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# IMPACT OF IRRIGATION WITH LOW QUALITY WATER ON THE PRODUCTIVITY OF SUGAR BEET IN SAHL EL-HUSSINIA PLAIN

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## ABSTRACT

This work was conducted at Sahl- El-Hussinia plain, El-Sharkia Governorate, (private farm) through two successive winter seasons of 2006-2007 and 2007- 2008 to study the effect of different irrigation sources on sugar beet productivity. The source of irrigation water was El- Salam canal i.e. mixed Nile water with agriculture drainage water (1:1), Bahr Hadoos drain e.g. agriculture drainage water and Bahr El-Bakar drain as sewage effluent.

**The obtained results could be summarized as follows:**

- There was a reduction of soil pH as a result of irrigation with different irrigation sources water specially the soil irrigated with Bahr El-Bakar drain during the two seasons.
- There was a relative decrease of soil salinity; 5.36 – 38.73 % of soil irrigated with El-Salam canal; 5.33 – 22.45 % of soil irrigated with Bahr Hadoos drain and 8.22–34.81 % from soil irrigated with Bahr El-Bakr drain.
- There was a relative increase of available N, P, K and available Fe, Mn and Zn in the first season, while there was significant differences in the second season in all studied soil.
- There was a significant increase of sugar beet production in soil irrigated with Bahr El-Bakar drain, while the sugar purity and sugar yield were increased in soil irrigated with El-Salam canal water. The different resources of irrigation water led to an increase in the concentration of N, P, K, Fe Mn and Zn in sugar beet shoot more than root in all studied traits.

**Keywords:** Saline soil–water quality–sugar beet- macro-micronutrients.

## INTRODUCTION

The El-Salam Canal project is the largest horizontal expansion project in Egypt depending on using drainage water for irrigation. The project provides irrigation water to reclaim an area of 620,000 feddans in the Northern Delta and Northern Sinai Peninsula (220,000 feddans in West of the Suez Canal and 400,000 feddans in East of the Suez Canal). The El-Salam Canal takes freshwater from the Damietta Branch of the Nile and drainage water from main drain Bahr Hadous (the largest open drain in the Eastern Delta), as well as drainage water is delivered by the lower El-Serw pumping station. The drainage water and fresh water are mixed in an equal volume, giving a total annual volume of 4.6 millions cubic meters in El Salam canal, Abd El-Gawad and Sakr (2005).

Soil salinity is the most important environmental factor influencing the agricultural productivity, especially in arid and semi–arid regions as in Egypt, Zein *et al.* (2002b).Egypt started to look to drainage water reuse for irrigation in order to cover the shortage of fresh water and meet their demands for more food production. In some areas, this water is polluted by the sewage effluents which are damped into the agricultural drainage system, Zein *et al*. (1998)

Sugar beet (*Beta vulgaris* L.) is one of the most cash crop in Egypt. Abou–Almagd *et al*. (2004) found that the total production of sugar beet in Egypt increased annually by 39936 ton in the period 1991–2001,While the consumption is increased annually by 71961 ton in the same period. The area of sugar beet in Egypt is increasing by 11755 feddans annually. Mass (1984) stated that sugar beet is a tolerant crop to salt concentration. Plaster (1992) reported that sugar beet can stand at level of soil salinity up to ECe 8-16 $dSm^{-1}$. Matsi *et al*. (2005) found that the soil pH and DTPA–extractable Fe seemed to have a significant positive impact on root, top and raw sugar yields. Zein *et al*. (2002b) showed that shoot yield of sugar beet cultivars were affected significantly by soil salinity .The interactions between soil salinity ranges and sugar beet cultivars were significant over the two seasons. Zein *et al*. (2002 a) revealed that the sugar beet roots contents of studied heavy metals Pb, Mn, Zn, Ni and Cu (mg $kg^{-1}$) were generally increased in the second seasons than those in the first season, specially when irrigated with drainage water and followed by that of mixed water treatment.

This study was carried out to investigate the possibility of using low water quality for irrigation on sugar beet productivity under saline soil conditions.

## MATERIALS AND METHODS

Two field experiments were carried out at Sahl El-Hussinia private farm, El- Sharkia Governorate, Egypt, during the two winter seasons, 2006-2007 and 2007–2008, where the soil was saline soil having clay texture and poor in organic matter content. Data in Tables (1) and (2) show the characteristic of site soils and irrigation water according to Richards (1954) The work plan included effect of different irrigation water resources on soil properties and sugar beet productivity individually or in contamination with four replicates for each treatment , which arranged in a complete randomized block design (RCBD) as follows El-Salam canal (Nile water mixed with agriculture drainage water, 1:1);Bahr Hadoos drain (agriculture drainage water) and Bahr El-Bakar drain (sewage effluent water ). The experiments were started on the 25$^{th}$ of October 2006 in the 1$^{st}$ season and on the 20$^{th}$ of October 2007 in the 2$^{nd}$ one ,where sugar beet (*Beta vulgaris*) seeds of variety Loil were sown in plots of 70 X 15 $m^2$. Mineral nitrogen fertilizer was applied urea (46 % $Nfed^{-1}$). Recommended nitrogen was added in three equal doses at the rate of $80kgNfed^{-1}$ after 21, 42 and 62 days of planting. Calcium super-phosphate (15.5% $P_2O_5$) was added in a rate of 15.5 kg $P_2O_5$ $fed^{-1}$ during soil preparation, while potassium sulphate (48 % $K_2O$) in a rate of 100 kg $fed^{-1}$ was added in three doses after 21, 42 and 62 days from planting to conserve it from leaching due to soil leaching water requirements. These mineral fertilizers rates were applied according to the recommendation of Egyptian Ministry of Agriculture bulletin (2006).Sugar beet plants were irrigated by surface system every 10 days after the first planting irrigation up to January and every 12 days after that till the 4th of April 2007 where plant harvesting was done on the 24th of April, 2007 and the 3rd of April 2008 after slight irrigation on the 4th of April, 2007 and the 25th of April, 2008.

One day before harvesting, 5 plants of each plot were taken with the soil surrounding roots as plant and soil samples. The plants were get red of surrounding soil particles, washed, divided into roots and shoots and weighed. The yield of each plot was recorded after obtaining all the plot plants which were roughly cleaned and weighed.

**Soil and irrigation water samples analysis:**

Soil samples were collected from 0–30cm depth and air–dried, ground, sieved through a 2mm sieve and analyzed to obtain the particle size distribution, main soil physical and chemical properties as follows:

1- Mechanical analysis was determined according to the international pipette method as described by Piper (1950).
2- Total carbonates were determined as calcium carbonate using Collins calcimeter as described by Piper (1950).
3- The organic matter was determined by Walkey and Black method as described by Hesse, (1971)
4- Soil reaction(pH) value was measured in the (1:2.5) soil suspension using Beckman glass electrode pH meter, Black, *et al;* (1965).
5- E.C. value was measured in saturation extract of soil paste in $dSm^{-1}$ (Jackson 1967).
6- Water soluble sodium and potassium were measured by using flame photometer, Black *et al.* (1965).
7- Water soluble calcium and magnesium were determined by titration against a standard EDTA solution. Black *et al.* (1965).
8- Water soluble chloride by titration using a standard $AgNo_3$ solution, Black *et al.* (1965).
9-The total nitrogen was determined by using the conventional method of Kjeldahl as described by Black *et al.* (1965).
10-The available phosphorus was calorimetrically determined at a wave length of 725 nm in the sodium bicarbonate saturation as described by Olsen and Sommers (1982).
11- The available potassium was determined by using flame photometer in the extraction with 1.0 N ammonium acetate at pH 7 (Knudsen, *et al.*1982).
12- Available micronutrients were extracted using ammonium bicarbonate and determined using Inductively Couped Plasma (ICP) Spectrometry model 400, as described by Soltanpour and Schwab, (1977).
13- Nitrate and ammonium were determined according to the methods reported by Black *et al.* (1965).

**Plant analysis:**

The crude dry matter of plant was wet digested as follows:

Sugar beet plant samples were oven-dried at 70ºC till a constant weight and the dry weight was recorded. The plant material was ground to a fine powder and sub sample of 0.2 g was wet disgusted using a mixture of $HClO_4$ and $H_2SO_4$ acids as described by Peterburgski, (1968). Thereafter, minerals estimation was performed as follows:

1- Nitrogen was determined by calorimetrically at a wavelength of 420 nm by the Nessler's method as described by Jackson, (1967).
2- Phosphorus was determined calorimetrically at a wavelength of 725 nm as described by Jackson, (1967).
3- Potassium was determined using Galen Kamp flame photometer as described by Jackson, (1967).
4- Mn, Zn and Fe by using atomic absorption immersion were determined according to Chapman and Pratt (1961).

**Statistical analysis:**

All data were statistically analyzed according to the technique of analysis of variance (ANOVA) and the significant difference (LSD) method was used to test the differences between the treatments means as published by Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique by means of SAS computer software package.

**Table 1: Some physical and chemical properties of studied soils study before planting.**

| Irrigation water resources | Mechanical analysis of soil (%) | | | | | O.M (%) | $CaCO_3$ (%) |
|---|---|---|---|---|---|---|---|
| | Coarse sand | Fine Sand | Silt | Clay | Texture | | |
| El-Salam canal | 1. 70 | 47.56 | 17.29 | 33.46 | Clay | 0.76 | 10.45 |
| Bahr Hadoos | 1.82 | 49.79 | 19.24 | 29.15 | Clay | 0.75 | 10.48 |
| Bahr El-Bakar | 1.94 | 51.35 | 22.15 | 24.56 | Clay | 0.82 | 10.52 |

**Table 2: Chemical analysis of irrigation water resources used during sugar beet cultivation in seasons, 2006/ 2007 and 2007/ 2008**

| Properties | Seasons | El-Salam Canal | | | | Bahr -Hadoos | | | | Bahr El- Bakar | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *period | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| PH (1:2.5) | 1st | 8.31 | 8.25 | 8.19 | 8.13 | 8.16 | 8.07 | 8.02 | 8.04 | 8.14 | 8.17 | 8.12 | 8.15 |
| | 2nd | 8.24 | 8.17 | 8.24 | 8.07 | 8.14 | 8.05 | 8.09 | 8.12 | 8.19 | 8.21 | 8.15 | 8.10 |
| EC ($dS\ m^{-1}$) | 1st | 0.97 | 1.07 | 1.16 | 1.05 | 1.17 | 1.22 | 1.27 | 1.24 | 1.34 | 1.30 | 1.27 | 1.16 |
| | 2nd | 1.02 | 1.14 | 1.12 | 1.09 | 1.13 | 1.26 | 1.31 | 1.28 | 1.37 | 1.34 | 1.23 | 1.19 |
| SAR | 1st | 3.52 | 3.67 | 3.69 | 3.51 | 4.09 | 3.10 | 4.21 | 4.30 | 4.12 | 5.94 | 4.66 | 4.29 |
| | 2nd | 3.66 | 3.70 | 3.73 | 3.54 | 4.14 | 4.13 | 4.27 | 4.35 | 4.13 | 6.34 | 4.87 | 4.35 |
| $NO_3$(mg/l) | 1st | 17.25 | 18.24 | 14.20 | 12.86 | 20.15 | 22.18 | 24.14 | 23.48 | 19.85 | 23.47 | 25.19 | 24.87 |
| | 2nd | 19.41 | 22.17 | 13.48 | 10.39 | 22.28 | 24.35 | 22.63 | 21.86 | 21.52 | 25.18 | 26.37 | 22.38 |
| $NH_4$(mg/l) | 1st | 8.78 | 12.45 | 13.20 | 10.85 | 13.45 | 10.68 | 15.23 | 9.96 | 14.20 | 16.38 | 18.27 | 15.86 |
| | 2nd | 9.05 | 15.73 | 12.86 | 14.22 | 10.59 | 14.61 | 17.49 | 12.48 | 16.20 | 15.87 | 16.69 | 16.37 |
| P (mg/l) | 1st | 4.69 | 4.76 | 5.10 | 5.02 | 5.14 | 5.21 | 5.19 | 5.23 | 5.87 | 5.92 | 5.96 | 5.91 |
| | 2nd | 4.93 | 4.89 | 5.18 | 5.09 | 5.12 | 5.24 | 5.16 | 5.27 | 5.02 | 6.09 | 6.12 | 6.05 |
| K (mg/l) | 1st | 6.21 | 6.34 | 6.28 | 6.24 | 6.52 | 6.58 | 6.64 | 6.66 | 6.92 | 6.96 | 7.01 | 6.99 |
| | 2nd | 5.99 | 6.14 | 6.18 | 6.22 | 6.49 | 6.52 | 6.58 | 6.55 | 6.95 | 6.98 | 7.06 | 7.03 |
| Fe (mg/l) | 1st | 2.96 | 2.98 | 3.04 | 3.08 | 3.16 | 3.19 | 3.24 | 3.21 | 4.15 | 4.23 | 4.18 | 4.13 |
| | 2nd | 3.02 | 3.04 | 3.08 | 3.10 | 3.18 | 3.22 | 3.26 | 3.19 | 4.13 | 4.27 | 4.25 | 4.18 |
| Mn (mg/l) | 1st | 1.16 | 1.20 | 1.17 | 2.12 | 2.11 | 2.14 | 2.12 | 2.06 | 2.55 | 2.59 | 2.57 | 2.51 |
| | 2nd | 1.18 | 1.24 | 1.20 | 1.17 | 2.15 | 2.18 | 2.15 | 2.10 | 2.58 | 2.62 | 2.59 | 2.55 |
| Zn (mg/l) | 1st | 0.93 | 0.99 | 1.08 | 1.02 | 1.03 | 1.10 | 1.12 | 1.05 | 1.09 | 1.13 | 1.15 | 1.14 |
| | 2nd | 0.89 | 0.94 | 1.12 | 1.04 | 1.08 | 1.14 | 1.16 | 1.08 | 1.15 | 1.16 | 1.13 | 1.17 |

*** (1) Sample taken in October. (2) Sample taken in December.**
**(3)Sample taken in February. (4) Sample taken in March**

# RESULTS AND DISCUSSION

**Soil chemical properties:**

**Soil reaction pH.**

Soil pH is one of the most important parameters which reflects the overall changes in soil chemical properties. Data in Table 3 show that the alternatively irrigation of soil cultivated with sugar beet crop, using different irrigation water sources has resulted in alternative reduction in pH values in all soils irrigated with Bahr El-Bakar and Bahr Hadoos drains than El- Salam canal. These results are in harmony with those found by El-Motaium and Abd El-Monem (2001).

Generally, all the studied soils are considered moderately alkaline of pH values varied from 8.30 to 8.26 for initial soils and 8.25 to 8.12 after two seasons during sugar beet planting .The lowest value is recorded for the surface layer of soil irrigated from El-Salam canal water followed by those irrigated from Bahr El-Bakar drain water and Bahr Hadoos drain water. The results obtained by Wahadan *et al.* (1999) found that the increased soil pH may by due to the pH resulting from dependent charge of clay and organic matter that in turn could adversely affect soil chemical and physical properties in saturated conditions.

**EC of studied soils after sugar beet harvesting:**

Data presented in Table 3 revealed that the EC values of soil tend to decrease with increasing irrigation water periods per year by using the different irrigation water sources. The corresponding relative decreases were 5.63 and 38.73 % of El-Salam canal water, 5.44 and 22.45 % of Bahr Hadoos drain water and 8.22 and 34.81% of Bahr El-Bakar drain water after two seasons during sugar beet cultivated in comparison with soils of control .These results are in agreement with those obtained by Abo-Soliman *et al.* (2001) They found that the highest rates of salt leaching were achieved with fresh water if it used continuously(47.15 %) or alternatively with sewage water (33.85 %), while the lowest rates of 17.9 and 21.0 % salt leaching were obtained with sewage water and drainage water, respectively. Also, the statically analysis revealed that EC values variations were high significant for the interaction between seasons and sources. These results are in agreement with those obtained by Shaban, (2005).

**Soluble ions in the studied soils:**

The concentrations of cations and anions of soil paste extracts for the studied of areas as surface layer (0-30cm) under alternatively irrigation technique during sugar beet cultivation are presented in Table 3. Data show that the soluble ions tend to slightly decrease along with two seasons. Under sugar beet cultivation the relative decreases during the two seasons were 19.89-33.69 % for Mg ;5.74–45.90 % for Na;7.72–26.40 % for $HCO_3$ ; 5.71–50.47 for Cl % and 7.27-7.97 % for $SO_4$ but the relative increases of Ca and K were 12.66–0.48 % and 13.85-20.00 % for soil irrigated with El-Salam canal water compared to initial soils. Also, the relative decreases for the soil irrigated with Bahr Hadoos drain water reached to 14.15–33.38 for Mg; 5.60–

25.60 % for Na; 6.25–25.00 % for Cl; 3.66–16.22 % for $SO_4$,0.13–20.52 % for $HCO_3$ while the relative increases were 16.46–39.46 for Ca;1.47–5.88 % for K . For the case of Bahr El-Bakar drain the corresponding relative decreases were 14.82–55.00 % for Mg; 8.39–37.40 % for Na;13.81–20.94 % for $HCO_3$; 6.84 – 39.32 % for Cl ; 9.73–37.32 % for $SO_4$ , but the relative increases were 12.68–28.19 for Ca and 6.00–10 % for K, compared to control before sugar beet planting. These results are in agreement with those obtained by El-Sheikh (2003) and Selem *et al.* (2000)

**Table 3: Some chemical properties of soil studied.**

| Treatments | | | | Cations (meq/ l) | | | | Anions (meq/l) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sources irrigation water** | **periods** | **pH(1:2.5)** | **EC(dS $m^{-1}$)** | **$Ca^{++}$** | **$Mg^{++}$** | **$Na^{+}$** | **$K^{+}$** | **$CO^{--}_3$** | **$HCO^{-}_3$** | **$Cl^{-}$** | **$SO^{--}_4$** |
| **Before planting** | | 8.26 | 14.2 | 6.32 | 13.12 | 122 | 0.65 | nil | 7.12 | 105 | 29.97 |
| **El-Salam canal** | **1st** | 8.21 | 13.4 | 7.12 | 10.51 | 115 | 0.74 | nil | 6.57 | 99 | 27.79 |
| | **2nd** | 8.14 | 8.7 | 9.34 | 8.70 | 66 | 0.78 | nil | 5.24 | 52 | 27.58 |
| **Before planting** | | 8.27 | 14.7 | 7.35 | 14.56 | 125 | 0.68 | nil | 7.16 | 112 | 28.43 |
| **Bahr Hadoous drain** | **1st** | 8.24 | 13.9 | 8.57 | 12.50 | 118 | 0.67 | nil | 7.35 | 105 | 27.39 |
| | **2nd** | 8.18 | 11.4 | 10.25 | 9.70 | 93 | 0.72 | nil | 5.85 | 84 | 23.82 |
| **Before planting** | | 8.30 | 15.8 | 9.54 | 16.67 | 131 | 0.50 | nil | 6.59 | 117 | 34.12 |
| **Bar El-Bakar drain** | **1st** | 8.25 | 14.5 | 10.75 | 14.20 | 120 | 0.53 | nil | 5.68 | 109 | 30.80 |
| | **2nd** | 8.12 | 10.3 | 12.23 | 7.50 | 82 | 0.55 | nil | 5.21 | 71 | 26.07 |
| **Statistical analysis** | | | | | | | | | | | |
| **LSD %5 level of Sources** | | 0.06 | 1.09 | 1.26 | 2.24 | 4.51 | 0.08 | nil | 1.26 | 4.14 | 0.63 |
| **LSD %5 level of Seasons** | | 0.09 | 1.66 | 1.03 | 6.39 | 2.48 | 0.14 | nil | 1.03 | 6.62 | 1.27 |

**Available macro elements in the studied soils:**

Data in Table 4 show the amounts of some available macronutrients N, P and K (mg $kg^{-1}$ soil) in studied soil as affected by irrigation with different water sources for two seasons during sugar beet cultivation. Generally, it is clear that the soils irrigated with Bahr El-Bakar drain water contained the relatively higher values of available N, P and K than that for Bahr Hadoos drain water and El-Salam canal water. This is a true, since the water of Bahr El-Bakar drain water is directly contaminated with sewage effluent, which is more enrichment in organic materials as well as N, P and K. The obtained data are in agreement with those reported by Hegazy (1993) Who found that the available N, P, and K were higher in soils irrigated with wastewater than in virgin non-irrigated soils. Abd El-Bary and El-Ashkar (1998) stated that the content of available N in soil was increased with increasing the irrigation periods with drainage water contaminated with sewage effluent. The values of N, P and K were high significantly increased in soils due to irrigation with Bahr El-Bakar and Bahr Hadoos drain water compared to El-Salam canal . The obtained data are in agreement with those obtained by El-Sheikh (2003)

**Available microelements in soils as affected by different irrigation water sources:**

Data presented in Table 4 show the changes in the available contents of Fe, Mn and Zn under sugar beet cultivation. Using alternatively irrigation water process with different irrigation water sources led to an increase for available Fe, Mn and Zn which ranged between 11.24–23.48 & 4.13–13.45 and 0.77–1.77 mg $kg^{-1}$ soil, respectively, in the two seasons during sugar beet cultivation. The corresponding relative increases were 8.01–20.73% for Fe; 36.32–83.05% for Mn and 15.58 –37.66 % for Zn with El-Salam canal water, compared to initial soil. Concerning the applied water of Bahr Hadoos drain, the relative increases for available Fe, Mn and Zn reached 14.85–26.47% for Fe, 46.74–61.19% for Mn and 32.56–37.21 % for Zn compared to control. As for as available contents of Fe, Mn and Zn in soil irrigated with Bahr El-Bakar drain water the relative increases were 32.66–42.56% for Fe; 33.78–65.23% for Mn and 9.86 and 24.65 % for Zn compared to control (before sugar beet planting) .These results agreed with those of Abd El-Naim *et al.* (1987) and Ibrahim *et al*. (1992) They found that the soil available Fe, Mn and Zn were increased by irrigation with sewage water after the three years of cultivation. The increase of microelements in all studied soils surface layers (0-30) depending on long time of crops cultivation and irrigation water periods , may be due to the increase of soil organic mater in surface layers. The obtained data are in agreement with those of El-Sheikh (2003) and Shaban (2005).

**Table 4: Available macro and microelements content in soil.**

| Irrigation Sources | Season (Year) | Macro elements (mg $kg^{-1}$) | | | Micro elements(mg $kg^{-1}$) | | |
|---|---|---|---|---|---|---|---|
| | | N | P | K | Fe | Mn | Zn |
| Before planting | | 31 | 3.21 | 239 | 11.24 | 4.13 | 0.77 |
| El-Salam canal | 1st | 39 | 4.59 | 245 | 12.14 | 5.63 | 0.89 |
| | 2nd | 42 | 5.12 | 256 | 13.57 | 7.56 | 1.06 |
| Before planting | | 36 | 4.89 | 254 | 12.39 | 5.67 | 0.86 |
| Bahr Hadoous drain | 1st | 45 | 6.34 | 266 | 14.23 | 8.32 | 1.14 |
| | 2nd | 49 | 6.58 | 274 | 15.67 | 9.18 | 1.18 |
| Before planting | | 44 | 5.18 | 262 | 16.47 | 8.14 | 1.42 |
| Bar El-Bakar drain | 1st | 55 | 7.24 | 277 | 21.85 | 10.89 | 1.56 |
| | 2nd | 65 | 7.53 | 284 | 23.48 | 13.45 | 1.77 |
| LSD %5 level of Sources | | 2.61 | 1.26 | 1.22 | 4.89 | 0.31 | 0.54 |
| LSD %5 level of Seasons | | 3.31 | 1.02 | 5.79 | 7.45 | 0.48 | 1.64 |

**Effect of different irrigation water resource on sugar beet avails under saline soil:**

Data presented in Table 5 show that the effect of different irrigation water on the sugar percentage, sugar yield and root yield of sugar beet crop under saline soil conditions in the seasons 2006 / 2007 and 2007 / 2008 were significant .The highest values were 17.51 %, 22.31 ton $fed^{-1}$ and 2.76 ton $fed^{-1}$ for sugar content, root yield and sugar yield in soil irrigated with Bahr El-Bakar drain. The relative increases were 9.40, 7.44 and 7.00 % for sugar content, 8.15 ,2.10 and 5.00 % for root yield, 3.20,0.92 and 9.10% for sugar yield and 3.49 ,3.75 and 3.66 % for sugar purity by irrigation water of El-

Salam canal water , Bahr Hadoos drain water and Bahr El-Bakar drain water compared to first season, respectively .It is worthy to mention that the superiority of crop yield at different irrigation water resources was mainly due to low soil EC for sugar beet grown in the two seasons .These results are agreement with those of Zein *et al* (2002b) and Ucan, and Gencoglan (2004)

**Table 5: Sugar content, root yield, sugar yield and sugar purity as affected by different irrigation resources in two seasons.**

| Sources Irrigation | Seasons | Sugar content (%) | Root yield (tonfed$^{-1}$) | Sugar yield (tonfed$^{-1}$) | Sugar purity (%) |
|---|---|---|---|---|---|
| El-Salam canal | 1st | 15.85 | 19.64 | 2.19 | 86 |
| | 2nd | 17.34 | 21.24 | 2.26 | 89 |
| Bahr Hadoous drain | 1st | 15.72 | 16.99 | 2.17 | 80 |
| | 2nd | 16.89 | 17.34 | 2.19 | 83 |
| Bar El-Bakar drain | 1st | 16.37 | 21.25 | 2.53 | 82 |
| | 2nd | 17.51 | 22.31 | 2.76 | 85 |
| LSD %5 level of Sources | | 4.49 | 6.34 | 1.25 | 6.28 |
| LSD %5 level of Seasons | | 1.22 | 1.37 | 1.03 | 9.56 |

**Macronutrients concentration in root and shoot of sugar beet plants.**

Effects of different irrigation water sources on N, P and K concentration in root and shoot of sugar beet present in Table 6 show that the concentration of nitrogen in shoot and root in all studied experiential were the sufficient limits or the critical concentration for N (3.50–5.75%) in shoot and (2.50–3.75 %) in root as mentioned by Owen (1999), where it limits ranged for 4.10–4.89 % in shoot and 2.89–3.24 % in root respectively .On the other hand, the irrigation with different irrigation water resources had a significant effect on N concentration in shoot and root of sugar beet plants during the two growing seasons . It was obvious from the obtained data that the irrigation for a long term caused an increase in N concentration taken by shoot and root of sugar beet plants, especially soil irrigated from Bahr El-Bakar drain water. The corresponding relative increases values were 1.22, 0.84 and 1.45 % for N content in shoots , while the values of N content in root, were 4.15 , 1.59 and 1.89 % in soil irrigated from El- Salam canalwater, Bahr Hadoos drain water and Bahr El- Bakar drain water compared to the first season, respectively.

Phosphorus is the second most limiting nutrient in sugar beet production. Data revealed that irrigation for a long term with different sources caused a significant increase in P concentration in shoot and root during the two seasons. Phosphorus is involved in energy transfer within the plant and aids in maintaining the structural integrity of the plant cell membranes. The highest values were 0.33 and 0.49% in shoot and root in the second seasons with Bahr El-Bakar drain water. The increase of P content in root or shoot of sugar beet due to decrease of soil pH and increase of organic matter resulting from irrigation with sewage water (Bahr El-Bakar drain water) for long term .Corresponding relative increases of P concentration values were 24.00, 15.00 and 18.00 % in shoot and 15.20, 14.00 and 11.40 % in root in soil irrigated with El- Salam canal water, Bahr Hadoos drain water and Bahr El- Bakar drain water compared the first seasons, respectively.

**Table 6: Concentration of macronutrients in shoot and root of sugar beet plants.**

| Sources Irrigation | Seasons | N (%) | | P (%) | | K (%) | |
|---|---|---|---|---|---|---|---|
| | | Shoot | Root | Shoot | Root | Shoot | Root |
| El-Salam canal | 1st | 4.10 | 2.89 | 0.25 | 0.33 | 3.41 | 1.42 |
| | 2nd | 4.15 | 3.01 | 0.31 | 0.38 | 3.46 | 1.47 |
| Bahr Hadoous drain | 1st | 4.76 | 3.14 | 0.27 | 0.36 | 3.52 | 2.10 |
| | 2nd | 4.80 | 3.19 | 0.31 | 0.41 | 3.55 | 2.17 |
| Bar El-Bakar drain | 1st | 4.82 | 3.18 | 0.28 | 0.44 | 3.59 | 2.21 |
| | 2nd | 4.89 | 3.24 | 0.33 | 0.49 | 3.62 | 2.25 |
| LSD %5 level of Sources | | 3.42 | 1.26 | 0.13 | 0.12 | 1.90 | 2.18 |
| LSD %5 level of Seasons | | 1.13 | 1.03 | 0.10 | 0.10 | 1.56 | 1.78 |

Regarding to potassium, it is important for the function of the stomata, pore-like openings of the plant leaves, through which transpiration of water and uptake of gaseous carbon dioxide occurs. Data presented in Table 6 show the concentration of K in shoot and root of sugar beet plants as affected by different irrigation water resources. Increasing the period of irrigation water led to a significant increase in K concentration in shoot and root of sugar beet plants, during the two growing seasons. The concentration of K in shoot and root were ranged between 3.41 and 3.26 % and between 1.42 and 2.25 %, respectively. The highest values were 3.62 and 2.25 % in shoot and root of sugar beet plants in soil irrigated with Bahr El-Bakar drain water in the second season. The relative increase in K percentage resulting from application different irrigation water resources were 14.66, 0.85 and 8.36 % in shoot and 3.52 , 3.33 and 1.81 % in root as affected by irrigation El-Salam canal, Bahr Hadoos drain water and Bahr El-Bakar drain water, respectively . The obtained data are in agreement with those reported by Koriem *et al*. (2002).

**Micronutrients concentration in shoot and root of sugar beet plants**

Data presented in Table 7 show the micronutrients (Fe, Mn and Zn) concentration in sugar beet cultivars generally were increased with increasing irrigation water quality. This increase was more pronounced with sugar beet for two seasons. Also the obtained data showed that sugar beet contents of Fe, Mn and Zn generally increased in the second season than in the first season, specially in soil irrigated from Bahr El-Bakar drain water due to the accumulation effect . The highest values of Fe, Mn and Zn concentration in sugar beet cultivar irrigated from Bahr El-Bakar drain water in the second season. These results are agreement with those obtained by Aboulroos *et al.* (1996) They found that heavy metals content in leaves of corn was increased with increasing levels of extractable metals in the soil.

Also the corresponding relative increases values were 1.22, 2.37 and 1.93 % for Fe in shoot, while the percentage of concentration of micronutrients in root were 2.79, 2.66 and 3.68 % for Fe in root compared to the first season when soil irrigated from El-Salam canal water, Bahr Hadoos drain water and Bahr El-Bakar drain water respectively. The relative increase in Mn values in the soil irrigated from El-Salam canal water , Bahr Hadoos drain water and Bahr El-Bakar drain water were 7.52, 7.89 and 8.94 % in shoot but the relative increases in root were 12.73, 9.32 and 7.61 % for Mn compared to the first season.

The corresponding values were 11.50, 5.97 and 8.31 % for Zn in shoot and 13.24, 12.35 and 6.75 % for Zn in root compared to the first season irrigated from El-Salam canal water, Bahr Hadoos drain water and Bahr El-Bakar drain water, respectively. All this micronutrients content in roots or shoots were safe. These results are agreement with those obtained by Zein *et al.* (2002a).

**Table 7: Concentration of micronutrients in shoot and root of sugar beet plants.**

| Sources Irrigation | Seasons | Fe (mg kg$^{-1}$) | | Mn (mg kg$^{-1}$) | | Zn (mg kg$^{-1}$) | |
|---|---|---|---|---|---|---|---|
| | | Shoot | Root | Shoot | Root | Shoot | Root |
| El-Salam canal | 1$^{st}$ | 245 | 179 | 51.47 | 16.34 | 38.25 | 21.30 |
| | 2$^{nd}$ | 248 | 184 | 55.34 | 18.42. | 42.65 | 24.12 |
| Bahr Hadoous drain | 1$^{st}$ | 253 | 188 | 61.37 | 21.13 | 49.37 | 25.10 |
| | 2$^{nd}$ | 259 | 193 | 66.21 | 23.10 | 52.32 | 28.20 |
| Bar El-Bakar drain | 1$^{st}$ | 264 | 190 | 68.14 | 26.15 | 57.41 | 31.10 |
| | 2$^{nd}$ | 268 | 197 | 74.23 | 28.14 | 62.18 | 33.20 |
| LSD %5 level of Sources | | 5.26 | 6.35 | 17.57 | 1.26 | 12.58 | 11.49 |
| LSD %5 level of Seasons | | 5.24 | 5.19 | 14.34 | 1.03 | 10.27 | 9.39 |

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## تأثير استخدام مياه الري رديئة الجودة على إنتاج محصول بنجر السكر في منطقة سهل الحسينية .

**الحسيني المرسى السيد خفاجي ، خالد عبده حسن شعبان و هدى صدقي سعيد**
**معهد بحوث الاراضى والمياه والبيئة – مركز البحوث الزراعية -الجيزة – مصر**

أقيمت تجربتين حقليتين في مزارع خاصة في ثلاث مواقع بمنطقة سهل الحسنية بمحافظة الشرقية وهى قرية الرواد ومنطقة بحر حادوس ومنطقة بحر البقر وتم زراعة بنجر السكر في الموسمين الشتويين 2007 و 2008 م ومنطقة جنوب سهل الحسينية تروى بثلاث مصادر من مياه الري هي مياه ترعة السلام وهى مياه مخلوطة بمياه صرف زراعي ( بحر حادوس ) ومياه النيل بنسبة 1:1 والمصدر الثاني مياه بحر حادوس وهي مياه صرف زراعي والمصدر الثالث مياه بحر البقروهي مياه صرف صحي.

تم دراسة هذه المصادر على إنتاجية بنجر السكر وجودتة تحت ظروف الاراضى الملحية المستصلحة حديثا.

النتائج المتحصل عليها:

1-انخفضت نسبة الملوحة ورقم حموضة التربة خاصة في الأرض المروية بمياه بحر البقر وترعة السلام وبحر حادوس

2-زادت نسبة العناصر الكبرى ( النتروجين والفوسفور والبوتاسيوم ) الميسر فى التربة زيادة معنوية مع استمرار الري لمدة موسمين متتالين لزراعة البنجر وخاصة المروية بمياه بحر البقر يلية بحر حادوس يلية ترعة السلام.

3-زادت نسبة العناصر الميسرة ( الحديد والمنجنيز و الزنك )في التربة وخاصة الأرض المروية بمياه بحر البقر والسلام وحادوس وكانت الزيادة في تلك العناصر معنوية خاصة في الموسم الثاني

4-وجد أن أعلى محصول لجذور البنجر كمحصول نهائي هو 22.31 طن للفدان في الأرض المروية بمياه بحر البقر وهو اقل في محصول السكر ودرجة النقاوة .

5- وجد أن أعلى نسبة لمحصول السكر وأعلى نقاوة للسكر في الأرض المروية بمياه ترعة السلام يليها الأرض المروية بمياه بحر البقر ثم مياه بحر حادوس وخاصة في الموسم الثاني.

6-كانت الزيادة في تركيز العناصر النتروجين والفوسفور والبوتاسيوم في الأوراق والجذور زيادة معنوية في كل الدراسة .

7-وجد أن الزيادة في العناصر الحديد والمنجنيز والزنك في الجذور والأوراق كانت في الحدود الآمنة .

8-نوصى بزراعة بنجر السكر في الاراضى الملحية المروية بمياه ترعة السلام.