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Effect of Irrigation with Drainage and Blended Waters on Yield and Quality of some Rice Varieties (*Oryza sativa*) as well as Soil Qualty at North Part of Nile Delta

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ABSTRACT

The current study was conducted in the Northern Nile Delta (Hammoul District) to evaluate the effect of irrigation with agricultural drainage and blended canal water on growth characteristics, yield and its components, and grain quality of three rice varieties during two successive seasons of 2020 and 2021. The irrigation treatments were as follows: irrigation using the agricultural drainage water(I_1), irrigation using agricultural drainage water, alternate with blended water one by one(I_2), and irrigation using the blended canal water(I_3). Sakha 104, Giza 177, and Giza 178 rice cultivars were used in this study. The results indicated that heading days, plant length (cm), panicle length (cm), number of panicle hill^{-1}, number of filled grains panicle^{-1}, 1000- grain weight (g), grain yield (t ha^{-1}), and harvest index were better with blended canal water than that with agricultural drainage water. The greatest yield of the Giza 178 variety was achieved with blended canal water, while its yield was reduced by 9.6% when irrigated with drainage water. The results showed that the mean grain yield of Sakha 104, Giza 177, and Giza178 in the 1st season were 9.64, 8.69, and 11.31 t ha^{-1}and in the 2nd season they were 9.83, 8.66, and 9.88 ton ha^{-1}, respectively. Also, the results showed that the yield of Giza 178 which was irrigated by drainage water was close to that produced by Sakha 104 or more than that of Giza 177, which was irrigated by the blended canal water.Therefore, Giza 178 cultivar can be irrigated by drainage water, since it surpassed both the cultivars under this condition.

Keywords: rice, salinity, drainage water, blended canal water.

INTRODUCTION

Rice (Oryza sativa) is the food for more than half of the world's population, and it is cultivated on 150 million hectares throughout the world. Rice is cultivated in Egypt, mainly in the Northern Nile Delta, where more than 200000 fed are subjected to different degrees of salinity due to saltwater intrusion from the Mid Sea. Rice production in these areas helps to leach salt from the upper soil layers, allowing the land to be used for agricultural uses again. The Egyptian Government. wants to reduce the area of rice fields from 1.7 million fed. to 500,000 fed.due to limited water resources. Only 724,200 fed. are available (Al-Waqa'a Al-Masryah, 2020). Some farmers at the end of irrigation canals have to informally irrigate their lands by drainage water directly by pumping from drains near their fields due to a sharp decrease in freshwater.

Salinity is a limiting environmental issue for plant pr oductivity that is growing increasingly common as the agricultural intensity rises. High salt concentrations have a n egative impact on 100 million hectares (5% of arable land) t hroughout the world, reducing crop growth and output (Ghas semi et al., 1995; Gunes et al., 2007; Kumar et al., 2010 and Tavakkoli et al., 2011).

Due to a complete lack of freshwater budget, Egypt's agriculture sector and food security are at risk. The most suitable way to solve the irrigation water deficit is to reuse agricultural drainage water. Due to salt problems, the quality of reused drainage water is a concern, particularly in dry regions like Egypt. As a result, the quality of water for reuse projects is important. The quantity of agricultural drainage employed for irrigation unofficially is believed to be 2800 - 4000 million m3/year (FAO, 2006). The availability of water for irrigation may be increased by recycling drainage water correctly and economically. Various countries around the world, including Australia, Egypt, India, Israel, Pakistan, and the United States, have large supplies of this water. With the application of improved farming and management practices, water that is traditionally classed as unsuitable for irrigation may be effectively used for producing crops without severe long-term implications for crops or soils.

Oster (1994) proposed three adjustments to traditional irrigation procedures that would allow salty irrigation water to be used: 1- Selecting a salinity-tolerant crop, 2- Improving water management, and 3- Maintaining the physical qualities of the soil, including soil permeability through tillage. El-Refaaee et al.(2008) found that Sakha 104 and Giza 178 rice cultivars yielded nearly the same amount of rice and even outperformed other cultivars, whereas Giza 177, a short-duration cultivar, was highly affected by soil salinity. In general, rice cultivars Sakha 101, Sakha 104, and Giza 178 do better with limited water, such as at the ends of irrigation canals. According to Zayed, B. A. et al. (2012), rice cultivars of both Giza 178 and SK2034H have high salt tolerance;

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however, SKHA2034 is more drought-resistant than Giza 178, making it a second choice as a drought-tolerant cultivar.

The goal of this study is to evaluate the effect of irrigation with agricultural drainage on growth characteristics, yield and its components, and grain quality of three rice varieties.

MATERIALS AND METHODS

A field experiment was conducted at the private farm (Elhamoul District) kaferelshikh Gov., Egypt, during the 2020 and 2021 growing seasons. The experiments were carried out to study the effect of irrigation water quality on the yield and quality of some rice cultivars (Sakha 104, Giza 177 and Giza 178) which are varied in their genetic characteristics.

This field experiment was carried out in a split-plot design in both seasons with three replicates. Main plots were devoted to quality of irrigation water treatments as follows: Irrigation using agricultural drainage water (I_1), irrigation using agricultural drainage alternative with blended canal water one by one(I_2), and irrigation using the blended canal water (I_3). Leaching fractions (0.15, 0.10 and 0.05) were used with I_1, I_2 and I_3, respectively depending on salinity levels of irrigation water and rice tolerance level to salinity. Three rice cultivars were distributed in subplots. The three cultivars were grown in a well-prepared seedbed through good tillage, dry leveling, and wet leveling (puddling) .

Seeds at the rate of 60 kg /fed were soaked in water for 48 hr then incubated for 24 hr to hasten early germination. Seeds were uniformly broadcasted in the nursery on 1^{st} and 2^{nd} May of the two seasons, The Rice seedlings aged 25 days were transplanted to the permanent field. the previous crop was Egyptian clover (Trifolium alexandrinum). Nitrogen fertilizer was added at the rate of 69 Kg N fed^{-1} in the form of Ammonium sulfate (20% N) in three equal splits application at 15, 30, and 45 days after transplanting. Zinc sulfate at the rate of 10 kg/fed was applied after puddling. For controlling weeds, Seven days after transplanting the herbicide Saturn 50% [S-(4-Chlorophenol methyl) diethyl carbamothioate]at the rate of 2L fed^{-1} was mixed with enough sand to make it easy for homogenous distribution.

The permanent field was tilled mechanically and wet leveled. The trial location was split into 27 plots (7x7.5 m2) to be 1/80 fed for each. Drainage water was drained into the experimental field from a nearby drain. For the three kinds, seedlings were planted at a rate of two seedlings per hill, with a distance of 20 cm between the rows and the hills. Throughout the growing season, all plots were continually flooded to a water head of 5 cm. Except for the two study parameters, irrigation treatments, and rice cultivars, all agricultural practices followed the Egyptian Ministry of Agric, recommended package of rice under saline soil, and Land Reclamation's recommendations.

Soil samples were randomly taken from two depths (0-30 and 30-60 cm) from each plot before transplanting and after harvesting. The hydrometer technique was used to determine the soil particle size distribution. According to Kim (1996), the soil in the experimental site was clayey, with 53.0% clay, 32.3% silt, and 14.7% sand. The electrical conductivity (EC), the concentrations of water-soluble cations (Ca^{++}, Mg^{++}, Na^+ and K^+), soluble anions (HCO_3^-, Cl^- and $SO_4^=$) were determined in 1:1 soil-water extract, the pH was determined in 1:1 soil water suspension and the available N P and K were determined in soil extract. Table 1 shows the analytical results of the soil sample obtained before cultivation (1) As stated in Table1, water samples from both irrigation canal and drainage water were collected and chemically tested according to Page (1982) as shown in Table 2. The procedures of FAO (1976)for determining the quality of irrigation water were used. Soluble sodium percentage (SSP), sodium adsorption ratio (SAR), residual sodium carbonates (RSC), soluble magnesium percentage (SMgP) and potential salinity (PS) are the water quality metrics.

Table 1. Soil mechanical and chemical characters of the experimental site before cultivation.

Characters	2020	2021
Sand%	14.7	14.7
Silt%	32.3	32.3
Clay%	53.0	53.0
Soil texture	Clay	Clay
pH (1:1, soil: water suspension)	8.2	8.4
EC (1:1, soil: water extract), dSm-1	5.57	3.86
Cations (meq/l)		
Ca^{++}	6.64	6.264
Mg^{++}	13.08	12.744
Na^+	34.65	16.87
K^+	1.44	2.66
Anions (meq/l)		
$CO_3^=$	0.0	0.0
HCO_3^-	1.6	1.6
Cl^-	19.7	16.5
$SO_4^=$	34.5	20.5
Available K (mg/kg)	900	901.6
Available P (mg/kg)	23.4	23.1
Available N (mg/kg)	54.6	54.4

Table 2. Chemical properties of the irrigation water used in the current experiment.

Parameters	Season 2020		Season 2021	
	Blended water	Drainage Water	Blended water	Drainage Water
EC (dSm^{-1})	1.67	2.70	1.73	2.86
Soluble cations (meq/l)				
Na^+	8.8	14.3	9.5	16.8
K^+	0.8	2.2	0.9	1.5
Ca^{2+}	3.5	6.0	3.4	6.1
Mg^{2+}	3.8	5.4	3.7	5.5
Soluble anions (meq/l)				
CO_3^-	0.0	0.0	0.0	0.0
HCO_3^-	5.4	9.7	5.3	9.9
Cl^-	8.0	12.6	7.3	14.1
$SO_4^=$	3.5	4.7	4.9	5.9

Quality of irrigation water:

1. Electrical conductivity (EC_{iw}, dSm^{-1}).
2. Cations and anions.Cations (Ca^{2+}, Mg^{2+}, Na^+, K^+) and anions (CO_3^{2-}, HCO_3^-, Cl^- and SO_4^{2-} ions) determined according to Page (1982).
3. Sodium Adsorption Ratio (SAR) or Soluble Sodium Percentage (SSP, %).

$$SAR = \frac{Na^+}{\sqrt{(Ca^{2+} + Mg^{2+})/2}}$$

$$SSP = \frac{Na^+}{\sum Cations} \times 100$$

4. Soluble Magnesium Percentage (SMgP, %):

$$SMgP = \frac{[Mg^{2+}]}{[Ca^{2+} + Mg^{2+}]} \times 100$$

5. Residual Sodium Carbonate (RSC, me/L):

$$RSC = \left[CO_3^{2-} + HCO_3^-\right] - \left[Ca^{2+} + Mg^{2+}\right]$$

6. The concentration of toxic compounds can be expressed by the values of Potential Salinity (PS):

$$PS(me/l) = Cl^- + 0.5 \times SO_4^{2-}$$

Water applied (Wa): The amount of water delivered through the spile tube was calculated according to Majumdar (2002) by the equation;

$$q = CA\sqrt{2gh}$$

Where: q = Discharge of irrigation water ($cm^3 s^{-1}$),
C = Coefficient of discharge = 0.62 (determined by experiment
A = Inner cross section area of the irrigation spile (cm^2),
g = Gravity acceleration (cm/s^2) and
h = Average effective head (cm).

The volume of water delivered: for each plot was calculated by substituting Q in the following equation:

$$Q = q \times T \times n$$

Where: Q = water volume m^3 $plot^{-1}$,
q = discharge (m^3/min),
T = total time of irrigation (min) and
n = number of spile tube per each plot.

Irrigation water productivity (IWP): The productivity of irrigation water in kg grain m^{-3} of irrigation water was calculated according to Ghane et al., (2010) and Ali et al., (2007), as follows:

$$IWP = \frac{Grain\ yield\ (kgha-1)}{total\ of\ applied\ water}$$

Growth characters; Some characterswere measured as follow:

1. Number of days to heading (days), 2. Plant height (cm)and 3. Panicle length (cm).

Yield and Its components: Some characterswere measured as follow:

1. Number of panicles/hill., 2. Number of filled grains/ panicle, 3. 1000 grains weight. and 4. Grain yield ton/fed.

5.Harvest Index (HI):

$$HI = \frac{Econmic\ yield\ (grain\ yield)}{Bilogical\ yield\ (grain + straw\ yields)} \times 100$$

Statistical Analysis: The analysis of variance was carried out according to Gomez and Gomez (1984) and means were compared using the LSD at 0.05 level of significant.

RESULTS AND DISCUSSION

1. Irrigation water applied (IWa) as affected by irrigation treatments:

The values of IWa are presented in Table (3) and Fig (1). It was clear that the total amounts of IWa as a mean of both seasons are12085, 11032 and 10403 m^3/ha resulting from I_1, I_2 and I_3 irrigation, respectively. So,the irrigation using the blended water (I_3) had the lowest amount of IWa, while irrigation using the agricultural drainage (I_1) had the highest IWa. This is related to the that irrigation events with drainage water during the growing season should be higher than that with other irrigation treatments according to the leaching fractions which were used to alleviate the accumulation of salts in the soil profile.

Table 3. Irrigation water applied (IWa)m^3ha^{-1}as affected by irrigation treatments

Growth stages	Season 2020			Season 2021			Mean of seasons		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Nursery	238	238	238	250	250	250	244	244	244
Seedling raising (30 days)	357	357	357	357	357	357	357	357	357
Preparation of the field	1309	1309	1309	1309	1309	1309	1309	1309	1309
June	2261	2261	2261	2154	2154	2154	2208	2208	2208
July	3570	3094	2618	4046	2975	2816	3808	3035	2717
August	3332	3094	2856	3582	3451	3213	3457	3273	3035
September	714	595	476	690	619	593	702	607	535
Total	11781	10948	10115	12388	11115	10691	12085	11032	10403

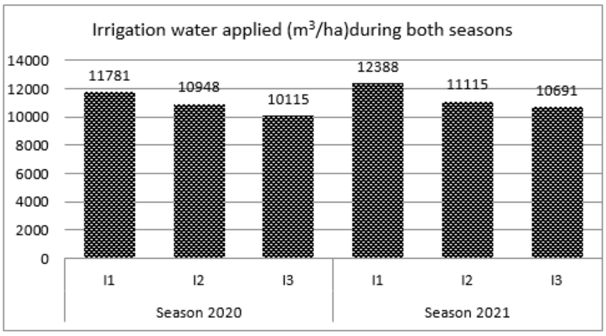

Fig. 1. Irrigation water applied (m^3ha^{-1}) as affected by quality of irrigation water

How suitable is this water for irrigation?

The most important parameters in determining water quality for irrigation are (1) Total concentration of soluble salts; (2) relative proportion of sodium to other cations; (3) concentration of boron or other elements that may be toxic, and (4) bicarbonates and carbonates as related to calcium and magnesium.The water quality parameters for canal and drainage waters used in this study are presented in Table (4).

Water electric conductivity (EC_{iw}): According to these data, the EC_{iw} for the two types of water varied from 1.67 to 2.70 dSm^{-1} in the 2020 season and from 1.73 to 2.86 in the 2021 season. The EC levels in the blended water canal and drainage water are less than the critical level (2.0 dSm^{-1}) according to FAO (1976). In general, it appears based on the given data that the two irrigation water types employed in this study may create one or more problems. The most common domain difficulties, when using the criteria for assessing water quality for irrigation, are salinity and sodicity problems. Therefore, using drainage water can be suitable for continuous irrigation without serious hazards if proper water management was used (application of leaching requirements).

Sodium adsorption ratio (SAR): According to the data, SAR values of both water sources are comparatively low when compared to the critical threshold level (less than 10) as stated by Richards (1972).

Soluble sodium percentage (SSP): In season 2020, SSP values for the two types of water varied from 52.1 to 53.2 in the 1st season, while in the 2nd season, SSP values ranged from 54.3 to 58.7. The statistics indicated that all SSP values were slightly below the critical level (60) according to Wilcox (1958).

Residual sodium carbonates (RSC): RSC assesses the irrigation water's proclivity for forming carbonate and dissolving or precipitating calcium and, to a lesser extent, magnesium carbonate. The precipitation of poorly soluble carbonates enhances the sodium hazard of irrigation water and increases the sodicity of irrigated soils as a result. The data indicated that there is no RSC in both water resources in both growing seasons due to that the sum of Ca^{2+}+Mg^{2+} is higher than the sum of CO_3^{2-}+HCO^{3-}, resulting in no sodium toxicity has occurred.

Potential salinity (PS): In the 1st season, PS for the two irrigation water types utilized varied from 9.8 to 14.9 meq/l, while in the 2nd season it ranged from 9.8 to 16.4 meq/l. Richards (1972) observed high PS values above the threshold limit(5meq/l)may be attributable to excessive chloride and sulfate contents in both irrigation sources.

pH: The pH of the blended water ranged between7.4-7.6 while the pH of the drainage waters ranged between 7.3 and 7.8. The pH values of both waters are, therefore, within the normal range (6.5-8.4) as outlined by Ayers and Westcot (1987).

Concerning the cationic concentration of both irrigation waters, the obtained results indicate that the Na^+cation was the dominant one, followed by Mg^{2+},Ca^{++} and K^+. The anionic centration showed that $Cl^-$was the dominant ion followed by HCO_3^- then $SO_4^=$. The $CO_3^=$ ions were not detected in both irrigation waters. The highest concentration of the ions occurred in the blended water, whereas the highest ones were in the agricultural drainage water.

Table 4. Water quality parameters used as irrigation water in the present study

Parameters	Season 2020		Season 2020	
	Blended water	Drainage Water	Blended water	Drainage Water
EC (dSm^{-1})	1.67	2.70	1.73	2.86
pH	7.56	7.25	7.40	7.78
Soluble cations (meq/l)				
Na^+	8.8	14.3	9.5	16.8
K^+	0.8	2.2	0.9	1.5
Ca^{2+}	3.5	6.0	3.4	6.1
Mg^{2+}	3.8	5.4	3.7	5.5
Soluble anions (meq/l)				
CO_3^-	0.0	0.0	0.0	0.0
HCO_3^-	5.4	9.7	5.3	9.9
Cl^-	8.0	12.6	7.3	14.1
$SO_4^=$	3.5	4.7	4.9	5.9
SAR	4.6	6.3	5.0	7.0
RSC (meq/l)	0.0	0.0	0.0	0.0
SSP	52.1	51.3	54.3	56.2
SMgP	22.5	19.4	21.1	18.4
PS (meq/l)	9.8	14.9	9.8	16.4

2. Soil salinity as affected by different treatments:

Soil electrical conductivity (EC) correlates with soil qualities, which impact on crop yield. The data in Table 5 demonstrated that all irrigation treatments caused clear decreases in soil ECeas well as all soluble ions in two depth soil depths (0-30 cm, and 30-60) after harvesting compared to that before cultivating in both growing seasons. these findings are consistent with those of Mahmoud (2008). Soil salinity was decreased from 5.57 before planting to 4.36, 3.86, and 3.36 dSm^{-1}with treatments I_1, I_2 and I_3, respectively during the 1st season, while it was decreased from 3.86 before planting to 3.21, 3, and 2.57 dSm^{-1} with the same treatments in the 2nd season, respectively.The highest value recorded from a depth of 30- 60 cm, may be due to continually percolating water leaching the salts from the topsoil. On the other hand, no differences was noted among all rice cultivars with all irrigation treatments as shown in Table 6.

Table 5. Soil chemical characters of the experimental site before and after cultivation

Paramerer	Season 2020				Season 2021			
	Before cultivation	After harvesting I_1	I_2	I_3	Before cultivation	After harvesting I_1	I_2	I_3
pH	8.40	8.23	8.23	8.23	8.20	8.14	8.14	8.14
EC (dSm^{-1})	5.57	4.36	3.86	3.36	4.36	3.41	3.00	2.63
Soluble Cations (meq/l)								
Ca^{2+}	10.6	4.9	4.7	4.6	6.3	5.0	4.0	5.0
Mg^{2+}	13.1	14.3	13.3	12.3	12.7	11.1	12.1	9.1
Na^+	30.7	24.4	20.4	16.8	19.9	19.1	14.0	11.4
K^+	1.4	1.6	1.5	1.3	1.7	1.7	1.5	1.4
Soluble Anions (meq/l)								
HCO_3^-	1.6	1.3	1.4	1.5	1.6	1.2	1.5	1.6
Cl^-	15.7	11.2	9.2	5.2	16.5	4.9	4.9	4.9
SO_4^{2-}	38.6	32.7	29.3	28.3	22.5	30.7	25.2	20.4
Available Nutrients (mg/kg)								
K	900	920	754.40	690.00	901.6	721.28	676.2	631.12
P	23.4	21.7	17.79	16.28	23.1	18.48	17.32	16.17
N	54.6	76.7	62.89	57.53	54.4	43.52	40.8	38.08

Table 6. Soil salinity (EC) as influenced by quality of irrigation water and rice cultivars

Rice variety	The 1st season, 2020					
	Ec (dSm^{-1}) 0 -30 cm			EC (dSm^{-1}) 30 -60 cm		
	I_1	I_2	I_3	I_1	I_2	I_3
Before planting	5.57	5.57	5.57	6.57	6.57	6.57
Sakha104	4.36	3.86	3.36	4.86	4.46	4.16
Giza177	4.36	3.86	3.36	4.86	4.46	4.16
Giza 178	4.36	3.86	3.36	4.86	4.46	4.16
The 2nd season, 2021						
Before planting	4.36	4.36	4.36	4.86	4.86	4.86
Sakha104	3.41	2.96	2.63	4.24	3.57	3.11
Giza177	3.41	2.96	2.63	4.24	3.57	3.11
Giza 178	3.41	2.96	2.63	4.24	3.57	3.11

3. Growth charactersticts:

All of the growth parameters, heading date, plant height (cm), and panicle length (cm) in the two growing seasons have high significant variances within the three rice cultivars, owing to differences in their genetic backgrounds as shown in Table7. Furthermore, it is obvious that different irrigation treatments had a considerable impact on all growth parameters under this study. However, the difference between the effects of I_3 (blended water), and I_2 (agricultural drainage alternating with the blended water) on these parameters were inconsequential. If the total of salts in irrigation water was found at a high level, a negative effect on crop growth and yield will occure, the excessive quantities of soluble salts will accumulate in the root zone and therefore the crop has extra difficulty in extracting enough water from the salty soil solution. This reduces water uptake by the plant and reduces plant growth.

Heading date: The number of days to heading was lowest with the I_3 treatment as compared with the other treatments in both seasons. The mean number of days to heading for both seasons with I_1,I_2, and I_3 water regimes were 98.56, 97.22, and 97.0 days, respectively, this might be due to the fact that drainage water encourages the plant to create new canopies to replace the damaged ones, hence extending the vegetative period**.** Concerning the number of days to heading as affected by rice cultivar Sakha 104 had the longest heading date (108.0 days) while Giza 177, and Giza 178 had 96.1, and 96.0 days respectively with respect to the interaction between rice varieties and irrigation treatments Giza178 rice varieties significantly produce the shortest period from sowing to heading with the three irrigation treatments in the two seasons (Table8).

Plant height: The highest plant height was recorded with (I_3) irrigation treatment as compared with both other treatments, which were exactly similar in their effects in both seasons. Poor quality water in the terms of drainage water significantly produces the shortest plant, while the blended water (I_3) significantly exerted the tallest plant in both seasons. The tested rice varieties apparently varied in their plant height in both seasons of study Sakha 104 had the tallest plant while, Giza177 brought the shortest plant in both seasons. The interaction effect showed that Sakha 104 with all tested irrigation treatments produces the tallest plant.These results agreed with that obtained by the increased plant height might be due to the effect of water in encouraging cell division and elongation. Also, it might be attributed to favorable root growth and higher mobility of elements (Gomaa et al., 2005 and Patil *et al*., 2017).

Panicle Length (cm), Panicle length (cm) are influenced by the quality of irrigation water and rice cultivars and the interaction between each other (Table7&8). The longest panicle was obtained by I_3 (blended water) in both seasons on the other side the shortest panicle existed by (1_1), these rustles are agreed with Gomaa et al. (2005). Concerning the rice cultivars' effect on panicle length, it was found that Giza178 gave the longest panicle in both growing seasons. These findings are in agreement with those obtained by Shereen et al.(2005) and Mirza et al.(2009).with respect to the interaction between rice varieties and irrigation treatments Giza178 rice varieties significantly produce the shortest period from sowing to heading with the three irrigation treatments in the two seasons.

Table 7. Heading date, plant height, and Panicle length as affected by quality of irrigation water and rice cultivars

Factors	Heading days		Plant height (cm)		Panicle length (cm)	
	2020	2021	2020	2021	2020	2021
Irrigation						
I_1	100.00	98.89	97.00	97.56	19.11	20.00
I_2	100.11	100.67	97.67	99.11	20.11	21.33
I_3	100.56	101.00	98.56	100.22	20.67	21.78
F-test	ns	ns	ns	*	**	**
LSD (0.05)	-	-	-	1.7084	0.5038	0.7344
Rice varieties						
Sakha104	108.22	108.89	102.22	103.67	21.22	21.89
Giza177	96.22	95.89	93.11	94.00	19.67	21.44
Giza 178	96.22	95.78	97.89	99.22	19.00	19.78
F-test	**	**	**	**	**	**
LSD (0.05)	0.6092	1.1777	0.6703	0.4842	0.8839	0.4636

*** = Significant at 0.05 level, ** = Significant at 0.01 level**

4. Yield and Its components:

The number of panicles/hill, number of filled grains/ panicle, 1000-grain weight and the grain yield and their interaction are illustrated in Tables (9&10).

A number of panicles /hill: The number of panicles/hills was significantly affected by the quality of irrigation water and had the same trend in both seasons. The numbers of panicles/hill were17.78, 19, and 19.78 in the 1st season and 18.11, 19.67, and 20.34 in the 2nd seasons for I_1, I_2, and I_3, respectively.There was no significant difference between the number of panicles/hill with I2 (alternate treatment) and I3 (blended water). These rustles are in agreement with that of Gomaa et al. (2005) who found that changing irrigation water types had little effect on a number of panicles /hill. Concerning the effect of rice cultivars, it was found that there were no significant differences between different varieties. The numbers of panicles/hills were 18.89, 18.44, and 19.22in the 1st season 19.67, 19.56, and 20.44, and in the 2nd season for Sakha 104, Giza 177, and Giza 178, respectively. In case of the interaction effects, the data revealed that Sakha 104with irrigated by the blended water gave the highest number of panicles/hills in both seasons (20.5), while the lowest value (17.5) was recorded by Giza 177 irrigated by drainage water.

Table 8. Heading days, plant height, and Panicle length as affected by the interaction between quality of irrigation water and rice cultivars

Treatments		Heading days		Plant height (cm)		Panicle length (cm)	
Irr.	Variety	2020	2021	2020	2021	2020	2021
I_1	Sakha104	106.67	107.00	101.67	102.00	20.33	20.67
	Giza177	97.00	94.00	92.33	92.33	19.33	20.67
	Giza 178	96.33	95.67	97.00	98.33	17.67	18.67
I_2	Sakha104	108.00	109.67	102.00	104.00	22.00	22.33
	Giza177	96.33	96.67	93.00	94.33	19.33	21.67
	Giza 178	96.00	95.67	98.00	99.00	19.00	20.00
I_3	Sakha104	110.00	110.00	103.00	105.00	21.33	22.67
	Giza177	95.33	97.00	94.00	95.33	20.33	22.00
	Giza 178	96.33	96.00	98.67	100.33	20.33	20.67
F-test		**	**	ns	ns	ns	**
LSD (0.05)		0.80	0.6898	-	-	-	0.70

The number of filled grains/ panicle: The data showed the number of filled grains/panicle was significantly affected by irrigation water quality and rice varieties. Applying drainage water for rice significantly restricted panicle number/hill. The blended water possessed the maximum number of panicle/hill in both seasons. The lowest mean number of panicles was given by drainage water in the study. The investigated rice varieties panicle number/ hill of the two seasons were at par.

The number of filled grains/ panicle was significantly influenced by irrigation water quality in both growing seasons. The number of filled grains/ panicle for irrigation water quality was determined to be 85.78, 93.33, and 93.56 in the 1st season, and 86.89, 93.67, and94.78 in the 2nd season under I1, I2, and I3, respectively. These results support the findings of Gomaa et al. (2005). When it came to the influence of rice cultivars on the number of filled grains/panicles, it could be observed that Giza 178 produced the most numbers of filled grains/ panicles, while Giza 177 recorded the lowest values in both growing seasons. Giza 178 is well known as a salt-tolerant variety with a high ability of current photosynthesis resulting in well grain filling resulted in high sink capacity and filled grains/panicle. Similar findings are reported by Zayed et al. 2012 and Mikhael et al. (2018).

1000-grain weight: The obtained data showed that the quality of irrigation water had a significant effect on 1000-grain weight. The 1000-grain weight in the 1^{st} season was 22.81, 23.15, and 24.39 g and in the 2^{nd} season was 22.93, 23.27, and 24.03 g with I_1, I_2, and I_3, respectively**.** Therefore, the 1000-grain weights were increased gradually with decreasing irrigation water salinity in the following order: $I_3 > I_2 > I_1$. These results are also found by Zeng and Shannon

(2000) and Ernesto *et al.* (2007) who reported that 1000-grain weight showed a significant decrease when they applied salt (NaCl) as a source of osmotic stress during the reproductive stage. Regarding the weight of 1000-grain with different rice cultivars, it was found that 1000-grain weights were 23.81, 22.02, and 24.52 gin the 1st season and 23.99, 21.88, and 24.35 g in the 2nd season for Sakha 104, Giza 177, and Giza 178, respectively. In sequence, the variety of Giza 178 recorded the highest 1000-grain weight, while Giza 177 recorded the lowest values in the two seasons. Concerning the effect of the interaction between irrigation treatments and rice varieties on 1000-grain weight (mean of both seasons), the highest 1000-grain weight (24.84 g) was obtained by Giza 178 irrigated by the blended water (I_3), while the lowest value (20.86 g) was obtained with Giza 177 irrigated by the agricultural drainage water (I_1) The observed variation among rice cultivars in 1000-grain weight are mainly attributed to the genetic background. These findings are in agreement with those obtained by (Shereen et al., 2005 , Mirza et al., 2009and Zayed et al. (2012).)

Table 9. Number of panicles/hill, filled-grains/panicle, grain yield (ton/ha), 1000 grains weight(g) and harvest index (hi) as affected by irrigation water quality and rice cultivars

Factors	No of panicles/hill		Filled-grains/panicle		Grain yield (ton/ha)		1000-grain weight		Harvest Index (HI)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
I_1	17.78	18.44	85.78	86.89	9.59	8.988	22.81	22.93	39.76	39.98
I_2	19.00	20.33	93.33	93.67	9.83	9.375	23.15	23.27	39.81	40.22
I_3	19.78	20.89	93.56	94.78	10.19	10.015	24.39	24.03	40.70	40.39
F-test	ns	*	**	**	*	*	*	**	**	ns
LSD0.05	-	1.7451	0.4363	0.97554	0.3182	0.5127	1.0013	0.4243	0.2992	-
Sakha104	18.89	19.67	82.22	82.67	9.64	9.83	23.81	23.99	40.18	40.22
Giza177	18.44	19.56	80.78	82.11	8.69	8.66	22.02	21.88	40.09	39.80
Giza 178	19.22	20.44	109.67	110.56	11.31	9.88	24.52	24.35	40.00	40.56
F-test	*	**	**	**	**	**	**	**	ns	*
LSD0.05	0.6092	0.4420	1.9717	1.7680	0.2849	0.3589	0.4221	0.2878	-	0.5391

*** = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.**

Table 10. Number of panicles/hill, filled-grains/panicle, grain yield (ton/ha), 1000 grains weight(g) and harvest index (HI) as affected by the interaction irrigation water quality and rice cultivars

Rice variety		No of panicles/hill		Filled-grains/panicle		Grain yield (t/ha)		1000-grain weight		Harvest Index (HI)	
		2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
	Sakha104	17.67	18.00	77.67	79.33	9.50	9.73	23.63	23.65	40.12	40.25
I_1	Giza 177	17.00	18.00	74.00	74.33	8.07	8.23	20.62	21.09	39.58	39.23
	Giza 178	18.67	19.33	105.67	107.00	11.19	9.00	24.18	24.04	39.58	40.47
	Sakha104	19.00	20.00	84.00	84.00	9.57	9.71	23.57	23.87	39.56	40.08
I_2	Giza 177	18.67	20.00	83.67	84.33	8.69	8.45	21.24	21.85	39.87	39.42
	Giza 178	19.33	21.00	112.33	112.67	11.23	9.97	24.64	24.08	40.01	41.15
	Sakha104	20.00	21.00	85.00	84.67	9.85	10.07	24.24	24.45	40.86	40.33
	Giza177	19.67	20.67	84.67	87.67	9.28	9.33	24.20	22.72	40.84	40.76
I_3	Giza 178	19.67	21.00	111.00	112.00	11.47	10.66	24.75	24.93	40.41	40.07
	F-test	ns	ns	ns	**	**	**	**	ns	ns	**
	LSD0.05	-	-	-	-	0.31	0.34	1.0013	-	-	0.58

Grain Yield:

Regarding the effect of irrigation water quality, grain yield and its attributes and their interaction are illustrated in Tables (9&10). The data showed that irrigation water quality significantly affected the grain yield. The grain yield values were 9.59, 9.83, and 10.19 ton ha-1 in the 1st season and 9.988, 9.375, and 10.015 ton ha^{-1}in 2nd seasons under I_1, I_2, and I_3, respectively. Table (11), data showed also that the increases due to I_3 in relation to $I_1$and I_2 were 8.9% and 5.2%, respectively in the 1st season, while in the 2ndseason the increases were 6.2 % and 3.6, respectively. Concerning the grain yield with different rice cultivars under this study, the grain yield was greater with Giza 178 than with either Sakha 104 or Giza 177which both of them were similar in their yields in both seasons. The grain yield in the 1stseason for Sakha 104, Giza 177, and Giza178 were 9.64, 8.69, and 11.31 ton $ha^{-1}$and in the 2021 season was 9.83, 8.66, and 9.88 ton ha^{-1}, respectively. The highest grain yield was obtained with Giza 178 irrigated by blended water(11.066 kg ha^{-1}). So, Giza 178 is the best variety, as it tolerated salinity and the decrease in its grain production was only 8.9% when it was irrigated by drainage water (I_1). Ascha and Wopereis (2001) explained that floodwater EC <2 dSm^{-1} hardly affected rice yield Hossain et al. (2020). Giza 178 is the best variety might be due to its ability to increase the activity of cell division and elongation, and enhanced physiological activity inside the plant such as photosynthesis, enzyme activity, transportation of the dry matter content to panicle for grain fillings resulting in high grain yield Hossain et al. (2020).

Harvest Index (HI): It was recognized that the harvest index (HI) was significantly affected by the irrigation water quality. The HI values in the 1st season were 39.76, 39.81, and 40.7 and in the 2nd season were 39.98, 40.22, and 40.39 with I_1, I_2, and I_3, respectively. This finding is consistent with the findings of Zeng and Shannon (2000), who found that when salinity was 3.40 dSm^{-1}, the Harvest index was dramatically reduced. Concerning the rice cultivars' effect on HI, it was insignificant among all cultivars' understudy in the 1st season, while it was significant in the 2nd season.

5. Irrigation water productivity (IWP):

Data illustrated in Table (11) showed that mean values (mean of the 2 seasons) of IWP of rice (kg grain/m^3 of water applied) as affected by the quality of irrigation water and rice cultivars during the 2020 and 2021 growing seasons.The results showed that I_3treatment increased IWPfor Sakha 104 by 15.6% and 10.3% more than I_1 and I_2irrigation and (16.1% and 11.1) for Giza 177 and 9.3 and 5.6 % for Giza 178, respectively

Table 11. Irrigation water applied (m^3ha^{-1}), grain yield (t ha^{-1}) and irrigation water productivity (kgm^{-3}).

Treatment		Season 2020			Season 2021			Mean of 2 season		
Rice varieties	**Irr.**	**IWa**	**GY**	**IWP**	**IWa**	**GY**	**IWP**	**IWa**	**GY**	**IWP**
Sakha 104	I_1	11781	9.496	0.81	9734.2	9.00	0.92	10757.6	9.248	0.86
	I_2	10948	9.568	0.87	8234.8	8.23	0.99	9591.4	8.899	0.93
	I_3	10115	9.853	0.97	8996.4	9.73	1.08	9555.7	9.7915	1.02
Giza 177	I_1	11781	8.068	0.68	9710.4	9.71	0.99	10745.7	8.889	0.83
	I_2	10948	8.687	0.79	8449	8.45	1.00	9698.5	8.5685	0.88
	I_3	10115	9.853	0.97	9972.2	9.97	0.99	10043.6	9.9115	0.99
Giza 178	I_1	11781	11.186	0.95	10067.4	10.07	1.00	10924.2	10.628	0.97
	I_2	10948	11.234	1.03	9329.6	9.33	1.00	10138.8	10.282	1.01
	I_3	10115	11.472	1.13	10662.4	10.66	0.99	10388.7	11.066	1.07

CONCLUSION

Using rice cultivar Giza 178 as the best cultivar between evaluated attributes under the same soil and water conditions is recommended in this study. In addition, agricultural drainage water is used for irrigation using alternating with other water sources. For most of the evaluated parameters including grain yield, irrigation with blended water yielded the same value as irrigation with blended water alternated with drainage water one by one. The Giza 178 variety, however, did not reduce yield by more than 9.6% when watered with drainage water. As a result, planting the Giza 178 variety, which performed Sakha 104 and Giza 177, is suggested to be cultivated under saline conditions. Despite the reality that Giza 178 was irrigated with drainage water, it produced almost as much as Sakha 104 and more than Giza 177, which was irrigated with the blended canal water. Thus, it can be concluded that agricultural drainage water alternating with other water sources can be used for irrigating some crops, especially high or moderate tolerant cultivars to salinity without serious effects on their yields or on soil properties.

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تأثير الرى بمياه الصرف الزراعى بالتناوب مع مياة مخلوطة على محصول وجودة بعض أصناف الأرز وجودة التربة

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[1] قسم بحوث المقننات المائية والرى الحقلى –معهد بحوث الاراضى والمياة والبيئة - مركز البحوث الزرعية

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أجريت الدراسة الحالية في شمال دلتا النيل (منطقة الحامول) حيث يوجد أكثر من 200 ألف فدان من التربة المتأثرة بالأملاح وتم زراعتها منذ عام 1970. وتعاني هذه المنطقة من نقص الإمداد بمياه الري لأنها تقع في نهايات الترع. يهدف هذا البحث لتقييم إمكانية الاستفادة من مياه الصرف الزراعي، حيث ندرة المياه في هذه المنطقة، لري الأرز وأثره على نمو وإنتاجية وجودة عدة أصناف من محصول الأرز خلال موسمي 2020 و 2021. وتم دراسة أثر الري بالصرف الزراعي ومياه الترع على خصائص النمو والمحصول ومكوناته وجودة الحبوب لثلاثة أصناف ارز. وكانت معاملات الري: أ - الري بمياة الصرف الزراعي, ب- الري بمياة الصرف الزراعي بالتناوب مع مياه مخلوطة , جـ - الري بمياه ترعة مخلوطة. واستخدمت أصناف الأرز:سخا 104، جيزة 177، جيزة 178.أظهرت النتائج أن عدد الأيام حتى طرد السنابل، طول النبات، طول السنبلة، عدد السنابل/الجورة، عدد الحبوب المملوءة /السنبلة ، محصول الحبوب، وزن 1000 حبة ومؤشر الحصاد كانت أفضل مع المياه المخلوطة من مياه الصرف الزراعي. ولقد تم تحقيق أكبر محصول للصنف جيزة 178 المروى بالمياه المخلوطة، كما أن محصولة نقص بحوالى 9.6٪ عند رية بمياه الصرف. وبينت النتائج أن صنف جيزة 178 التى كانت تروى بمياه الصرف أنتجت محصول يقترب من محصول صنف سخا 104 وأكثر من محصول جيزة 177التي كانت تروى بالمياه المخلوطة. ونتيجة لذلك، يقترح زراعة صنف جيزة 178 بمياه الصرف، والذي تفوق على كلا من سخا 104 وجيزة 177 تحت ظروف هذة التجربة.