Egypt. J. Soil Sci. **42,** No. 1 **, pp. 161 - 183 (2002)**

Potential Effects of Low Quality Water for Irrigation in El Fayoum Governorate, Egypt

E.A. Khater, T.S. Abdel Aal and F.R Farrag
Soils and Water Dept., Fac. of Agric., El Fayoum, Cairo University, Egypt.

THIS WORK aims to evaluate the reuse of the agricultural drainage water and sewage effluent for irrigating soils having different properties at El Fayoum Governorate, with special reference to follow the build up of salinity and some pollutants and their effect on both the soils and plants grown.

Monitoring the chemical composition of the studied irrigation water resources showed that although water salinity differs from one site to another, yet the low and the high salinity levels were recorded at similar times of August and January, respectively. Obtained data revealed that the EC_w and adjusted SAR values increased with an average of 2.5 and 4.5 times, respectively, for the low quality waters as compared to the Nile one, denote more problems are expected for both irrigated soils and plants grown. Data revealed also that, in spite of the relatively high contents of macro and trace elements in the used low quality waters, yet they are still within the permissible limits.

Concerning the changes occurred in soil constituents, data clearly showed a relatively increase in the ECe, $CaCO_3$, pH value, HCO_3^-, ESP and, somewhat Mg^{2+} in the case of drainage water reuse. Exception being the ECe value and organic matter content, the reverse is true in the case of sewage effluent, this is mainly due to the relatively high contents of the dissolved acid materials which arc depressed $CaCO_3$ content and increased the accumulated organic residues. Also, the values of soil bulk density, water constants, drainable pores and hydraulic conductivity tended to decrease in the soils irrigated with the low quality water.

In a harmony status for both studied irrigation water and soil, special optimization for increasing the contents of total and available macro- nutrients , (N, P and K) and trace elements (Fe, Mn, Zn, Cu, Cd, Ni, Pb and Co) in soils irrigated with low quality waters. The elemental composition of wheat grown on the soils irrigated with the used low quality water indicated that a relatively low content of trace elements in the plant tissues, probably due to the soil salinity depressed the nutrients uptake, and in turn their concentrations. The reverse is true in the plants irrigated with the sewage effluent, may be due to it supports the active uptake of them.

In general, gradual increase of salinity level for irrigation water and soil leads to a marked reduction in the studied plant growth parameters and grain yield. Moreover, data showed that the studied plant parameters were not only limited by the soil salinity level, but also its texture grade. Thus, the mixing of saline water with fresh one must be achieved at a certain available level should be recommended, especially at the seedling stage.

Keywords: Reuse of low quality water, soil salinity, Nutrients status in both the irrigation water and soils.

In the last few years, the reuse of agricultural drainage and sewage waters became part of the official policy of the Fayoum Governorate to maximize the use efficiency of the limited water resources and water balance as well as to achieve the extension programs of the agricultural development. But, the uncontrolled application of such waters must have many restricted effects on both soils and the plants grown, especially in the long-term use. The hazard effects are mainly depended on the soil properties and water quality, beside the kinds of the crops grown.

So, many questions have been raised concerning the safe limits of water hazard for each soil or plant, the dual between both fresh Nile water and the low quality one, the relevant robust crops and finally the dispersed of soil properties must be left behind. To formulate a responsible schedule for the proper use of the water resources and the protection of the cultivated lands and crops, several attempts must be find out to recommend the superiority of these uses,

In general, El Fayoum soils are heavy to light clayey derived mainly from the Nile flood alluvium, with a majority of moderate saline condition, except for those adjacent to Qarun lake, where salinity and drainage problems ate severe.

Also, these soils could be categorized according to their productivity into six classes, having percentages of the total area reached 0.15, 20.25, 42.10, 14.40, 10.20 and 12.90 (Soil Survey Staff, 1980).

Irrigation water is supplied through the legendary Bahr Yousef canal, which is derived from the River Nile at the Assiut Barrge and enters El Fayoum depression at El Lahun Gap. The total supply of irrigation water is about 2.3 billion m^3/year, an amount of 0.714 billion m^3/year (about 31 %) ends up the public network drains and finally passes back to both Qarun (0.486 billion m^3/year) and El Raiyan lakes (0.228 billion m^3/year). So, any increase of water supply at El Lahun will naturally leads to proportionally increase of water flowing into Qarun lake, and in turn, increasing its water level and adversely affects the soil potentiality of the adjacent area.

In recent studies on the irrigation water resources used for El Fayoum soils, Hegazi (1999) found that salinity and adjusted SAR of the Nile water contaminated either with the agricultural drainage water or sewage effluent. He found that the relative mobility of the micro-nutrients (Fe, Mn, Cu and Zn) and heavy metals (Cd, Ni, Pb and Co) under both the investigated irrigation waters and soils gave emphasis of availability for each element. He also pointed out that these elements in both the irrigation waters and soils are still within the permissible limits. He added that according to Ayers and Westcot (1985), the majority of these waters are not safety and severe problems are expected for the irrigated soils.

Abdellah (1995) and Hegazi (1999) mentioned that the concentrations of boron and trace elements did not exceed the normal limits and still within the permissible ranges. Data obtained by Khalil (2000) pointed out, in spite of the relatively high contents of macro and trace elements in the used low quality waters at El Fayoum Governorate, yet they did not reach the hazard effects.

Concerning the changes occurred in soil constituents, Hegazi (1999) found that the usage of the low quality water (contaminated with agricultural drainage or sewage effluent) for irrigating the soils of El Fayoum, year after year, markedly increased soil salinity, especiaylly those have heavy texture and suffering from lack of drainage. El Sebaey (1995) found that the values of

TABLE 1. Particle size distribution of the studied soil profiles.

Soil site	Depth (cm)	Particle size distribution %				Texture class
		C. sand	F. sand	Silt	Clay	
El Mazatly						
I-N	0-30	28.9	43.7	7.9	19.5	Sandy loam
	30-60	35.3	42.9	9.2	12.6	Loamy sand
	60-100	34.8	34.8	14.6	15.8	Sandy loam
	100-150	22.3	45.6	13.5	18.6	Sandy loam
I-ND	0-30	25.7	46.4	11.4	16.5	Sandy loam
	30-60	34.5	42.6	8.2	14.6	Sandy loam
	60-100	47.1	33.8	10.5	8.6	Loamy sand
	100-150	26.3	53.7	8.4	11.6	Loamy sand
II-N	0-20	14.2	40.9	12.5	32.4	Sandy clay loam
	20-65	17.3	39.2	15.3	28.2	Sandy clay loam
	65-90	19.0	38.9	13.3	28.8	Sandy clay loam
	90-150	17.7	41.9	15.2	25.2	Sandy clay loam
II-ND	0-20	15.4	44.3	11.3	29.0	Sandy clay loam
	20-65	14.4	38.6	12.9	32.1	Sandy clay loam
	65-90	13.5	42.9	10.0	33.6	Sandy clay loam
	90-150	16.6	41.1	11.7	30.6	Sandy clay loam
III-N	0-30	1.4	20.6	17.1	60.9	Clay
	30-70	0.9	19.7	20.1	59.3	Clay
	70-100	1.3	22.6	12.7	63.4	Clay
	100-150	1.4	19.6	13.3	65.7	Clay
III-ND	0-30	1.2	13.6	25.8	59.4	Clay
	30-70	1.0	9.6	27.5	61.9	Clay
	70-100	0.9	13.4	28.2	57.5	Clay
	100-150	1.0	14.2	24.5	60.3	Clay
El Nazla						
IV-N	0-25	10.6	14.8	17.6	57.0	Clay
	25-75	12.5	16.0	18.2	53.3	Clay
	75-100	9.2	14.3	17.8	58.7	Clay
	100-150	11.5	15.3	19.4	53.8	Clay
IV-D	0-25	8.2	19.4	18.3	54.1	Clay
	25-75	7.1	25.0	15.7	56.2	Clay
	75-100	11.1	20.5	12.8	55.6	Clay
	100-150	10.8	18.3	16.4	54.5	Clay
El Edwa						
V-N	0-20	59.8	22.8	9.4	8.0	Loamy sand
	20-60	60.1	23.8	8.2	7.9	Sand
	60-100	59.4	20.6	10.3	9.7	Loamy sand
	100-150	61.8	24.5	8.5	5.2	Sand
V-S	0-20	58.5	23.1	6.4	12.0	Loamy sand
	20-60	53.8	30.9	8.4	4.9	Sand
	60-100	57.8	28.9	6.6	6.7	Sand
	100-150	54.4	29.3	9.1	7.2	Loamy sand

effect of the used low quality water on plants grown for each of the studied soil sites, the vegetative growth measurements (heights of plant and spike) were estimated. At the harvesting stage, the plant samples were collected, crushed and digested to determine the content of elements uptake, ie., Fe, Mn, Zn, Cu, Cd, Ni, Pb and Co. In addition to the crop yield of wheat grains was estimated for each of the studied pair sites.

Methods of analyses

Particle size distribution was carried out by using the Pipette Method, (Richard's, 1954). Soil moisture characteristics and hydraulic conductivity were measured according to Klute (1986). Soil bulk density was determined by using Core Method according to Black and Hartge (1986). The saturated soil paste extract and the irrigation water samples were used to determine ECe and soluble ions, in addition to soil pH was determined in soil paste (Page *et* al., 1982). Calcium carbonate content was determined volumetrically by using Calcimeter according to Avery and Basocomb (1974). Organic matter content was determined according to Walkely and Black Method as described by Hesse (1971).

Boron and nitrogen contents were determined according to Black (1982) and Tel (1982) respectively. Phosphorous, potassium and trace elements(Fe, Mn, Zn, Cu, Cd, Ni, Pb and Co) as total, available and soluble contents were determined in the irrigation water and the digestion extract of soil and plant tissues according to Jackson (1969).

Results and Discussion

The inadequate of Nile water supply in El Fayoum Governorate could be paid by recycling the different side-waters of both agricultural drainage water and sewage effluent. Therefore, it is important to give enough information about the alternative irrigation water resources and their effects on both the imgated soils and plants grown, which are suggested in the following items.

a) Monitoring the chemical composition of the studied water resources

The chemical composition of the used water resources *(Le.,* Nile water, mixture with the drainage water and sewage effluent) for irrigating the soils of El Mazatly, El Nazla and El Edwa along the yearly quarter periods, are illustrated in

Tables 2 and 3; Data obtained revealed that, in general, the pH value varies in a narrow range, *i.e.*, **7.2-7.5, 7.6-7.9** and 7.0-7.2 for the Nile water, drainage water and **sewage** effluent, respectively. Also, it is noticed that although the water salinity differs from a site to another, yet the relative low and the high EC_W values **were** recorded at similar times of August and January, respectively.

The data revealed also that some of the Nile resource such as that occupied

TABLE 2, Chemical composition of the used Nile waters for irrigating the soils of El Mazatly (Nt), El Nazla (Nz) and El Edwa (Ne) during the yearly quarter periods.

Month	Water type	pH	EC in dS/m	Soluble ions in meq/l							Adj. SAR	B ppm
				HCO_3^-	Cl^-	SO_4^{--}	Ca^{2+}	Mg^{2+}	Na^+	K^+		
Jan.	Nt	7.4	1.03	2.6	6.7	0.9	4.2	2.5	3.3	0.20	3.73	0.16
	Nz	7.5	1.32	3.1	9.3	0.75	5.8	2.3	4.7	0.35	4.88	0.18
	Ne	7.3	0.68	2.2	3.2	1.67	3.2	1.8	1.9	0.17	2.18	0.13
Apr.	Nt	7.3	0.83	2.9	4.2	1.35	3.9	1.7	2.6	0.25	3.12	0.17
	Nz	7.4	1.12	2.0	8.3	1.4	5.4	2.0	4.1	0.20	4.20	0.22
	Ne	7.2	0.49	1.8	2.4	0.86	2.0	1.2	1.7	0.16	2.06	0.10
Aug.	Nt	7.5	0.76	2.8	3.3	1.7	4.1	1.3	2.1	0.20	2.47	0.15
	Nz	7.3	0.99	2.2	6.1	1.8	4.4	2.1	3.3	0.30	3.57	0.25
	Ne	7.4	0.41	2.0	1.9	0.45	2.0	0.9	1.3	0.15	1.79	0.09
Dec.	Nt	7.3	0.97	2.9	6.8	0.4	4.8	1.4	3.7	0.20	3.70	0.18
	Nz	7.5	1.16	3.0	5.9	2.86	5.7	1.6	4.3	0.16	4.75	0.22
	Ne	7.2	0.58	2.3	2.4	1.48	2.7	1.2	2.1	0.18	2.66	0.15

TABLE 3. Chemical composition of the used mixed Nile with the drainage water (ND), drainage water (D) and sewage effluent (s) during the yearly quarter periods.

Month	Water type	pH	EC in dS/m	Soluble ions in meq/l							Adj. SAR	B ppm
				HCO_3^-	Cl^-	SO_4^{--}	Ca^{2+}	Mg^{2+}	Na^+	K^+		
Jan.	ND	7.6	1.92	3.6	11.8	8.1	4.8	3.0	11.5	0.20	12.58	0.27
	D	7.7	2.36	4.2	14.4	5.45	4.2	2.6	16.8	0.45	19.59	0.34
	S	7.1	2.09	6.5	13.9	1.5	5.8	4.2	10.9	1.00	12.33	0.50
Apr.	ND	7.7	1.74	4.2	12.8	3.95	4.5	2.9	10.2	0.35	11.83	0.29
	D	7.9	2.15	5.1	12.9	3.7	5.1	3.5	12.6	0.50	14.40	0.30
	S	7.0	1.89	5.7	10.8	2.81	4.9	2.7	11.1	0.51	13.04	0.45
Aug.	ND	7.6	1.19	3.2	6.75	2.45	3.6	1.2	7.3	0.30	9.57	0.23
	D	7.8	1.75	4.4	9.6	3.2	3.3	2.8	10.7	0.40	13.42	0.35
	S	7.1	1.49	6.8	7.25	1.8	4.5	2.6	8.0	0.75	10.32	0.49
Dec.	ND	7.8	1.59	3.9	8.3	4.2	5.8	2.8	7.4	0.40	8.17	0.26
	D	7.9	1.93	6.9	11.0	2.1	2.9	1.7	14.8	0.60	21.96	0.29
	S	7.2	1.87	5.7	9.7	3.38	5.9	2.5	9.6	0.78	8.01	0.50

Bahr El Nazla had a relative high salinity level (0.99-1.32 dS/m). This is more attributed to the faraway distance from the entrance of the Nile water to El Fayoum depression at El Lahun bridge (0.35 dS/m; Hegazi, 1999), which encouraged the dissolved salts from the natural rocky ridges, beside its contaminated with the locality drainage water at some areas.

As a general view, studying the water salinity level of the studied irrigation waters denotes, in general, an increase in the EC_w values, which reached 1.19-1.92 dS/m, 1.75-2.36 dS/m and 1.49-2.09 dS/m for the mixed, drainage water and sewage effluent, respectively. as compared to the Nile one (0.41-1.32 dS/m). Also, the distribution patterns of both the cations and anions for the Nile water are $Ca^{2+} > Na^{+} > Mg^{2+} > K^{+}$ and $Cl^{-} > HCO_3^{-} > SO_4^{--}$, respectively. The corresponding ones far the low quality waters were $Na^{+} > Ca^{2+} > Mg^{2+} >$ K t and $Cl^{-} > HCO_3^{-} >$ or SO_4^{--} .

As for the adjusted SAR, data revealed also that its values reached 1.79-4.88, 8.17-12.58, 13.42-21.96 and 8.01-13.04 for the studied Nile water, mixed water, drainage water and sewage effluent, respectively, the maximum value was associated to the explicit contaminated water of El Wadi drain. As for the SAR value, which used a function of water sodicity, and according to Ayers and Westcot (1985) scale, the mixed, drainage water and sewage effluent belong to the second (6.0-9.0) and third (>9) classes, which denote no and severe problems, respectively. That means, increasing of problems are expected for the irrigated soils on a long-term using, since the EC_w values of those low quality waters were ranged between 1.19 and 2.36 dS/m, in addition to the adjusted SAR was more than 9 through the majority of year months.

Because boron content is more effective on a wide range for the different crop, the scored values of 0.09-0.25, 0.23-0.29, 0.29-0.35 and 0.45-0.50 ppm for the Nile mixed, drainage and sewage waters, respectively. are still in the save range and cause no problems according to Ayers and Westcot (1985).

The obtained results of the elemental composition revealed that, in spite of their contents exhibited wide variations among the studied irrigation waters, a more increase towards the sewage effluent was occurred. The dominance of such elements in these waters were followed the descending trend of K> N> P> Fe>

B> Zn> Mn> Pb> Cu> Ni> Co> Cd. With one exception of Mn which showed superiority over Zn in the sewage effluent. Also, according to the save scale of FAO (1992) the obtained values of these elements are still within the permissible limits.

b) Soil and plant characteristics as affected by the quality of irrigation water

The data presented in Table 4 reveal that the bulk density value tends to decrease in the soils irrigated with the low quality waters as compared to those irrigated with the Nile water. It is also noticed that the occurred reduction rate depends on the soil texture and salinity of the irrigation water, where its values tended to increase with increasing the water salinity and the finest degree of soil. That is true since the influence of salt accumulations enhanced the coagulation of particles and create a renewed false aggregates that was accompanied by large pores (Reeve and Bower, 1960).

Data obtained in Table 4 indicate also that the higher the clay content is, the greater the soil moisture content is at any particular tension due to the influence of the matrix and capillary potentials. Consequently, the available moisture content exceeds with the clay content increase. The corresponding values for the field capacity, wilting point and available water were 17.92, 8.16 and 9.76 % for loamy sand soil of site I versus 49.46 20.14 and 29.32% for clay soil of site III, respectively. The values of soil moisture content at both field capacity and wilting point increased with increasing the salinity levels of both irrigation water and soil, may be due to the effect of osmotic potential. It is worthy to mention that the soil moisture content increased with increasing the soil salinity for the wilting point, in turn, leads to depress the available water content reached about 21.9-23.4 % in the sails having relatively fine texture (sites III and IV).

Moreover, the application of saline irrigation water plays an active role in changing the hydro-physical properties of soils, especially pore size distribution which in turn reflects on the water movement in soil (Talha et *al.*, 1979). It is easily noticed that the volume of drainable and water holding pores decreased on account of the increase of fine capillary ones as a result of using saline irrigation water, which are directly related to the degradation of soil aggregates and the swelling of Na-clay.

Water flow in soil pedality depends on many factors, especially the volume of drainable pores. Thus, data in Table 4 indicate that decreasing the values of

TABLE 4. Soil bulk density, soil moisture constants, pore size distribution and hydraulic conductivity of the studied soil sites.

Soil site	Depth (cm)	Bulk density (g/cm^3)	Soil moisture content %			Pore size distribution %			Hydro. Cond. (cm/h)
			Field capacity	Wilting point	Avail. Water	VDP	WHP	FCP	
El Mazatly									
I-N	0-30	1.49	23.62	11.17	12.45	51.53	12.15	36.32	7.12
	30-60	1.52	20.16	9.31	10.85	41.38	10.03	48.59	15.48
	60-100	1.55	17.92	8.16	9.76	37.46	13.26	49.28	8.59
	100-150	1.57	21.79	9.55	12.24	40.94	11.82	47.24	6.92
I-ND	0-30	1.44	24.97	14.29	10.68	40.71	9.74	49.55	5.49
	30-60	1.48	22.65	13.67	8.98	29.86	7.56	62.58	10.54
	60-100	1.50	18.98	10.41	8.57	24.73	8.95	66.35	6.17
	100-150	1.53	24.18	14.38	9.80	22.78	9.38	67.84	4.16
II-N	0-20	1.37	34.76	13.86	20.90	45.72	18.91	35.37	3.67
	20-65	1.43	36.78	15.28	21.50	38.07	25.50	36.43	2.31
	65-90	146	31.84	16.45	15.39	31.37	28.09	40.54	2.09
	90-150	1.52	32.37	16.31	16.32	26.64	33.88	39.48	1.93
II-ND	0-20	1.29	36.49	19.19	17.30	37.11	14.35	48.54	1.95
	20-65	1.35	39.01	21.87	17.14	30.32	17.75	51.93	1.12
	65-90	1.39	34.95	23.65	11.30	24.95	18.58	56.47	1.48
	90-150	1.46	34.19	20.72	13.47	19.79	21.44	58.77	0.95
III-N	0-30	1.21	49.46	20.14	29.32	23.40	28.63	37.96	0.61
	30-70	1.24	48.53	23.31	25.22	18.71	29.17	52.12	0.38
	70-100	1.27	46.93	20.91	26.02	17.50	31.95	50.55	0.24
	100-150	1.29	47.35	21.52	25.83	13.29	30.13	56.58	0.15
III-ND	0-30	1.08	52.75	25.85	22.90	17.59	24.09	58.32	0.33
	30-70	1.11	50.03	28.78	21.25	14.62	24.51	60.87	0.12
	70-100	1.19	48.11	26.67	21.44	13.95	27.12	58.93	0.10
	100-150	1.26	48.17	27.85	20.32	9.85	25.06	65.09	0.07
El Nazla									
IV-N	0-25	1.23	45.25	21.04	24.21	26.62	25.75	47.63	0.76
	25-75	1.26	44.85	23.19	21.66	22.97	22.80	54.23	0.69
	75-100	1.30	43.75	20.63	23.12	20.64	27.93	51.43	0.42
	100-150	1.35	40.87	18.17	22.70	18.29	29.46	52.25	0.28
IV-D	0-25	1.06	46.11	27.56	18.55	18.45	19.56	61.99	0.24
	25-75	1.15	46.44	28.71	17.73	15.23	18.02	66.75	0.19
	75-100	1.20	48.34	27.87	17.47	14.85	21.18	63.97	0.14
	100-150	1.24	43.02	25.65	17.37	11.68	23.25	65.07	0.08
El Edwa									
V-N	0-20	1.62	24.73	8.36	16.37	54.16	14.56	31.28	9.30
	20-60	1.65	20.86	9.67	11.19	49.92	7.38	35.73	16.91
	60-100	1.67	19.58	10.49	909	50.04	8.93	41.03	18.57
	100-150	1.58	22.78	10.35	12.43	45.91	9.72	44.37	10.62
V-S	0-20	1.56	26.11	11.25	14.86	43.69	16.70	39.61	6.61
	20-60	1.60	21.67	12.01	9.66	47.77	11.76	38.47	9.34
	60-100	1.65	21.06	13.62	7.44	41.30	10.85	47.85	11.26
	100-150	1.62	23.24	13.95	9.29	37.63	12.18	50.19	8.51

VDP = Volume drainable pores of diameter >8.62 μ, WHP = Water holding pores of diameter 8.62-0.19 μ and FCP = Fine capillary pores of diameter 4.19 μ.

these pores, as a result of increasing soil salinity and alkalinity, decreases the values of hydraulic conductivity. This behaviour may be due to the dispersion of soil particles created by sodium ions that occupy a pronounced area of the exchangeable sites.

The use of salty irrigation water considerably affects many soil properties through the concomitant accumulation of salts and their specific ions which equilibrate in soil solution. Data in Table 5 reveal that soil pH value markedly decreased in the soils irrigated with the sewage effluent, especially in the uppermost layer and gradually decreased with soil depth. Also, there is evidence that soils supplied with suspended organic materials exhibited during the continuos irrigation by the sewage effluent, where the organic matter content was increased from 0.9 to 2.7 %.

On the contrary, soil pH tends to increase with increasing the salinity level in the irrigated soils with a mixture or drainage water. It was interesting to note that soils supplied a remarkable increase in soluble Na applied, leading to a pronounced increment in the exchangeable Na, and in turn soil pH.

Table 5 reveals that soil salinity build up proportionally increases by increasing salt concentration of irrigation water. On percentage basis of the ECe value the salinity build up of sandy loam, sand clay loam and clayey soils (sites I, II and III) after about ten years from irrigation with the same saline water approached 254.8, 316.3 and 295.8 in the uppermost layers, respectively, relative to the initial soil salinity upon using fresh water of the Nile. These results pointed out that soil salinity build up is influenced not only by salt concentration of irrigation water but also by the mode of soil characteristics.

Concerning the distribution pattern of the soluble cations possesses a descending trend of $Na^{+}>Ca^{2+}>Mg^{2+}>K^{+}$ in soils irrigated with the Nile water, vs $Na^{+}>Mg^{2+}>Ca^{2+}>K^{+}$ in those irrigated with the low quality waters. Somewhat, the superiority of Mg^{2+} over Ca^{2+} in the soil solution is evident by the relatively high Mg^{2+} values in the used low quality waters, especially, that contaminated with sewage effluent. Whereas, the soluble anions trend is similar for all the studied soils and takes the pattern of $Cl^{-}> SO_4^{--}>HCO_3^{-}$.

TABLE **5. Chemical analysis of soil paste extract of the studied soils.**

Soil site	Depth (cm)	pH (paste)	EC (dS/m)	Soluble ions in meq/l						
				HCO_3^-	Cl^-	SO_4^{--}	Ca^{2+}	Mg^{2+}	Na^+	K^+
El Mazatly										
I-N	0-30	7.53	1.86	2.18	11.12	6.95	7.85	2.26	8.90	0.29
	30-60	7.50	2.72	2.22	14.92	11.36	10.72	5.12	12.55	021
	60-100	7.65	2.98	1.98	12.31	16.41	12.54	7.35	10.50	0.26
	100-150	7.51	3.12	2.30	15.39	6.95	13.59	5.71	12.65	0.15
I-ND	0-30	7.75	6.60	2.98	35.42	38.80	9.43	10.17	46.85	0.75
	30-60	7.90	7.11	2.82	39.08	39.90	8.12	9.48	58.69	0.51
	60-100	7.80	8.45	2.78	46.95	34.97	13.25	12.72	69.11	0.62
	100-150	7.89	5.98	3.03	39.19	27.98	7.03	5.13	47.31	0.73
II-N	0-20	7.30	2.45	2.21	22.81	9.41	8.10	4.82	12.41	0.27
	20-65	7.65	3.12	2.56	21.62	13.93	9.20	6.31	16.55	0.34
	65-90	7.71	4.02	2.61	15.91	17.57	11.17	7.18	23.20	0.25
	90-150	7.85	3.87	2.17	13.98	20.39	9.20	5.04	25.45	0.21
II-ND	0-20	7.84	10.20	3.35	58.24	42.61	14.75	15.13	73.24	1.08
	20-65	7.91	11.61	3.12	66.51	59.02	12.10	14.17	91.14	1.29
	65-90	7.99	10.52	3.22	63.25	41.03	1128	19.27	76.20	0.75
	90-150	8.05	8.72	3.52	48.90	36.48	13.00	12.94	62.42	0.54
III-N	0-30	7.75	3.42	2.82	17.32	14.76	14.02	8.00	12.59	0.49
	30-70	7.92	3.95	2.62	25.91	12.77	10.99	6.09	23.88	0.34
	70-100	7.85	5.31	2.81	28.22	23.57	19.16	8.28	26.81	0.35
	100-150	7.96	6.58	2.97	49.82	14.41	23.41	9.12	34.45	0.22
III-ND	0-30	8.45	13.51	3.85	83.48	50.57	12.25	13.95	110.2	1.50
	30-70	8.64	11.95	3.72	71.22	47.16	11.86	9.39	99.70	1.15
	70-100	8.81	12.21	4.02	69.59	49.79	9.84	7.75	104.9	0.91
	100-150	8.82	14.76	4.18	95.71	50.81	14.16	11.14	124.8	0.60
El Nazla										
IV-N	0-25	7.81	4.69	2.73	29.00	15.97	20.69	7.03	19.30	0.68
	25-75	7.87	4.15	2.49	32.94	17.37	25.56	7.50	19.25	0.49
	75-100	7.92	6.08	2.85	41.22	17.83	26.23	10.37	24.98	0.32
	100-150	7.96	6.75	2.69	45.45	20.06	22.76	13.81	31.34	0.29
IV-D	0-25	8.54	15.72	3.43	92.59	63.58	10.91	12.57	134.77	1.35
	25-75	8.73	16.81	4.06	95.58	70.86	11.68	13.08	145.15	0.59
	75-100	8.61	17.21	3.89	105.86	65.15	12.91	10.22	151.05	0.72
	100-150	8.73	18.89	4.24	114.28	83.18	11.85	10.10	169.20	0.55
El Edwa										
V-N	0-20	7.80	1.82	1.75	9.17	8.48	6.72	4.81	7.52	0.35
	20-60	7.69	2.55	1.74	17.91	8.25	7.11	6.18	14.29	0.32
	60-100	7.75	3.05	1.76	16.21	13.63	8.65	7.29	15.41	0.25
	100-150	7.88	2.68	1.95	14.32	11.83	7.35	6.35	14.21	0.19
V-S	0-20	7.13	4.07	2.14	27.23	22.53	5.52	7.83	27.52	1.03
	20-60	7.45	5.72	2.50	34.42	31.88	7.61	11.43	38.94	0.92
	60-100	7.61	6.95	2.73	45.01	32.96	10.63	14.76	45.20	0.71
	100-150	7.75	4.89	2.37	34.89	23.94	8.22	10.94	31.15	0.89

A comparative study presented in Table 6 indicated that the ESP value tends to be higher in the soils irrigated with the mixed and drainage waters, with a progressively increase for soil having clay texture (soil site IV). This behavior is confirmed by the relatively high values of the soluble sodium and adjusted SAR in the used low quality waters, especially the drainage one. This stimulates more displacement of Ca and Mg by Na on soil colloidal complexes. Therefore, the efficient field drainage system and suitable soil amendment as gypsum should be applied during the usage of these waters to avoid the alkalinity hazard.

Data in Table 6 show that, in general, the initial values of $CaCO_3$ in the studied soils are found in a moderate content (4.9-14.2 %). Exception of those are characterized by the relatively coarse texture such as soil sites I and V (El Mazatly and El Edwa), which attain a relatively low content (1.6-7.9 %). Moreover, the organic matter content was not only occurred in a relatively low content, but also with different contents among the studied sites. Both $CaCO_3$ and organic matter are generally tended to decrease with depth. Also, the reversible trends of both constituents throughout the profile layers of soils irrigated with low quality water is more pronounced, especially those irrigated with sewage one.

In this concern, the relative increase in the $CaCO_3$ content in the soils irrigated with saline water are mostly related to the precipitation of the dissolved $Ca(HCO_3)_2$ in a form of secondary $CaCO_3$. Whereas, the reduction of organic matter content in soil may be attributed to the highest growth inhibition under salinity stress of both irrigation water and soil. The reverse is true for the soils irrigated with sewage effluent, may be due to the dissolution effect of organic acids for $CaCO_3$ and the precipitation of the suspended organic materials from the irrigation sewage effluent, especially in the surface layer.

The two studied sandy loam soil sites at BI Mazatly and El Edwa (I and V) were chosen to evaluate the associated changes in the elemental composition for the uppermost layers of soil and plants grown as affected by applying the different irrigation water resources. The results obtained for water analysis, Table 7 showed that the boron content tends to increase in the used low quality waters, where its values were reached 0.30 and 0.50 ppm in the mixed and sewage waters, respectively, compared to the relatively low one (0.15 ppm) of the Nile water. Because the boron content is more effective on a wide range for

TABLE 6. $CaCO_3$, organic matter contents, cation exchange capacity, exchangeable cations and exchangeable sodium percent of the studied soil profiles.

Soil site	Depth (cm)	$CaCO_3$ %	Organic matter %	CEC (me/100 g soil)	Exchangeable cations (meq/100 g soil) Ca	Mg	Na	K	ESP
El Mazatly									
I-N	0-30	6.5	1.5	13.11	8.25	3.45	0.89	0.39	6.78
	30-60	5.8	1.4	11.27	9.22	1.75	0.96	0.28	8.54
	60-100	3.7	0.9	6.02	4.18	1.04	0.56	0.16	9.28
	100-150	2.6	0.5	9.37	6.50	1.55	0.98	0.24	10.46
I-ND	0-30	7.9	1.2	16.50	7.53	6.27	1.97	0.45	11.97
	30-60	7.1	0.8	10.65	5.65	3.15	1.40	0.31	13.11
	60-100	5.4	0.7	13.04	8.06	2.45	2.02	0.36	15.48
	100-150	3.8	0.3	14.15	7.34	4.20	2.31	0.22	14.15
II-N	0-20	6.3	2.6	22.80	14.12	6.08	1.73	0.64	7.58
	20-65	7.8	1.9	25.93	15.15	7.35	2.56	0.47	9.89
	65-90	5.2	1.1	27.15	18.05	5.55	2.89	0.52	10.64
	90-150	4.9	0.9	22.17	15.40	4.30	1.78	0.60	8.02
II-ND	0-20	8.1	1.9	25.59	11.12	9.18	4.22	0.82	16.50
	20-65	9.2	1.3	20.05	8.25	7.45	3.67	0.55	18.30
	65-90	6.6	0.8	21.89	8.17	8.23	4.56	0.63	20.84
	90-150	5.4	0.6	18.16	7.40	6.20	3.58	0.71	19.72
III-N	0-30	9.8	2.4	44.30	28.23	10.17	4.51	1.18	10.17
	30-70	7.6	2.3	46.09	29.11	9.02	5.81	1.03	12.60
	70-100	5.1	1.9	41.46	24.09	11.35	4.95	1.11	11.93
	100-150	4.9	1.5	45.75	30.00	8.40	6.35	0.97	13.89
III-ND	0-30	13.7	1.6	47.34	18.12	13.40	13.99	1.68	27.46
	30-70	10.1	1.1	42.03	14.83	12.22	13.53	1.47	32.18
	70-100	8.6	0.8	45.67	13.17	14.42	16.46	1.39	36.05
	100-150	7.3	0.7	46.92	16.20	13.15	16.51	0.87	35.19
El Nazla									
IV-N	0-25	9.9	2.0	40.45	23.11	12.40	3.74	1.19	9.25
	25-75	8.2	1.7	41.55	27.51	8.12	4.19	1.52	10.09
	75-100	6.8	1.3	42.63	28.11	9.50	3.83	1.10	8.98
	100-150	5.7	0.8	37.81	21.15	10.81	4.60	0.82	12.17
IV-D	0-25	14.2	1.1	42.35	12.13	14.20	14.01	1.86	33.08
	25-75	11.8	0.9	40.81	10.92	12.31	12.22	2.07	37.29
	75-100	10.1	0.7	43.11	11.54	13.25	16.54	1.58	40.65
	100-150	6.5	0.4	39.22	9.95	10.53	17.39	1.20	44.35
El Edwa									
V-N	0-20	7.6	0.9	7.64	5.02	1.96	0.39	0.16	5.13
	20-60	6.4	0.7	2.83	1.59	0.86	0.19	0.12	6.56
	60-100	4.8	0.4	4.15	2.65	1.14	0.26	0.08	6.20
	100-150	5.1	0.3	5.37	3.06	1.72	0.39	0.10	7.35
V-S	0-20	3.1	2.7	6.13	3.12	1.98	0.64	0.43	10.41
	20-60	2.2	1.6	5.42	2.90	1.38	0.63	0.39	11.58
	60-100	1.6	1.3	7.39	3.83	2.31	0.89	0.24	12.03
	100-150	4.5	0.8	3.72	1.98	0.95	0.50	0.15	13.34

the different crops, the scored values of 0.30-0.50 ppm are still in the save range and **cause no** problems **(Ayers** and **Westcot,** 1985).

TABLE 7. Macro, micro and non-nutritive heavy metals contents in ppm for *the* studied irrigation waters, soils and plants.

Natural Resource			K	Fe	Cu	Mn	Zn	B	Cd	Ni	Pb	Co
Irrigation waters												
N	1.5	0.25	6.9	0,20	0.020	0.05	0.08	0.15	0.007	0.010	0.05	0.009
ND	3.6	0.40	9.7	0.45	0.035	007	0.10	0.30	0.015	0.020	0.08	0 020
S	19.8	5.50	19.7	0.75	0.065	0.70	0.25	0.50	0.030	0.060	0.20	0.030
Irrigated soils												
SN	510 1.3*	370 4.6	5060 143	19300 3.4	37 1.05	240 1.4	55 0.6	27 0.18	0.3 0.02	11.7 0.18	26 0.25	3.5 0.09
SND	650 2.1*	498 5.7	6170 267	23410 4.9	54 1.60	385 2.9	89 1.15	32 0.35	0.6 0.04	16.5 0.32	33 0.45	5.1 0.20
SS	787 45.1*	790 17.6	8695 3.85	28820 9.1	69 2.1	525 3.7	125 2.2	45 0.70	0.8 0.07	21.6 0.60	41 0.75	8.7 0.50
Plant grown												
PN	-	-	-	140.3	16.5	23.5	31.2	28.4	0.25	1.65	1.40	1.25
PND	-	-	-	137.2	12.2	19.0	27.5	24.2	0.20	1.20	1.25	0.95
PS	-	-	-	167.9	18.7	24.9	33.0	31.6	0.30	1.80	1.60	1.45

Irrigation water: **N=Nile** water, **ND=Mixture** of Nile with drainage and **S=Sewage** effluent.

Irrigated soils : Soils irrigated with the Nile (SN), mixture **(SND)** and sewage effluent (SS). Plant grown: Plants irrigated with the Nile (PN) mixture **(PND)** mid sewage effluent **(PS).**

- Available contents of the studied elements.

The contents of macro- (N, P and K), micro-nutrients (Fe, Mn, **Zn** and Cu) and non nutritive heavy metals (Cd, Ni, Pb and Co) are also illustrated in Table 7. The obtained data revealed that, in spite of **their** contents exhibited wide variations **among** the studied irrigation waters, with a more increase towards the sewage effluent, dominance of such elements in these waters followed the descending trend of K> N> **P>** Fe> B> Zn> **Mn> Pb>** Cu> **Ni>** Co> Cd. With one exception of Mn which showed superiority over Zn in the sewage effluent. Also, according to the **save** scale of **FAO** (1992) the obtained values of these elements are still within the permissible **limits.**

The values obtained clearly showed an increase taking place for the total and available contents of the studied macro (N, P and K), micro- nutrients (Fe, Mn, Zn and Cu), and non nutritive heavy metals (Cd, Ni, Pb and Co) in the soils irrigated with the low quality waters as compared to those irrigated with the Nile one (Table 7). These findings stand in parallel similar to those obtained in the used irrigation waters. Also, the elemental accumulation is more obvious in the soil irrigated with the sewage effluent, That condition may be due to extensive utilization and contamination with the pollutants, which are exhibited a more mobility and availability for plant roots in the relatively coarser soil media.

The relatively high content of the plant nutrients and heavy metals in the sewage effluent supports the active uptake of these elements during the stages of plant growth. Therefore, data in Table 7 showed a pronounced decrease in the contents of micro-nutrients and non nutritive heavy metals (*i. e.*, Fe, Cu, Mn, Zn, B, Cd, Ni, Pb and Co) in the wheat tissues grown on the soils irrigated with the mixed water. Whereas, a marked increase for the content of the studied elements was recorded in the wheat plants grown on soils irrigated with the sewage effluent.

c) *Influence of salinity stress on growth and yield of wheat*

Growing plants under salinity stress show considerable difference in physiological and biological activities, as a result of the adaptive mechanisms during evolution. These adaptations also cause readjustment in the activities of certain key enzymes of the plant metabolism (Ahmed and Zaheer, 1974).

In this respect, data presented in Table 8 reveal that the increase in soil salinity, especially in the clay soils of El Mazatly and El Nazla (sites III and IV), is mainly associated with the decrease in the growth parameters, *i.e.*, height of plant and spike length and, in turn, leading to a pronounced decrease in yield of wheat grains. That means an inverse correlation between salinity and grain weight, as higher the soil salinity the lower was the weight of grains.

The harmful effect of salinity stress could be referred to highest growth inhibition under the continuous irrigation by saline water, Under the present study, such application of salinity progressively increased Na-uptake by wheat plants. Subsequently, under this condition wheat plants had the highest Na accumulation to certain toxicity level. This may explain the relatively low salt tolerance of wheat, Accordingly, plants uptake of Na could be controlled by salinity level of irrigation water, its management and plant genotype (Amer, 1999).

TABLE 8. Growth parameters of wheat plants and grain yield as affected by soil texture and salinity strew of irrigation water.

Soil Site	Texture class	Water Quality	Plant height (cm)	Spike length (cm)	Grain yield (ton/fed)
El Mazatly					
I	Sandy loam	N	82.3	11.7	3.008
		ND	66.1	7.8	1.369
II	Clay loam	N	97.7	12.8	3.697
		ND	58.6	5.9	1.178
III	Clay	N	86.8	10.5	3.176
		ND	46.3	4.8	0.843
El Nazla					
IV	Clay	N	89.4	11.3	2.952
		D	44.9	4.5	0.786
El Edwa					
V	Sandy loam	N	80.2	10.6	2.982
		S	84.3	8.9	2.157

Data illustrated in Table 8 showed that reduction in the studied plant growth parameters and yield of grains was not only limited by salinity level of soil or water, but also the texture grade of soils, as shown in the different soil sites of El Mazatly area. However, the decrease percentages as a result of the application of the low quality for plant height, spike length and grain yield per feddan were 19.68, 33.33 and 54.49, respectively, for the sandy loam soils. The reduction rate was more evidence under the same condition of irrigation for the sandy clay loam and clay soils, *i. e.,* 40.02, 53.91 & 68.14 % (site II) and 46.66, 54.29 and 73.46 % (site III), respectively.

It is worthy to mention that in spite of a nearly similar condition for water salinity and soil texture at the soil sites of I and V, the reduction rate was higher in plant components stressed by soil salinity (site I). For example, soil salinity stress of irrigation water applied to site I was quite detrimental to cause 19.68, 33.33 and 54.49 % decline in plant height, spike length and grain yield, respectively, vs 0.00, 16.04 and 27.67 % for the same parameters in the soil site No. V (Table 8). This may interpret the positive effect of the sewage effluent on the soil properties and plant nutrition.

In conclusion, **gradual** increase of salinity should alleviate the **plant** nutrients disruption, **as** well as, the **plants** showed **an adaptive** mechanism to **cope** salinity stress through the regulation of some organic solutes. So, the mixing of saline water with fresh water at a certain available level should **be** recommended, **especially** at the **seedling** *stage.*

References

Abdellah, HA. (1995) Chemical studies **on** the effect of irrigation by polluted water on some Egyptian soils. ***Ph.*** D. ***Thesis,*** **Fac.** of Agric. Moshtohor, Zagazig Univ., Egypt.

Abdel-Sabour, M.F., **Ismail, A.S. and Abou Naga ,** H.H. (1996) Environmental impact of Cairo sewage effluent on **El-Gabal** El- **Asfer** farm. ***Egypt. J.*** *Soil Sci. 36,329.*

Ahmed, R. and Zaheer,M. (1974) Some physiological and biochemical studies of Spinach grown on saline soil. I **bid 6,49 (c.f.** ***Plant and Cell Physiol.*** **19, 99).**

Amer, **A.F.** (1999) **Effect** of salinity stress, increasing gradually and suddehly treatment, on plant nutrient uptake and content of **some** carbohydrate fractions. Egypt. ***J. Soil Sci.*** *39* **(1), 111.**

Avery, B.W. and Basocomb, C.L. *(1974) "Soil Survey laboratory Methods."* **Harpenden** England.

Ayers, R.S. and Westcot, D. W. (1985) ***Water Quality for Agriculture, Irrigation and Drainage, Paper 29, FAO,*** Rome, 97.

Black, CA. (1982)"Methods of Soil Analysis." Soil **Sci.** Soc. of Amer., Inc. Publisher, Madison Wisconsin, U.S.A.

Black, G.R. and Hartge, K.H. (1986) Bulk density. **In:** Methods of ***Soil Analysis,*** Part *1,* A.Klute, (Ed.), Agronomy Monograph, No.9,363.

El-Sebaey, M.M.M. (1995) Studies on chemical pollution of different waters with some **heavy** metals in **Fayoum** Governorate. ***M. Sc. Thesis,*** **Fac.** of Agric., Moshtohor, **Zagazig** Univ., Egypt.

FAO (1992) Waste water treatment and **use** in agriculture. ***Soils Bull.*** 47, Rome.

Felhendler, R., Shainberand, I. and Frenkel, H. (1974) Dispersion and hydraulic conductivity of soil in mixed solution. Trans 10th *Int. Congr.* Soil *Sci., Moscow,* **Vol.1, Nauka, pp.103-112.**

Hegazi, I.M.A. (1999) Factors affecting utilization and development in lands and water resources of the northern area of El Fayoum, Egypt. *Ph. D.* Thesis, **Fac.** of Agric., El Fayoum, Cairo Univ., Egypt.

Hesse, P.R. (1971) *"A Text-Book of* Soil Chemical *Analysis."* John Murray, London, **Great Britain**

Jackson, M.L. (1969) *"Soil* Chemical Analysis." Advanced Course, Published by the Author, Dept. of Soils, Univ. of Madison, Wisconsin, **U.S.A.**

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.** of Agric., Cairo Univ, Giza, Egypt.

Khalil; M.E.A. (2000) Optimization of low quality water on solving irrigation problems in El Fayoum Governorate, Egypt. *Fayoum* **J.** *Agric.* Res. *and Dev.* **14 (1), 73.**

Klute, A. (Ed.) (1986) *"Methods* of Soil Analysis." **No.9** Part 1, Amer. Soc. Agron. Inc. Madison, Wisconson, USA.

Omar, M.S. and Aziz, MA. (1982) The use of saline irrigation water, its effect on soil properties and plant growth. I- Soil aggregation. Egypt. **J.** Soil *Sci.* 22.11.

Page, A.I., Miller, RH. and Keeney, D.R. (Ed.) **(1982)** Methods of Soil Part 2: Chemical and Microbiological Properties, 2nd *ed* Amer. **Soc.** of Agron., Madison, **Wiscosin,** U.S.A.

Reeve, R.C. and Bower, CA. (1960) Use of high salt waters as a **fllocculant** and **sourcse** of **divalent** cations for reclaiming **sodic** soils. Soil *Sci.* **90,139.**

Richards, L.A. (Ed) **(1954)** "Diagnosis **and** Improvement of *Saline and* Alkali Soils." **U.S. D. A. Handbook No.60.**

Shainberg, I. and **Letey,** J. (1983) Response of soils to sodic and saline conditions, *Hilgardia*, Vol. *52* (2), (*c.f. Soil Salinity Under Irrigation,* Springer-Verlay, Berlin Heidelberg, New York, Tokyo,1984).

Sharma, D.P., Singh, K.V, Roa, G.K. and **Kumbhare, P.S.** (1990) Reuse of saline drainage water for irrigation in sandy loam soils. *Symposium on Land Drainage for Salinity Control, I: Arid and Semi-Arid Regions.*

Soil Survey Staff *(1980) Soil Survey And Land Classification of Fayoum Governorate.* Soils, Water and Environ. Res. Inst. Agric. Res.Centre,Giza. Egypt.

Talha, M., Abdel Samiey, A.C. and Omer, M.S. (1979) Factors affect in water movement in alluvial soils of Egypt. *Egypt.* J. *Soil Sci.* **18**, 2.

Tel, D.A. (1982) Determining nitrate, nitrite and ammonium in soil extracts (Techicon All). *Automated and Semi-automated Methods for Soil and Plant Analysis,* 7, 8.

(Received 10/2000)

التـاثيـرات الناجمـة عن استـخدام مـياه قليلة الصلاحيـة فى الرى بمحافظة الفيوم – مصر

السيد عبد الحى خاطر، طلبة صالح عبد العال ، فراج ربيع محمد فراج
قسم الأراضى والمياه – كلية الزراعة بالفيوم – جامعة القاهرة – مصر .

تمثل هذه الدراسة محاولة علمية لتقييم مدى ملائمة مياه الصرف الزراعى والصحى فى بعض أراضى محافظة الفيوم ذات خواص متباينة ، بهدف الإسترشاد بالنتائج المتحصل عليها فى متابعة عمليات التملح والمحتوى من بعض الملوثات لتحديد طرق خدمة مائية أرضية مناسبة لكل نوع منها .

وقد تبين من متابعة التركيب الكيميائى لمختلف المصادر المائية المستخدمة فى رى الأراضى تحت الدراسة بالرغم من أن هناك تباين واضح فى ملوحتها من موقع الى آخر إلا أن الحدود الصغرى والعظمى لملوحتها قد سجلت في فترة زمنية متماثلة تقريبا هى شهرى أغسطس ويناير على التوالى. كما أن النتائج المتحصل عليها توضح أن قيم الـSAR,EC لتلك المياه قليلة الصلاحية تزيد فى المتوسط بما يعادل ٥ . ٢ ، ٥ . ٤مرة على الترتيب بمقارنتها بمياه النيل مما يتوقع معه ظهور بعض المشاكل للأراضى التى تروى منها وكذلك للنباتات النامية عليها. وتشير النتائج أيضا إلى أنه بالرغم من الإرتفاع النسبى لمحتوى تلك المياه من بعض المغذيات الكبرى والصغرى إلا أنها ما زالت فى نطاق الحدود الآمنة .

وفيما يختص بتأثير نوعية المياه المستخدمة فى الرى على خواص الأراضى تحت الدراسة، فإن النتائج تشير إلى حدوث زيادة

فى ملوحة التربة وقيم كاك أم ، الصوديوم المتبادل ، وأحيانا الماغنسيوم الذائب. وفيما عدا ملوحة التربة ومحتواها من المادة العضوية تشير النتائج إلى أن هناك تناقص فى تلك القيم المشار إليها فى حالة إستخدام مياه الصرف الصحى فى الرى، ويرجع ذلك إلى تاثير الأحماض العضوية على إذابة وإنخفاض محتوى كا: أ٣ وفى نفس الوقت زيادة تراكم المعلقات العضوية فى الطبقات السطحية .

كما توضح النتائج حدوث إنخفاض فى قيم الكثافة الظاهرية ، الثوابت المائية ، مسام الصرف ، التوصيل الهيدروليكى كنتيجة لإستخدام المياه قليلة الصلاحية . وفى تجاوب ملحوظ مابين مياه الرى والتربة توضح النتائج حدوث النتائج حدوث زيادة فى المحتوى الكلى والميسر فى بعض العناصر الكبرى (N,P&K) والصغرى (Fe, Mn, Zn &Cu) وكذلك الثقيلة منها (Cd, Ni, Pb & Co)فى الأراضى التى تروى بالمياه قليلة الصلاحية ، وقد إنعكس ذلك سلبيا على محتوى نباتات القمح النامية بها لحدوث تثبيط نوعى في ميكانيكية إمتصاص تلك العناصر، والعكس صحيح فى حالة نباتات القمح النامية في الأراضى التى تروى برائق الصرف الصحى .

وبصفة عامة فقد أظهرت النتائج أن التأثير السلبى لإستخدام المياه قليلة الصلاحية على قياسات النمو الخضرى والمحصول من الحبوب ليس ناجما فقط من زيادة ملوحة مياه الرى والتربة ولكن أيضا يرتبط بتباين قوامها. لذا فإن نظام خلط المياه العذبة بأخرى مالحة يجب أن يتحقق عند مستوى ملوحة مناسب وموصى به خاصة فى مرحلة الإنبات ونمو البادرات .