Response of some Rice Cultivars (*Oryza sativa* L.) to the Reuse of Drainage Water in Different Combinations with Nile Irrigation Water

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ABSTRACT

This investigation was carried out at the Experimental Farm station, El-Karada, Kafr El-Sheikh Governorate, Egypt during 2002 and 2003 seasons to investigate the effect of water salinity levels (100% drainage water "w_1", 50% fresh water + 50% drainage water "w_2" , 66.67% fresh water + 33.33% drainage water "w_3" , 75% fresh water + 25% drainage water "w_4," 80% fresh water + 20% drainage water "w_5" and 100% fresh water "w_6") on yield of three rice cultivars; (Giza 177", v_1" Giza 178 "v_2" and Sakha 104 "v_3"). The results indicated that Giza 178 produced the highest average values of leaf area, root length,. number of root per plant, root volume, shoot/root ratio, panicle length, No. of branches per panicle and panicle weight in both seasons. On the other hand, Sakha 104 cultivar had the highest average values of No. of filled grains/panicle, 1000- grain weight, spikely ratio, grain yield per fed. and water utilization efficiency in the two seasons. Giza 177 had the highest average values of dry matter accumulation and plant height at harvest in both seasons. Using the irrigation water with 100% or 80% fresh water recorded the highest average values of the forementioned characters, whereas, the lowest averge values were obtained by w_1 and w_2 treatments. Data clear that no significant differences among the three rice cultivars for rice quality. Also, rice quality had no significant effect due to irrigation with water salinity . Generally, from the result of this study, the mixed water of the fresh and the drainage water for sakha 104 cultivar produced the highest yield.

INTRODUCTION

Rice (Oryza sativa L.) is one of the most important cereal crops in the world due to its grain nutritive value and the relatively lower cost of production than any other food sources. In Egypt, rice is one of the principal cereal food as well as exporting agriculture crop. RRTC (2002) reported that the total cultivated area in 2001 was 1.340 million feddan produced 5.230 million tons of paddy rice with an average yield about 3.900 ton/fed.

Under the conditions of arid and semi-arid regions, as in Egypt, irrigation water is a limiting factor for agricultural expansion. The use of low water quality, such as drainage water might be requested. About 7.7 billion m^3 of drainage water are expected to be used for irrigation in the Delta (Abu zeid, 1995). The policy of the government in Egypt is to reuse drainage water for irrigation by mixing with Nile water 1: 1 if the concentration is 700 to 1500 mg/L., ratios of 1: 2; 1:3 if its concentration is 1500 to 3000 mg/L respectively and 1:4 if its concentration is more than 3000 mg /L . Studying crop production under different levels of saline water is considered for evaluation water use. It is known that field crops and their varieties differ greatly in their response to salinity. Actual response to salinity varies also with stage of plant growth, (Jefferies, 1988). The degree of injury, however, depends on the nature and concentration of salts, soil pH , water regime, method of planting, seedling age, growth stage of the plant, duration of exposure to salt, and temperature (US Salinity Labs. Staff, 1954). Ponnamperuma and Bandy Opadhya (1980). reported that, symptoms of salt injury in rice are stunted growth, rolling of leaves, white leaf tips, white blotches in the laminae, drying of older leaves, and poor root growth. The percentage of dead leaves is a good measure of salt injury. Also, salinity during reproductive stage decreases grain yield much more than salinity during vegetative growth stage (Akbar and Ponnamperuma 1982). Most rice cultivars are severely injured in submerged soil culture on EC of 8-10 dsm^{-1} at 25C°; sensitive ones are damaged even at $2dsm^{-1}$ (Mass and Hoffman 1997). Continuous irrigation in saline soils is generally recommended to help salt leaching from the root zone, particularly with poor quality water. It was found that irrigation at 4-day interval under these conditions gave the highest yield (Abo-Soliman et al. 1992, El-Mowelhi et al. 1995 a or b and Zayed 1997).

The objective of the present investigation was to study the response of some rice cultivars to different irrigation water qualities and also to define the adapted cultivar with using low water quality.

MATERIALS AND METHODS

Two field trials were conducted at the Farm of El-Karda Agricultural Research station, kafer El-sheikh Governorate, Egypt, during 2002 and 2003 growing seasons to study the effect of different levels of water salinity on some rice cultivars. Some physical and chemical properties of the soil site for the two experiments were determined according to FAO (1976) and Black (1965) and presented in tables (1and 2). The chemical analysis of fresh and drainage water were according to Richard's Analysis (1969) and are presented in Table (3). Each experiment included 18 treatments, which were the combination of the three rice cultivars Giza 177 (v_1) , Giza 178 (v_2) and sakha 104 (v_3) and six water salinity levels as follows:

1-100 % Drainage water (w_1).
2-50% fresh water + 50% drainage water (w_2).
3-66.67% fresh water + 33.33 % drainage water (w_3).
4-75% fresh water + 25 % drainage water (w_4).
5-80% fresh water + 20 % drainage water (w_5).
6-100% fresh water (w_6).

The total water applied in the two seasons was 4192.91 and 4402.56 m^3/fed., respectively.

The design of each experiment was split-plot design with four replications. The main-plot was assigned for the six water salinity levels and the sub-plot for the three rice cultivars. Therefore, six main plots were utilized each was 10x20 m and was surrounded by two meter wide ditches for water delivery.

Rice grains at a rate of 50 kg/fed. was used and sown as usual on 15th and 17th May the first and second seasons, respectively. A recommended phosphorus fertilizer was added to all plots during the preparation of the soil site at the rate of 15 kg P_2O_5/fed. Nitrogen fertilizer was applied in the form of ammonium sulfate (20.50%) at the rate of 60 kg N/fed.

Seedling (3-4/hill) were transplanted in hills 20cm apart and 20cm between rows. The weeds were chemically controlled using Saturn (2 l/fed.) at 7 days after sowing in the nursery and at four days after transplanting in the field.

The two outer rows were excluded to eliminate the border effect and growth attributes samples were taken from inter three rows of each plot and the following characters were estimated:

I-a. Growth characteristics:

1- Dry matter accumulation: samples were randomly taken at 20, 35, 50 and 65 days after transplanting. Samples were air dried and then to a constant weight in a forced air-oven at 70°c and dry weight was recorded.

2-Leaf area: Leaf area was measured according to the method proposed by Gomez (1972).

3- Growth rates: were estimated according to Radford (1967) and Hunt (1989) as follows:

3.a) Crop growth rate: (CGR). $= \dfrac{W2-W1}{T2-T1}$ (g/m^2/week)

3.b) Relative growth rate: (RGR) $= \dfrac{\log_e w_2 - \log_e w_1}{T2-T1}$ (g/g/week)

Where, w_1 and w_2 refer to the weight of dry matter at time t_1 and t_2

3.c) Net assimilation rate: (NAR)=

$$\frac{W2 - W1}{T2 - T1} \cdot \frac{\log_e w2 - \log_e w1}{LA2 - LA1}$$

(g/cm^2/week)

Where, LA_1 and LA_2 refer to the leaf area at time t_1 and t_2

I.b. Shoot and Root characters at panicle initiation:

1- Root length "cm"

2- Number of roots /plant .Number of all developed secondary and tertiary roots/ plant was counted (IRRI, 1984).

3- Root volume (cm^3): volume of the root /plant was determined at the maximum tillering stage in cubic centimeters by emerging the roots in a measure cylinder tube filled with water. (IRRI, 1984).

4- Shoot/Root ratio.

II- Yield and its components:

At harvest, plants of ten guarded hills were taken at random from the fifth inner rows in each sub-plot (3x4m) to determination the following characters: panicle length (cm), number of branches/panicle, number of filled grains/panicle, panicle weight (g), 1000-grain weight, spikely percentage, and plant height according to the standard evaluation system for rice IRRI (1996).

In addition, the five central rows of each plot were harvested and left for air drying about three days, then tied and threshed. Grain yield (kg/m^2) was determined (at grain moisture content about 15%) then converted to estimate grain yield in tons/fed. Water utilization efficiency was calculated as follows:

WUE= Rice grain yield (tons/fed) /total water applied (m^3/fed).

For the quality characteristics. grain length, grain width was determined as average of 15 grains of rough rice per genotype. Grain shape was determined according to Khush et al. (1979). Gel consistency was measured as described by Cagampang et al. (1973). Moreover, gelatinization temperature was measured in terms of alkali disintegration, six uniformly milled grains /replicate were placed in small petri plate containing 1.7% KOH solution at 30 ± 1° c for 14 hours samples were scored for the nature and degree of disintegration following the procedure outlined by IRRI (1975).

III – Irrigation water applied:

Discharge measurements were made by using a fixed crested weir using its Empirical equation according to Masoud (1967), as follows:

$$Q = CLH^{3/2}$$

Where:

Q = Discharge in cubic meter per minute.
L = Length of the crest in meter
H = water head in meter
C = Coefficient of discharge

All collected data were statistically analyzed using the IRRISTAT. computer program (IRRI, 1991). Duncan's (1955) multiple range test (DMRT) was used to compare means at 0.01 and 0.05 level of probability.

RESULTS AND DISCUSSION

I-a Growth characteristics:

1-Dry matter accumulation (g/hill):

The data presented in Table (4) indicate that the response of (DMA) to water salinity levels was positively affected. The treatments of 100% or 80% of irrigation with fresh water recorded significantly the highest average values. Whereas. the lowest average values were obtained by 50% or 100% of drainage water, this reduction might be attributed to the hazard effect of high salinity levels on plant photosynthesis. Also, the drainage water caused a harmful effect on the seed germination. Data also, indicate that sakha 104 cultivar had a highest dry matter accumulation comparing with Giza 177 and Giza 178 in the first and second growth stages while, in the third and fourth growth stages Giza 177 was the highest.

The effect of the interaction among cultivars and irrigation with water salinity levels on dry matter accumulation was significant in both seasons. The highest average values were recorded by Giza 177 with w_5 and w_6 treatments, while, the three cultivars with w_1 and w_2 treatments gave the lowest average values. Similar results were obtained by El-Mowelhi et al. (1995 a or b), Assey (1987), Zayed et al. (1997) and Zein and Shahawy (2000).

2- Leaf area :

It is clear from Table (5) that leaf area was affected significantly by irrigation with water salinity in both seasons. The highest averages were recorded by all treatments, except, w_1 and w_2 treatments which had the lowest averages in the two seasons.

Data also, indicate that no significant differences were obtained between cultivar Giza 178 and Sakha 104 in all growth stages except Giza 178 which surpassed significantly all other cultivars in the fourth growth stage in both seasons.

The effect of the interaction between cultivars and irrigation with water salinity levels on leaf area was significant in both seasons. The three cultivars with the two treatments w_5 and w_6 gave the highest averages, while, w_1 and w_2 treatments gave the lowest ones in both seasons. Similar results have been reported by Matsushima (1966), Technical report No. 48 (1986), Ebaid (1995) and Fukai (1996).

3- Crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR)

Data in Figs.(1, 2 and 3) showed that these characters responded significantly to irrigation with different levels of water salinity in both seasons. All the mixed water gave the best results for these characters, except those of w_1 and w_2. The lowest average values for dry matter accumulation which affected badly with w_1 and w_2 treatments and also, this reduction might be attributed to the hazard effect of high salinity and sodocity of drainage water on photosynthesis rate. Data showed that cultivars varies significantly in CGR, RGR and NAR in both seasons. Giza 177 produced significantly the highest values for these characters, while Giza 178 had the lowest values in the two seasons. This superiority of Giza 177 over the other two cultivars can be attributed to its relatively higher dry matter accumulation (Table 4) while, the opposite was true for Giza 178 in both seasons. Similar results have been reported by Radford (1967) and Hunt(1989). The interaction had a significant effect in both seasons.

I-b Root characteristics:

The data presented in Table (6) showed that all these characters were affected significantly by irrigation water salinity levels in both seasons. The highest average values for these characters were recorded by w_5 and w_6 treatments, while, w_1 and w_2 treatments had the lowest values, due to its high salinity and sodocity levels. Data also, indicate that significant differences among the three cultivars in root length, number of roots/plant, root volume and shoot/root ratio in both seasons. Giza 178 produced significantly highest average values for these charactars, while, Sakha 104 had the lowest averages only in the number of roots/plant and root volume. These results are in harmony with those obtained by Ebada (1992) and Zayed (1997) which they found that Giza 178 gave the highest averages for root length and shoot/roots ratio chracters compared with sakha 102 and Sakha 104 cultivars.

The interaction was significant between cultivars and irrigation with water salinity levels in the two seasons. The highest average values for these characters were recorded by cultivars with w_5 and w_6 treatments, while, the lowest average values were recorded by cultivars with w_1 and w_2 treatments.

II. Yield and its components:

II. a. yield components:

Data presented in Tables (7 and 8) showed that these characters were affected significantly by irrigation with water salinity levels in both seasons.

The use of irrigation water with 100% or 80% fresh water recorded the highest average values of the forementioned characters, whereas, the lowest average values were obtained with 50% or 100% of drainage water treatments, which have high salinity and sodocity levels.

Data also, indicate that significant differences among the three rice cultivars in plant height, panicle length, panicle weight, number of grains/panicle, 1000-grains weight and spikely percentage characters, except number of branches/panicle in both seasons. It is clear that Sakha 104 Produced significantly highest average values followed by Giza 178 cultivar, for these characters except, plant height, whereas, Giza 177 gave the highest average value for plant height .

The interaction was significant between cultivars and irrigaition water salinity levels in both seasons. Giza 177 with all mixed water except drainage water only "w_1" produced the highest average values in plant height, panicle length and number of branches/panicle while, Sakha 104 produced the highest values for number of grains/ panicle, 1000- grains weight and spikely percentage characters when irrigated with all levels of water salinity except

100% drainage water treatment. These results showed great similarity to those obtained by Mass (1990), Ebada (1992), Ebaid (1995) and Mass and Hoffman (1997).

II. b. Grain yield and water utlization efficiency(WUE):

Results indicate that these characteristics responded significantly to irrigation water salinity levels in both seasons. The results showed that using fresh water (w_6) for irrigation produced the best grain yield. and WUE (4.69 tons/fed and 1.12 kg/m^3 of water, respectively) in the first season and (4.46 tons/fed and 1.06 kg/m^3 of water, respectively) in the second season. Also, it was found that mixed water gave slightly reduced grain yield, while, reusing drainage water (w_1) significantly dropped the grain yield and WUE (the reduction rates of grain yield and WUE were 45.59 and 45.63% , respectively) in both seasons. These results are in agreement with those obtained by Yadov (1973), Verma and Neue (1984), Technical report No.48 (1986) Ebaid (1995), El-Mowelhi et al (1995a or b), and Mass and Hoffman (1997).

Data also, showed that cultivars had highly significant variation in grain yield and WUE in both seasons. Sakha 104 produced significantly highest grain yield and WUE while, Giza 177 had the lowest averages in grain yield and WUE in both seasons (Tables 7 and 8 and Fig. 4). This superiority of Sakha 104 cultivar in grain yield over the two cultivars can be attributed to its relatively higher panicle weight, number of filled grains/panicle and 1000-grain weight, while the opposite was true for Giza 177, in both seasons.

The interaction was significant between rice cultivars and irrigation water salinity levels. The highest average values were obtained by Sakha 104 with all mixed water salinity levels except w_1 treatment, of compared with the other two cultivars. Similar findings have been reported by Ebaid (1995), El-Mowelhi et al (1995 a or b) and Mass and Hoffman (1997).

III. Rice Quality

Data presented in Table (9) showed that these characters insignificant affected by all irrigation water salinity levels in both seasons. Data also, showed no significant differences among rice cultivars for all these characters in both seasons. All rice cultivars were in soft gel consistency and had low GT. indicating less resistance and shorter cooking time. These results showed great similarity to those obtained by Cagampang et al. (1973), Khush *et al.* (1979), El-Kady *et al.* (1992), Rafey *et al.* (1992) and IRRI (1996).

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Table 1. Soil physical properties of the experiment site.

Soil depth cm	Particle size distribution			Soil texture
	Sand %	Silt %	Clay %	
0-20	15.60	22.20	62..00	Clay
20-40	18.30	25.20	56.50	Clay
40-60	22.35	26.20	51.45	caly

Table 2. Soil chemical properties of the experiment site.

Soil depth cm	Ec ds/cm	PH 1:2.5	Soluble cations (meq/L)				Soluble anions (meq/L)			
			Ca++	Mg++	Na+	K+	Co_3-	Hco_3-	cl-	So_4--
0-20	1.98	8.2	5.6	5.00	9.2	0.65	-	9.1	6.5	4.85
20-40	2.20	8.1	6.4	5.70	9.7	0.75	-	9.00	6.9	6.65
40-60	2.60	8.2	6.9	5.85	14.3	0.85	-	10.2	12.1	5.60

So_4 = Was determined by difference between cations and anions.

Table 3. Chemical analysis of fresh and drainage water (averages of four random samples during).

Samples	PH	Ec ds/cm	Soluble cations (meq/L)				Soluble anions (meq/L)				SAR
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3	Hco_3	cl	So_4	
					15/6/2002						
fresh water	8.4	0.61	3.35	2.00	0.66	0.28	-	3.20	1.80	1.47	0.40
Drainage water	7.9	1.21	4.68	2.52	2.72	1.10	-	6.40	3.45	2.34	1.43
					5/8/2002						
fresh water	7.4	0.55	2.18	1.97	1.44	0.86	-	4.00	1.25	0.52	0.93
Drainage water	7.62	1.72	6.22	4.33	5.16	2.26	-	8.12	6.75	2.73	2.24
					12/6/2003						
fresh water	8.00	0.46	1.50	1.50	1.65	0.26	-	3.10	1.2	0.85	1.35
Drainage water	7.60	1.74	7.43	3.26	4.42	1.57	-	7.4	7.15	2.85	1.91
					11/8/2003						
fresh water	8.1	0.62	1.38	2.75	1.25	0.92	-	3.23	2.03	1.13	0.87
Drainage water	7.6	2.12	5.14	7.03	4.97	4.07	-	6.82	8.87	5.52	2.01

Table 4. Effect of irrigation with different levels of water salinity and rice cultivars as well as their interaction on dry matter accumulation (g/hill) at four growth stages in the two seasons (2002 - 2003).

Treatments	Growth-1 45 days		Growth-2 60 days		Growth-3 75 days		Growth-4 90 days	
	2002	2003	2002	2003	2002	2003	2002	2003
water salinity levels								
W1	52.23f	50.66f	64.47f	62.54f	70.17f	68.07f	95.08e	92.23e
W2	65.27e	63.52e	77.38e	75.06e	83.36e	80.86e	128.74d	124.87d
W3	74.35d	72.12d	86.41d	83.82d	110.93d	107.60d	139.42c	123.24c
W4	82.52c	80.04c	94.95c	92.10c	123.17c	119.48c	159.57b	154.78b
W5	92.46b	89.69b	103.82b	100.70b	131.54b	127.60b	172.88a	167.69a
W6	109.87a	106.58a	122.11a	118.45a	148.78a	144.32a	170.06a	164.95a
Cultivars								
V1	80.42b	78.01b	92.66c	89.88c	114.99a	111.54a	154.22a	149.59a
V2	71.63c	69.49c	83.81b	81.29b	109.51b	106.22b	131.64c	127.69c
V3	86.30a	83.71a	98.10a	95.16a	109.48b	106.20b	147.01b	136.60b
Interaction								
V1 W1	47.87c	46.43c	60.11c	58.31c	73.34de	71.14de	96.49c	93.59c
V1 W2	72.04b	69.88b	84.28b	81.75b	87.73d	85.09d	137.25bc	133.13bc
V1 W3	75.52b	73.25b	87.76b	85.13b	108.79c	105.53c	146.98b	142.57b
V1 W4	78.82b	76.46b	91.07b	88.34b	129.88b	125.98b	171.26ab	166.12ab
V1 W5	87.38b	84.76b	99.62b	96.63b	144.89a	140.46a	186.35a	180.76a
V1 W6	120.89a	117.26a	133.13a	129.14a	145.83a	141.02a	186.99a	181.38a
V2 W1	53.78c	52.17c	66.02c	64.04c	68.64d	66.58d	70.04c	67.94c
V2 W2	65.49b	63.53b	77.34b	75.02b	81.73c	79.28c	124.40b	120.67b
V2 W3	74.96ab	72.71ab	86.64ab	84.04ab	111.91bc	108.55bc	126.34b	122.55b
V2 W4	74.40ab	72.17ab	87.20ab	84.58ab	122.19b	118.52b	151.87ab	147.31ab
V2 W5	75.8ab	73.53ab	88.04ab	85.40ab	123.38b	119.68b	155.63a	150.96a
V2 W6	85.37a	82.81a	97.61a	94.68a	149.20a	144.72a	161.57a	156.76a
V3 W1	55.04e	53.39e	67.28e	65.26e	68.54e	66.48e	118.72d	115.16d
V3 W2	58.29d	56.54d	70.53d	68.41d	80.62d	78.20d	124.56c	120.82c
V3 W3	72.58c	70.40c	84.82c	82.28c	112.08c	108.72c	144.95bc	104.60bc
V3 W4	94.33b	91.50b	106.57b	103.37b	117.45bc	113.93bc	155.57b	150.90b
V3 W5	114.21ab	110.78ab	123.79ab	120.08ab	126.45b	122.66b	176.66a	171.36a
V3 W6	123.36a	119.66a	135.60a	131.53a	151.76a	147.21ab	161.61ab	156.76ab

Means followed by a similar letter are not significantly different at the 5 % level by DMRT.

Table 5. Effect of irrigation with different levels of water salinity and rice cultivars as well as their interaction on Leaf area (cm^2) at four growth stages in the two seasons (2002-2003)

Treat-ments	Growth-1 45 days		Growth-2 60 days		Growth-3 75 days		Growth-4 90 days	
	2002	2003	2002	2003	2002	2003	2002	2003
water salinity levels								
W1	1713.92bc	1685.71bc	1862.08b	1821.80b	2258.19c	2177.30c	2497.55b	2391.27b
W2	1861.057b	1802.52b	2114.01bc	2008.30bc	2492.95bc	2529.76bc	2856.46b	2713.64b
W3	2047.21b	1853.24b	2378.55b	2259.63b	2830.00b	2549.35b	3037.75ab	2849.45ab
W4	2130.11ab	2023.63ab	2491.49b	2366.92b	2734.59b	2453.10b	3218.89ab	2807.81ab
W5	2321.33a	2296.99a	2611.72ab	2420.85ab	2982.44ab	2842.70ab	3639.31a	3374.15a
W6	2703.78a	2477.10a	3031.89a	2940.58a	3201.05a	3040.99a	3889.09a	3694.64a
Cultivar								
V1	1787.71b	1698.32b	2395.73ab	2275.94ab	2159.52b	2051.54b	2479.16b	2404.79b
V2	2168.14a	2059.73a	2430.98a	2309.43a	2758.65a	2620.72a	3386.35a	3217.03a
V3	2077.51a	1973.63a	2426.50a	2305.18a	2720.79a	2584.75a	2809.91b	2669.41b
Interaction								
W1	1654.75d	1572.01d	1942.50e	1845.38e	2226.25d	2114.94d	2568.75c	2440.31c
W2	1812.70d	1722.07d	2058.75d	1955.81d	2454.04bc	2815.70bc	2815.96b	2675.16b
V1 W3	2133.85c	2027.16c	2475.38bc	2351.61bc	2963.89c	2331.34c	2925.25b	2669.70b
W4	2227.43c	2116.06c	2400.75c	2280.71c	2577.58b	2448.70b	2957.50b	2809.63b
W5	2370.81b	2527.51b	2538.18b	2411.27b	2846.75ab	270441ab	3607.50a	3427.13a
W6	2660.54a	2252.51a	2958.80a	2810.86a	3052.50a	2899.88a	3444.65a	3272.42a
W1	1722.50d	1809.02d	1810.00d	1830.46d	2414.09d	2293.39d	2789.66d	2705.97d
W2	1904.23d	1911.11d	2170.79cd	2062.25cd	2527.31cd	2400.94cd	2754.18d	2616.47d
V2 W3	2011.67c	1635.95c	2256.43b	2143.61b	2671.55c	2537.97c	3254.94c	3092.23c
W4	2018.11c	1917.20c	2646.30b	2513.99b	2671.55c	2537.97c	3440.19c	2517.78c
W5	2351.18b	2233.56b	2336.05ab	2219.25ab	3175.56b	3016.78b	3702.93b	3268.18b
W6	3001.00a	2851.58a	3366.30a	31978.99a	3591.84a	3412.25a	4376.19a	4157.38a
W1	1764.50d	1676.09d	1833.75d	1789.56d	2134.24c	2123.58c	2134.24c	2027.53c
W2	1867.78d	1774.39d	2112.50c	2006.88c	2497.50b	2372.63b	2999.25b	2849.29b
V3 W3	1996.11c	1896.60c	2403.85b	2283.66b	2854.56ab	2778.75ab	2933.06b	2786.41b
W4	2144.8b	2037.62b	2427.43b	2306.06b	2954.69a	2372.63a	3258.97ab	3096.02ab
W5	2242.0ab	2129.9ab	2960.93a	2632.03a	2925.00a	2806.91a	3607.50a	3427.13a
W6	2449.79a	2327.22a	2770.56ab	2812.88ab	2958.80a	2810.86a	3846.44a	3654.12a

Means followed by a similar letter are not significantly different at the 5 % level by DMRT.

Table 6. Effect of irrigation with different levels of water salinity and rice cultivars as well as their interaction on root characters and shoot /Root ratio at panicle initiation in the two season (2002-2003).

Treatments	Root length "cm)		No.of Roots/plant		Root Volume"cm3"		Shoot/Root Ratio	
	2002	2003	2002	2003	2002	2003	2002	2003
water salinity levels								
W1	28.44c	27.02c	246.89e	234.55f	30.44c	28.92c	1.50b	1.43b
W2	27.89c	26.50c	270.33d	256.81e	32.67b	31.04b	1.18cd	1.12cd
W3	29.22b	27.76b	276.56d	262.73d	33.00ab	31.35ab	1.35c	1.28c
W4	30.11b	28.60b	285.47c	271.20c	34.67ab	32.94ab	1.54b	1.46b
W5	32.00ab	30.40ab	327.67a	311.28a	36.33a	34.51a	1.82ab	1.73ab
W6	34.11a	32.40a	303.00b	287.85b	36.00a	34.20a	1.98a	1.88a
Cultivars								
V1	29.05c	27.60c	288.00b	273.60b	33.67ab	31.99ab	1.38b	1.35b
V2	32.00a	30.40a	294.73a	279.99a	35.28a	33.52a	1.54a	1.46a
V3	30.33b	28.81b	272.22c	258.61c	32.61b	30.98b	1.50a	1.43a
Interaction								
W1	26.33c	25.01c	258.55d	245.10d	27.00b	25.65b	0.75c	0.95c
W2	26.33c	25.01c	255.33d	242.56d	34.00a	32.30a	1.00c	0.95c
V1 W3	27.33bc	25.96bc	253.67d	240.99d	34.33a	32.61a	1.32b	1.25b
W4	30.33ab	28.81ab	275.67c	261.89c	34.67a	32.94a	1.39b	1.32b
W5	32.00a	30.40a	383.67b	364.49b	37.33a	35.46a	1.78a	1.69b
W6	32.00a	30.40a	301.67a	286.59a	34.67a	32.94a	2.01a	1.91a
W1	29.67b	28.19b	258.00c	245.10c	34.33b	32.61b	1.00c	0.95c
W2	29.33b	27.86b	296.67bc	281.84bc	32.33c	30.71c	1.34ab	1.27ab
V2 W3	30.67b	29.14b	300.33bc	285.31bc	33.67b	31.99b	1.46ab	1.39ab
W4	31.67b	30.09b	304.07ab	288.87ab	34.67b	32.94b	1.73b	1.64b
W5	31.00b	29.45b	303.33d	288.16ab	37.33ab	35.46ab	1.76b	1.67b
W6	39.67a	37.69a	306.00a	290.70a	39.33a	37.36a	1.95a	1.85a
W1	29.33b	27.86b	224.67e	213.44e	30.00b	28.50b	1.14c	1.08c
W2	28.00b	26.60b	259.00d	246.05d	31.67ab	30.09ab	1.21b	1.15b
V3 W3	29.67a	28.19a	275.67c	261.89c	31.00ab	29.45ab	1.26b	1.20b
W4	28.33b	26.91b	276.67c	262.69b	34.67a	32.94a	1.50ab	1.43ab
W5	33.00a	31.35a	296.00b	281.20b	34.33a	32.61a	1.92a	1.82a
W6	33.67a	31.99a	301.33a	286.26a	34.00a	32.30a	1.97a	1.87a

Means followed by a similar letter are not significantly different at the 5 % level by DMRT

Table 7 Effect of irrigation with different levels of water salinity and rice cultivars as well as their interaction on grain yield (ton/fed.), its components and WUE (kg/m^3) in 2002 season.

Treatments	Plant height "cm"	Panicle length "cm"	No.of branches/ panicle	Panicle weight "g"	No.of grains/ panicle	1000-grains weight "g"	% Spikely	Grain yield (tons/ fed.	WUE (kg/ m^3)
water salinity levels									
W1	81.89e	20.59d	9.95bc	2.90e	78.67e	21.43e	11.04a	3.93c	0.94c
W2	84.91d	21.94c	10.72b	2.90e	103.44d	23.40d	6.51b	4.03c	0.96c
W3	814.70d	22.39b	11.06ab	3.03d	103.00d	24.80c	5.32bc	4.45ab	1.06ab
W4	94.86c	22.30b	11.61a	3.32c	117.22c	26.51b	4.83c	4.47ab	1.07ab
W5	105.72b	23.50ab	11.61a	4.01b	132.22b	26.60b	3.61cd	4.37b	1.04b
W6	112.47a	24.00a	12.28a	4.39a	143.78a	30.38a	1.91d	4.69a	1.12a
Cultivars									
V1	95.46a	21.99b	11.44a	3.16b	108.78c	25.35b	4.28b	3.99b	0.95b
V2	94.21b	23.70a	11.17a	3.57a	113.33b	21.78c	6.24a	4.31ab	1.03b
V3	92.61c	21.67bc	11.00a	3.56a	117.00a	29.46e	6.08a	4.45a	1.06a
Interaction									
W1	83.93e	21.57c	10.17c	2.74d	74.00e	19.94de	7.00a	3.60b	0.86b
W2	88.30d	20.20d	10.83bc	2.64d	103.00c	21.00d	5.57a	3.52b	0.84b
V1 W3	88.00d	21.17c	11.17bc	3.27bc	88.67d	23.33c	3.17ab	4.13a	0.98a
W4	94.34c	22.27ab	11.83ab	3.19c	124.00b	27..30b	3.76ab	4.20a	1.00a
W5	100.93b	23.37a	11.83ab	3.49ab	115.67b	27.40b	4.25ab	4.00ab	0.95ab
W6	117.23a	23.40a	12.83a	3.64a	147.33a	33.03a	1.94b	4.47a	1.07a
W1	81.47d	21.47d	10.17b	3.12c	78.33e	19.66cd	14.23a	3.87b	0.92b
W2	82.07d	24.30ab	11.17ab	3.13c	89.33d	20.77bc	6.49b	4.07ab	0.97ab
V2 W3	86.28c	23.67b	11.17ab	3.31c	103.00c	21.20b	6.45b	4.42a	1.05a
W4	95.00b	22.23c	11.17ab	3.26c	114.33b	21.27b	4.47c	4.43a	1.06a
W5	109.57a	25.23a	11.50a	4.03b	146.33a	22.17ab	4.07c	4.40a	1.05a
W6	110.87a	25.30a	11.83a	4.59a	148.67a	25.60a	1.73d	4.67a	1.11a
W1	80.27d	18.73d	9.50d	2.85c	83.67c	24.70c	11.88a	4.33ab	1.03ab
W2	84.37c	21.33c	10.17cd	2.92c	118.00b	28.44bc	7.46b	4.50ab	1.07ab
V3 W3	79.83b	22.33b	10.83bc	2.67c	117.33b	29.86b	6.35b	4.80a	1.14a
W4	85.23b	22.40b	11.83ab	3.50b	117.33b	30.95ab	6.25b	4.77a	1.14a
W5	106.67ab	21.90b	11.50ab	4.50ab	134.67a	30.31ab	2.50c	4.70a	1.12a
W6	109.30a	23.30a	12.17a	4.93a	135.33a	32.52a	2.05c	4.93a	1.18a

Means followed by a similar letter are not significantly different at the 5 % level by DMRT.

Table 8 Effect of irrigation with different levels of water salinity and rice cultivars as well as their interaction on grain yield (ton/fed.), its components and WUE (kg/m^3) in 2003 season.

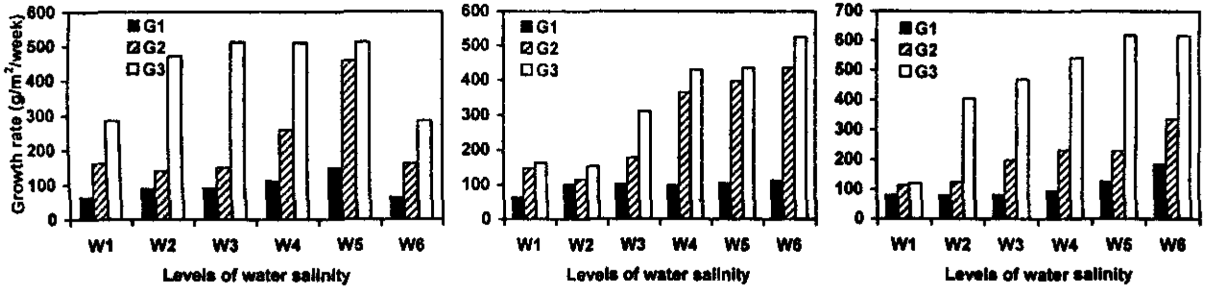
Treatments	Plant height "cm"	Panicle length "cm"	No.of branches/ panicle	Panicle weight "g"	No .of grains /panicle	1000-grains weight "g"	% Spikely	Grain yield (tons/ fed.)	WUE (kg/m^3)
	2003	2003	2003	2003	2003	2003	2003	2003	2003
water salinity levels									
W1	77.80e	19.56d	9.25bc	2.76d	74.74e	20.36e	10.49a	3.73c	0.89c
W2	80.67d	20.84c	9.97c	2.76d	98.27d	22.23d	6.18b	3.83c	0.91c
W3	80.47d	21.27b	10.22b	2.88d	97.85d	23.56c	5.05bc	4.23b	1.01b
W4	90.11c	21.19b	10.75ab	3.15c	122.56c	25.18b	4.59c	4.25b	1.01b
W5	100.44b	22.33ab	10.80ab	3.81b	125.61b	25.33b	3.43cd	4.15b	0.99b
W6	108.51 a	22.80a	11.42a	4.17a	136.59a	28.86a	1.81d	4.46a	1.06a
Culltivar									
V1	90.69a	20.89b	10.64a	3.00b	103.34c	24.08b	4.07b	3.79c	0.90c
V2	89.50b	22.52a	10.34a	3.39a	107.66b	20.69c	5.93a	4.09b	0.98b
V3	87.98c	20.59bc	10.23a	3.38a	116.80a	27.99a	5.78a	4.23a	1.01a
Interaction									
W1	79.73e	20.49c	9.46c	2.60d	70.30e	18.94d	6.65a	3.42bc	0.81bc
W2	83.89d	19.19d	10.07bc	2.51d	97.85c	19.95d	5.29a	3.34bc	0.80bc
V1 W3	83.60d	20.11c	10.39bc	3.11bc	84.24d	22.16c	3.01ab	3.92ab	0.93ab
W4	89.62c	21.16ab	11.00ab	3.03c	117.80b	25.94b	3.57ab	3.99ab	0.95ab
W5	95.88b	22.20a	11.00ab	3.32ab	109.89b	26.12b	4.04ab	3.80b	0.91b
W6	116.37a	22.23a	11.93a	3.46a	139.96a	31.38a	1.84b	4.25a	1.01a
W1	77.40d	20.40d	9.46b	2.96c	74.41	18.68cd	13.52a	3.68b	0.88b
W2	77.97d	23.09ab	10.39ab	2.97c	84.86d	19.73c	6.17b	3.87b	0.92b
V2 W3	81.97c	22.49b	10.20ab	3.14c	97.85c	20.14b	6.13b	4.20a	1.00a
W4	90.25b	21.12c	10.26ab	3.10c	108.61b	20.21b	4.25c	4.21a	1.00a
W5	104.09a	23.97a	10.70a	3.83b	139.01a	21.06ab	3.87c	4.18a	1.00a
W6	105.33a	23.04a	11.00a	4.36a	141.24a	24.32a	1.64d	4.44a	1.06a
W1	76.26d	17.79d	8.84d	2.71c	79.49c	23.47c	11.29a	4.11ab	0.98ab
W2	80.15c	20.26c	9.46cd	2.77c	112.10b	27.02bc	7.09b	4.28ab	1.02ab
V3 W3	75.84b	21.21b	10.07bc	2.54c	111.46b	28.37b	6.03b	4.56a	1.09a
W4	90.47b	21.28b	11.00ab	3.33b	141.26b	29.40ab	5.94b	4.53a	1.08a
W5	101.34ab	20.81b	10.70ab	4.28ab	127.94a	28.79b	2.38c	4.47ab	1.07ab
W6	103.84a	22.14a	11.32a	4.68a	128.56a	30.89a	1.95c	4.68a	1.12a

Means followed by a similar letter are not significantly different at the 5 % level by DMRT.

Table 9. Effect of irrigation with different levels of water salinity on Grain quality in both seasons 2002- 2003

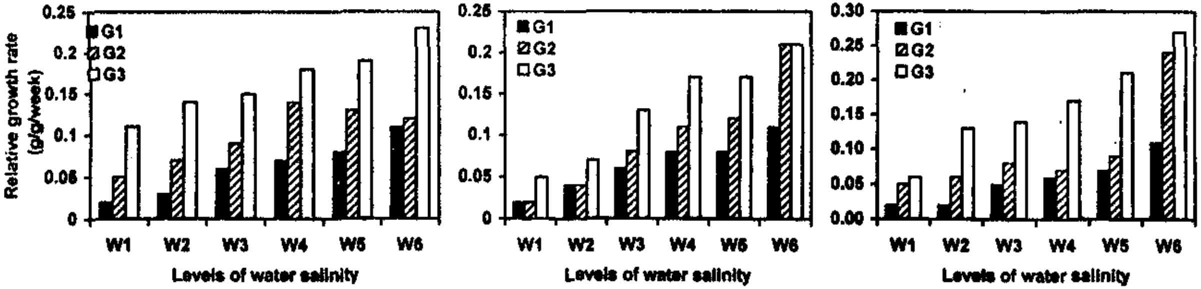
Variables	F test	Water salinity levels "W"						F test	Cultivars "C"			CxW inter-action
		W1	W2	W3	W4	W5	W6		Giza 177	Giza 178	Sakha 104	
2002 season												
Grain length	Ns	7.97	7.77	7.8	7.8	7.83	7.83	Ns	7.83	7.83	7.83	Ns
Grain width	Ns	3.20	3.13	3.06	3.20	3.30	3.13	Ns	5.13	3.18	3.15	Ns
Grain shape	Ns	2.52	2.51	2.53	2.44	2.81	2.64	Ns	2.69	2.49	2.55	Ns
Gel consistency	Ns	83.22	83.00	86.50	96.50	96.17	100	Ns	88.33	82.67	90.17	Ns
Gelatinization Temperature	Ns	5.33	5.00	5.33	5.67	6.00	5.60	Ns	5.50	5.33	5.67	Ns
2003 season												
Grain length	Ns	6.97	7.20	7.30	7.83	7.96	7.96	Ns	7.58	7.58	7.45	Ns
Grain width	Ns	2.93	2.97	2.98	3.03	3.23	3.30	Ns	3.03	3.10	3.11	Ns
Grain shap	Ns	2.37	2.42	2.46	2.58	2.46	2.42	Ns	2.52	2.45	2.39	Ns
Gel consistency	Ns	83.60	83.70	86.00	95.70	97.00	99.6	Ns	88.30	93.33	91.30	Ns
Gelativization temperature	Ns	5.04	5.06	5.16	5.76	5.95	5.98	Ns	5.55	5.42	5.52	Ns

Means followed by a similar letter are not significantly different at the 5 % level by DMRT.



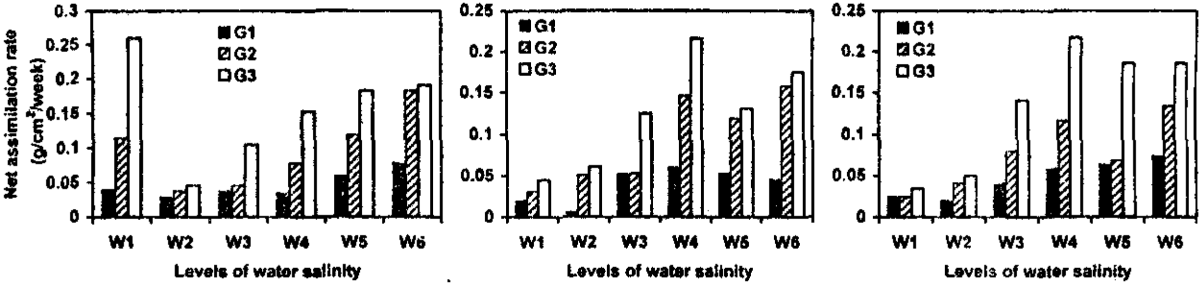
V1 V2 V3

Fig. (1): Effect of mean interaction between irrigation with different levels of water salinity and three rice cultivars on crop growth rate at different stages in 2002-2003.



V1 V2 V3

Fig. (2): Effect of mean interaction between irrigation with different levels of water salinity and three rice cultivars on relative growth rate at different stages in 2002-2003.



V1 V2 V3

Fig. (3): Effect of mean interaction between irrigation with different levels of water salinity and three rice cultivars on net assimilation rate at different stages in 2002-2003.

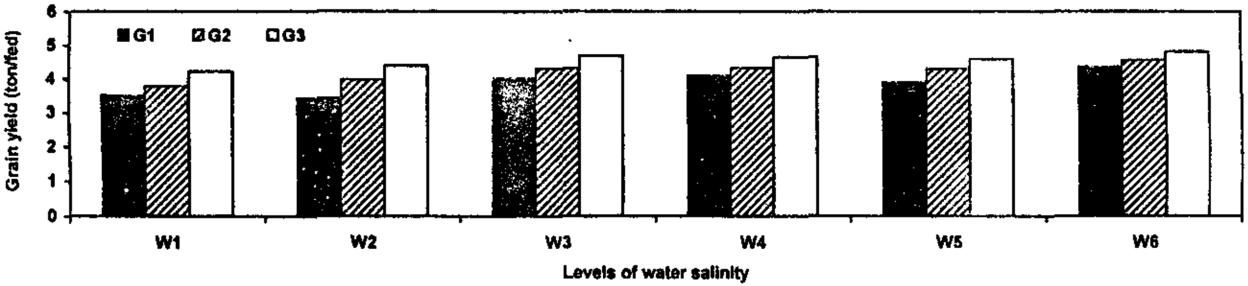


Fig. (4): Effect of mean interaction between irrigation with different levels of water salinity and three rice cultivars on grain yield (ton/fed) in 2002-2003.

الملخص العربى

استجابة بعض أصناف الأرز لإعادة استخدام مياه الصرف بنسب مختلفة من الخلط مع مياه النيل

عادل أحمد ماضي

معهد بحوث إدارة المياه وطرق الري – المركز القومي لبحوث المياه – القاهرة – مصر

أجـري هذا البحث بالمزرعة التجريبية بالقرضا – محافظة كفر الشيخ – مصر خلال موسمي ٢٠٠٢ – ٢٠٠٣م. لدراسة تأثير ست معاملات من نسب الخلط المختلفة كالآتي:-

(١) ١٠٠% ماء صرف.
(٢) ٥٠% ماء ري +٥٠ % ماء صرف.
(٣) ٦٦,٦٧% ماء ري + ٣٣,٣٣ % ماء صرف.
(٤) ٧٥% ماء ري + ٢٥% ماء صرف.
(٥) ٨٠% ماء ري + ٢٠% ماء صرف.
(٦) ١٠٠% مـاء ري علـي النمو الخضري، المحصول ومكوناته وكذلك جودة المحصول لثلاثة أصناف من الأرز (جيزة ١٧٧ – جيزة ١٧٨ – سخا ١٠٤).

وأوضحت النتائج:-

١- تفـوق الصـنف جيزة ١٧٨ علي بقية الأصناف في صفات (المساحة الورقية ، طول الجذر/نبات ، حجم الجذر ، % الأشطاء/الجذور ، طول السنبلة، عدد الفروع الأولية /سنبلة ووزن السنبلة) في كلا الموسمين.
٢- تفوق الصنف سخا ١٠٤ علي بقية الأصناف في صفات (عدد الحبوب الممتلئة/سنبلة ، وزن ١٠٠٠ حبة ، % للعقم ، محصول الحبوب/ نبات، محصول الحبوب طن/ف وكفاءة الانتفاع المائى)في كلا الموسمين.
٣- تفوق الصنف جيزة ١٧٧ علي بقية الأصناف في صفتي (الوزن الكلي الجاف وطول النبات عند الحصاد) في الموسمين.
٤- أدت معاملتي ١٠٠% ماء ري و ٨٠% ماء ري + ٢٠% ماء صرف إلى الحصول علي أعلي قيم للصفات تحت الدراسة، أما المعاملة بنسبة ٥٠% ماء ري + ٥٠% ماء صرف وكذلك المعاملة ١٠٠% ماء صرف أدت كل منهما إلى تدهور المحصول نتيجة لتدهور صفات مكوناته.
٥- أوضـح الـتفاعل أن أعلي قيم للصفات المختلفة تحت الدراسة كانت للصنف سخا ١٠٤ مع كل المعاملات المختلفة لنسب الخلط فيما عدا المعاملة بمياه صرف بنسبة ١٠٠%
٦- لم تتأثر صفات الجودة لأصناف الأرز تحت الدراسة بالمعاملات المختلفة لنسب الخلط في الموسمين.
٧- مـن نـتائج البحث السابقة يمكن التوصية بزراعة الصنف سخا ١٠٤ مع استخدام نوعيات مختلفة من مياه الري المخلوطة بصورة آمنة.