EGYPTIAN ACADEMIC JOURNAL OF
BIOLOGICAL SCIENCES
BOTANY

H

ISSN 2090-3812

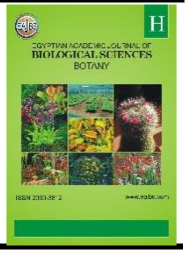
www.eajbs.com

Vol. 13 No.2 (2022)

Citation: Egypt. *Acad. J. Biolog. Sci.* (H. Botany) *Vol.13(2) pp207-216(2022)*
DOI: 10.21608/EAJBSH.2022.279082

Egypt. Acad. Journal Biology. Sci., 13(2):207-216(2022)

Egyptian Academic Journal of Biological Sciences
H. Botany
ISSN 2090-3812
www.eajbsh.journals.ekb.eg.



Reducing the Effect of Agricultural Drainage Water Salinity on Sugar Beet Productivity and Quality by Some Soil Amendments

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ARTICLE INFO
Article History
Received:14/10/2022
Accepted:12/12/2022
Available:17/12/2022

Keywords:
Sugar beet, humic acid, Sulphur, silver nanoparticles yield, and quality.

ABSTRACT

Field trials for two seasons (2020-2021 and 2021-2022) were conducted to investigate the influence of canal water, agricultural drainage water, and different concentrations of silver nanoparticles ($AgNO_3$NPs) (0, 60 and 75 ppm), humic acid (0,6 and 8 kg/fed) and sulphur (0, 200 and 400 kg/fed) on yield, quality characteristics, and production of sugar beet under the conditions of the salt-affected soil. Each field experiment included two factors in a split-plot design with three replications. The main plots were assigned to water irrigation treatments; whereas the rates of soil amendment (silver nanoparticles, sulfur, and humic acid) were arranged randomly within the sub-plots. Each subplot included six ridges which were 0.50 m apart and 3.50 m in length; so, the area of each subplot was 10.50 m^2 (1/400 fed.). The most important results revealed that the canal water led to significant improvements in all traits of root yield, top yield, quality, gross yield, and pure sugar. In addition, increasing soil amendment (sulfur, humic acid, and silver nanoparticle) fertilization decreased significantly potassium (%), -α amino nitrogen (%), and sodium (%) in sugar beet root; however, the highest mean values of the sugar yield, and white sugar yield were recorded under the irrigation with canal water or drainage water with the application of 75ppm silver nanoparticles Meanwhile the lowest previous mentioned characters were obtained under irrigation with drainage water and control treatment (without any addition of soil amendments), during the two seasons. This showed that soil amendments (sulphur, humic acid, and silver nanoparticles) fertilization and irrigation treatment acts dependently on the sugar yield of the sugar beet plant under this study.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) belongs to the family Amaranthaceae and the order Caryophyllales. It is an important cash crop having a wide range of industrial and commercial utilization and is one of the world's two traditional sugar crops. Sugar beet production began in Egypt in 1982 and reached 682.771 feddan by 2021. (Sugar Crops Council 2021). In salty environments, silver nanoparticles boost plant competitiveness and the possibility for greater plant exploitation of available water and light from the environment for photosynthesis. In general, the addition of silver nanoparticles to S.

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hortensis improves the yield of seed germination and growth of this plant in greenhouse settings, making it easier to establish the necessary circumstances for survival.(Nejatzadeh 2021).

Humic acid (HA) is a major component of humic matter, which is the main organic component of soil (humus). Humic substances are commercial products made up of some organic molecules produced by the decomposition, and microbial activity of dead biological material and plant tissue (Orsi 2014; Ekin, 2019). Rassam *at el.* (2015) studied the effect of using humic acid in calcareous soil at concentrations of, no application of humic acid(0), 2.5 l/ ha and 5 l/ha., the application of humic acid at the rate of 2.5 l/ ha caused a significant increase of sucrose% (SC), root yield, sugar yield and a reduction in molasses sugar forming substances content, compared to the control treatment. However, Rehab *et. al.* (2019) reported that rising humic acid rates from 0, up to 6 kg/fed significantly boosted root, biological, sugar yields ton/fed, TSS%, potassium percentage, and white sugar percentage. . On the other hand, sugar beet plants that were grown under control conditions provided the lowest results. (zero kg/fed humic acid). In addition, increasing humic acid rates from zero up to 6 kg/fed resulted in a considerable drop in sodium%, α-amino nitrogen%, and extraction%.

MATERIALS AND METHODS

Two field experiments were conducted at Research Farm of the Faculty of Agriculture - Saba Pasha – Alexandria University, Alexandria Government, Egypt during the two successive seasons, 2020/ 2021 and 2021/ 2022, to study the effect of canal water, agricultural drainage water and different concentrations of silver nanoparticles (AgNO3NPs), humic acid and Sulphur on purity behavior and production of sugar beet karm cv. under the conditions of the salt-affected soil.

In order to ascertain the physical and chemical characteristics of soil in accordance with Piper (1950), soil samples were collected at a depth of 0: 30 cm from various experimental sites. The results are shown in Table (1).

Table 1 a. Soil Physical and chemical properties of experimental sites in both seasons.

Soil properties	Seasons	
	2019/2020	**202/2021**
A- Mechanical analysis		
Sand	14.50	14.70
Silt	42.10	42.10
Clay	43.40	43.20
Soil texture	Clay loam	Clay loam
B- Chemical properties		
pH (1:1)	8.20	8.30
EC (1:1) dS/m	4.10	4.15
1- Soluble cations (1:2)		
K^+	1.40	1.45
Ca^{++}	9.00	10.00
Mg^{++}	11.30	11.50
Na^+	13.60	13.80
2- Soluble anions (1:2)		
CO^-_3+ HCO^-_3	2.80	2.90
CL^-	19.70	19.80
SO^-_4	12.80	13.50
Calcium carbonate (%)	6.70	6.90
Total nitrogen (%)	1.10	1.20
Available P (mg/kg)	3.70	3.60
Organic matter (%)	1.50	1.60

The chemical analysis of Nile and drainage water as shown in Table (2) was done according to the method described by Chapman and Partt (1978).

Table 1b. Chemical analysis of Nile and drainage water.

Water qualities			
Properties	**Nile water**	**Drainage water**	
EC, dS/m	0.59	1.88	
Ph	7.25	6.90	
Soluble Anion (meq/L)			
CO3=	-	-	
HCO_3-	3.54	5.25	
Cl-	0.94	12.91	
SO4=	0.78	4.37	
Soluble Cations (meq/L)			
Mg++	1.60	3.35	
Ca++	1.68	4.88	
Na++	1.76	13.76	
K+	0.22	0.54	
Heavy metals content (ppm) in water samples			
Cd	0.004	0.032	
Pb	0.300	0.430	
Ni	0.021	5.526	
	Cd	Pb	Ni
Critical level	0.010	5.00	0.200
Critical level (according to FAO, 1985 and Richards, 1969)			

The design of each field experiment was a split-plot design with three replications. The main plots were assigned to irrigation water treatments, while the rates of soil amendment treatments (silver nanoparticles–Sulphur-humic acid) were arranged randomly within the sub-plots. Each subplot included six ridges 0.5 m apart and 3.50 m in length, making the plot area, 10.50m^2 (1/400 fed).

The experimental field was well prepared through plowing, laser levelling, and compaction, ridging, and then divided into the experimental units. Calcium superphosphate (15.5 % P2O5) was applied during soil preparation at the rate of 200 Kg/fed. Sugar beet balls were hand sown 4- 5 balls/ hill using the dry sowing method on one side of the ridge in hills spacing of 0.20 m, on the 14th and 24th of September during 2020/2021 and 2021/2022 seasons respectively. The plots were irrigated immediately after sowing. Plants were thinned at the age of 4 leaf stages to obtain one plant/ hill. The common agricultural practices for growing sugar beet, except the factors under study were followed according to the recommendations of The Ministry of Agriculture and Land Reclamation.

The Treatments Of The Experiment Were As Follows:

A. Irrigation Treatments:

b. Canal water.
c. Drainage water.

B. Soil amendments:

1. **Humic Acid Fertilizer Levels Used:**

Humid acid treatments were applied at one dose after thinning and before the second irrigation (50 days after sowing).

a. Without humic acid (control treatment).
b. 6 Kg humic acid/ fed.
c. 8 Kg humic acid/ fed.

2. **Sulphur Fertilizer Levels Used:**

Sulphur fertilizer levels were applied during soil preparation.

a. without Sulphur (control treatment).
b. 200 Kg Sulphur. / fed.
c. 400 Kg Sulphur. / fed.

3. **Silver nanoparticles (AgNO3NPs) used:**

Spraying plants was done at the age of 50 days.

a. Without (control).
b. 60 ppm.
c. 75 ppm.

Silver nanoparticles (AgNO3NPs were purchased from El-Gamhoria Company, Egypt then solutions, at various rates and treatments were executed immediately after thinning.

The most important characters, at the age of 200 days were taken from the three middle ridges of each subplot, as follows:

Yield Characters:

1- Root yield (tons/ fed).
2- Top yield (tons/ fed).
3- Gross sugar yield (tons/ fed) = Roots yield/ fed × Gross sugar%.
4-White sugar yield (tons/ fed) = Roots yield/ fed × White sugar%.

Quality Characters:

1- Total soluble solids % (T.S.S %).
It was measured in the juice of fresh roots by using Hand Refractometer according to Me Ginnis, (1982).
2- Soluble non-sugar content (impurities parameters, sodium, potassium and α-amino-N in meq/ 100 g beetroots).
3- Purity percentage (QZ%).

QZ = (ZB × 100)/ (Pol); ZB = **Pol – {0.345 (K + Na) + 0.094 α- amino- N + 0.29}**

4 - Sugar percent (SC %)
5 - Molasses sugar percent (MS%)

MS = {0.343 (K + Na) + 0.094 (α- amino- N) – 0.31}

6- White sugar content (WSC), was calculated according to the following formula of (Reinefeld *et al*. 1974):

WSC = SC – MS.

Statistical Analysis:

All data were statistically analyzed by the "COSTAT" Computer software package, and the analysis of variance (ANOVA) was computed using CoStat V 6.4 (2005) program. and the least significant difference (LSD) method was used to test the differences between treatment means at 5 % rates of probability. The statistical analysis was carried out according to Steel and Torrie (1981).

RESULTS AND DISCUSSION

The results of the effect of canal water, agricultural drainage water and different concentrations of silver nanoparticles (AgNO3NPs), humic acid and Sulphur rates on root yield, top yield, sugar yield and white sugar yield (ton/fed), during 2020/2021 and 2021/2022, are shown in Table (2).

The results indicated that root yield, top yield, sugar yield and white sugar yield, were significantly affected by the application of irrigation treatments during both seasons of this study, as shown in Table 2. In general, growing sugar beet under irrigation by drainage water reduced significantly the mean values of root yield, top yield, sugar yield and white sugar yield, during both seasons of this study, as shown in Table 2. The decrease may be attributed to the water salinity in general badly affects crop production and growth by the influence on several facets of plant metabolism like osmotic adjustment, ions uptake, protein, synthesis of nucleic acids, enzyme activities and hormonal balance. These results are in agreement with (Munns and Tester 2008).

The same Table's findings showed that the rates of fertilization with soil amendments (sulphur, humic acid, and silver nanoparticles) had a significant impact on the mean values of root yield, top yield, sugar yield, and white sugar yield during both seasons of this study. In addition, the mean values of the previously mentioned characters were gradually elevated with rising sulphur, humic acid and silver nanoparticles rates.

The highest mean values of root yield were (28.40 ton/fed), obtained under the application of 60 ppm of silver nanoparticles, during the first season, and under the application of 60 ppm (25.22 ton/fed), and 75ppm (25.31ton/fed) during the second season, meanwhile the differences between mean values of root yield under 60 ppm and 75ppm were not great enough to reach the 5% level of significance. In addition, the highest mean values of top yield, sugar yield, and white sugar yields were obtained under the application of 75 ppm of silver nanoparticles during 2020/2021, and 2021/2022 seasons, meanwhile, during the first season, the differences of the mean values of sugar yield, and white sugar yield under the application of 60 ppm and 75 ppm of silver nanoparticles were not great enough to reach the 5% level of significance, as shown in Table (2). This result may be expected since, Ag NO_3-NPs can improve growth, chlorophyll content, photosynthetic efficiency and anti-oxidative defense systems under abiotic stress (Sami *et al*., 2020).

The interaction between irrigation and soil amendments (Sulphur, humic acid and silver nanoparticles rates) was significant for root yield, top yield, sugar yield and white sugar yield, during the two seasons of this study. The highest mean values of root yield (27.32 ton/fed), top yield (20.39 ton/fed), expected sugar yield (5.60 ton/fed) and extracted white sugar yield (4.35 ton/fed) were obtained by the addition of 75ppm of silver nanoparticles under canal water irrigation, during 2021/2022 season. Meanwhile, during the first season 2020/2021, the addition of 60 ppm of silver nanoparticles under irrigation with canal water or drainage water, produced the highest mean values of expected sugar yield and extracted white sugar yield. This demonstrated how the effects of soil amendments and irrigation treatments, acted dependently on the previously mentioned characteristics, as shown in Table (2). However, the lowest root yield, expected sugar yield, extracted white sugar yield and top yield mean values were obtained with the interaction between agricultural drainage water with control treatment (without application of any soil amendments) during the two seasons as shown in Table (2).

The analysis data of the electrical conductivity for the soil at the site of the experiment reported EC (1:1) 4.15 dS/m (Table 1a), and drainage water EC 1.88 dS/m, as compared to Nile water EC 0.59 dS/m (Table 1b). By growing sugar beet in salt-affected soil with EC (1:1) 4.15 dS/m, the addition of 60 ppm of silver nanoparticles under irrigation with canal water (0:59 dS/m EC) or drainage(1.88 dS/m EC), produced the highest mean values of expected sugar yield (6.77 and 5.63 t/fed) and extracted white sugar yield (4.43 and 4.37 t/fed) for canal and drainage water, respectively, with increased percentages of 39% and 43% for expected sugar yield and 56% and 65% for extracted white sugar yield under the canal and drainage water, respectively, when compared to irrigating with canal or drainage water without silver nitrate nanoparticles application (Table2). These outcomes are to be predicted since according to Nejatzadeh(2021), in saline environments, silver nanoparticles improve plant competitiveness and the possibility of better plant utilization of available water and light from the environment for photosynthesis. The results of the effect of canal water, agricultural drainage water and different concentrations of silver nanoparticles ($AgNO_3$NPs), humic acid and Sulphur rates on the (k) potassium content, (Na) sodium content, α-amino-N content and Molasses sugar are shown in Table (3).

The results in Table (3), indicated that (K content) was significantly affected by irrigation with canal water and agricultural drainage water. In general, data showed that irrigation with canal water produced the lowest mean values of k (potassium content) (7.63 and 7.32) during the two seasons compared to the other water source (agricultural drainage water. While irrigation with agricultural drainage water produced the lowest mean values of α-amino-N content (2.11) during the first season but was not significantly affected during the second season. In addition, sodium content and molasses sugar were not significantly affected during the two seasons, as shown in Table 3.

Rates of soil amendments (sulfur, humic acid, and silver nanoparticle fertilization) resulted in significant differences in the potassium content, sodium content, α-amino-N content, and molasses sugar mean values, according to the results in Table 3. In addition, were gradually reduced with increasing sulphur, humic acid, and silver nanoparticle rates. These results are to be expected since the mean values of root yield, top yield, sugar yield, and white sugar yield, were gradually increased with increasing sulphur, humic acid, and silver nanoparticle rates, as shown previously in Table (2).

The lowest mean values of (k) potassium content (6.67 and 6.52), (Na) sodium content (1.95 and 2.05), α-amino-N content (1.92 and 2.13), and molasses sugar (4.45 and 4.63), were obtained with silver nanoparticle application of 75 ppm, respectively. While the control treatment (without the addition of any soil amendments) achieved the highest mean values of (k) potassium content (8.33 and 7.94), (Na) sodium content (2.60 and 2.80), α -amino-N content (2.51 and 2.81), and molasses sugar (5.76 and 6.01), during 2020/2021, and 2021/2022 seasons, respectively .as shown in Table (3).

The interaction between irrigation treatments and soil amendments (sulphur, humic acid, and silver nanoparticle rates) was significant for potassium content, sodium content, α-amino nitrogen, and molasses sugar during the two seasons. The lowest potassium content, sodium content and molasses sugar mean values were obtained by applying irrigation with canal water and silver nanoparticles at 75 ppm. However, the highest potassium content, sodium content and molasses sugar mean values were obtained with the interaction of agricultural drainage water with control treatment (without the addition of any amendments) during the two seasons., In addition, the lowest α-amino-N content values were 1.83 and 2.13, obtained under the interaction between agricultural drainage water with silver nanoparticles applied at 75 ppm. during the two seasons, however, the highest α-amino-N content mean values (2.58 and 2.88) were obtained with the interaction between agricultural drainage water with control treatment (without the addition of any amendments) during 2020/2021, and 2021/2022 seasons, respectively, as shown in Table (3). These results exhibit the same trend as did the results obtained by previous researchers Thomas *et. al.* (2003), applying 25 kg of sulphur per hectare. resulted in large increases in dry matter and roots, as well as a 25% increase in root output. Additionally, α-amino N was decreased, which improved beet quality. Hoffmann *et.. al.* (2004) determined that the amount of beet produced and the amount of sucrose increased while the amount of potassium, sodium, and amino nitrogen in the beet significantly increased with a very low input of Sulphur. Rahimi (2020) reported that the largest amount of recoverable sugar (15.64%) was attained by adding humic acid to sugar beet, which improved its sugar content, in addition, the lowest mean values for K, Na, and α- amino nitrogen were seen. Rehab *et. al*. (2019) proved that rising humic acid rates from 0, up to 6 kg/fed significantly boosted root, biological, sugar yields ton/fed, TSS%, potassium%, and white sugar %. where adding more humic acid (6 kg/fed) achieved the greatest mean results. On the other hand, sugar beet plants that were grown under control conditions provided the lowest results. (Zero kg/fed humic acid). In contrast, increasing humic acid rates from zero to 6 kg/fed resulted in a considerable drop in sodium%, -amino nitrogen%, and extraction%, with the lowest values being obtained with the addition of 6 kg/fed humic acid.

Table 2. The effect of some irrigation treatments, and some soil amendments on root yield, top yield, sugar yield and white sugar yield (ton/ fed) during 2020/2021 and 2021 / 2022 seasons.

Characters	A) Irrigation treatments	First season 2020/2021								Second season 2021/2022							
		B) Soil amendment															
		Control	S 200 kg	S 400 kg	HA 6 kg	HA 8 kg	AgNPs 60 ppm	AgNPs 75 ppm	Average (A)	Control	S 200 kg	S 400 kg	HA 6 kg	HA 8 kg	AgNPs 60 ppm	AgNPs 75 ppm	Average (A)
Root yield (t/fed)	Canal water	23.58	26.37	26.55	25.33	26.50	29.58	27.55	26.50	22.92	24.71	25.02	25.47	26.19	27.27	27.32	25.56
	Drainage water	21.70	24.42	24.58	23.31	24.38	27.22	25.35	24.42	19.05	21.33	21.79	22.08	22.42	23.17	23.30	21.88
	Average (B)	22.64	25.39	25.57	24.32	25.44	28.40	26.45	25.46	20.98	23.02	23.41	23.78	24.30	25.22	25.31	23.72
	LSD at 0.05	A	0.05							A	0.029						
		B	1.3							B	0.41						
		AB	1.85							AB	0.58						
Top yield (t/fed)	Canal water	12.63	14.72	15.12	13.58	14.33	15.67	16.29	14.62	15.08	17.24	17.64	17.51	18.09	19.71	20.39	17.95
	Drainage water	11.62	13.63	14.00	12.50	13.19	14.41	14.99	13.48	12.11	14.13	14.71	15.13	15.33	15.96	16.50	14.84
	Average (B)	12.12	14.17	14.56	13.04	13.76	15.04	15.64	14.05	13.60	15.68	16.17	16.32	16.71	17.83	18.44	16.39
	LSD at 0.05	A	0.028							A	0.13						
		B	0.32							B	0.34						
		AB	0.46							AB	0.45						
sugar yield (t/ fed)	Canal water	4.15	4.67	4.88	4.70	5.07	5.77	5.52	4.97	4.08	4.46	4.66	4.79	5.10	5.45	5.60	4.88
	Drainage water	3.93	4.51	4.65	4.47	4.74	5.63	5.44	4.76	3.49	4.05	4.21	4.30	4.41	4.92	5.16	4.36
	Average (B)	4.04	4.59	4.76	4.59	4.90	5.70	5.48	4.87	3.79	4.26	4.43	4.54	4.75	5.18	5.38	4.62
	LSD at 0.05	A	0.039							A	0.057						
		B	0.28							B	0.15						
		AB	0.40							AB	0.21						
White sugar yield (t/ fed)	Canal water	2.83	3.30	3.31	3.42	3.74	4.43	4.30	3.62	2.75	3.13	3.12	3.45	3.74	4.16	4.35	3.53
	Drainage water	2.64	3.21	3.35	3.27	3.53	4.37	4.31	3.53	2.31	2.89	3.01	3.13	3.25	3.82	4.07	3.21
	Average (B)	2.74	3.26	3.33	3.35	3.63	4.40	4.30	3.57	2.53	3.01	3.07	3.29	3.49	3.99	4.21	3.37
	LSD at 0.05	A	0.04							A	0.062						
		B	0.23							B	0.16						
		AB	0.33							AB	0.22						

S = sulphur H.A.=humic acid AgNPs= silver nanoparticles.

Table 3. The effect of irrigation treatments, and some soil amendments on (k) potassium content, (Na) sodium content, α-amino-N content and Molasses sugar during 2020/2021 and 2021 / 2022 seasons.

Characters	A) Irrigation treatments	First season 2020/2021								Second season 2021/2022							
		B) Soil amendment															
		Control	S 200 kg	S 400 kg	HA 6 kg	HA 8 kg	AgNPs 60 ppm	AgNPs 75 ppm	Average (A)	Control	S 200 kg	S 400 kg	HA 6 kg	HA 8 kg	AgNPs 60 ppm	AgNPs 75 ppm	Average (A)
k content	canal water	8.12	7.97	7.87	8.07	8.13	6.82	6.43	7.63	7.82	7.55	7.53	7.73	7.77	6.43	6.43	7.32
	Drainage water	8.33	8.07	7.95	8.10	8.00	7.07	6.90	7.77	8.07	7.70	7.63	7.83	7.78	6.70	6.60	7.47
	Average (B)	8.23	8.02	7.91	8.08	8.07	6.94	6.67	7.70	7.94	7.63	7.58	7.78	7.78	6.57	6.52	7.40
	LSD at 0.05	A	0.073							A	0.06						
		B	0.23							B	0.23						
		AB	0.34							AB	0.33						
Na content	canal water	2.40	2.13	2.10	2.12	2.07	1.98	1.91	2.10	2.60	2.37	2.33	2.27	2.23	2.17	2.00	2.28
	Drainage water	2.80	2.30	2.17	2.13	2.00	1.97	2.00	2.19	3.00	2.43	2.40	2.25	2.13	2.12	2.10	2.35
	Average (B)	2.60	2.22	2.13	2.13	2.03	1.98	1.95 +	2.15	2.80	2.40	2.37	2.26	2.18	2.14	2.05	2.31
	LSD at 0.05	A	NS							A	NS						
		B	0.17							B	0.21						
		AB	0.25							AB	0.30						
α –amino nitrogen	canal water	2.43	2.20	3.00	2.00	1.93	1.95	2.00	2.22	2.73	2.47	3.27	2.27	2.20	2.20	2.13	2.47
	Drainage water	2.58	2.20	2.23	2.03	1.97	1.93	1.83	2.11	2.88	2.43	2.52	2.27	2.22	2.15	2.13	2.37
	Average (B)	2.51	2.20	2.62	2.02	1.95	1.94	1.92	2.16	2.81	2.45	2.89	2.27	2.21	2.18	2.13	2.42
	LSD at 0.05	A	0.08							A	NS						
		B	0.23							B	0.25						
		AB	0.33							AB	0.35						
Molasses sugar	canal water	5.58	5.22	5.93	5.06	5.01	4.54	4.43	5.11	5.83	5.41	6.14	5.25	5.19	4.71	4.59	5.30
	Drainage water	5.94	5.31	5.26	5.11	4.97	4.61	4.46	5.09	6.20	5.45	5.50	5.28	5.18	4.74	4.68	5.29
	Average (B)	5.76	5.27	5.59	5.09	4.99	4.57	4.45	5.10	6.01	5.43	5.82	5.26	5.18	4.72	4.63	5.30
	LSD at 0.05	A	NS							A	NS						
		B	0.27							B	0.29						
		AB	0.39							AB	0.41						

S = sulphur H.A.=humic acid AgNPs= silver nanoparticles.

The results of the effect of normal water (canal water), agricultural drainage water and different concentrations of silver nanoparticles (AgNO3NPs), humic acid and Sulphur rates on the sugar percent (SC%), total soluble solids (TSS%), purity percentage (QZ%) and white sugar content (WSC), are shown in Table (4).

The results indicated that sugar %, total soluble solids %, purity %, and white sugar content were significantly affected by irrigation treatments (canal water and agricultural drainage water). In general, regarding the water source, data indicated that irrigation with canal water gave the lowest mean values of sugar percent (18.70% and 19.04%), total soluble solids percent (23.34% and 23.50%), and white sugar (13.59 %and 13.73%) during the two seasons, respectively compared to the other water source- (agricultural drainage water). While the highest mean values of sugar percent (19.46% and 19.88%), total soluble solids percent (24.55% and 24.80%), and white sugar percent (14.37% and 14.59%) were respectively achieved with irrigation by agricultural drainage water during the two seasons, whereas the lowest values of purity percentage (79.23% and 80.12%,) respectively, during the two seasons achieved with irrigation by agricultural drainage water, While irrigation by canal water gave the highest mean values of purity (80.14% and 80.98%) during the two seasons, as shown in Table 4. These results are to be expected since the effects of water treatment as irrigation by canal water or drainage water have the same trend on the sugar yield and the white sugar ton/fed. as well as on K%, Na%, and α- amino nitrogen%, as previously mentioned in Tables (2 and 3).

The results in same Table 4, revealed that the rates of soil amendment (sulphur, humic acid and silver nanoparticles) fertilization resulted in significant differences in sugar %, total soluble solids %, purity %, and white sugar %mean values, which were gradually increased with increasing sulphur, humic acid and silver nanoparticles rates. The highest mean values of sugar percent (20.75% and 21.33%), total soluble solids percent (25.24% and 25.64%), purity percent (82.22% and 83.22%), and white sugar percent (16.30% and 16.70%) obtained under the application of 75ppm of silver nanoparticles, during the two seasons respectively. While the lowest mean values of the previous characters were achieved under control treatment (without the addition of any soil amendment). as shown in Table 4.

The interaction between irrigation treatments and soil amendments (sulphur, humic acid and silver nanoparticles rates) was significant for sugar %, total soluble solids %, purity%, and white sugar%, during the two seasons (2020/2021 and 2021/2022). The highest sugar %, total soluble solids %, and white sugar % mean values were obtained by applying irrigation with drainage water and silver nanoparticles at 75 ppm. However, the lowest sugar %, total soluble solids % and white sugar %, mean values were obtained with the interaction between irrigation with canal water with control treatment (without the addition of any soil amendments) during the two seasons.The highest purity% mean values (82.67% and 83.73%) were obtained by the interaction between irrigation with canal water, and silver nanoparticles at 75 ppm. during 2020/2021 and 2021/2022 seasons, respectively. Meanwhile, the lowest purity % mean values (76.20% and 77.07%,) were obtained with the interaction between irrigation drainage water and control treatment (without the addition of any soil amendments), as shown in Table 4. The results showed that the application of irrigation treatment i.e., irrigation using canal water or drainage water with the application of different rates of sulphur or humic acid or silver nanoparticles acts dependently on the previously mentioned characters, as shown in Table (4.) These results exhibit the same trend as the results obtained by previous researchers. Adding humic acid to sugar beet improved its sugar content, while the lowest values for K, Na, and α amino nitrogen were obtained. (Moustafa 2020) . A considerable increase in root length, root diameter, fresh weight per plant, root, top, and sugar yields/fed, as well as a minor improvement in juice quality when humic acid rates were raised from 0 to 5 kg / fed. (Abdel Fatah and Khalil 2020)The results show that adding 8 or 12 l/fed of potassium humate to the soil significantly increased mean values of the leaf area index (LAI), root diameter, fresh weight of the roots and foliage per plant, sucrose percentage, and quality index, as well as extractable sugar percentage, root, and sugar yields. Also, Rehab *et al.* (2019) reported that rising humic acid rates from 0, up to 6 kg/fed significantly boosted root, biological, sugar yields ton/fed, TSS%, potassium %, and white sugar percentage.

Table 4: The effect of irrigation treatments, and some soil amendments on sugar (%), Total soluble solids (%), Purity percentage (QZ%) (%) and White sugar (%) during 2020/2021 and 2021 / 2022 seasons.

Characters	A) Irrigation treatments	First season 2020/2021								Second season 2021/2022							
		B) Soil amendment															
		Control	S 200 kg	S 400 kg	HA 6 kg	HA 8 kg	AgNPs 60 Ppm	AgNPs 75 ppm	Average (A)	Control	S 200 kg	S 400 kg	HA 6 kg	HA 8 kg	AgNPs 60 ppm	AgNPs 75 ppm	Average (A)
Sugar co (%)	canal water	17.60	17.73	18.38	18.57	19.10	19.50	20.03	18.70	17.83	18.07	18.62	18.80	19.47	19.97	20.50	19.04
	Drainagewater	18.10	18.47	18.90	19.17	19.43	20.70	21.47	19.46	18.33	19.00	19.30	19.47	19.67	21.23	22.17	19.88
	Average (B)	17.85	18.10	18.64	18.87	19.27	20.10	20.75	19.08	18.08	18.53	18.96	19.13	19.57	20.60	21.33	19.46
	LSD at 0.05	A	0.13							A	0.18						
		B	0.42							B	0.59						
		AB	0.59							AB	0.85						
T SS (%)	canal water	22.74	22.36	23.17	22.90	24.19	23.75	24.23	23.34	22.78	22.59	23.20	22.94	24.47	24.06	24.48	23.50
	Drainage water	23.75	23.84	23.79	23.99	24.63	25.59	26.25	24.55	23.79	24.26	24.03	24.08	24.69	25.94	26.80	24.80
	Average (B)	23.25	23.10	23.48	23.45	24.41	24.67	25.24	23.94	23.28	23.42	23.61	23.51	24.58	25.00	25.64	24.15
	LSD at 0.05	A	0.11							A	0.12						
		B	0.75							B	0.89						
		AB	1.06							AB	1.26						
Purity percent QZ (%)	canal water	77.42	79.33	79.35	81.08	79.00	82.13	82.67	80.14	78.32	80.00	80.25	81.97	79.60	83.00	83.73	80.98
	Drainage water	76.20	77.47	79.47	79.90	78.90	80.90	81.77	79.23	77.07	78.33	80.33	80.87	79.67	81.87	82.70	80.12
	Average (B)	76.81	78.40	79.41	80.49	78.95	81.52	82.22	79.69	77.69	79.17	80.29	81.42	79.63	82.43	83.22	80.55
	LSD at 0.05	A	0.49							A	0.33						
		B	1.35							B	1.38						
		AB	1.91							AB	1.93						
White sugar %	canal water	12.02	12.51	12.45	13.50	14.09	14.96	15.60	13.59	12.00	12.66	12.47	13.55	14.28	15.26	15.91	13.73
	Drainage water	12.16	13.15	13.64	14.06	14.46	16.09	17.00	14.37	12.14	13.55	13.80	14.19	14.49	16.50	17.49	14.59
	Average (B)	12.09	12.83	13.05	13.78	14.28	15.53	16.30	13.98	12.07	13.10	13.14	13.87	14.39	15.88	16.70	14.16
	LSD at 0.05	A	0.13							A	0.26						
		B	0.49							B	0.59						
		AB	0.70							AB	0.83						

S = sulphur H.A.=humic acid AgNPs= silver nanoparticles.

Conclusion:

It is possible to suggest that using the applied irrigation water treatments, such as irrigation with canal water or irrigation with drainage water while applying 75 ppm of silver nanoparticles, raised the mean values of predicted sugar production and extracted white sugar substantially, under Alexandria's governorate conditions. Directly and indirectly, population growth is boosting food consumption, which in turn is raising water demand. The availability of water may decline due to climate change in specific regions and during specific times. The use of drainage water, in agriculture may have positive and negative impacts. With careful planning and management, the use of drainage for agriculture can be beneficial to farmers, cities and the environment. Meanwhile, we can deduct from the same field experiment's statistical analysis that the adoption of soil amendment treatments (sulphur, humic acid, and silver nanoparticles) enhanced root yield top yield, sugar yield, and white sugar yield gradually and significantly.

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