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SOME SOIL SALINITY PROBLEMS IN RELATION TO IRRIGATION WITH LOW QUALITY WATERS

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ABSTRACT: **This research was carried out to study the problems of soil salinity in soils irrigated with low quality waters. To conduct this objective, areas of soil in Edko region, El-Behaira Governorate were chosen, where the different qualities of water were used for irrigation. Area of study was divided in to three sub areas; 1,2 and 3 where area 1 are subjected to irrigation from Mahmoudia canal, but the areas 2 and 3 are received water of low qualities. Three soil profiles at different depths; 0-20, 20-40, 40-60, and 60-80 cm were taken from each area.**

Obtained results indicated that the irrigation with low water qualities; C_3S_1 and/or C_4S_1, significantly increased the soil salinity and soil sodicity.

Concentration of soluble cations and anions in areas under study had the following descending order:
$Na^+ > Mg^{++} > Ca^{++} > K^+$ for cations, and $Cl^- > SO_4^= > HCO_3^-$ for anions.

Data also indicated that the irrigation with waters of low quality significantly increased the soil exchangeable Na^+ and K^+ but decreased the soil exchangeable Ca^{++} and Mg^{++}.

Key words: **Irrigation water quality soil salinity, soil sodicity, Redistribution of some soluble and exchangeable ions.**

INTRODUCTION

Agriculture expansion policy in Egypt includes both of the barren extension areas and the improvement of the agricultural production of the already cultivated lands.

The lack of fresh water is an obstacle restricting the development of the cultivated lands. The utilization of low quality waters such as drainage water is of vital importance for the countries of the arid and semiarid region.

Since, the reuse of low quality water for irrigation has become a major feature of water resources in Egypt to meet the increasing need of irrigation water for agriculture, some problems of soil chemical, physical and nutritional problems might be met.

The use of such water for irrigation resulted in salt build up in soil (Beecher, 1991; Khan, 1991; El-Sheikh 2000, Ragab, 2001, and Rajesh and Bajwa, 1997). Seleem *et al.*, (1989) found that irrigating soil with drainage water led to an increase in soils salinity. Similar results were reported by Mostafa *et al.*, (1992); El-Samanoudy (1992) and Abu-Sinna *et al.*, (1994).

Khan *et al.*, (1992) stated that sodicity in soil increased with increasing salinity of irrigation water. Balba (1960) reported that the application of saline irrigation water decreased the exchangeable calcium and increased the exchangeable sodium. Eisenberg *et al.*, (1982) detected a positive relationship between the soil ESP and EC values of irrigation water. Kandil, (1990) reported that ESP values increased more significantly under the use of drainage and mixed water than canal water. Similar results were obtained by El-Sayed (1990).

MATERIALS AND METHODS

In an endeavor to conduct the main objective of this study, the area of Edko region extending from Zarkon village to Edko City, El-Behaira Governorate was chosen, where the different qualities of water were used for irrigation. This region was divided in to three areas; 1, 2 and 3 according to the quality of their irrigation water, each of them is about 500 Feddans. Area 1 lying on the northern side of Edko Road was irrigated from Mahmoudia Canal. The other two areas; 2 and 3 lie on the southern side of the same road where, area 2 received a mixture of water from Mahmoudia Canal and drainage water. Area 3 received only drainage water.

Three soil profiles were randomly chosen in each area. Soil samples were taken from each to represent the depths of 0-20, 20-40, 40-60 and 60-80 cm and chemically analysed. Irrigation water used was chemically analysed, Table (1).

Chemical analyses of soil and irrigation waters were done according to the standard methods described by Richards (1954) and Jackson (1958). Cation exchange

Table (1): Chemical characteristics of irrigation water at different studied areas I, II and III

Area of source of irrigation water	Rep.	pH	EC_{iw} dS/m	Cations (me/L)				Anions (me/L)				SAR	Water Class
				Na^+	K^+	Ca^{++}	Mg^{++}	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$		
I	1	8.1	0.62	2.96	0.30	2.78	2.32	T.	4.20	2.00	2.16	1.85	C_2S_1
Nile	2	8.19	0.56	2.40	0.20	2.89	1.70	T.	4.00	2.00	1.19	1.58	C_2S_1
water	3	8.17	0.59	2.96	0.26	2.78	1.81	T.	4.60	2.00	1.21	1.95	C_2S_1
Mean (I)		8.15	0.59	2.10	0.25	2.82	1.94	T.	4.26	2.00	1.52	1.36	C_2S_1
II	1	8.23	1.34	9.60	0.36	4.44	2.70	0.10	4.80	10.0	2.20	5.08	C_3S_1
Mixed	2	8.40	1.35	9.84	0.38	5.00	5.20	0.15	4.80	10.0	4.91	4.35	C_3S_1
water	3	8.62	1.58	9.40	0.28	4.44	3.21	0.20	3.40	9.0	4.93	4.81	C_3S_1
Mean (II)		8.41	1.42	9.61	0.34	4.62	3.70	0.15	4.33	9.66	4.01	4.75	C_3S_1
III	1	8.26	3.09	25.58	0.57	5.56	8.73	0.10	5.20	26.0	9.41	9.76	C_4S_1
Drainage	2	8.26	3.21	26.95	0.60	5.56	8.73	0.10	5.80	27.0	8.94	10.00	C_4S_1
water	3	8.60	3.15	24.75	0.57	3.33	9.94	0.18	6.30	23.0	9.11	9.61	C_4S_1
Mean (III)		8.37	3.15	25.76	0.58	4.82	9.13	0.13	5.76	25.3	9.15	9.82	C_4S_1

Classification of water class according to Richards (1954).

C_2S_1 = Medium salinity, low sodium hazard
C_3S_1 = High salinity, low sodium hazard
C_4S_1 = Very high salinity, low sodium hazard
EC_{iw} = Electrical conductivity of irrigation water.

capacity (CEC) and exchangeable cations were measured according to Tucker (1954).

RESULTS AND DISCUSSION

Soil salinity and soil pH:

Table (2) shows the redistribution of soil salinity and pH through the soil profile. Data show that area subjected to irrigate with Mahmoudia Canal water (C_2S_1) had average values of soil EC_e; 0.80, 0.93, 0.95, and 0.90 dSm^{-1} through the soil depths; 0-20, 20-40, 40-60, and 60-80 cm in corresponding with; 3.52, 5.69, 8.33, and 9.42 dSm^{-1}, respectively in the area irrigated with the mixed water (C_3S_1). Area that affected by irrigation with drainage water (C_4S_1) had average values of soil EC; 4.51, 5.76, 7.45, and 8.89 dSm^{-1}, respectively.

Thus, there is an evidence indicating that the different water qualities led to a significant difference in soil EC_e, Table (3). Each of mixed water (C_3S_1) and drainage water (C_4S_1) showed an insignificant difference of soil EC_e at both surface and subsurface soil layers. Therefore, the problems of soil salinity were associated with the increase of salinity of the applied water as well as the increase of soil depth. These findings were in harmony with the results of Beecher (1991), El-Sheikh (2000), and Ragab (2001).

Considering the data of soil pH, Table (2) it will be concluded that there were insignificant effects of the quality of irrigation water on the pattern of soil pH in studied areas; Table (3). This finding agreed with the results of Kandil (1990), and El-Sheikh (2000).

Redistribution of soil soluble cations and anions:

Reference to the data in Table (2), it could be stated that, sodium is the major soluble cation in all studied areas. It shows a great increase of both surface and subsurface soil layers in areas irrigated with the mixed water (C_3S_1) and drainage water (C_4S_1). This increase was also associated with depth. Irrigation with low quality water resulted a significantly build up of soil soluble Na^+ as compared with the area irrigated with Mahmoudia Canal, Table (3).

The other soluble cations; K^+, Ca^{++} and Mg^{++} had the same pattern of Na^+ but the significance of increase was different. However, in surface layers, the soluble Ca^{++} and Mg^{++} were significantly higher in soils which received drainage water (C_4S_1) followed by that irrigated with the mixed water (C_3S_1). Soluble K^+ was significantly.

Table (2): Chemical characteristics of the studied soils as affected by the quality of irrigation water.
(Area I)

Rep.	EC_{iw} (dS/m)	Water class	Depth (cm)	EC_e (dS/m)	pH	SP	Cations (me/L)				Anions (me/L)				ESP
							Na^+	K^+	Ca^{++}	Mg^{++}	$CO_3^=$	HCO_3^-	Cl^-	$SO^=_4$	
			0-20	0.88	7.85	86	4.8	0.14	3.89	1.21	0.0	3.6	4.0	2.44	9.74
1	0.62	C_2S_1	20-40	1.26	7.92	81	8.4	0.10	4.45	1.67	0.0	3.4	4.0	7.22	10.16
	N.W		40-60	1.22	8.01	82	8.32	0.06	3.34	3.29	0.0	3.2	7.0	4.81	13.9
			60-80	1.14	8.07	81	8.32	0.06	2.23	1.34	0.0	3.4	4.0	4.55	15.8
			0-20	0.54	7.57	77	2.4	0.18	2.34	1.25	0.0	2.5	2.0	1.67	6.29
2	0.56	C_2S_1	20-40	0.50	7.77	80	2.72	0.16	2.34	1.25	0.0	2.2	1.5	2.77	6.97
	N.W		40-60	0.51	7.91	75	3.12	0.14	2.23	0.83	0.0	2.2	2.0	2.12	7.02
			60-80	0.58	7.89	69	3.28	0.12	2.78	0.79	0.0	2.6	2.0	2.37	11.11
			0-20	1.00	7.96	75	7.68	0.16	3.34	1.25	0.0	3.6	3.0	5.83	11.29
3	0.59	C_2S_1	20-40	1.05	8.02	85	8.64	0.10	2.78	0.79	0.0	3.4	5.0	3.91	14.01
	N.W		40-60	1.14	8.10	88	10.32	0.10	2.78	0.82	0.0	3.8	4.0	6.52	14.29
			60-80	1.13	8.44	83	11.28	0.08	1.73	0.82	T.	4.2	4.0	5.71	19.47
			0-20	0.80	7.79	79	4.96	0.16	3.19	1.23	0.0	3.23	3.0	3.31	9.01
Mean	0.59	C_2S_1	20-40	0.93	7.90	82	6.58	0.12	3.19	1.24	0.0	3.00	3.83	4.63	10.4
(I)	N.W		40-60	0.95	8.00	81	7.25	0.10	2.78	1.65	0.0	3.06	4.33	4.48	11.7
			60-80	0.95	8.13	77	7.62	0.08	2.24	0.98	0.0	3.40	3.33	4.21	15.5

N.W = Nile water
EC_{iw} = Electrical conductivity of irrigation water.
EC_e = Electrical conductivity of soil paste.

Table (2): Cont.

(Area II)

Rep.	EC_{iw} (dS/m)	Water class	Depth (cm)	EC_e (dS/m)	pH	SP	Cations (me/L)				Anions (me/L)				ESP
							Na^+	K^+	Ca^{++}	Mg^{++}	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	
1	1.34 M.W	C_3S_1	0-20	4.48	8.33	125	43	1.34	5.56	6.17	00	3.8	36	16.27	27.73
			20-40	4.92	8.52	132	45	1.08	4.45	5.75	T	4.4	45	6.88	38.99
			40-60	6.69	8.44	117	76	1.49	5.56	6.68	00	4.4	73	12.33	32.87
			60-80	8.88	8.44	120	80	1.76	5.00	7.24	00	3.2	76	14.81	38.40
2	1.35 M.W	C_3S_1	0-20	3.72	8.54	108	31.9	0.96	3.89	6.31	T	4.2	29	9.86	26.47
			20-40	5.4	8.49	145	53	1.22	2.78	3.34	00	4.0	48	8.34	42.32
			40-60	9.15	8.33	150	92	1.82	5.00	4.18	00	3.8	86	13.2	48.57
			60-80	10.42	8.49	126	102	2.12	3.34	7.88	00	3.0	99	13.19	52.06
3	1.58 M.W	C_3S_1	0-20	2.37	8.06	95	16.8	0.88	4.56	5.71	00	3.4	14	10.55	14.72
			20-40	6.76	7.86	102	50	2.33	8.03	15.2	00	2.2	29	44.4	24.35
			40-60	9.17	7.87	97	51	2.50	20.05	33.6	00	2.0	34	71.7	20.02
			60-80	8.96	7.94	100	56	3.20	18.08	30.5	00	2.0	34	72.5	26.57
Mean (II)	1.42 M.W	C_3S_1	0-20	3.52	8.31	109	30.5	1.06	4.67	6.06	00	3.8	26.3	12.2	22.97
			20-40	5.69	8.29	126	49.3	1.54	5.08	8.09	00	3.53	40.6	19.8	35.22
			40-60	8.33	8.21	121	73.0	1.93	10.30	14.8	00	3.4	64.3	32.4	33.82
			60-80	9.42	8.29	115	79.3	2.36	9.04	15.2	00	2.73	69.6	33.5	39.01

M.W = Mixed water
EC_{iw} = Electrical conductivity of irrigation water.
EC_e = Electrical conductivity of soil paste.

Table (2): Cont..

(Area III)

Rep.	EC_{iw} (dS/m)	Water class	Depth (cm)	EC_e (dS/m)	pH	SP	Cations (me/L)				Anions (me/L)				ESP
							Na^+	K^+	Ca^{++}	Mg^{++}	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	
1	3.09 D.W	C_4S_1	0-20	5.26	7.73	106	39.6	0.94	5.78	15.22	00	3.2	38	20.34	22.61
			20-40	6.05	7.98	112	51.0	0.88	7.22	10.64	00	3.2	48	18.54	26.78
			40-60	9.10	8.10	115	77.0	1.50	10.0	20.61	00	3.0	75	31.11	31.87
			60-80	10.66	8.16	103	92.0	2.68	11.67	21.49	00	3.0	90	34.84	28.81
2	3.21 D.W	C_4S_1	0-20	5.49	8.01	86	38.4	0.88	8.33	13.61	00	3.6	35	22.62	28.69
			20-40	4.73	8.15	85	38.2	0.92	5.00	8.71	00	3.4	38	11.48	29.01
			40-60	5.99	7.95	120	46.0	1.18	6.11	10.73	00	2.2	44	17.82	30.86
			60-80	8.18	7.74	125	52.0	1.76	16.11	21.65	00	2.0	61	18.52	41.17
3	3.15 D.W	C_4S_1	0-20	2.78	8.57	75	20.4	0.53	3.33	4.83	00	4.6	16	8.33	23.52
			20-40	6.52	7.71	70	29.2	1.22	19.4	26.5	00	2.2	31	43.14	19.80
			40-60	7.26	7.65	70	43.0	1.18	22.2	27.3	00	2.6	40	51.08	20.94
			60-80	7.85	7.68	59	43.0	1.22	17.8	23.5	00	3.0	40	42.55	24.46
Mean (III)	3.15 D.W	C_4S_1	0-20	4.51	8.10	89	32.8	0.78	5.8	11.2	T	3.8	29.6	17.1	24.94
			20-40	5.76	7.94	89	39.5	1.00	10.5	15.3	00	2.9	39	24.4	25.19
			40-60	7.45	7.90	101	55.3	1.28	12.8	19.5	00	2.6	53	33.3	27.89
			60-80	8.89	7.86	95	62.3	1.88	15.2	22.2	00	2.6	63.6	33	31.48

D.W = Drainage water
EC_{iw} = Electrical conductivity of irrigation water.
EC_e = Electrical conductivity of soil paste.

Table (3): Variance analysis and L.S.D of chemical characteristics for the studied soils as affected by the quality of irrigation water.

A- Surface layer (0-40 cm)

Irrigation source	EC_e (dS/m)	Cations (mg/L)				Anions (mg/L)		
		Na	K	Ca	Mg	HCO_3	Cl	SO_4
N.W	0.87b	5.77b	0.14c	3.19b	1.23c	3.11	3.25b	3.97b
M.W	4.61a	39.95a	1.30a	6.76ab	7.08b	3.66	33.5a	16.05a
D.W	5.14a	36.13a	0.89b	8.18a	13.2a	3.36	3.36a	20.74a
$L.S.D_{0.05}$	0.70	14.01	0.37	4.25	3.76	N.S	14.13	10.42

B- Subsurface layer (40-80 cm)

Irrigation source	EC_e (dS/m)	Cations (mg/L)				Anions (mg/L)		
		Na	K	Ca	Mg	HCO_3	Cl	SO_4
N.W	0.95b	7.44b	0.09b	2.52	1.31b	3.23	3.83b	4.35
M.W	8.88a	76.17a	2.15a	15.0	15.0ab	3.06	567.0a	32.9
D.W	8.17a	58.83a	1.58a	13.9	2.09a	2.63	58.3a	32.6
$L.S.D_{0.05}$	2.86	40.74	1.21	N.S	17.9	N.S	42.5	N.S

* Means with the same letter are not significantly different.

N.S = Not significant different.

greater in soils subjected to irrigation with the mixed water (C_3S_1) followed by that received drainage water. Whereas, in subsurface soil layers, the different water qualities had an insignificant effect on soil soluble Ca^{++}. Soluble K^+ was significantly increased in soils irrigated with mixed water (C_3S_1) and drainage water (C_4S_1). Soluble Mg^{++} was significantly greater in soils received drainage water, Table (3).

Finally, the concentration of soluble cations in studied areas were in the following descending order: $Na^+ > Mg^{++} > Ca^{++} > K^+$.

Soil soluble anions:

As previously mentioned of soil soluble cations, Cl^- represent the major soluble anions followed by $SO_4^=$ through the soil profile. Bicarbonate ions were relatively lower than Cl^- and /or $SO_4^=$, Table (2). The concentration of both Cl^- and $SO_4^=$ were relatively increased with depth, a counteractive trend was observed with HCO_3^-, where it relatively increased at the upper soil layers. This is may be a reflection of roots and micro-organisms activity.

However, the different water quality shows an insignificant effect on the redistribution of soil soluble HCO_3^-.

Irrigation with each of mixed water (C_3S_1) and drainage water (C_4S_1) significantly increased the soil soluble Cl^- at both surface and subsurface soil layers.

The distribution pattern of soil soluble Cl^- through the soil profile shows an accumulation in the subsurface layers and this reflects to the relatively high mobility of this anions as reported by Khan *et al*., (1992). Mixed water and drainage water showed an no significant effect on soluble Cl^-, Table (3). Soluble $SO_4^=$ was significantly greater in the surface soil layers under irrigation with low quality water, but there was no significant difference between mixed and drainage water. In the subsurface soil layers, irrigation with waters of different quality showed no significant effect on soil soluble $SO_4^=$.

Soluble anions were in the following descending order:

$Cl^- > SO_4^= > HCO_3^-$.

Soil cation exchange capacity (CEC), soil sodicity and Exchangeable cations:

Data of soil CEC (Table 4) show that the values of soil CEC in area irrigated with Mahmoudia Canal water were relatively higher than those in other areas irrigated with mixed (C_3S_1) and drainage water especially at the upper soil layers. This trend might be due to the depressive effect of salinity on the activities of microorganisms responsible for decomposition of organic matter (El-Toukhy, 1987). At the subsurface soil layers, the irrigation with different qualities of water had an insignificant effect on soil CEC, Table (5).

Soil Sodicity:

Regarding to the data of soil ESP, Tables (4) and (5) show that soils irrigated with mixed water and/or drainage water have a significant increase of soil ESP as compared with that received Mahmondia canal water especially at surface soil layers.

Thus, there is an evidence to indicate that the irrigation with mixed water (C_3S_1) and/or drainage water (C_4S_1) increased the soil sodicity. These results were in harmony with that of Eisenberg *et al.*, (1982), Kandil, (1990), El-Sayed (1990), El-Gazzar (1996), and Habib (1999). This might be due to the equilibrium between the soluble and exchangeable cations and the redistribution of cations on the colloidal complex.

Therefore, irrigation with low quality water, of sodic hazards causes problems of soil sodicity especially in the root zone.

Exchangeable cations:

Data on exchangeable cations (Tables 4 and 5 show that irrigation with water of low quality, (C_3S_1 or C_4S_1 waters) significantly increased exchangeable Na^+ and K^+. On the other hand, exchangeable Ca^{++} and Mg^{++} significantly decreased. This reflects a replacement of Ca^{++} and Mg^{++} by Na^+ and K^+ due to the relatively high salinity level of the irrigation water as well as the increase of Na^+ and K^+ concentrations of the irrigation water. These findings agree with those obtained by Balba (1960), Lal and Singh (1974), Kandil, (1990), and El-Gazzar (1996). In addition, the above situation of exchangeable cations are appreciably noticed in the surface soil layers.

Data also indicate no significant variations between water classes C_3S_1 and C_4S_1 on the trend of exchangeable cations, with the exception of exchangeable K^+ that significantly decreased more in the soils irrigated with water of C_4S_1 class than those which received water of C_3S_1 class. This reflects Na competition under conditions of relatively high salinity.

Table (4): SAR, CEC, exchangeable cations and exchangeable cations in percent of CEC for the studied soils as affected by the quality of irrigation water.

(Area I)

Rep.	EC_w (dS/m)	Water class	Depth (cm)	SAR	CEC me/100g	Exchangeable cations (me/100g)				Exchangeable cations (%)			
						Na^+	K^+	Ca^{++}	Mg^{++}	ESP	EKP	ECaP	EMgP
			0-20	3.0	60.36	5.88	1.46	33.71	19.31	9.74	2.42	55.95	31.99
1	0.62	C_2S_1	20-40	4.8	61.75	6.27	1.04	28.36	26.08	10.16	1.68	45.93	42.23
	N.W		40-60	5.67	54.60	7.59	0.75	20.54	25.72	13.9	1.37	37.62	47.11
			60-80	7.7	57.85	9.14	1.27	24.90	22.54	15.8	2.16	25.32	38.00
			0-20	1.79	58.68	3.69	1.41	39	14.58	6.29	2.40	66.46	24.85
2	0.56	C_2S_1	20-40	2.03	57.86	4.03	1.50	31.06	21.27	6.97	2.59	53.68	36.76
	N.W		40-60	2.52	54.97	3.86	1.42	28.43	21.26	7.02	2.58	51.72	38.68
			60-80	2.46	51.01	5.65	1.20	25.20	19	11.11	2.35	49.36	37.18
			0-20	5.07	53.34	6.02	1.55	28.99	16.78	11.29	2.90	54.35	31.46
3	0.59	C_2S_1	20-40	6.47	54.89	7.69	1.17	27.84	18.19	14.01	2.13	50.72	33.14
	N.W		40-60	6.45	56.60	8.09	1.06	21.52	25.93	14.29	1.88	38.02	45.81
			60-80	9.98	56.60	11.02	0.97	23.22	21.39	19.47	1.72	41.02	37.79
			0-20	3.28	57.46	5.20	1.47	33.9	16.9	9.01	2.57	58.9	29.4
Mean	0.59	C_2S_1	20-40	4.43	58.16	6.00	1.23	29	21.8	10.4	2.13	50.1	37.4
(I)	N.W		40-60	4.88	55.40	6.51	1.07	23.5	24.3	11.7	1.94	42.5	43.9
			60-80	6.71	55.15	8.60	1.14	24.4	21	15.6	2.07	44.24	38.08
			0-80	4.82	56.54	6.57	1.22	27.7	21	11.65	2.17	47.52	37.12

N.W = Nile water
SAR = Sodium adsorption ratio
ESP = Exchangeable sodium percentage
EKP = Exchangeable potassium percentage
ECaP = Exchangeable calcium percentage
EMgP = Exchangeable magnesium percentage

Table (4): Cont.

(Area II)

Rep.	EC_{iw} (dS/m)	Water class	Depth (cm)	SAR	CEC me/100g	Exchangeable cations (me/100g)				Exchangeable cations (%)			
						Na^+	K^+	Ca^{++}	Mg^{++}	ESP	EKP	ECaP	EMgP
1	1.34 M.W	C_3S_1	0-20	17.77	42.56	11.8	3.84	12.17	14.75	27.73	9.02	28.59	34.66
			20-40	19.91	43.34	16.9	2.95	14.91	8.58	38.99	6.81	34.40	19.80
			40-60	30.77	41.43	13.62	2.59	16.01	9.21	32.87	6.26	38.64	22.23
			60-80	32.39	47.53	18.25	4.19	17.63	7.46	38.40	8.81	37.09	15.70
2	1.35 M.W	C_3S_1	0-20	14.12	40.76	10.79	2.60	21.41	5.96	26.47	6.38	52.53	14.60
			20-40	30.29	42.65	18.05	3.03	13.69	7.88	42.32	7.10	32.10	18.48
			40-60	43	47.6	23.12	3.36	10.11	11.01	48.57	7.06	21.24	23.13
			60-80	43.04	41.65	21.68	2.70	10.96	6.31	52.06	6.48	26.31	15.15
3	1.58 M.W	C_3S_1	0-20	7.40	42.94	6.32	2.74	14.42	19.46	14.72	6.38	33.58	45.32
			20-40	14.67	41.15	10.02	3.10	15.36	12.67	24.35	7.53	37.33	30.79
			40-60	9.80	37.85	7.58	2.35	16.85	11.07	20.02	6.21	44.52	29.25
			60-80	11.28	35.45	9.42	3.48	9.51	13.04	26.57	9.82	26.83	36.78
Mean (II)	1.42 M.W	C_3S_1	0-20	13.09	42.08	9.63	3.06	16.0	13.39	22.97	7.26	38.23	31.52
			20-40	21.62	42.38	14.99	3.03	14.65	9.71	35.22	7.15	34.61	23.02
			40-60	27.85	42.29	14.77	2.76	14.32	10.43	33.82	6.51	34.8	24.87
			60-80	28.90	41.54	16.45	3.46	12.70	8.93	39.01	8.37	30.07	22.54

M.W = Mixed water
SAR = Sodium adsorption ratio
ESP = Exchangeable sodium percentage
EKP = Exchangeable potassium percentage
ECaP = Exchangeable calcium percentage
EMgP = Exchangeable magnesium percentage

Table (4): Cont.

(Area III)

Rep.	EC_{iw} (dS/m)	Water class	Depth (cm)	SAR	CEC me/100g	Exchangeable cations (me/100g)				Exchangeable cations (%)			
						Na^+	K^+	Ca^{++}	Mg^{++}	ESP	EKP	ECaP	EMgP
1	3.09 D.W	C_4S_1	0-20	12.22	45.20	10.22	2.20	18.64	14.14	22.61	4.87	41.24	31.28
			20-40	17.06	49.67	13.30	2.29	24.35	9.73	26.78	4.61	49.02	19.59
			40-60	19.68	45.94	14.64	2.03	16.66	12.61	31.87	4.42	36.26	27.45
			60-80	22.6	37.11	10.69	2.64	12.57	11.21	28.81	7.11	33.87	30.21
2	3.21 D.W	C_4S_1	0-20	11.59	44.37	12.73	1.99	19.51	10.14	28.69	4.49	43.97	22.85
			20-40	17.83	38.98	11.31	1.85	16.53	9.29	29.01	4.75	42.41	23.85
			40-60	15.86	52.78	16.29	2.64	21.67	12.18	30.86	5.0	41.06	28.08
			60-80	12.0	54.62	22.49	2.36	22.49	7.28	41.17	4.32	41.18	13.33
3	3.15 D.W	C_4S_1	0-20	10.02	35.75	8.41	1.80	13.63	11.91	23.52	5.05	38.12	33.31
			20-40	6.09	29.09	5.76	1.48	13.19	8.66	19.80	5.09	45.34	29.77
			40-60	8.65	34.82	7.29	1.69	15.60	10.24	20.94	4.85	44.8	29.41
			60-80	9.45	34.62	8.47	1.60	14.82	9.73	24.46	4.62	42.81	28.11
Mean (III)	3.15 D.W	C_4S_1	0-20	11.27	41.77	10.45	10.45	17.26	12.06	24.94	4.80	41.11	29.14
			20-40	13.66	39.24	10.12	10.12	18.02	9.22	25.19	4.81	45.59	24.40
			40-60	14.73	44.51	12.74	12.74	17.97	11.67	27.89	4.75	40.70	28.31
			60-80	14.68	42.11	13.88	13.88	13.29	9.40	31.48	5.35	39.28	23.88

D.W = Drainage water
SAR = Sodium adsorption ratio
ESP = Exchangeable sodium percentage
EKP = Exchangeable potassium percentage
ECaP = Exchangeable calcium percentage
EMgP = Exchangeable magnesium percentage

Table (5): Variance analysis and L.S.D of SAR, CEC, exchangeable cations and exchangeable in percent for the studied soils as affected by the quality of irrigation water.

A- Surface layer (0-40 cm)

Irrigation source	SAR	CEC	Exchangeable cations (me/100g)				Exchangeable cations (%)			
			Na	K	Ca	Mg	ESP	EKP	ECaP	EMgP
N.W	3.86b	57.8a	5.60b	1.35c	31.5a	19.4a	9.74b	2.35c	54.5a	33.4
M.W	17.4a	42.2b	12.3a	3.04a	15.3b	11.5b	29.1a	7.20a	36.4b	27.2
D.W	12.5ab	40.5b	10.3ab	1.93b	17.6b	10.5b	25.0a	4.81b	43.3b	26.7
$L.S.D_{0.05}$	8.99	8.20	5.87	0.54	6.20	6.77	12.9	1.07	7.92	12.6

B- Subsurface layer (40-80 cm)

Irrigation source	SAR	CEC	Exchangeable cations (me/100g)				Exchangeable cations (%)			
			Na	K	Ca	Mg	ESP	EKP	ECaP	EMgP
N.W	5.80	55.3	7.56	1.11c	23.9a	22.6a	13.6b	2.01c	40.5	40.7a
M.W	28.4	41.9	15.6	3.11a	13.5b	9.68b	36.4a	7.44a	32.4	23.7b
D.W	14.7	43.9	13.3	2.16b	17.3ab	10.5b	29.6ab	5.05b	40.0	26.1b
$L.S.D_{0.05}$	N.S	N.S	N.S	0.58	8.31	3.78	2.78	1.45	N.S	9.81

* Means with the same letter are not significantly different.

N.S = Not significant different.

REFERENCES

Abu-Sinna, M.A.; Hassanin, S.A.; Seleem. M.I and Kandil, N.F. (1994). "Effect of irrigation with Bahr El-Baqar drain on some soil physical properties. Com. Sci. and Dev Res. No. 689, V. 46: 131-149.

Balba, A.M. (1960). Effect of sodium water and gypsum increment on soil chemical properties and plant growth. Alex. J. Res., 8: 51-54.

Beecher. H.G. (1991). Effect of saline water on rice yields and soil properties in the Murrumbidgee valley. Australian J. Experimental Agric., 31:6, 819-823.

Eisenberg, J.; Dan, J. and Kayumdjisky, H. (1982). Relationship between moisture penetration and salinity in soils of the Northern Negev (Israel). Geoderma, 28: 313-344.

El-Gazzar, A.A. (1996). Use of low quality water in irrigation and its effect on soil properties. Ph. D. Thesis, Fac. Agric. Zagazig Univ.

El-Samannoudy, I.M. (1992). "Impact of applying drainage water on hydrophysical properties of clayey soils in Fayoum Depression". Egypt. J. Soil Sci., 32 (3), 373-390.

El-Sayed, A.H. (1990). "Effect of drainage water quality on soil and plant". M.Sc. Thesis, Fac. Agric., Ain Shams Univ. Egypt.

El-Sheikh, O.M. (2000). Effect of quality of irrigation water on the absorption of some elements. M.Sc. Thesis, Fac. Agric. Zagazig Univ. Egypt.

El-Toukhy, M.M. (1987). Studies on the status of some nutrient elements in the soil adjacent to Idko, Beheira Governorate M.Sc. Thesis, Fac. Agric, Cairo Univ.

Habib, E.K, (1999). Effect of irrigation water salinity on water consumptive use of sudan grass and properties of African calcareous soils. M.Sc. Thesis, Institute of African Res. And studies. Dep. Natural Resources, Cairo Univ.

Jackson, M.L. (1958). Soil Chemical Analysis Constable LTD, London.

Kandil, N.F. (1990). "Effect of using drainage water on soil physical, chemical and hydrological properties in some soils of Egypt". Ph. D. Thesis, Fac. Agric, Cairo Univ.

Khan, H.R. (1991). Effect of gypsum, Zinc, and saline water on the yields and nutrient uptake by rice in a coastal saline soil. Inter. J. Trop. Agric., 9:3, 225-233.

Khan, H.R.; Faiz, S.M.; Islam, M.N.; Adachi, T. and Ahmed, I.U. (1992). Physical chemical characteristics of a saline soil under rice as influenced by gypsum and Zn. Current Agric, 16 (1-2): 11-20.

Lal, P. and Singh, K.S. (1974). A comparative study of the effect of qualities of irrigation water on different soils. J. India Soc. Soil Sci., 22: 19-25.

Mostafa, M.A.; Kalid, E.M.; El-Seweedy, A.M. and Abd El-Nour, A. (1992). The effect of chemical properties of certain soils of Egypt. Egypt. J. Soil Sci. 32 (3): 391-406.

Ragab, A.M. (2001). Physical properties of some Egyptian soils. Ph. D.Thesis, Fac. Agric. Cairo Univ. Egypt.

Rajesh, K. and Bajwa, M.S. (1997). Salt balance in soil and plant growth as affected by conductive use of different saline water and good quality canal water. J. of Res., Punjab Agric. Univ. 34: 1, 1-12.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils" U.S. Dep. Agric. Handbook 60. U.S.A.

Seleem, M.M.; Abd El-Aziz, S.M. and Abo-Zied, W.A. (1989)."Some chemical changes in properties of soil irrigated with drainage water". Annals of Agricultural Science Moshtohor, 27(4) 2521-2531.

Tucker, B.M. (1954). "The determination of exchangeable calcium and magnesium in carbonate soils". Aus. J. Agric. Res. 5:706-715.

بعض مشاكل ملوحة التربة المتعلقة بالرى بمياه منخفضة النوعية

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نفذت هذه الدراسة للتعرف على بعض مشاكل ملوحة التربة وعلاقتها بمياه الرى منخفضة النوعية - لتنفيذ هذه الدراسة اختيرت منطقة إدكو بمحافظة البحيرة ، حيث توجد مساحات من الأراضى تروى بمياه مختلفة النوعية ، بعضها تروى من ترعة المحمودية وأخرى تروى بمياه خلط والثالثة تروى بمياه صرف، أخذت من كل منطقة ثلاث قطاعات أرضية لأعماق مختلفة من صفر-٢٠ سم ، ٢٠-٤٠سم ، ٤٠-٦٠سم ، ٦٠-٨٠ سم. حللت العينات لبعض الصفات الكيميائية.

أوضحت النتائج المتحصل عليها أن الرى بمياه منخفضة النوعية أدى إلى زيادة معنوية فى كل من ملوحة التربة وقلويتها الصودية. كما دلت النتائج على إعادة توزيع الكاتيونات والأنيونات الذائبة على النحو التالى:

الصوديوم>الماغنسيوم>الكالسيوم>البوتاسيوم للكاتيونات

والكلوريد > الكبريت > البيكربونات للأنيونات.

كما دلت النتائج أيضاً على أن الرى بمياه منخفضة النوعية أدى معنوياً إلى زيادة قيم كل من الصوديوم والبوتاسيوم المتبادل على حساب النقص فى قيم كل من الكالسيوم والماغنسيوم المتبادلين.