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EFFECT OF IRRIGATION WATER SOURCE ON SOME SOIL CHEMICAL PROPERTIES

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ABSTRACT

The study aims to study the effect of irrigation water characteristics from different sources (i.e., fresh water and agricultural drainage water) on some chemical properties of the soil (soil pH, soil electrical conductivity “ECe”, sodium adsorption ratio “SAR”, cations exchange capacity “CEC” and exchangeable sodium percentage “ESP”).Therefore, water samples were collected from 15 different sites of the Bahr Mouise canal and likewise from the Bahr El-Baqar drain, which are located in Sharkia Governorate, Egypt. In parallel with water sampling, soil samples were taken from the same areas that are irrigated with these waters (i.e., Bahr Mouise canal and Bahr El-Baqar drain). Soil and water samples were analyzed.The results indicated that the irrigation water sources (i.e., Bahr Mouise canal and Bahr El-Baqar drain) were affected on the different of the chemical characteristics of soil. The pH values of the soil that irrigated with Bahr Mouise canal water were ranged from 7.62 to 8.35 with an average 8.01±0.21, while pH values of the soil that irrigated with Bahr El-Baqar drain water were ranged from 7.99 to 8.56 with an average 8.27±0.16. The EC values of the soil that irrigated with Bahr Mouise canal water were ranged from 0.61 to 3.86 dS/m with an average 1.23±1.00 dS/m, while ECe values of the soil that irrigated with Bahr El-Baqar drain water were ranged from 1.82 to 2.67dS/m with an average 2.35±0.30 dS/m. Regarding sodium adsorption ratio (SAR), the SAR values average in soil that irrigated with Bahr Mouise canal (ranged from 0.84 to 7.65 mmolc/l with an average 2.12±1.91 mmolc/l) were less than the SAR values average in soil that irrigated with Bahr El-Baqar drain (ranged from 2.49 to 3.79 mmolc/l with an average 3.27±0.38 mmolc/l) with statistically significant differences between them (p-value < 0.05). In addition, the results showed that the CEC values in the soil that irrigated with Bahr El-Baqar drain (ranged from 49.66 to 71.37 cmolc/kg soil with an average 58.31±6.61 cmolc/kg soil) were superiority of the soil that irrigated with Bahr Mouise canal (ranged from 25.57 to 48.3 cmolc/kg soil with an average 39.43±6.18 cmolc/kg soil). Regarding exchangeable sodium percentage (ESP), remarked that the soil that irrigated with drainage water, i.e., Bahr El-Baqar drain, (varied from7.11 to 8.14% with an average 7.72±0.30%) contain ESP values greater than the soil that irrigated with Bahr Mouise canal (varied from 5.80 to 11.20% with an average 6.82±1.52%). Irrigation water sources significantly influenced (P< 0.05) the ESP of the irrigated soil soils. However, all the ESP values fall below 15. The study concluded that frequent irrigation, whether with fresh water (Bahr Mouise canal) or agricultural drainage water (Bahr El-Baqar drain), had a great impact on the studied chemical properties of the soil (i.e., pH, ECe, SAR, CEC and SAR). The soil that irrigated with Bahr El-Baqar drain waters recorded the highest values of pH, ECe, SAR, CEC and SAR. With the results obtained and when compared with the Scherer (1996), which gives recommended guideline of soil properties, it can conclude all soils that irrigated with Bahr Mouise canal or Bahr El-Baqar drain were normal soils, where the ECe< 4, pH < 8.5, ESP < 15 and SAR < 13. Accordingly, we can say that all the two sources of water can be used for irrigation proposes

Keywords: chemical soil properties, irrigation water sources, agricultural drainage water

INTRODUCTION

World population has been growing exponentially since the early 20th century. It is currently estimated that it is growing at 1.1 percent annually. Increasing human population translates to increasing demands for food. Food insecurity therefore is one of the major global problems. To overcome this problem, alternative strategies and options to increase food production, ensure maximum utilization of limited land, and use of appropriate technologies need to be considered. One option includes that of opening up more land for crop production through irrigation in the arid and semi-arid lands (Adhan, 2009; Ndegwa and Kiiru, 2011). Irrigation technology allows for whole year-round production of food even in rain scarce lands such as arid and semi-arid lands.

Crop growth is usually affected by the water use for irrigation during the dry period by water deficit that significantly decrease crop yields. Irrigation is needed when natural precipitation is not adequate to secure vegetables grain and forage production (Abu-Awwad and Kharabsheh, 2000). Depending on the size of the farm and the type of irrigation system, application of water is often made possible by using modern power sources from well pumps, taps, canal and storage of large quantities of water in reservoirs, ponds, streams and rivers. Soil and water losses by erosion and runoff must be controlled in order to allow for sustainable agriculture. On relatively sandy soil with low organic matter content, Truman and Rowland (2005) found high erosion risk when a supplementary irrigation system was used. Natural water has different salt concentrations and qualities and contains principally salts of high solubility like sodium, calcium, magnesium and potassium chlorides and sulfates. Salinisation and sodication could limit the soil's productivity, leading to fertility reduction (Al-Zubi, 2007). If the level of Na^+ in the soil is high, the colloidal fraction behavior will be affected.

The drainage water use in irrigation were officially and non-officially. Officially reuse is the practice of pumping part of the drainage water flow into the irrigation water system. Physically, officially reuse occurs lifting specified amounts of drainage water for mixing with better water quality canals. Unofficially reuse is practiced by individual farmers who decide, when and how drainage water will be used for supplementing their needs of irrigation water. Unofficially reuse of drainage water normally takes place near the tail ends of the irrigation canals, (EL-Komy 2012).

The agricultural drainage water in Egypt is considered one of the most important untraditional water resources. The idea of reusing agricultural drainage water in irrigation started to take considerable place in the water policies, and the used agricultural drainage water was estimated by 4.5 bilion m3yr-1 in Delta area (El-Eshmawiy *et al*., 2006). The government of Egypt has implemented EL Salam canal project to reuse drainage water from Bahr Hadous and EL Serw drains after blending with the Nile water to create new communities along the canal and to re-charting Egypt's population map (Hafez, Azza *et al*., 2008). It is well known that the quality of drainage water resources in Dakahlia province is better than these drains, so it is necessary to extend reusing of these water in irrigation. Therefore, the main objectives of our work are study the effect of irrigation with fresh or drainage water on some soil chemical and physical properties.

MATERIALS AND METHODS

Water Sampling

Water samples were taken randomly from 15 different sites (12 samples from each site during year 2017) from the Bahr Mouise canal as fresh water, and likewise from the Bahr El-Baqar drain as agricultural drainage water, which are located in Sharkia Governorate, Egypt by31°15′9″ & 32°12′4″ E and 30°10′9″ & 31°9′9″N. Each sample was chemically analyzed according to the method described in (APHA, 1995). pH and EC of water was measured immediately in the different sites using calibrated pH-meter and EC-meter, respectively. $CO_3^=$ and HCO_3^- was determined by titration with a standard solution of sulphuric acid using phenolphthalein as an indicator for former and methyl-orange for latter. Cl was determined by titration with silver nitrate using potassium chromate as an indicator according to the mohr's method. $SO_4^=$ was calculated by difference between total cations and anions. Ca^{2+} and Mg^{2+} were determined by titration with versinate solution. Na^+ and K^+ was determined using flame photometer.

Soils Sampling

In parallel with water sampling, soil samples were taken from the same areas that are irrigated with these waters (i.e., Bahr Mouise canal and Bahr El-Baqar drain) at a depth 0-60 cm. Soil attributes were analyzed according to the protocol described by (Richards, 1954; van Reeuwijk, 2002) as follows: The pH value was measured using a pH-meter [with a combined glass / reference. (Ag/AgCl) electrode] in irrigation water or in the saturated soil pastes. Total soluble salts, were determined in terms of measuring the electric conductivity (ECe) of the soil paste extract. Cation exchange capacity were determined using centrifuge method. SAR of irrigated soil was calculated according to Richards, 1954 as shown in the following equation;

$$SAR = Na / SQRT((Ca^{2+} + Mg^{2+})/2)$$

Statistical analysis

Analysis of variance (ANOVA) was done using SPSS software to compare between the sources of water (i.e., the Bahr Mouise canal as fresh water, and likewise from the Bahr El-Baqar drain as agricultural drainage water). Also, minimum, maximum, average and standard deviation was calculated.

RESULTS AND DISCUSSION

Irrigation water properties

The pH values of Bahr Mouise canal were ranged from 7.57 to 7.86 with an average 7.75±0.08, while pH values of Bahr El-Baqar drain was ranged from 7.77 to 8.44 with an average 8.11±0.24 (Table 1 and Fig. 1). The result indicated that the pH of Bahr Mouise canal and Bahr El-Baqar drain are considered to be within the normal range (6.5–8.4) for most crops (Ayers and Westcot, 1985). Dinka (2016) observed that the high pH of irrigation water is associated with high concentrations of Na and major anions (HCO_3^-, CO_3^{2-}, Cl and SO_4). Water pH does not have direct consequences on crops, except at extremes (Briyan *et al*., 2007). Dinka (2016) reported that that the pH >8.2 with excessive HCO_3 significantly affects crop production and create clogging problem, in case of drip and micro spray irrigation systems. Moreover, high pH water can cause salts to precipitate and can reduce the efficacy of pesticides (Bauder *et al*., 2014).

The EC values of Bahr Mouise canal were ranged from 0.50 to 2.46 dS/m with an average 0.88±0.61 dS/m, while the EC values of Bahr El-Baqar drain was ranged from 1.15 to 1.65 dS/m with an average 1.46±0.16 dS/m (Table 1 and Fig. 1). According to Ayers and Westcot (1985), EC values of irrigation water <0.7 is adequate for irrigation (No degree of restriction on Use), 0.7 – 3 is slight to moderate for irrigation while > 3 is extreme restriction. Therefore, the EC value of the water from Bahr Mouise canal have indicated slight to moderate of salinity (0.88±0.61 dS/m) as well as Bahr El-Baqar drain (1.46±0.16 dS/m). while according to USSL (1954), EC values of irrigation water <0.25 is low salinity (no plant growth problems associated with normal irrigation, "class 1"), 0.25-0.75 is medium salinity (Little/no plant growth problems associated with normal irrigation, "class 2"), 0.75-2.25 is high salinity (Potential plant growth problems with salt sensitive plants, "class 3") and >2.25 is very high salinity (Severe plant growth problems; select only salt-tolerant plants "class 4"). Accordingly, the EC value of the water from Bahr Mouise canal have high of salinity (0.88±0.61 dS/m) as well as Bahr El-Baqar drain (1.46±0.16 dS/m) and these waters cannot be used in soils that have a limited drainage, Therefore, a good drainage system must be available when using this water with poor internal drainage conditions, both soil salinity and SAR could increase by up to a factor of ten. Therefore, it is important to remember that management of irrigation water is directly dependent upon soil drainage conditions.

Table 1 and Fig. 1are showing the ion Ionic composition of water. The results showed that the dominant cation was Na+ in both cases (i.e., Bahr Mouise canal and Bahr El-Baqar drain) where the values of Na+ ranged from 0.97 to 12.26 mmolc/l with an average 2.88±3.2 mmolc/l for Bahr Mouise canal and 3.70 to 5.39 mmolc/l with an average 4.78±0.56 mmolc/l for Bahr El-Baqar drain. Regarding Ca^{2+} and Mg^{2+} cations, the Bahr Mouise canal was ranged from 1.37 to 4.22 mmolc/l with an average 2.08±0.96 for Ca^{2+} and 1.44 to 3.83 mmolc/l with an average 2.07±0.76 mmolc/l for Mg^{2+}, while in Bahr El-Baqar drain the values varied from 2.54 to 4.39 mmolc/l with an average 3.56±0.51 mmolc/l for Ca^{2+} and 2.50 to 4.70 mmolc/l with an average 3.41±0.79 mmolc/l for Mg^{2+}. The K^+ ranged from 0.83 to 4.82 mmolc/l with an average 1.77±1.30 mmolc/l for Bahr Mouise canal and 1.60 to 3.98 mmolc/l with an average 2.88±0.89 mmolc/l for Bahr El-Baqar drain. Generally, cations take this order $Na^+ > Ca^{2+} > Mg^{2+} > K^+$.

Ayers and Westcot (1985) reported that the usual range in irrigation water of Na^+, K^+, Ca^{2+} and Mg^{2+} are 0-40, 0-2, 0-20 and 0-5 mmolc/l, respectively, and this indication to the Bahr Mouse canal and Bahr El-Baqar drain are considered to be within the normal range for major cations (Na^+, K^+, Ca^{2+} and Mg^{2+}). The amount of Na ions in the water predicts the sodicity danger of the irrigation water (Singh, 2000). Sodium ions are important criteria for irrigation water quality because of its effect on soil permeability and water infiltration (Ajayi, 1990). Adamu (2013) showed that Sodium contributes directly to the total salinity of the water and may be toxic to sensitive crops, in addition the Na^+ cause deflocculation of particles and subsequent sealing of soil pores thereby preventing water passage into the soil and Sodic water causes excess Na+ to be adsorbed to exchange complex and, in the process, causes dispersion of aggregates and thereby blocking pores in the soil and preventing or reducing infiltration of applied water. Generally, values greater than 9.0cmol/l in terms of Na concentrations are regarded as posing increasing severity of sodicity especially in soils high in clay content (Davis & Dewest, 1966). The calcium plays a vital role in the regulation of ionic relations in plants and in improving the soil physical condition offers the possibility of combating salinity by both physical manipulation of the soil environment and genetic manipulation of the plant (Rengasamy, 1987). Without salts and without calcium, the soil disperses and the dispersed finer soil particles fill many of the smaller pore spaces, sealing the surface and greatly reducing the rate at which water infiltrates the soil surface. Soil crusting and crop emergence problems often result, in addition to a reduction in the amount of water that will enter the soil in a given amount of time and which may ultimately cause water stress between irrigations (Ayers and Westcot 1985).

Concerning the anions concentration, The HCO_3 ranged from 0.33 to 1.73 mmolc/l with an average 0.66±0.52 mmolc/l for Bahr Mouise canal and 2.87 to 6.24 mmolc/l with an average 4.23±1.03 mmolc/l for Bahr El-Baqar drain, while the Cl^- values ranged from 1.83 to 2.95 mmolc/l with an average 2.19±0.31 mmolc/l for Bahr Mouise canal and 2.95 to 5.86 mmolc/l with an average 4.02±0.83 mmolc/l for Bahr El-Baqar drain. the SO_4^{2-} values ranged from 7.57 to 7.86 mmolc/l with an average 7.75±0.08 mmolc/l for Bahr Mouise canal and 4.17 to 7.96 mmolc/l with an average 6.38±1.26 mmolc/l for Bahr El-Baqar drain.

Ayers and Westcot (1985) reported that the usual range in irrigation water of HCO_3, Cl^- and SO_4^{2-} are 0-10, 0-30 and 0-20 mmolc/l, respectively, and this indication to the Bahr Mouse canal and Bahr El-Baqar drain are considered to be within the normal range for major anions (HCO_3, Cl and SO_4). The guidelines for interpretations of water quality for irrigation that mentioned by Ayers and Westcot (1985) showed that there is no toxicity problem due to HCO_3, Cl and SO_4.

Analysis of variance proved that there are statistically significant differences between the values of Bahr Mouise canal and Bahr El-Baqar drain in all the measured variables, where the p-value was less than 0.05, except for sulphates.

Table 1 : Some properties of waters of Bahr Mouise Canal and Bahr El-Baqar drain

	Bahr Mouise Canal				**Bahr El-Baqar drain**				**P**	**Sig.**
	Min	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**		
Ph	7.57	7.86	7.75	0.08	7.77	8.44	8.11	0.24	0.00	Yes
EC ds/m	0.50	2.46	0.88	0.61	1.15	1.65	1.46	0.16	0.00	Yes
Ions mmolc l^{-1}										
Na^+	0.97	12.26	2.88	3.20	3.70	5.39	4.78	0.56	0.03	Yes
K^+	0.83	4.82	1.77	1.30	1.60	3.98	2.88	0.89	0.01	Yes
Ca^{2+}	1.37	4.22	2.08	0.96	2.54	4.39	3.56	0.51	0.00	Yes
Mg^{2+}	1.44	3.83	2.07	0.76	2.50	4.70	3.41	0.79	0.00	Yes
HCO_3^-	0.33	1.73	0.66	0.52	2.87	6.24	4.23	1.03	0.00	Yes
Cl^-	1.83	2.95	2.19	0.31	2.95	5.86	4.02	0.83	0.00	Yes
SO_4^{2-}	7.57	7.86	7.75	0.08	4.17	7.96	6.38	1.26	0.77	No

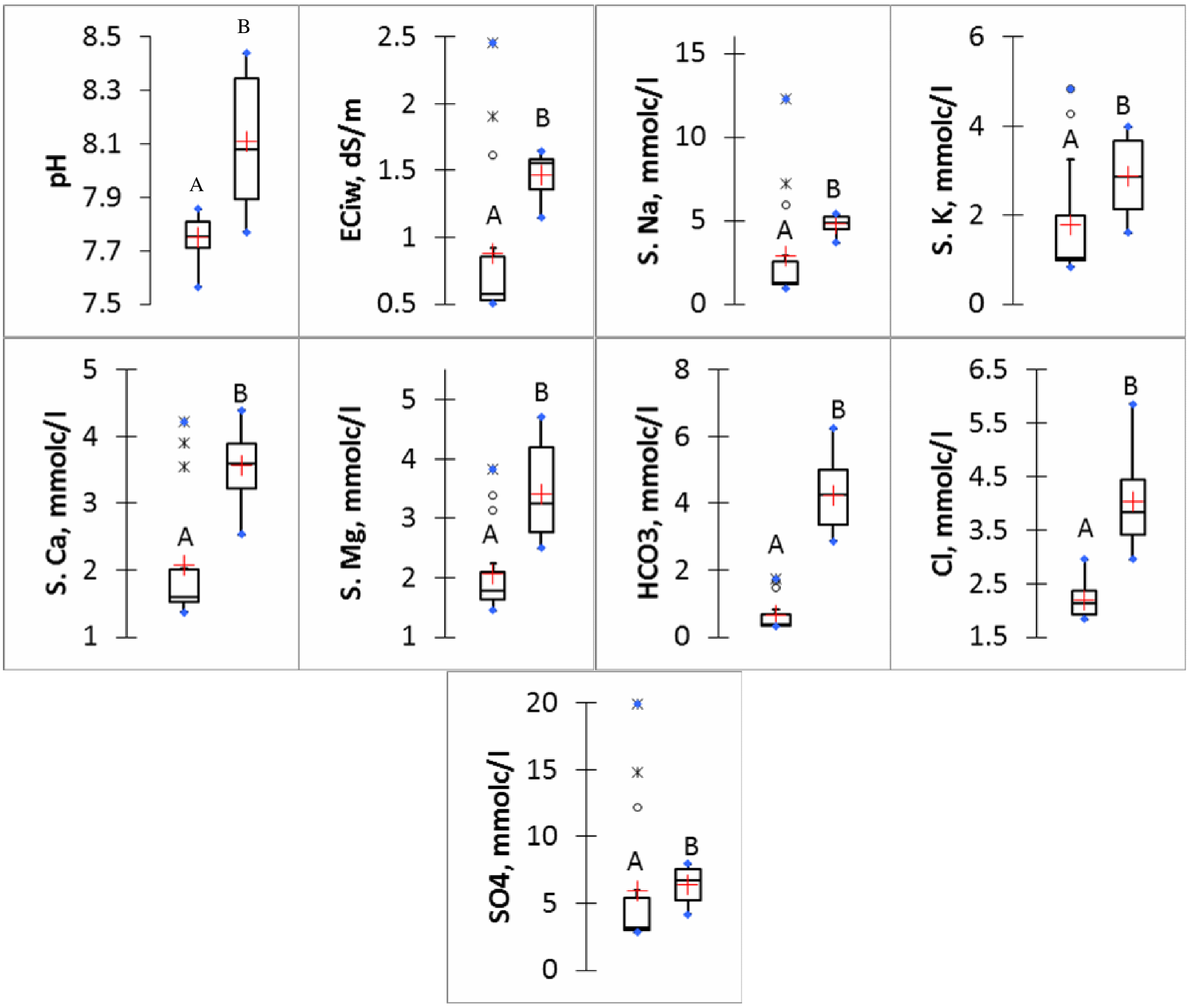

Fig.1 : Boxplot of Some properties of waters of Bahr Mouise Canal (A) and Bahr El-Baqar drain (B)

Effect of irrigation water sources on some soil chemical properties

The pH values of the soil that irrigated with Bahr Mouise canal water were ranged from 7.62 to 8.35 with an average 8.01±0.21, while pH values of the soil that irrigated with Bahr El-Baqar drain water were ranged from 7.99 to 8.56 with an average 8.27±0.16 (Table 2 and Fig. 2). Haliru and Japheth (2019) reported that the soil that received water from well recorded the highest pH value, this was however, statistically similar ($P<0.05$) to soils irrigated with river water. Effects of supplementary irrigation on chemical and physical soil properties in the rolling pampa region of Argentina was studied by Mon *et al*., (2007) and found that a slight increase in pH (from 6.13 to 6.45).

The statistical analysis was proved that the EC values of the soil that irrigated with Bahr Mouise canal water were ranged from 0.61 to 3.86 dS/m with an average 1.23±1.00 dS/m, while pH values of the soil that irrigated with Bahr El-Baqar drain water were ranged from 1.82 to 2.67dS/m with an average 2.35±0.30 dS/m. There are statistically significant differences between the values of EC and pH of Bahr Mouise canal and Bahr El-Baqar drain where the p-value less than 0.05. The increase in the maximum value of salts in the Mouis Bahr canal (3.86 dS/m) is due to there are samples taken from the end of the canal and the soils in this area are saline and saline sodic soils.

Since irrigation water contains some level of mixture of naturally occurring salts, irrigation over time results in accumulation of salts in the soils (Rhoades, 1996). The extent which the salts accumulate in the soil will depend on the irrigation water quality, irrigation water management and the adequacy of drainage (Grattan, 2002). Haliru and Japheth (2019) reported that Electrical conductivity of the soil was not significantly influenced ($P >0.05$) due irrigation with different water sources. However, the higher EC values from the combined sources (river + well) may be due to the effect of the salt content of wells used for irrigation during the dry season (Hakim *et al*., 2009). Irrigation plays a role of promoting leaching of salts (Valenzo *et al*., 2001). Mon *et al*., (2007) state that the irrigation process has affected on chemical where in irrigated soils, chemical data shows, on average, a slight increase in ESP (from 2.56 to 5.52) and in pH (from 6.13 to 6.45). Al-Ghobari (2011) was studied the effect of irrigation water quality on soil properties under center pivot irrigation systems and found the distribution of salts through the soil profile is highly correlated with the salinity of irrigation water and soil type. Saline water increased the soil salt content throughout the profile to a greater extent than nonalien water. A field experiments were conducted by Al-Ghobari (2011) and the average water salinity levels used for irrigation water were 0.46 dS/m for field A, 1.4 dS/m for field B, 2.44 dS/m for field C, 5.02 dS/m for field D and 6.55 dS/m for field E. observed that there were differences in the effect of water quality on soil salinity depending on the irrigation water quality and quantity where the concentration of salts in the upper horizons of the profiles was due to evaporation of water from the salts applied in irrigation water and the irrigation waters used in both fields (D and E) have high water salinities. Padekar*et al.*, (2016) state that the pH of the soils did not reflect any specific comparable trend, but pH was higher in irrigated than unirrigated soils, particularly in the upper layer of the soil profile. also, The EC was higher in all the irrigated soils than the unirrigated ones. Muamar *et al.* (2014) reported that irrigation with wastewater was resulted in an increase in EC from 893 to 943 µS/cm with an average of 921 µS/cm, in soil irrigated with wastewater while the average value of EC in the soil irrigated with ground water varied from 600 to 705 µS/cm with a mean of 657 µS/cm.

Regarding sodium adsorption ratio (SAR), the SAR values average in soil that irrigated with Bahr Mouise canal (ranged from 0.84 to 7.65 mmolc/l with an average 2.12±1.91 mmolc/l) were less than the SAR values average in soil that irrigated with Bahr El-Baqar drain (ranged from 2.49 to 3.79 mmolc/l with an average 3.27±0.38 mmolc/l) with statistically significant differences between them (p-value < 0.05). Wenju *et al.* (2008) found that the use of saline water causes the ECe of the top soil (0–100 cm) to be higher and more variable than the subsoil (100–180 cm). Also, the use of poor-quality water for irrigation could have detrimental effects on specific absorption rate (SAR), and EC. Volschenk (2005) showed that effects of salinity on soil properties are not restricted to low salinity and high SAR, but that clay dispersion may occur where irrigation water with a SAR of below or about 1 and EC of less than 0.1 dS m^{-1} is applied to soil.

The values of the exchangeable cations are reflected in the values of the cation exchange capacity (CEC), thus, it is clear from the results that presented in Table 2 and Fig. 2 that the CEC values in the soil that irrigated with Bahr El-Baqar drain (ranged from 49.66 to 71.37 cmolc/kg soil with an average 58.31±6.61 cmolc/kg soil) were superiority of the soil that irrigated with Bahr Mouise canal (ranged from 25.57 to 48.3 cmolc/kg soil with an average 39.43±6.18 cmolc/kg soil). Haliru and Japheth (2019) reported that Irrigation water sources had a significant influence (P <0.05) on the cation exchange capacity (CEC) of soil. Maximum mean CEC value was obtained from soils under well water irrigation followed by farms receiving river water which was statistically same to soils irrigated with combined well and river water.

Regarding exchangeable sodium percentage (ESP), remarked that the soil that irrigated with drainage water, i.e., Bahr El-Baqar drain, (varied from7.11 to 8.14% with an average 7.72±0.30%) contain ESP values greater than the soil that irrigated with Bahr Mouise canal (varied from 5.80 to 11.20% with an average 6.82±1.52%). Irrigation water sources significantly influenced (P< 0.05) the ESP of the irrigated soil soils. However, all the ESP values fall below 15. The low ESP values may be attributed to the chemical properties of the irrigation water sources which show a dominance of calcium and magnesium ions to that of sodium (Haliru and Japheth 2019). Quirk (1971) reported that the relative amounts of cations (Ca, Mg, and Na) in the exchange sites of the soil particles determine the effect of salts on the soil. Increasing sodicity hazards may be associated with values exceeding 15, where an ESP, of 15% as threshold above which Na becomes a problem, is apparently still generally used as norm in many countries (Abrol, 1988). Vinten *et al.* (1983) stated that wastewater irrigation would increase ESP and clogging of the soil porosity. Chemura *et al.* (2014) was assessment of irrigation water quality and selected soil Parameters at Mutema Irrigation Scheme, Zimbabwe and found pH, SAR and ESP were significantly higher (p < 0.05) in irrigated blocks compared to non-irrigated areas of the scheme, indicating an influence of irrigation water on soils characteristics in irrigated plots. Mg^{2+} and Ca^{2+} in the soils positively correlated with Na^{+} ($R2 = 0.67$ and $R2 = 0.57$ respectively).

Table 2 : pH, ECe and soluble ions of irrigated soil with irrigation waters of Bahr Mouise Canal and Bahr El-Baqar drain

	Bahr Mouise Canal				Bahr El-Baqar drain				P	Sig.
	Min	Max	Mean	SD	Min	Max	Mean	SD		
Ph	7.62	8.35	8.01	0.21	7.99	8.56	8.27	0.16	0.00	Yes
ECe, ds/m	0.61	3.86	1.23	1.00	1.82	2.67	2.35	0.30	0.00	Yes
CEC, cmolc/kg soil	25.57	48.30	39.43	6.18	49.66	71.37	58.31	6.61	0.00	Yes
ESP, %	5.80	11.20	6.82	1.52	7.11	8.14	7.72	0.30	0.03	Yes

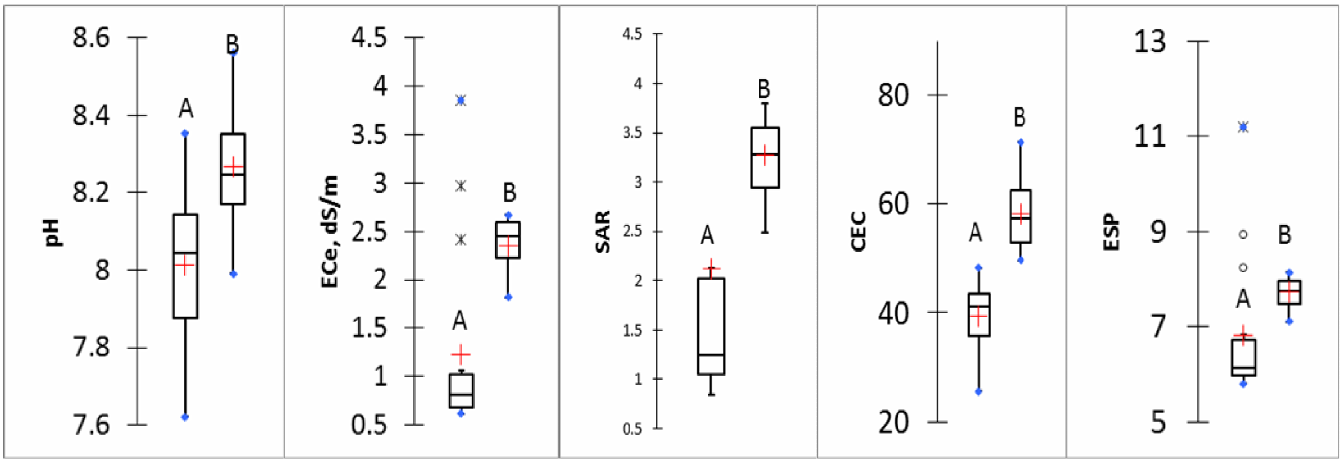

Fig. 2 : Boxplot of pH, ECe, SAR, CEC and ESP of irrigated soil with irrigation waters of Bahr Mouise Canal (A) and Bahr El-Baqar drain (B)

CONCLUSION

Frequent irrigation, whether with fresh water (Bahr Mouise canal) or agricultural drainage water (Bahr El-Baqar drain), had a great impact on the studied chemical properties of the soil (i.e., pH, ECe, SAR, CEC and SAR). The soil that irrigated with Bahr El-Baqar drain waters recorded the highest values of pH, ECe, SAR, CEC and SAR.With the results obtained and when compared with the Scherer (1996), which gives recommended guideline of soil properties, it can conclude all soils that irrigated with Bahr Mouise canal or Bahr El-Baqar drain were normal soils, where the ECe< 4, pH < 8.5, ESP < 15 and SAR < 13. Accordingly, we can say that all the two sources of water can be used for irrigation proposes

REFERENCES

Abrol, I.P.; Yadav, J.S.P. and Massoud, F.I. (1988). Salt-affected soils and their management (No. 39). *Food & Agriculture Org*.

Abu-Awwad, M. and Kharabshed, A. (2000). Influence of supplemental irrigation and soil surface furrow on barley yield in arid areas affected by surface crust. *J. Arid Environ*.; 46: 227-237.

Adamu, G.K. (1997). An assessment of erodibility of selected soils under different land management systems at Bayero University, Kano New campus: Unpublished PGD Project Soil evaluation: BUK.

Ajayi, F.; Nduru, M. and Oningue, A. (1990). Halting the salt that kills crops African Farmer No.4, pp 10-12

Al-Ghobari, H.M. (2011). The effect of irrigation water quality on soil properties under center pivot irrigation systems in central Saudi Arabia. *WIT Transactions on Ecology and the Environment,* 145: 507-516.

Al-Zubi, Y. (2007). Effect of irrigation water on agricultural soil in jordan valley: An example from arid area conditions. *J. Arid Environ*.; 7: 63-79.

APHA (1995). Standard Methods of Analysis of Water and Wastewater (19^{th} Ed.), American Public Health Association (APHA), Washington DC, USA

Ayers, R.S. and Westcot, D.W. (1985). Water quality for agriculture. FAO Irrigation and Drainage Paper 29 Food and Agric. Organization (FAO) of the United Nation, Rome, Italy.

Bauder, T.A.; Waskom, R.M.; Sutherland, P.L. and Davis, J.G. (2014). Irrigation Water Quality Criteria. Colorado State University Extension. Fact Sheet no. 0.506.

Briyan, G.; Donald, A.; Robert, G.; Jason, W. and Dan, M. (2007). Managing irrigation water quality: for crop production in the Pacific Northwest. A Pacific Northwest Extension Publication, PNW 597-E.

Chemura, A.; Kutywayo, D.; Chagwesha, T.M. and Chidoko, P. (2014). An assessment of irrigation water quality and selected soil parameters at mutema irrigation scheme, Zimbabwe. *Journal of Water Resource and Protection*, 2014.

Davis, S.W. and Dewest, R.J.M. (1966). Hydrology John Willey and Sons. New York 463p.

Dinka, M.O. (2016). Quality composition and irrigation suitability of various surface water and groundwater sources at Matahara Plain. *Water resources*, 43(4): 677-689.

EL-Eshmawiy, K.H.; EL-Shiraif, L.M.; Taha, A.E. and Negm, A.L. (2006). The economic Value of varied salinity irrigation water use in the Egyptian agriculture. *J. Applied Sci. Res*.; 2(12):1117-1128

EL-Komy, M.N. (2012). Assessing the quality of irrigation water resources in north Kaer-EL-Sheikh Governorate. M. sci. Thesis, fac. Of science, Mansoura Univ

Grattan S.R. (2002). Irrigation Water Salinity and Crop Production. Division of Agriculture and Natural Resources, University of California.

Hafez, Azza K.M.; EL-Katib, K.; Gad Alla, Hanaa and EL-Manharawy, S. (2008). EL-Salam Canal project, Sinia ll. *Chemical water quality investigations, Desalination* 227:274-285.

Hakim, M.; Islam, M.M.; Juraimi, A.S.; Begum, M.; Hasanuzzaman, M. and Uddin, M.K. (2009). Suitability Evaluation of Groundwater for Irrigation, Drinking and Industrial Purposes. American *Journal of Environmental Sciences*, 5(3): 413-419.

Haliru, M. and Japheth, O. (2019). Soil Chemical Properties As Influenced By Irrigation Water Sources in Sokoto, Nigeria.

Mon, R.; Irurtia, C.; Botta, G.F.; Pozzolo, O.; Melcón, F.B.; Rivero, D. and Bomben, M. (2007). Effects of supplementary irrigation on chemical and physical soil properties in the rolling pampa region of Argentina. Cien. Inv. Agr.(In English) *International Journal of Agriculture and Natural Resources*, 34(3): 143-150.

Muamar, A.; Tijane, M.H.; Shawqi, E.; El-Housni, A.; Zouahri, A. and Bouksaim, M. (2014). Assessment of the impact of wastewater use on soil properties. *J. Mater. Environ. Sci*, 5(3): 961-966.

Padekar, D.; Bhattacharyya, T.; Ray, S. K.; Tiwary, P.; & Chandran, P. (2016). Influence of irrigation water on black soils in Amravati district, Maharashtra. *Current Science*, 1740-1755.

Rengasamy, P. (1987). Importance of calcium in irrigation with saline-sodic water—A viewpoint. *Agricultural water management*, 12(3): 207-219.

Richards, L.A.; 1954. Diagnosis and improvement of saline and alkali soils. LWW.

Singah, B.R. (2000). Quality of irrigation water in Fadama lands North-western Nigeria. I. Ground and Surface Water in Kebbi State. *Nig. J. Basic. And Apl. Sci*., 9: 133-148.

Truman, C. and Rowland, D. (2005). Conservation tillage to manage water and supplemental irrigation. Proceedings of the 2005 Georgia Water Resources Conference, (GWRC`05), University of Georgia, Athens, GA, pp: 25-27.

Valenzo, F.P.; Murphy, B.W. and Greene, R.S.B. (2001). The Long Term Effects of Lime ($CaCO_3$), Gypsum and Tillage on the Physical and Chemical Properties of a Sodic Red-Brown Earth. *Australian Journal of Soil Science*. 39: 1307-1331.

van Reeuwijk, L. (2002). International Soil Reference and Information Centre. The Netherlands.

Vinten, A.J.; Mingelgrin, H. and Yaron, B. (1983). The effect of suspended soils in wastewater on soil hydraulic conductivity and vertical distribution of suspended solids. Soil Sci. Soc. Am. J.; 47: 408–412.

Volschenk, T. (2005). The effect of saline irrigation on selected soil properties, plant physiology and vegetative and reproductive growth of plsteyn apricots. Ph.D. Thesis, Fac. of Agric. (soil science) Univ. Stellenbosch. South Africa.