International Journal of PharmTech Research
CODEN (USA): IJPRIF, ISSN: 0974-4304, ISSN(Online): 2455-9563
Vol.9, No.9, pp 138-149, 2016

Adverse Impacts of El-Salam Canal Irrigation Water on Chemical Characterizations of Sinai Soils

Mohamed Saber[1]*, Salah Abu-Sedera[1], Ibrahim A. Matter[1], and Alaa Zaghloul[2*]

[1]Agricultral Microbiology Department, National Research Centre, Dokki, Giza, Egypt.
[2]Soil and Water Use Department, National Research Centre, Dokki, Giza, Egypt.

Abstract : The relationship among irrigation water type, soil characterization and production of cultivated crops are widely closed. El-Salam canal in North of Sinai consisted of mixture of both drainage and Nile water (1:1 ratio) is main source of irrigation. Long application period of such water in Gelbana region, El-Tina plain beside poor drainage, all led to deteriorate soil characterizations and decrease crop production in such soils. In this work, through 7 months water samples were collected from El-Salam canal and different chemical characterization were analyzed and sample from Nile water (NW) was also collected as control. The soil sample was collected from the cultivated farm irrigated with this low quality mixed water was also collected and analyzed for their chemical characterization, the control soil sample was chosen from the same region with coarse texture and well managed farm. The obtained results reveled that all chemical characterization values of water samples through the studied period were higher than NW values. For example, the pH of water samples collected from El-Salam canal significantly higher that NW ranged between 7.35 and 7.86, meanwhile, it was 7.32 in NW. According to Doneen parameter this water is not safe to be used in irrigation. Significant amounts of potential toxic elements were also noticed in this type of water varied from month to month especially in lead Pb. The directed effect of this low quality water was observed in different soil characterizations such as heavy metals content, sodium adsorption ratio etc...
This study concluded that long term application of such low quality water should be followed by remediation technique(s) to minimize its healthy hazards.
Key words: irrigation, low quality water, soil characterization.

1. Introduction

The total land area of Egypt estimated as approximately 1 million km^2, most of which considered as arid areas. The populations mainly concentrated in the narrows Nile Valley and Nile Delta. The total Egyptian cultivated area is about 8.6 million feddan, which consist only about 3% of the total land area[1]. As many countries, Egypt facing water scarcity, and only 5.4 % of the land resources is qualified as excellent due to its limited water resources, salinity, sodicity problems and its dry climate[2,3]. Crops production in Egypt depends on irrigation due to aridity conditions, very low annual rainfall[4].

Horizontal agricultural expansion in Sinai Peninsula which represents 6% of the total area of Egypt requires water supplementation for irrigation. This water could be provided from the Nile as well as other water resources such as drainage water. For this reason, the Egyptian Government establish El-Salam Canal which considered as one of the five-mega irrigation projects in Egypt to develop the area located to the east of Suez canal in northern Sinai[4].

El-Salam Canal conveys its water from Nile River (Damietta branch) mixed with drainage water from two main drains eastern Nile delta *i.e.* Hadous drain and El-Serw drain[5]. The water of El-Salam Canal aimed to cultivate nearly 620,000 feddans, includes 220,000 feddan west of Suez Canal and about 400,000 feddans certainly newly reclaimed lands located at the east of Suez Canal in north Sinai[4].

Long term irrigation with waste water affects physicochemical properties of the soil hence proper irrigation management as well as periodic monitoring of soil quality parameters are required to minimize adverse effect on the soil[6]**.**

The current study aims to investigate direct and indirect effects of mixture low quality waters applied on some important chemical characterizations which influenced crop production cultivated in this area.

2. Material and methods

Study areas:

El-Salam Canal and surrounded land at Sahl El-Tena region, north of Sinai, Egypt.

Water sampling:

Representative periodical monthly water samples were collected between the periods from January 2012 to July 2012 (5 liter each) from El-Salam Canal as well as a control water samples from River Nile at Tanash village, Giza governorate.

Soil sampling:

Surface (0-30 cm) soil samples from different cultivated farms that irrigated with mixed drainage water from El-Salam Canal at Baloza (Sahl El-Tena, North Sinai) were monthly collected during the course of study. Soil samples were solar-dried, before being grinded into fine particles with one mm average size and cold stored in their fresh state until analyses.

Chemical methods:

Chemical characterizations of the water samples were carried out according to APHA [7]. The sequence of some parameters such as temperature, DO, electrical conductivity (EC), and pH value were measured directly in the field. Temperature in water was measured by thermometer while EC was measured by EC meter (YSI Model 33. S.C.T). Also the concentrations of bicarbonate were determined directly by titration with standard 0.02M HCl and phenolphthalein and methyl orange indicators. The pH value was determined using a portable pH meter. The total chloride was measured by titration of 50-mL samples against 0.0141N silver nitrate solution using potassium chromate as indicator. Total dissolved salts (TDS) were determined gravimetrically.

Instrumentation and analysis of PTEs

Flame Atomic Absorption Spectrometry (FAAS) technique frequently used in determining PTEs in natural aquatic samples. In this study, a Perkin–Elmer flame atomic absorption spectrometer (FAAS) and HACH DR890 colorimeter was used. Atomic absorption measurements were carried out using air: acetylene flame, while HACH colorimeter measurement was performed using provided kits. The operating parameters for working elements were followed as recommended by the manufacturer.

3. Results and discussion

Chemical characterization of water samples collected from El-Salam Canal

Water analyses were carried out monthly for 7 months including chemical and heavy metals, to investigate the situation analysis of El-Salam Canal. Through the studied period, Data of the chemical properties of the water in Figures 1-4 and Table (1), indicated that through the 7 months the electrical conductivity ranged between 1.18 and 1.75 $dS.m^{-1}$ equal to total dissolve salts (TDS) values ranged between

755 and 1120 ppm. Compared to Nile Water (NW) analysis, the obtained values are significance high than that of NW.

The salinity of water is not only due to the ratio of mixing the drainage water with the Nile water 1:1 but it may be due to the evaporation factor and high wind speed as in the climatic map.

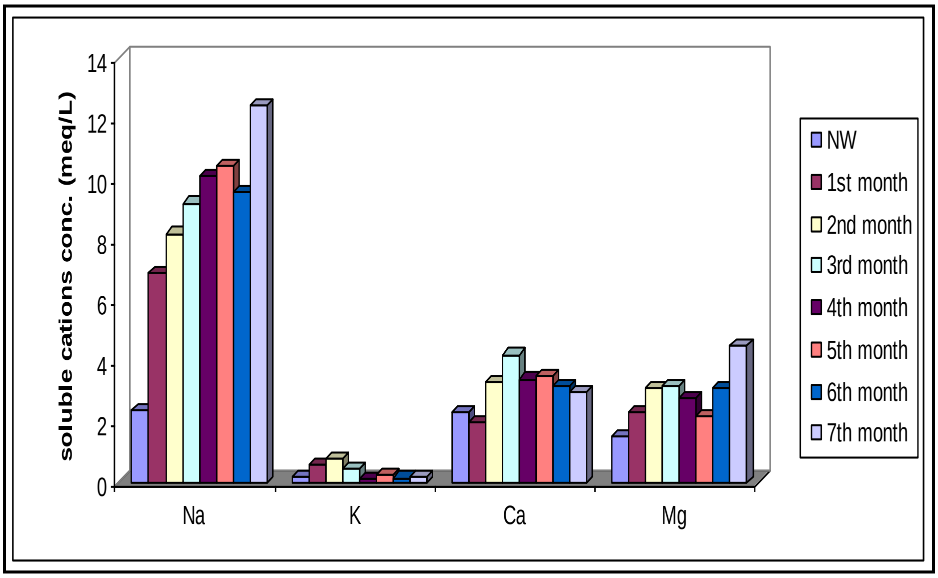

Figure (1) soluble cations in water samples determined through 7 month from El-Salam canal

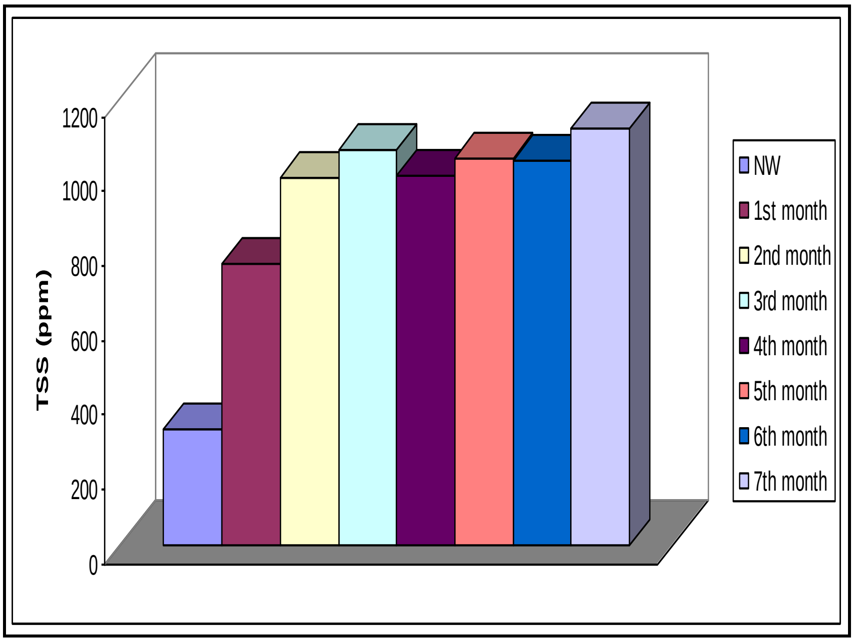

Figure (2) Total soluble salts (TSS) of El-Salam canal through the studied period compared to Nile Water (NW)

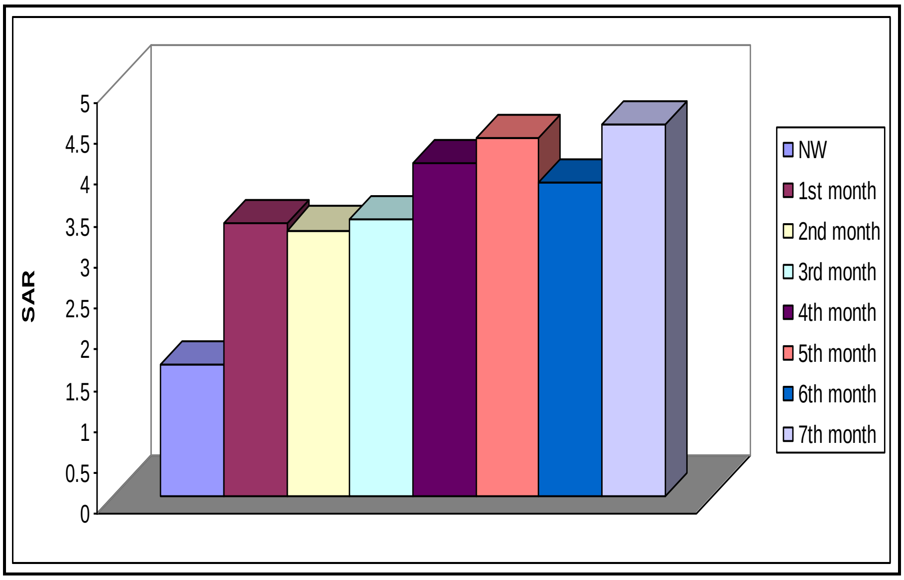

Figure (3) Sodium adsorption Ratio (SAR) of El-Salam canal through the studied period compared to Nile Water (NW)

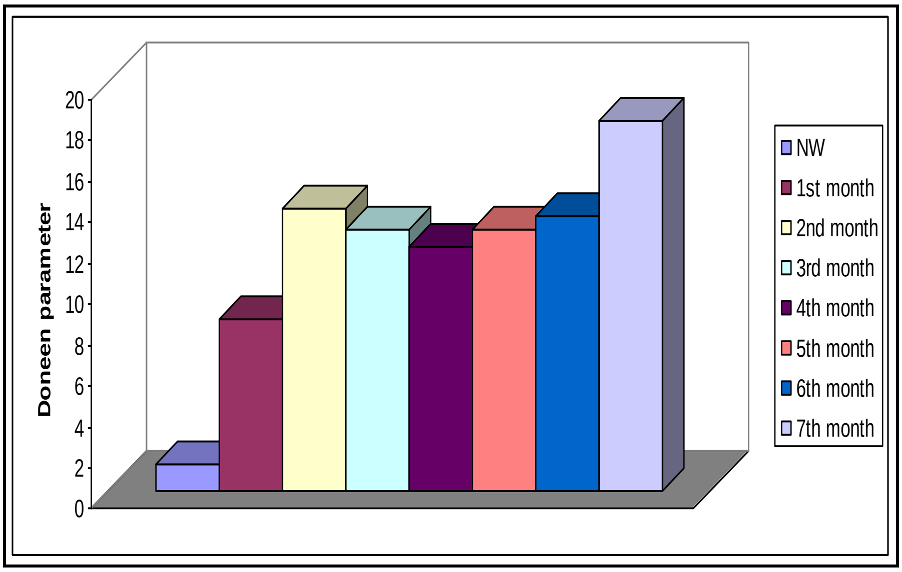

Figure (4) Doneen factor of El-Salam canal through the studied period compared to Nile Water (NW)

The other probability is filtration factor which results from the hydraulic pressure of high salinity water sources (salinity of Red Sea about 43,000 mg/L) in the Suez Canal or water of saline lakes, which spread on surface and down this area. The variation in mixing ratio of Nile water and the drainage water must be considered otherwise it will lead up to negative impacts in the project.

According to the soluble cations data, results referred that the Na+ was the highest cation compared to K, Ca and Mg, meanwhile K+ was the lowest one. For example, at the 7th month the value of Na+ was 12.4 ppm while Ca++ and Mg values were 3 and 4.5 ppm respectively. It should be mentioned here the respective value of Na+ in NW was 2.35 ppm.

Concerning the SAR values, data indicated that this parameter changed through the months. For example, in January, the parameter value was 3.33 increased to 4.06 in April and the highest value observed in July. In other words, increasing the weather temperature led to increase the values of this parameter beside the related parameter such as EC. The comparison study with NW indicated the increase of El-Salam canal water by about 150% and may over in some months like summer months.

Table (1) Some chemical characterization of Water samples collected from El-Salam Canal through 7 months

Date of sampling	Type of Water	EC (dS.m-1)	TSS (ppm)	pH	Na	K	Ca	Mg	SAR	(0.5 $SO4^{--}$ $+Cl^{-}$)
					ppm					
NW	Safe Water for irrigation	0.49	313.6	7.32	2.35	0.15	2.33	1.52	1.6	1.32
January 2012	Unsafe to be used in irrigation	1.18	755.2	7.39	6.9	0.6	2	2.3	3.33	8.4
February 2012		1.54	985.6	7.52	8.2	0.79	3.3	3.1	3.24	13.8
March 2012		1.66	1062.4	7.35	9.2	0.42	4.2	3.2	3.38	12.81
April 2012		1.55	992	7.46	10.1	0.1	3.4	2.8	4.06	11.93
May 2012		1.62	1036.8	7.52	10.4	0.23	3.5	2.2	4.36	12.8
June 2012		1.61	1030.4	7.86	9.56	0.14	3.2	3.1	3.81	13.48
July 2012		1.75	1120	7.68	12.4	0.16	3	4.5	4.53	18.08

The general evaluation of El-Salam canal and according to **Doneen** [8], results indicated that application of such water in light texture is not safe. The results showed that the Doneen parameter (0.5 SO_4^{--}+Cl^-), in all months this parameter increased over 5 which mean that application of such water for long time is not safe. In this relation, in July, Doneen parameter was 19.08; meanwhile, the corresponding value for NW was 1.32.

Monitoring of potential toxic elements PTEs in El-Salam canal

Potential toxic elements (PTE's) were analyzed in the irrigation water of El-Salam canal as a main source of irrigation in the studied sites. Data in Table (2) and Figure 5 represents 8 different PTE's as well as the both save level of these elements and the analysis of Nile water.

In this part we will discuss two important points, the 1st related with the comparison between the save level and the water of El-Salam canal and the 2nd the comparison between this water type and NW. For the 1st point, the obtained results indicated that at different months, all the PTE's were under the toxic levels except Cd and Mn the numerical values showed that in June the concentration of these were 0.08 and 0.514 ppm, whereas the save levels for these PTE's were 0.01 and 0.2 ppm respectively, worth to mention that the same trend was almost observed in other months.

For the 2nd point, data indicated that all PTE's showed significant increase compared to NW concentrations of these pollutants especially in summer months. For example, data indicated that Ni, Cd, Pb, Mn and Fe were non-detected in NW, These PTE's values were 0.07, 0.08, 1.71 and 0.61 ppm in July month. Also, Cu, Zn and Cr, although all these PTE's were detected in NW, the same values in July were significant high for El-Salam canal. The same observation was also observed in other months.

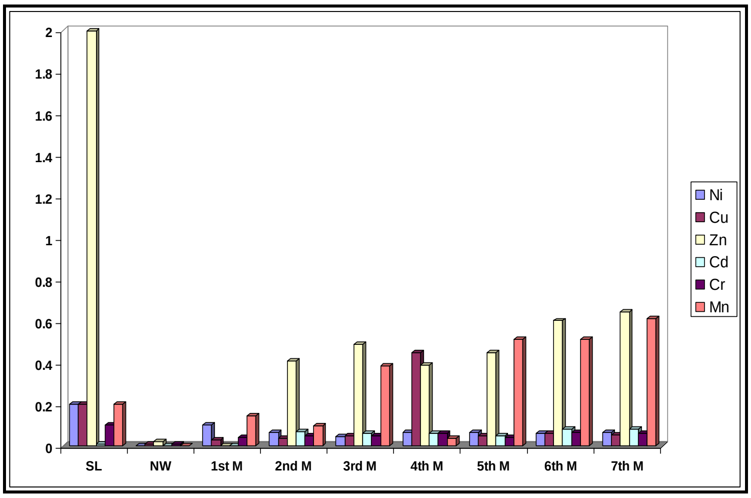

Figure (5) Concentrations of Ni, Cu and Zn in El-Salam canal through the studied period compared to Nile Water (NW) and safe limits (SL).

Table (2) Chemical analysis of water samples collected from El-Salam Canal

No.	Date of sampling	Ni	Cu	Zn	Cd	Pb	Cr	Mn	Fe
		mg/l							
Save level		0.2	0.2	2	0.01	5	0.1	0.2	5
Nile water		-	0.01	0.02	-	-	0.01	-	-
1	January 2012	0.1	0.03	0	-	0.9	0.04	0.145	2.201
2	February 2012	0.064	0.037	0.41	0.07	0.8	0.05	0.098	2.402
3	March 2012	0.046	0.05	0.49	0.06	1	0.05	0.386	1.051
4	April 2012	0.064	0.45	0.39	0.06	1.5	0.06	0.038	2.102
5	May 2012	0.064	0.049	0.45	0.05	1.4	0.04	0.512	2.51
6	June 2012	0.06	0.062	0.604	0.08	1.5	0.065	0.514	2.45
7	July 2012	0.066	0.055	0.645	0.08	1.71	0.061	0.612	2.5

Chemical characterization of Sinai soils collected from different sites

In this work we selected two types of soil, the 1st was soil samples collected from El-Tina plain which represents light texture and the 2nd was course texture with well management considered to be our control for Al-Tina plain soils. Some chemical and physical properties are represents in Table (3) and Figures 6-13. As shown in this Table increasing the soil texture, led to significant increase soil salinity. Data indicated that increasing the soil clay content from about 15 to 22%, led to increase soil salinity from 1.8 to 2.7 $dS.m^{-1}$. In sandy soil, however, the electrical conductivity was 0.4 $dS.m^{-1}$. It should be mention that the EC of such soils were not in hazard level. The land use of these soils mainly depends on Beet as a main crop with alfa alfa to carry out the soil salinity. Other farmers cultivate wheat or cotton according to the season with low production mainly related to soil properties and low quality water. Worth to mention that cultivation of citrus in control soil is in excellent conditions mainly due to the well management of the soil and improvement of water quality.

Data in the same Table showed that soil organic matter (OM) was low, this result perhaps could be related to the scarce of apply OM in such soils. The range of organic matter ranged between 0.10 and 0.5 represent low content of OM.

Although data of soil acidity was in normal range, data indicated that soils of El-Tina plain were higher than the control soil. Numerically, the soil acidity ranged between 7.6 and 7.85, in control soil the soil pH was 7.51.

Data in Table (4) represents the other chemical properties of the studied soils. These properties actually could be explanation of the effect of water applied in these soils. Data in Table represents the exchangeable cations which showed clearly were higher in their values compared to the control soil. As shown in the Table using of Beet as a crop led to decrease these exchangeable cations especially sodium.

Significant variations were observed in the same data related with the CEC, ESP and surface area (SA). In the 1st parameter values data showed that the CEC of El-Tina plain soils were ranged between 18 and 62 meq/100 g, the control value was 5.5 meq/100 g. This significant between the soils mainly related to the presence of light components (silt and clay) higher than the sandy soil in the control and this result perhaps clearly in the difference in the SA parameter. Accordingly, the tendency of such soils to retain the pollutants (as it will be shown) or salts is expected.

The SAR and ESP of the collected soils may explain this point. Data showed that the SAR values of the El-Tina plain were ranged between1.03 to 2.54, decreased to 0.64 in control soil. At the same trend, the corresponding values for ESP were ranged between 36 and 71% in El-Tina plain against about 18% in control treatment. This result clearly represents the effect of soil texture on the deterioration of soil system and the importance of applied some management for such soils to minimize the hazards of using such low quality water.

Effect of mixed water applied from El-Salam canal on the presence of PTE's in the studied soil samples.

According to the obtained results, data showed that some of trace elements represented in the Table not toxic for the growing plants such as FE, Mn, Mo and Zn. However, excessive quantities will undesirable accumulations in plant tissues and subsequently reduction in plant growth. There have been few filed experiments from which toxic limits could be established especially for irrigation with such waters. However, research dealing with disposal waste water has gained sufficient experience to prove useful in defining limitations.

Table (3) Chemical characteristics of soil samples collected from Sinai * (Oven dry basis)

Soil No.	Soil Depth cm	sewage farming Years	Landscape	pH	EC ($dS.m^{-1}$)	OM %	TDS (ppm)	Sand %	Silt %	Clay %	Texture
1	0-30	>35	Wheat	7.84	2.2	0.23	1408	47.4	31.3	21.3	Loam
	30-60			7.79	2.7	0.1	1728	55.7	21.5	22.8	Sand clay loam
2	0-30		Beet	7.79	2.7	0.59	512	44.7	31.6	23.7	loam
	30-60			7.62	2.1	0.39	1344	46.5	33.8	19.7	Loam
3	0-30		Beet	7.67	1.8	0.52	1152	51.2	33.4	15.4	Loam
	30-60			7.69	2.7	0.28	1728	48.2	32.6	19.2	Loam
4	0-30		Citrus (Crl.)	7.03	0.4	0.18	256	78.9	18.8	2.3	Sandy
	30-60			7.51	0.4	0.21	256	77.7	19.2	3.1	Sandy

Table (4): Some chemical properties of the studied soil samples collected from El-Tina plain Sinai governorate.

Soil No.	Soil Depth cm	Period of land use Years	Landscape	Exchangeable Cations Meq/100g				CEC (Meq. 100g-1)	SAR	ESP	S. area
				Na	Ca	Mg	K				
1	0-30	>35	Wheat	35	7.8	8.3	1.1	52.2	2.54	67.05	98.41
	30-60			44	13.4	4.2	0.7	62.3	6.05	70.63	105.34
2	0-30		Beet	6.4	2.4	3	0.5	12.3	1.28	52.03	109.49
	30-60			21	4	3	1	29	2	72.41	91.01
3	0-30		Beet	12	3.2	3	0.5	18.7	1.71	64.17	71.15
	30-60			29.6	2.4	3.3	0.6	35.9	1.22	82.45	88.7
4	0-30		Citrus (crl.)	1.2	0.6	4.3	0.6	6.7	0.27	17.91	14.32
	30-60			0.8	1.2	2.7	0.8	5.5	0.64	14.55	22.41

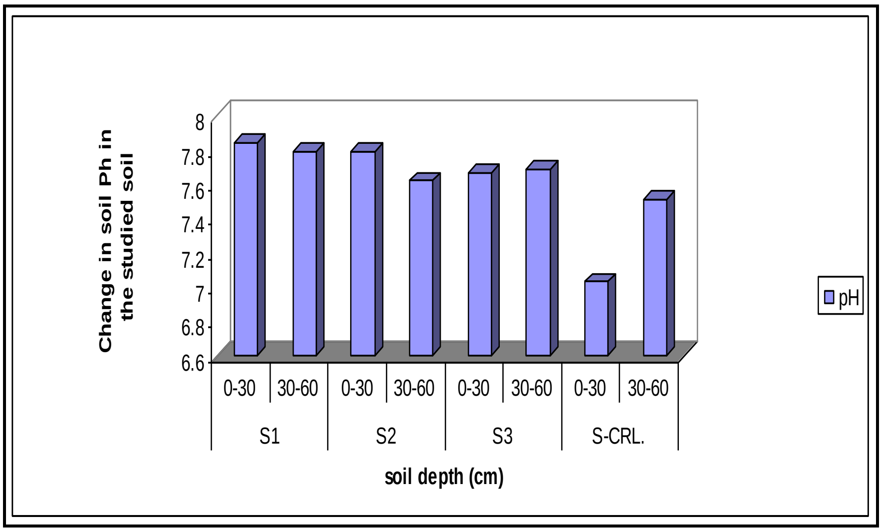

Figure (6) Change in soil pH in selected soil samples compared to control soil

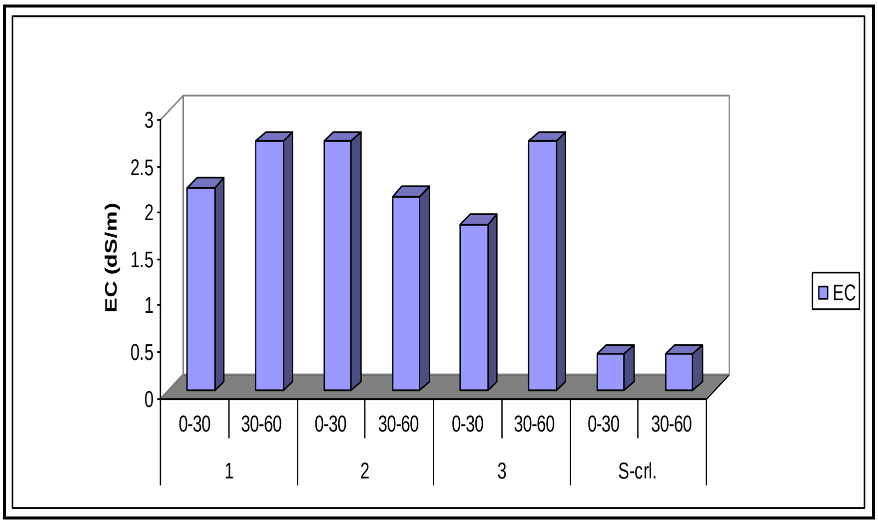

Figure (7) Change in soil electrical conductivity (EC) in selected soil samples compared to control soil

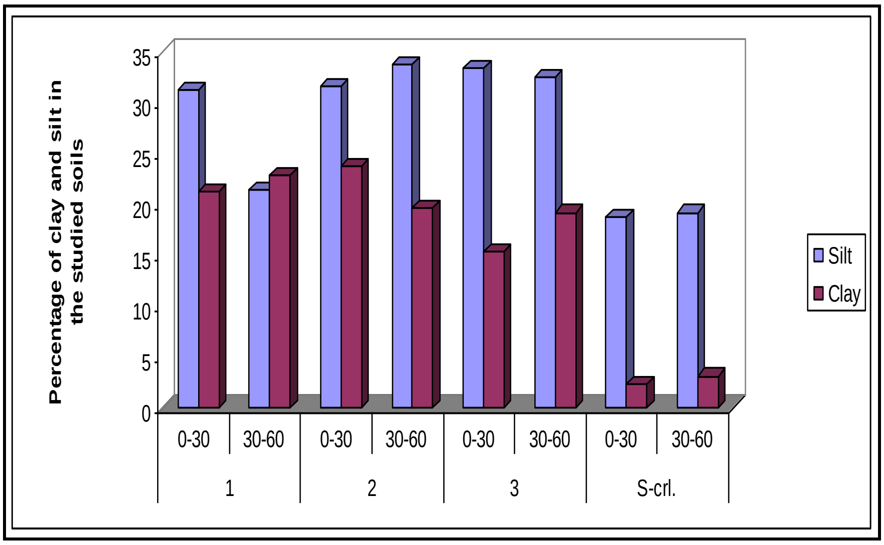

Figure (8) percent of silt and clay fraction in selected soil samples compared to control soil

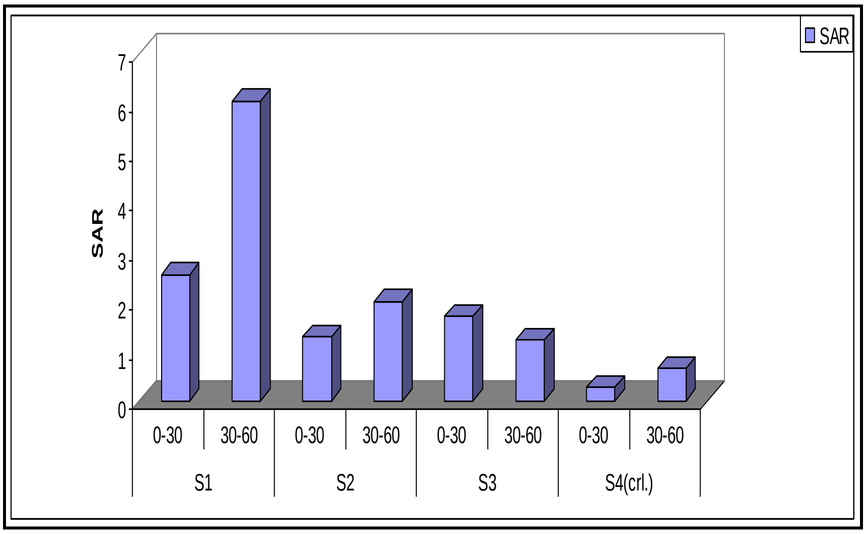

Figure (9) Sodium adsorption ratio (SAR) in selected soil samples compared to control.

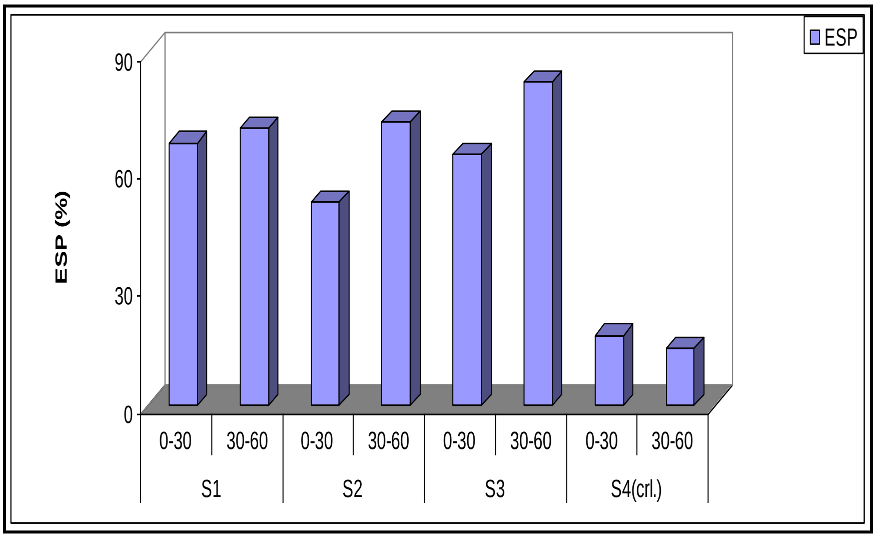

Figure (10) Exchangeable sodium percent (ESP) of selected soil samples compared to control soil

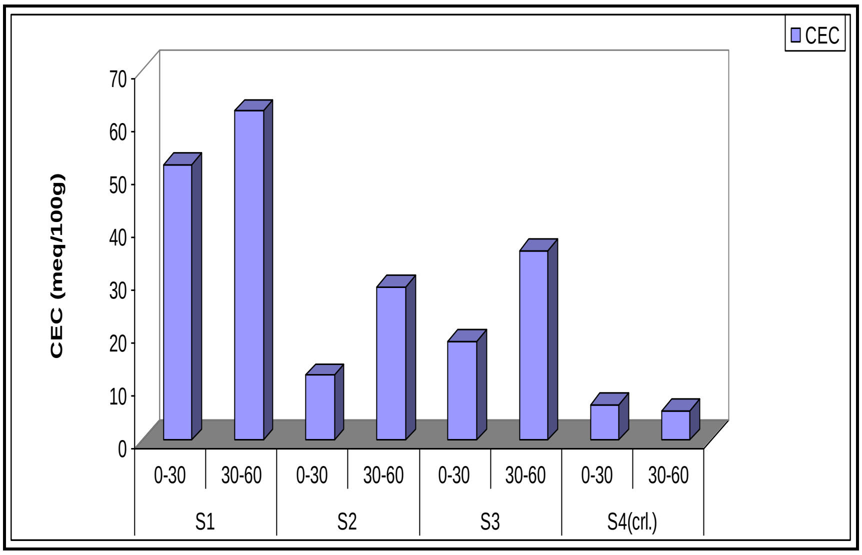

Figure (11) Cation Exchange capacity (CEC) of selected soil samples compared to control soil

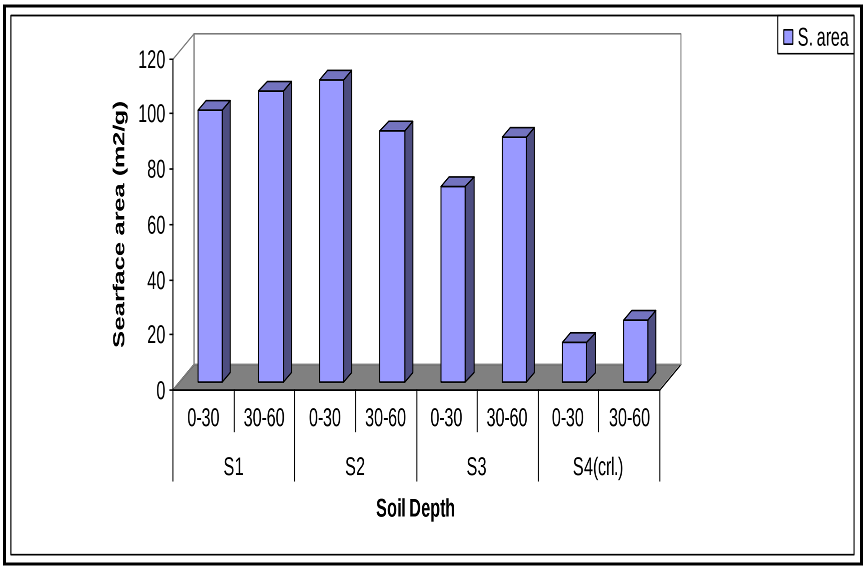

Figure (12) surface area of selected soil samples compared to control soil

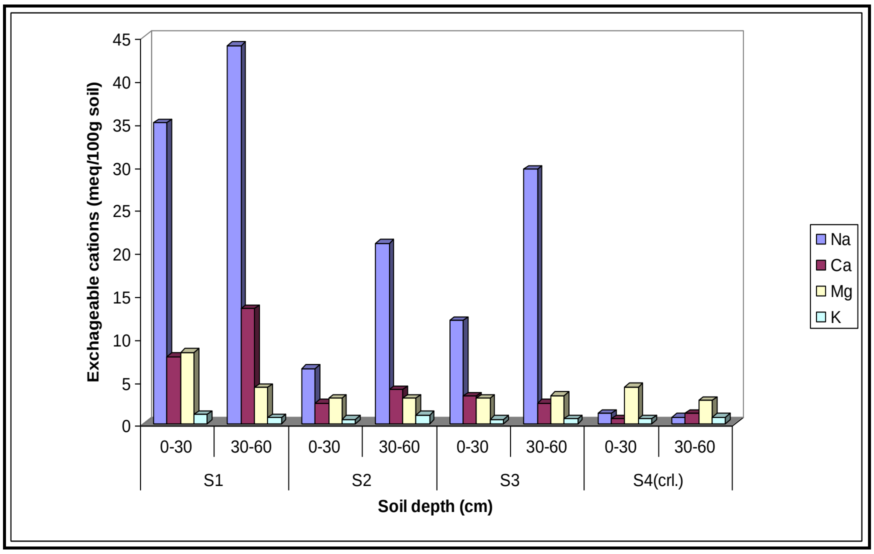

Figure (13) Exchangeable cations of selected soil samples compared to control soil

It is now recognized that most trace elements are readily fixed and accumulated in the soils and because this process is largely irreversible, repeated applications of amounts in excess of plant needs eventually contaminate a soil and may either render it nonproductive percent or the product unusable. Recent surveys of wastewater use have shown that more than 85 percent of the applied trace elements accumulate in the soil and most accumulates in the surface few centimeters.

Although plants do take up the trace elements, the uptake is normally so small that this alone cannot be expected to reduce appreciably the trace element in the soil in any reasonable period of time. Data in Figure (14) represented the PTE's in the studied soil samples collected from both El-Tina plain and sandy soil used as a control in our work. As a general most of the PTE's determined were found in the soil samples. For example, Cd was found within the range from 4 to 9 ppm; Cu from 5 to 12 ppm; Fe from 36 to 62 ppm; Mn from 2 to 12 ppm; Pb from 6 to 10 ppm; Zn from 22 to 44 ppm and Ni from 4 to 10 ppm, the corresponding higher values for the control soil regardless the depth of soil sample were 0; 0.9; 8.4; 2.1; 0; 3.2 and 0 respectively. This result perhaps represents the deterioration of such water on soil system of this region.

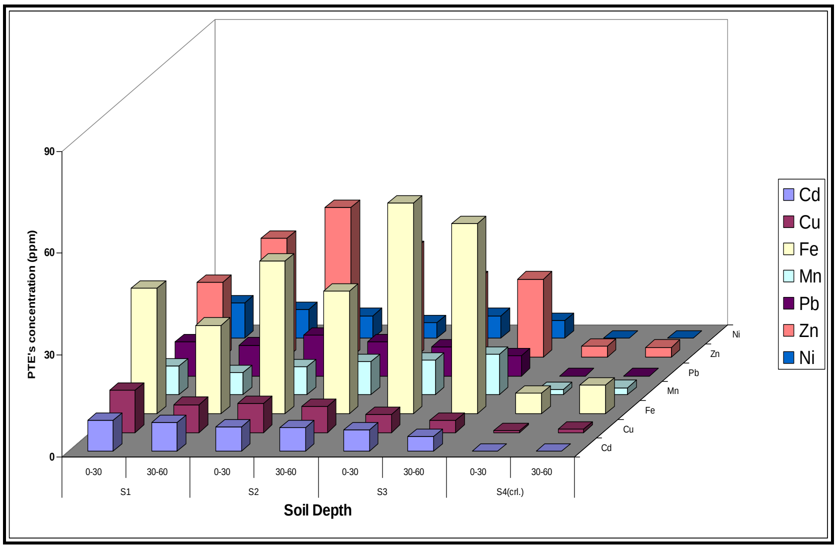

Figure (14) Total potential toxic elements of selected soil samples compared to control soil

Zinc equivalent values which represent the toxicity level were not in toxic level (250) in El-Tina plain soils. However, especial consideration should be taken to minimize the expected hazards in the future by using such low quality water.

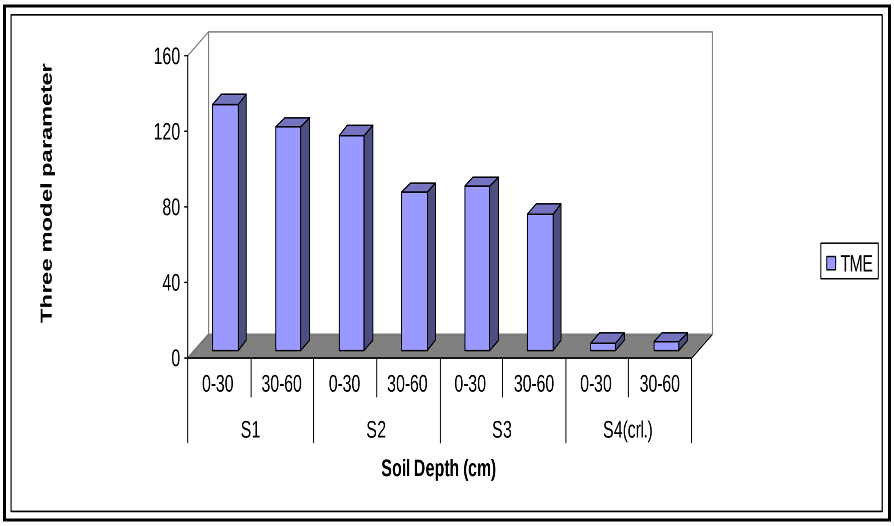

Figure (15) Zinc equivalent parameter of selected soil samples compared to control soil

Low quality water due to limitation of water resources consist a considered source for irrigation water in Egypt. However, at the time being, it is contaminated with many chemicals and biological constituents which have adverse impacts on sustainable farming and soil ecosystems. Hence, improving planning and management practices to robust these low quality water uses in farming are critical for sustaining future burdens in Egypt rest on competent use of available contemporary water resources.

The biological indicators of soil and water contamination should be those easy to measure, highly sensitive and anticipative. In this regard, however, two major parameters should be cared about, the size of microbial biomass mainly enteric pathogens, bacteria, *Streptomyces*, fungi as well as their activities. Masto et al (2009)[9] arranged soil bio-indicators in descending order of worth as follows, microbial biomass, CO_2 efflux, and dehydrogenase activity. Abd-el-Malek et al [10] biologically characterized sewaged soils at El-Gabal-El-Aster farm in Egypt and reached a conclusion that dehydrogenase activity test is the most reliable parameter. Consequently the biological characterization of the different sampled soils and low quality water in this task will be targeted in terms of both the intensities and activities of biomass with special prominence on the existence of enteric pathogens as an effectual parameter for water and soil biological contamination.

Acknowledgement

The authors would like to express their appreciations and gratitude to the authorities of Science and Technology Development Fund (STDF) for financing the present work through the project number 3033 contracted with the National Research Center.

References

1. ICARDA. (2011). Water and Agriculture in Egypt, Technical paper based on the Egypt-Australia-ICARDA Workshop on On-farm Water-use Efficiency July 2011, Cairo-Egypt
2. FAO. (2005). Fertilizer use by crop in Egypt First version, published by FAO, Rome, 2005.
3. Nasr, P., & Sewilam, H. (2015). The potential of groundwater desalination using forward osmosis for irrigation in Egypt. *Clean Technologies and Environmental Policy*, *17*(7), 1883-1895.
4. Hafez, A. (2005). Investigation of El-Salam Canal Project in Northern Sinai, Egypt. In *The 9th International Water Technology Conf., IWTC9* (pp. 953-970).
5. Mohamed, A. I. (2013). Irrigation water quality evaluation in el-salam canal project. International Journal of Engineering and Applied Sciences, 3 (1): 21-28.
6. Abdel-Aziz, R. (2015). Impact of Treated Wastewater Irrigation on Soil Chemical Properties and Crop Productivity. International Journal of Water Resources and Arid Environments, 4(1): 30-36.
7. APHA, AWWA, WPCF. American Public Health Association, Washington, U.S.A, 20TH Edition 1992.
8. Doneen, L. D. (1954). Salinization of soils by salt in irrigation water. Trans. Amer. Geophy. Union. 35: 943-950.
9. Masto, R.E.; Pramod K.; Singh, C.D.; Patra, A.K. 2009. Changes in soil quality indicators under long-term sewage irrigation in a sub-tropical environment. Environmental Geology 56: 1237- 1243.
10. Abd-El-Malek, Y., Monib. M.,Rizk, S,. and Shehata, S. (1976) Evaluation of some biological tests as parameters for microbial activities in soils. II. Field investigations. Zentralbl Bakteriol Parasitenkd Infektionskr Hyg. 131(8):722-9.

*****