as affected by application water technique, water sources and soil moisture depletion under sugar beet crop.

Water source	Continuous			Alternative		
	50%	70%	Mean	50%	70%	Mean
F	0.98	0.92	0.950	1.02	1.08	1.050
D	1.04	1.03	1.035	1.09	1.03	1.060
W	1.02	0.99	1.005	1.07	1.02	1.045
S	1.07	1.06	1.065	1.10	1.07	1.085
S1:W1	0.93	0.87	0.900	1.10	1.11	1.110
S2:W1	0.82	0.85	0.840	0.92	0.88	0.900
mean	0.98	0.95	0.97	1.05	1.03	1.040

3 - Soil salinity and alkalinity:

Data in Table (8) elucidated that the irrigation with fresh water continuously or alternatively with sewage water gave the lowest values of soil salinity (5.3 and 5.7 dSm^{-1} respectively).whereas the highest values were recorded with the continuous and alternative irrigation by well water (8.4 and 7.3 dSm^{-1} respectively)

Also, the lowest value of exchangeable sodium percentage (ESP) was obtained by irrigation with fresh water (10.5), while, the highest values were obtained by continuous and alternative irrigation by well water (16.93and 15.12respectively), this may be due to the high content of sodium salts (SAR) in well water. For soil moisture depletion levels, it is worthy to mention that there is no clear difference between ECe or ESP values under the depletion rate.

.

Table (8): Soil salinity (ECe, dSm^{-1}) and alkalinity (ESP) as affected by application technique, water sources and soil moisture depletion under sugar beet crop.

Water source	ECe, dSm^{-1}			ESP		
	Cont.	**Alter.**	**Mean**	**Cont.**	**Alter.**	**Mean**
F	5.3	5.3	5.30	10.50	10.50	10.50
D	6.7	6.5	6.60	11.63	10.80	11.22
W	8.4	7.3	7.85	16.93	15.12	16.03
S	6.0	5.7	5.65	14.35	12.46	13.41
S1:W1	6.9	6.3	6.60	13.01	11.54	12.28
S2:W1	6.2	5.9	6.05	11.91	11.48	11.70
mean	6.58	6.25	6.42	13.06	12.26	12.52
50%	6.45	6.85	6.62	14.59	13.60	14.10
70%	6.20	6.95	6.58	12.75	11.48	12.12

Sunflower Crop:

1 - Sunflower seed yield:

Table (9) showed that seed yield of sunflower was significantly affected by all treatments. The effect of water sources on seed yield could be arranged in descending order as follows: F > D > S2:W1 > S1:W1 > W > S.

This trend means that blending sewage water with well water increased sunflower yield more than the separate use of each water source. This result was in good agreement with Ayers and Westcott, (1985).Regarding

application technique, it could be noticed that the alternative technique surpassed the continuous one. On the other hand the irrigation with different water sources at 50% depletion increased the yield of sunflower seeds compared with soil moisture depletion at 70%.

Table (9): Sunflower seed yield (gm/Lysim.) as affected by water sources, application technique and soil moisture depletion.

Water sources	Sunflower seed yield (gm/Lysim.)
F	148.6
D	125.9
W	100.5
S	73.0
S1:LW1	104.9
S2:W1	112.3
F-test	*
LSD 0.05	3.2
Continuous irrigation	109.2
Alternative irrigation	112.7
F-test	*
50% Depletion	114.93
70% Depletion	106.9
F-test	*
WxP	*
WxD	*
PxD	*
WxPxD	**

2 - Elemental content of sunflower seeds:

Data in Table (10) indicated that the irrigation with sewage water resulted in increasing the concentration of elements followed by irrigation with sewage water blended with well water at ratio 2:1 or 1:1. On the other hand the irrigation by well water caused the lowest concentration of elements. It is observed from the data that the irrigation at 70% depletion increased the elemental content as compared with irrigation at 50% depletion. Regarding the application technique, it is noticed that the alternative irrigation decreased the elemental content as compared to continuous irrigation. It could be concluded that irrigation by sewage water at 70% soil moisture depletion increased the elemental content in sunflower seeds. Also the alternative irrigation decreased the macronutrients (N, P and K) and the micronutrients as well as heavy metals (.i e. Zn, Mn, Ni, Fe….). This result may be due to that the high content of sewage water from both macro and micro-elements which increased them in the soil solution consequently increased its uptake by plants and seeds content of those elements.

3 – Water measurements:

3 .1 – Amount of applied water:

Data in Table (11) showed that 50% depletion treatment received irrigation water more than 70% depletion. The alternative irrigation with different water sources recorded the highest values of applied water depth as compared to the continuous irrigation. Regarding water source, data indicated that irrigation by fresh water received the highest depth of water than the other water sources**.**

3. 2 – Water utilization Efficiency (WUE):

Water utilization Efficiency (WUE) (calculated as kg seeds per cubic meter of water added to sunflower plants). The values are shown in Table (12). The highest values were obtained from treatments irrigated by sewage water alternated with fresh water and subjected to 70% depletion. While the lowest values achieved with irrigation by well water and 50% depletion.

Table (11): Applied water depth (cm) as affected by application technique, water sources and soil moisture depletion under sunflower crop.

Water sources	Continuous			Alternative		
	50%	**70%**	**mean**	**50%**	**70%**	**mean**
F	68.9	59.7	64.3	69.1	60.1	64.6
D	64.1	55.8	59.9	68.4	57.5	62.9
W	62.6	55.0	58.8	63.6	56.7	60.2
S	65.8	52.6	59.2	67.0	54.9	60.9
S1:W1	62.9	55.2	59.1	63.2	56.9	60.1
S2:W1	61.9	53.0	57.5	62.9	54.2	58.6
mean	64.4	55.2	59.8	65.7	56.7	61.2

Table (12): Water utilization efficiency (kg/m^3) as affected by application water technique, water sources and soil moisture depletion under sunflower crop.

Water source	Continuous			Alternative		
	50%	**70%**	**mean**	**50%**	**70%**	**Mean**
F	0.32	0.38	0.35	0.33	0.37	0.35
D	0.29	0.30	0.30	0.28	0.30	0.29
W	0.20	0.21	0.21	0.23	0.23	0.23
S	0.41	0.48	0.45	0.44	0.45	0.45
S1:W1	0.32	0.32	0.32	0.30	0.32	0.31
S2:W1	0.33	0.36	0.35	0.32	0.38	0.35
mean	0.31	0.34	0.33	0.32	0.34	0.33

4 – Soil salinity and alkalinity:

Data in Table (13) show the effect of water sources, application water technique and soil moisture depletion on soil salinity (ECe) and exchangeable sodium percentage (ESP). The lowest values of ECe (dSm^{-1}) were achieved by using continuous irrigation by fresh water and alternative sewage sludge (5.77 and 6.55dSm^{-1} respectively) .While the highest values of ECe were recorded using well water under both continuous and alternative irrigation technique (10.50 and 8.39 dSm^{-1}respectively). The increase of ECe with well water may be due to its high salinity content as shown in Table 2 (ECw = 3.1 dSm^{-1}) compared to other water sources.

The highest values of ESP were obtained with continuous and alternative irrigation by well water (19.92 and 17.79 respectively).The increase in ESP value may be due to the high proportion of soluble Na^{+} in well water compared to soluble Ca^{++} and Mg^{++}. Also, data showed the effect of soil moisture depletion on salinity and ESP. There is no clear effect on ECe values due to application water technique at 50% depletion, but at 70% depletion the continuous irrigation resulted in increasing ECe values (7.84dSm^{-1}) compared to alternative irrigation technique (7.13dSm^{-1}). The increase of ECe values at 70% depletion could be attributed to the decrease of amount water applied, and consequently increase salts accumulation in the soil. On the other hand the highest value of ESP was recorded using continuous technique at 70% depletion (17.01).

Table (13): Soil salinity (ECe, dSm^{-1}) and alkalinity (ESP) as affected by application water technique, water sources and soil moisture depletion under sunflower crop.

Water source	ECe, dSm^{-1}			ESP		
	Cont.	Alter.	Mean	Cont.	Alter.	Mean
F	5.77	5.77	5.77	11.50	11.50	11.50
D	8.38	7.48	7.93	13.69	12.00	12.85
W	10.50	8.39	9.54	19.92	17.79	18.86
S	7.25	6.55	6.90	16.88	14.67	15.78
S1:W1	8.64	7.25	7.94	15.31	13.58	14.45
S2:W1	7.75	6.79	7.27	14.02	12.57	13.94
mean	8.05	7.29	7.67	15.22	14.12	14.56
50%	7.03	6.39	6071	15.00	13.51	14.26
70%	7.84	7.13	7.49	17.01	16.00	16.51

REFERENCES

Abd-Allah, M.A.A., 1998. Influence of sulphur and organic manures application on yield of sugar beet, subsequent crops and some chemical properties of salt affected soils. Ph.D. Thesis, Fac. Agric.Kafr El- Sheikh Univ.

Abd El-Dayem, M. S., 1994. “Future strategy for facing the incremental water requirements, ideas, precautions and determinants”. Water Science, 15th issue, April 1994. (in Arabic).

Amer, A A.; S. A. Abd El-Wahab and M. A. Abou El-Soud; 1997, “ Effect of water quality on soil salinity and some crops production”, J. Agric. Sci. Mansoura University.

Ayers, R. S. and D. W. Westcot, 1985, Water quality for agriculture, FAO, Rome, Italy.

Balba, A. M., 1960, “Effect of Sodium Water and gypsum increments on soil chemical properties and plant growth” , Alex. Jour. Agric. Res. 8:51-64

Butorac, A., Filipan, T. , Basic, F.;Mesic,M.;Buletac, J. and Kisic,I.(1995). Response of sugar beet to agravital and waste water fertilizing .1. Root and sugar yield and macronutrient content in root and leaf.Poljopriveredna-Znanstvena-Smotra,60(1):69-80.

Cochran, W. G. and G. M. Cox, 1960, "Experimental Designs", 2nd ed., John Welly, New York, :293-316.

Cottenie, A.; M. Verloo; L. Kiekens; G. Velghe and R. Camerlynck, 1982, chemical analysis of plants and soils, Lab, Anal, and Agrochem. State Univ., Gent. Belgium, chapter2, 3:14-54.

El-Gamal, A. Z., 1966, Water quality studies prediction of the effect application of irrigation water of different qualities to Marut soil on the soil characteristics and plant growth, Diploma, Land Reclamation and Improvement institute, Alexandria University.

Franzen, D.; C. Fanning and T. Gregoire, 1994, Managing Saline Soils In North Dakota", SF-1087, November 1994, North Dakota State Univ. NDSU Extension Service.

Greenberg, A. E.; R. R. Trussell and L. S. Clesceri, 1985, "Standard Methods for the Examination of Water and Wastewater", 16th Edition, American Public Health Association, 1015 15th street, NW, Washington, U.S.A. PP:143-260 and 525-533.

Hamdi, H.; S. Youssef and M. M. El- Mansey, 1966, " The Effect of Saline Irrigation Water With Different Sodium And Calcium Concentrations on Some Soil Properties" , J. Soil Sci. U. A. R., No.6:17-23.

Hamdi, H.; S. Youssef; A. El-Shabassy and Y. Tewfick, 1968, "Studies On The Effect Of Saline Irrigation Water On The Chemical Composition Of A Clay Soil", J. Soil Sci. U.A.R., 8:17-23.

Israelson, O. W. and V. E. Hansen, 1962, " Irrigation Principals and Practices", 3rd ed. John Welly and Sons Inc. New York.

Jackson, M. L., 1970, " Soil Chemical Analysis, 6th ed. Prentice, Hall Englewood Cliffs, N. J. P: 183-203.

Marshner, H., 1998, Mineral Nutrition of Higher Plants; 2nd edition, Academic Press, Harcourt Brace Company, publishers London, Sand Diego, New York, Boston, Sydney, Tokyo and Torento.

Mengel, K. and E. A. Kirkby, 1987, Principles of Plant Nutrition. International Ptash Institute. 4th Edition, Switzerland, P603.

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

Page, A.L. (Ed) (1982). Method of soil analysis, part 2 : Chemical and Microbiological Properties ,(2nd Ed.) . Am. Soc. At Agron. Inc. Soil Sci. Of Am. Inc., Madison, Wisconsin, USA.

Pescod, M. B., 1992, "Wastewater Treatment and Use I Agriculture", FAO, Irrigation and Drainage Paper 47, Rome, www.FAO.org/docreb.

UNCED, 1992, Agenda 21 of the United Nations Conference on Environment and development, Dublin Conference, ICWE, 1992.

تأثير الري بمصادر مياه مختلفة تحت ظروف استنفاذ الرطوبة الأرضية علي ملوحة التربة وقلويتها وعلي محصولي بنجر السكر وعباد الشمس

السيد عامر السيد جازية ، محمد عبد الله أحمد عبد الله ، محمد أحمد عبد العزيز و بهجت عبد القوى زامل
معهد بحوث الأراضي والمياه والبيئة-مركز البحوث الزراعية – مصر

أقيمت تجربة في أحواض أسمنتية بمحطة البحوث الزراعية بسخا – كفر الشيخ علي مدي موسمين زراعيين متتاليين ، 2007 و 2008 وذلك لتقييم تقنية تبادل الري بمصادر مياه مختلفة (مياه صرف زراعي – مياه صرف صحي – مياه آبار) مع مياه النيل العذبة تحت ظروف استنفاذ رطوبي (50% و 70%) من الماء الميسر ،ودراسة مدي تأثير ذلك علي محصولي بنجر السكر وعباد الشمس ، وكفاءة استخدام المياه وكذلك ملوحة التربة وقلويتها.

تأثر محصول بنجر السكر معنويا بالرى بمصادر المياه المختلفة و الاستنفاذ الرطوبى وتقنية تبادل الرى بمصادر المياة المختلفة . وقد زاد محتوي محصول بنجر السكر من العناصر المغذية والعناصر الثقيلة نتيجة للري بمياه الصرف الصحي مخلوطة /أو بدون خلط مع مياه الآبار . كما أن تقنية الري المتبادل قد زادت من كفاءة استعمال المياه ، وأظهر الري بمياه النيل العذبة واستخدام تقنية الرى التبادلى لمصادر المياه المختلفة مع المياه العذبة انخفاضا فى قيم الملوحة والقلوية مقارنة باستخدام هذه المصادر منفصلة.

بالنسبة لمحصول عباد الشمس فقد تأثر محصول الحبوب بالمعاملات الثلاثة (مصدر مياه الري – تقنية تبادل الري بين مصادر المياه المختلفة مع مياه النيل العذبة – الاستنفاذ الرطوبي) . وأعلي كمية محصول عباد الشمس كانت عند الري بمياه النيل العذبة تحت استنفاذ رطوبي 50% . وأعلي قيمة لكفاءة استعمال المياه سجلت عند الري بمياه صرف صحي متبادل مع مياه النيل العذبة واستنفاذ رطوبي 70% ، وأقل قيم لملوحة التربة كانت عند استعمال مياه النيل العذبة، بينما أعلي قيم لملوحة التربة كانت عند استعمال مياه الآبار مع /أو بدون تبادل مع مياه النيل العذبة. واتضح أن خلط مياه الصرف الصحي بمياه الآبار أدي إلي خفض قلوية التربة مع استخدام تقنية تبادل الري مع المياه العذبة .

Table (5): Elemental content of sugar beet root as affected by soil moisture depletion, application water technique and water sources.

Dep.	App.	Water sources	N %	P %	K %	Zn ppm	Cd ppm	Pb ppm	Co ppm	Ni ppm	B ppm	Mn ppm	Fe ppm	Cr ppm	Cu ppm
50 % depletion	Continuous	**F**	1.5	0.13	1.0	20.8	0.20	1.40	1.11	2.13	1.36	35	632	2.43	2.6
		D	1.8	0.14	1.3	27.6	0.23	1.41	1.28	2.98	1.45	36	677	2.98	3.0
		W	1.6	0.12	1.1	23.4	0.18	1.18	1.05	2.98	1.02	32	602	1.13	2.3
		S	2.5	0.18	1.4	36.4	0.37	2.18	1.87	4.93	2.38	48	833	3.91	4.7
		S1:W1	2.0	0.15	1.2	28.1	0.26	1.51	1.36	3.74	1.62	40	697	3.23	3.2
		S2:W1	2.3	0.16	1.3	30.9	0.29	1.67	1.53	4.08	1.79	42	731	3.32	3.6
		mean	**1.9**	**0.15**	**1.2**	**27.9**	**0.26**	**1.56**	**1.37**	**3.47**	**1.60**	**39**	**695**	**2.83**	**3.2**
	Alternative	**F**	1.5	0.13	1.0	20.8	0.20	1.40	1.11	2.13	1.36	35	632	2.43	2.6
		D	1.6	0.14	1.2	25.8	0.21	1.40	1.12	2.51	1.30	35	660	2.47	2.7
		W	1.4	0.11	1.1	21.4	0.14	1.39	0.88	2.24	1.00	28	550	1.00	2.0
		S	2.4	0.15	1.3	32.6	0.28	1.92	1.66	4.25	2.00	43	801	3.47	3.8
		S1:W1	1.8	0.14	1.2	25.2	0.23	1.58	1.13	3.21	1.26	36	666	2.53	2.9
		S2:W1	2.1	0.15	1.3	27.9	0.25	1.50	1.38	3.74	1.51	39	692	3.17	3.3
		mean	**1.8**	**0.14**	**1.2**	**25.6**	**0.22**	**1.53**	**1.21**	**3.01**	**1.41**	**36**	**667**	**2.51**	**2.9**
70 % depletion	Continuous	**F**	1.7	0.14	1.1	33.4	0.24	1.49	1.21	3.07	1.50	35	708	3.15	3.1
		D	2.0	0.17	1.4	38.4	0.22	1.67	1.89	3.97	1.53	39	744	3.31	3.7
		W	1.3	0.11	1.1	30.5	0.21	1.48	1.13	2.70	1.33	34	715	1.95	3.0
		S	2.9	0.23	1.8	47.2	0.29	2.57	2.51	5.61	2.94	57	893	4.59	5.5
		S1:W1	2.2	0.17	1.2	37.9	0.22	1.66	2.07	4.00	1.87	43	774	3.57	4.1
		S2:W1	2.5	0.20	1.4	42.2	0.25	1.91	2.25	4.77	2.47	49	828	4.07	4.4
		mean	**2.1**	**0.17**	**1.3**	**38.3**	**0.24**	**1.80**	**1.84**	**4.02**	**1.94**	**43**	**777**	**3.44**	**4.0**
	Alternative	**F**	1.7	0.14	1.1	33.4	0.24	1.49	1.21	3.07	1.50	35	708	3.15	3.1
		D	1.7	0.14	1.3	34.3	0.22	1.55	1.45	2.98	1.79	38	719	3.48	3.4
		W	1.0	0.12	1.1	25.8	0.16	1.25	1.10	2.81	1.05	28	663	1.79	2.7
		S	2.6	0.19	1.6	43.3	0.26	2.32	2.14	5.12	2.61	41	860	4.20	5.0
		S1:W1	1.9	0.15	1.2	35.0	0.24	1.63	1.42	3.81	1.70	36	740	3.50	3.8
		S2:W1	2.2	0.17	1.4	38.1	0.24	1.84	1.73	4.34	2.00	39	791	3.81	4.0
		mean	**1.8**	**0.15**	**1.3**	**35.0**	**0.23**	**1.68**	**1.51**	**3.69**	**1.78**	**36**	**747**	**3.32**	**3.7**

Table (10): Elemental content (macro nutrients as % and micro elements ,ppm) of sunflower as affected by soil moisture depletion, application technique and water sources.

Dep.	App.	Water sources	N	P	K	Zn	Cd	Pb	Co	Ni	B	Mn	Fe	Cr	Cu
50 % depletion	Continuous	F	2.4	0.14	1.4	35.3	0.21	1.70	1.7	3.8	1.5	37	503	1.33	3.5
		D	2.5	0.16	1.6	32.2	0.31	2.41	2.1	4	2.8	39	560	3.90	5.5
		W	2.1	0.13	1.3	31.2	0.19	1.65	1.6	2.9	1.6	33	514	1.31	3.1
		S	2.7	0.16	1.7	39.2	0.41	2.51	2.6	4.4	3.1	41	640	5.20	8.1
		S1:W1	2.5	0.15	1.5	38.2	0.33	2.23	2.4	3.5	2.7	39	550	4.30	6.2
		S2:W1	2.6	0.15	1.6	38.2	0.36	2.33	2.4	3.9	2.7	37	570	4.60	7.1
		mean	**2.5**	**0.15**	**1.5**	**35.7**	**0.30**	**2.14**	**2.1**	**3.8**	**2.4**	**38**	**556**	**3.40**	**5.6**
	Alternative	F	2.4	0.14	1.4	35.3	0.21	1.7	1.7	3.8	1.5	37	503	1.33	3.5
		D	2.2	0.14	1.6	34.2	0.23	2.25	1.6	3.1	2.4	36	515	3.50	4.5
		W	1.9	0.13	1.3	29.2	0.25	1.63	1.4	2.7	1.7	31	560	1.21	2.9
		S	2.6	0.16	1.6	37.1	0.27	2.42	1.9	3.9	2.8	39	640	4.30	7.2
		S1:W1	2.3	0.15	1.6	35.2	0.22	2.31	1.8	3.2	2.6	37	540	3.20	5.1
		S2:W1	2.3	0.14	1.6	36.2	0.23	2.22	1.6	3.6	2.5	35	470	3.60	6.2
		mean	**2.3**	**0.14**	**1.5**	**34.5**	**0.24**	**2.09**	**1.7**	**3.4**	**2.3**	**36**	**538**	**2.9**	**4.9**
70 % depletion	Continuous	F	2.4	0.14	1.4	36.4	0.23	1.5	1.6	4.2	1.7	36	530	1.5	3.4
		D	2.6	0.15	1.6	38.1	0.26	2.15	1.9	4.3	2.7	38	615	4.5	5.2
		W	2.2	0.1	1.7	33.2	0.25	1.73	1.6	3.8	1.6	33	615	1.4	4.1
		S	2.8	0.17	2.1	44.2	0.31	2.51	2.3	5.6	3.3	44	704	6.4	9.1
		S1:W1	2.6	0.16	1.8	39.2	0.27	2.21	1.9	4.7	2.6	37	610	4.3	6.2
		S2:W1	2.7	0.15	1.8	41.2	0.29	2.24	2.1	5.4	2.8	39	640	4.6	7.3
		mean	**2.6**	**0.15**	**1.7**	**38.7**	**0.27**	**2.06**	**1.9**	**4.7**	**2.5**	**38**	**619**	**3.8**	**5.9**
	Alternative	F	2.4	0.14	1.4	36.4	0.23	1.50	1.6	4.2	1.7	36	530	1.5	3.4
		D	2.3	0.14	1.6	35.4	0.25	1.63	1.8	3.9	2.1	38	515	4.7	4.9
		W	2.1	0.13	1.4	29.2	0.25	1.65	1.5	2.9	1.8	33	540	1.3	2.9
		S	2.7	0.16	1.7	40.1	0.31	2.21	2.2	4.9	3.1	44	604	5.2	6.3
		S1:W1	2.3	0.15	1.5	36.2	0.26	1.71	1.9	3.8	2.2	40	570	4.3	5.1
		S2:W1	2.5	0.14	1.6	38.1	0.26	1.89	2	4.1	2.3	39	590	4.7	5.5
		mean	**2.4**	**0.14**	**1.5**	**35.9**	**0.26**	**1.77**	**1.8**	**4.0**	**2.2**	**38**	**558**	**3.6**	**4.7**