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SANDY SOIL PROPERTIES AND ITS PRODUCTIVITY AS AFFECTED BY IRRIGATION WATER QUALITY

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ABSTRACT: ***This pot experiment was carried out to evaluate some of irrigation water sources of Menufiya Governorate and its effect on sandy soil properties and its content of nutrients and plant growth. The evaluated water sources were Nile water, agricultural drainage water and sewage water. These sources were mixed together at different 12 of mixed ratios. Also, the used sandy soil was taken from El Sadat City, Minufiya Governorate. This experiment was conducted out in winter season (2005/2006) on wheat and repeated in summer (2006) on corn as tested plants.***

Irrigation sandy soil with the tested water sources resulted in an increase of soil EC, soluble ions and the content of macro – and micronutrients, except Nile water. The high increase of the previous properties was found in the soil irrigated with the mixtures have a high mixed ratios of sewage water, where the lowest one was found with the treatments of Nile water. At different irrigation treatments, EC and the content of soluble ions and nutrients after the second growth season were higher than those found after the first growth season. On the other hand soil pH was decreased followed irrigation with the tested water sources, where this decrease was more clear with the treatments of sewage water especially after the second growth season.

The high obtained dry matter yield of wheat and corn were found in the plants irrigated by irrigation mixtures having a high mixed ratios of sewage water, where the lowest values were associated the treatments of Nile water. The plants content of the determined macro and micronutrients depending on the mixture ratios of the three water sources, where the high content of N, P, Mg, Fe, Mn, Zn and Cu was found in the plants irrigated by mixtures have a high mixed ratios of sewage water. On the other hand the high content of K and Ca was found in the plants irrigated by irrigation mixtures have a high mixed ratios of agricultural drainage water. The lowest content of all determined nutrient were found in the plants irrigated by Nile water. At different treatments of irrigation, the dry matter yield and the content of all determined nutrients of corn plants were higher than those of wheat plants.

Key words*: Sandy soil, Sewage water, Agricultural drainage water, Salinity, Macro – and micronutrients, Wheat and corn.*

INTRODUCTION

A number of water management strategies are available to minimize the adversities of some water on agriculture production. The strategies include crop selection, type and design irrigation system adequate leaching and irrigation management. In many arid and semi-arid countries, water is become increasingly scarce resource. Plants are forced to consider any source of water, which might be used economically and effectively futher development when ever good quality water is scarce, water of marginal quality will have to be considered for use in agriculture (*Abou Hussien et al., 1994; Shaban, 1998 and 2005; Abou Hussien and Shaban, 2008 and Ragab et al., 2008*).

Wheat and corn plants (plus rice) are most cereal crops of the world, especially in the third world countries. In Egypt, the total area cultivated with wheat and corn were about 2.4 and 1.8 million feddan in 1995/1996 season (*Amin, 1997*).

Sandy soil in Egypt represent more than 70% of total area. Most of these soils may be reclaimed with low costs compared with other desertic soils. Also, these soils are more suitable to many economic cultivation such as wheat and corn. In addition, such these soils are located within or nearly of Wady of Nile river.

This work aims to identify the suitability of some waters sources for irrigation and their effect on: sandy soil properties and its content of available nutrients and, also on wheat and corn plants and its content of nutrients.

MATERIALS AND METHODS:

This study was carried out on new reclaimed sandy soil of Egypt to evaluate the effect of some wastewater sources on this soil properties and its productivity. Surface soil samples (0-20cm) were collected from El Sadat City, Minufiya Governorate, air-dried, ground, good mixed, sieved through a 2mm sieve and analyzed for some physical and chemical properties and also for the content of some available macro-and micronutrients according to *Cottenie et al., (1982) and Page et al., (1982)*. The obtained data were recorded in Table (1 a, b and c).

Table (1): The main properties of the used sandy soil

a- Physical properties:

Particles size distribution (%)				Textural grade	W.H.C. %
C-sand	F-sand	Silt	Clay		
90.50	4.85	2.82	1.80	Sand	27.00

b- Chemical properties:

pH for 2.5 soil water susp.	EC dSm^{-1}	Soluble ions (meq/L)								OM %	$CaCO_3$ %
		Cations				Anions					
		Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	CO_3^-	SO_4^{2-}		
7.30	0.81	3.17	2.00	2.05	0.85	1.60	0.60	0.00	5.87	0.072	2.60

c- Available nutrients (mg/kg):

Macronutrients			Micronutrients			
N	P	K	Fe	Mn	Zn	Cu
90.00	6.87	13.50	0.50	1.20	0.18	0.20

Three sources of irrigation water of Menufiya Governorate i.e. Nile water (Baher Shibin El Kom), agricultural drainage water (Talla drain) and sewage water (Sabal drain). The chemical analysis and the content of some nutrients of these water sources were determined according to *Cottenie et al., (1982).* and the obtained data were listed in Table (2).

Table (2): Chemical composition of the used irrigation water sources.

Continent and unit	Nile water	Agricultural drainage water	Sewage water	Continent and unit	Nile water	Agricultural drainage water	Sewage water
EC dSm^{-1}	0.68	1.90	1.85	SAR	2.44	6.84	6.89
Soluble ions (meq/L)				pH	7.41	7.45	7.48
Na^+	3.05	11.35	11.50	Nutrients content (mg/L)			
K^+	0.62	2.13	1.33	N	7.33	18.50	23.82
Ca^{2+}	1.82	4.00	3.90	P	3.20	5.50	7.60
Mg^{2+}	1.31	1.52	1.80	Fe	0.80	0.95	1.11
Cl^-	4.00	4.38	10.49	Mn	0.30	0.62	1.01
CO_3^{2-}	0.00	0.00	0.00	Zn	0.10	0.16	0.21
HCO_3^-	0.40	9.30	1.10	Cu	0.03	0.20	0.50
SO_4^{2-}	2.40	5.32	6.94				

The tested water sources were used for irrigation at 12 different mixed ratios which shown in Table (3).

Table (3): Mixing ratios of the used irrigation water sources.

Mixture number	Nile water	Agricultural drainage water	Sewage water	Mixture number	Nile water	Agricultural drainage water	Sewage water
1	100	-	-	7	50	-	50
2	75	25	-	8	25	-	75
3	50	50	-	9	-	-	100
4	25	75	-	10	-	75	25
5	-	100	-	11	-	50	50
6	75	-	25	12	-	25	75

Two pot experiments were conducted at sequential growth seasons (winter 2005/2006 on wheat plant and summer 2006 on corn plant). A 36 pot of 20cm depth and 15cm diameter were used in each experiment. Each pot was filled with 3kg of the sieved sandy soil, fertilized by superphosphate (15.5% P_2O_5) at rate 300mg/kg and planted with 10 grams of wheat (*Triticum sp.*). The pots were moisted with Nile water at 60% of soil W.H.C. After 10 days of planting, the plants were thinned to 6 plants/pot. Ammonium nitrate (33.5% N) and potassium sulphate (48% K_2O) were added at rates of 300 and 200 mg/kg soil, respectively. The pots were divided into 12 groups (3 pot/group). The pots of each group were irrigated with one of the used irrigation water mixtures at 60% of soil W.H.C. during the experimental period every three days. The plants of each pot were harvested at the soil surface after 80 days of planting (flower stage). The harvested plants were washed with tap water followed by distilled water, air-dried, oven-dried at 70^oC for 24 h, weighted, ground and analyzed for the content of some macro – and micronutrients. This experiment was repeated exactly in summer 2006 on corn plants (*Zea mays L*), where the pots were planted by 8 seeds and thinned to 4 plants/pot after 10 days of planting. The fertilization and irrigation treatments were carried out as those of the first experiment. The harvested corn materials were prepared for analysis as prementioned with wheat materials. The pots of each experiment were arranged in completely blok design with three replicates. The obtained data of dry matter yield of each plant were statically analyzed according to *Snedecor and Sochran (1980)*.

After the harvesting, the soil of each pot was takes and prepared for analysis as premetioned with the original soil samples. A weight (0.2g) of oven-dried plant materials of each replicate was digested using 5 ml of H_2SO_4 – $HClO_4$ mixture (mixed ratio of 3:1) as described by *Jackson (1973)*. The content of N, P, K, Ca, Mg, Na, Fe, Mn, Zn, and Cu was determined in the digestion according to *Cottenie et al., (1982) and Page et al., (1982)*.

RESULTS AND DISCUSSION

- Irrigation water quality:

The presented data in Table (2) show, according to EC (dSm^{-1}) values and the content (mg/L) of soluble cations and anions, the tested water sources takes the order: agricultural drainage water > sewage water > Nile water. Also, according to *Ayers and Wastcot (1985)*, these water sources can be classified non saline for Nile water and slight or moderate salinity for another two sources. The predominant soluble cation of these sources was Na^+ followed by Ca^{2+}, where the predominant soluble anion was Cl^- followed by SO_4^{2-}. Also, the values of SAR were varied from source to another, where these sources takes the order: sewage water > agricultural drainage water > Nile water according to SAR values. Also, according to SAR values, Nile water was un hazard, where the other two sources were low hazard (*Ayers*

***and Wastcot, 1985*). The high pH value was found in sewage water and the lowest was in Nile water. Also, pH of these water sources were within the permissible limits of pH which ranged between 6 and 9 (*Ayers and Wastcot, 1985)*. Similar results on some water sources of Menufiya Governorate were found by *Abou Hussien et al., (1994) and Tantawy (2004)*.**

Regarding to the studied water sources content of N, these sources classified as slight – moderate (5.0 to 30 mg NO_3-N/L) category (*Ayers and Wastcot, 1985*). Based on the content of N and P, these sources takes the order: sewage water > agricultural drainage water > Nile water. *Pupadapaulos and Sryliauon (1991)* mentioned that, excessive of P in irrigation water has not been a problem as P has guideline for its values for evaluation its hazardous effect, but might be valuable for fertilization planting. *Hafiz (2001), Shaban (2005) and Abou Hussien and Shaban (2008)* obtained on similar results.

The used sources of water content of Fe, Mn, Zn, and Cu, the data in Table (2) show that, based on the content of these nutrients can be arranged as follows: Fe > Mn > Zn > Cu and the high content of these elements was found in the sewage water followed by that found in agricultural drainage water. Also, the content of these micronutrients in the three sources was lower than 1.105, 1.005, 0.210 and 0.501 mg/L for Fe, Mn, Zn and Cu, respectively. This means that the concentration of these elements in the three water sources are presented within safe or permissible limits and possible using these water sources for irrigation especially in short term (*National Academy Engineering, 1977)*.

- Soil properties:

The presented data in Table (4) show EC (dSm^{-1}) of the tested soils and its content of soluble cations and anions (meq/L) was varied depending on mixed ratio of the tested water sources and growth season. The high increase of EC and the content soluble ions was found in the soil irrigated by the mixtures have a high mixed ratios of sewage water followed by those have high mixed ratios of agricultural drainage water. So, the tested mixtures can be arranged according to their effect or EC and soluble ions as follows: mixture number 9 > 8 > 10 > 11 > 5 > 4 > 12 > 3 > 7 > 2 > 6 > 1. The increase of EC and the content of soluble ions at second growth season were higher than those found with the first growth season. This trend may be resulted from the greater amounts of irrigation water used in summer season compared with that used in winter season. Under all irrigation treatments in two growth seasons, the predominant soluble cation was Na^+ followed by Ca^{2+} and the predominant soluble anion was Cl^- followed by SO_4^{2-}. These results were in agreement with three water sources. *El Sheikh (2000 and 2003), Shaban (2005) and Abou Hussien and Shaban (2008)*, obtained on similar results. The obtained data also, show little decrease of soil pH as a result of irrigation by the tested irrigation water. The arrangement of

irrigation mixtures according to their effect of the decrease of soil pH was number 9 > 12 > 11 > 10 > 8 > 5 > 7 > 6 > 4 > 3 > 2 > 1. Such decrease could be attributed to the decomposition of organic materials of the sewage water and its products of CO_2 and organic acids. At different treatments of irrigation, soil pH after first growth season were higher than that found after second growth season, *El Gala et al., (2003) and Shaban (2005)* obtained on similar results.

The presented data in Table (5) show the effect of irrigation water quality on sandy soil content (mg/kg) of some available macro- and micronutrients. These data show that, except the content of k, the high content of other nutrients was found in the soil irrigated with mixtures having high mixed ratios of sewage water, where the lowest one was found in the soil irrigated by Nile water only. Thus and according to the effect of irrigation mixtures on soil content of these nutrients can be arranged as follows: number 9 > 12 > 8 > 11 > 7 > 5 > 10 > 6 > 4 > 3 > 2 > 1, for N. P and the determined micronutrients and was: 5 > 4 > 10 > 3 > 11 > 9 > 8 > 12 > 7 > 2 > 6 > 1 for K.

Table (4): Soil pH, total soluble salts and soluble ions of sandy soil as affected by irrigation water quality.

Growth season	Mixture number	pH (1:25 soil water susp	EC dSm^{-1}	Soluble ions (meq/L)							
				Cations				Anions			
				Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	CO_3^-	HCO_3^-	SO_4^{2-}
First	1	7.26	1.01	4.83	2.27	2.05	0.90	1.69	0.65	0.00	7.71
	2	7.25	1.27	6.90	2.41	2.07	1.33	1.87	0.85	0.00	9.98
	3	7.20	1.94	11.95	2.65	3.14	1.67	2.38	2.02	0.00	15.01
	4	7.18	2.02	12.30	2.76	3.47	1.70	2.72	2.34	0.00	15.14
	5	7.12	2.14	12.52	2.97	4.01	1.87	2.94	2.55	0.00	15.91
	6	7.17	1.42	8.94	2.44	1.40	1.37	1.96	0.75	0.00	11.76
	7	7.13	1.67	10.40	2.45	2.28	1.60	2.20	0.90	0.00	13.60
	8	7.09	2.23	15.30	2.50	2.33	2.13	2.37	1.07	0.00	18.86
	9	7.05	2.48	17.55	2.59	2.40	2.21	2.38	1.36	0.00	21.06
	10	7.09	2.17	13.70	2.66	3.33	2.00	2.57	2.04	0.00	17.09
	11	7.08	2.13	13.60	2.62	3.13	1.93	2.39	2.01	0.00	16.90
	12	7.06	1.95	12.85	2.46	2.30	1.88	2.21	1.00	0.00	16.29
Second	1	7.25	2.59	18.73	3.01	3.00	1.20	3.05	1.33	0.00	21.52
	2	7.23	2.64	18.80	3.19	3.05	1.33	3.38	1.57	0.00	21.45
	3	7.20	2.95	20.22	3.88	3.70	1.67	4.06	2.18	0.00	23.26
	4	7.15	3.25	20.44	5.38	4.47	2.21	4.23	2.50	0.00	25.77
	5	7.10	3.37	21.19	5.64	4.53	2.33	4.40	3.33	0.00	25.97
	6	7.12	2.69	19.26	3.17	3.02	1.47	3.11	1.50	0.00	22.29
	7	7.12	2.79	19.36	3.28	3.40	1.60	3.38	1.61	0.00	22.61
	8	7.09	3.28	23.22	3.36	3.45	2.80	3.55	1.87	0.00	27.38
	9	7.00	3.41	23.54	3.42	3.48	3.61	3.58	2.00	0.00	28.52
	10	7.05	3.28	21.53	4.91	3.72	2.67	4.07	2.20	0.00	26.53
	11	7.03	3.15	21.52	3.73	3.67	2.60	3.72	2.03	0.00	25.75
	12	7.02	3.04	21.30	3.35	3.43	2.35	3.54	1.87	0.00	24.99

These trends were in harmony with the original water sources content of the determined nutrients. The soil content of these nutrients after second

growth season was higher than that found after first season. Also, the arrangement of the determined macronutrients according to their content were K > N > P and this arrangement for the determined micronutrients was Mn > Fe > Cu > Zn. The previous trends were found in two growth season with different treatments of irrigation. *Mostafa (2001), El Gala et al., (2003), Tantawy (2004), and Abou Hussien and Shaban (2008)* obtained on similar results with several irrigation water sources of Egypt.

Table (5): Sandy soil content (mg/kg) of some macro – and micronutrients as effected by irrigation water quality.

Growth season	Mixture number	Macronutrients			Micronutrients			
		N	P	K	Fe	Mg	Zn	Cu
First	1	98.00	7.45	15.18	0.74	1.46	0.24	0.45
	2	110.74	8.36	17.56	0.82	1.51	0.26	0.47
	3	114.66	8.66	22.26	0.84	1.56	0.28	0.50
	4	114.70	9.75	24.33	1.02	1.57	0.31	0.51
	5	127.40	10.82	25.44	1.26	1.76	0.41	0.78
	6	114.80	9.89	16.22	1.13	1.60	0.32	0.57
	7	127.50	10.94	17.72	1.38	1.80	0.44	0.81
	8	127.60	11.00	19.20	1.44	1.87	0.55	0.91
	9	144.06	11.94	19.51	1.86	1.95	0.77	1.15
	10	117.60	10.65	23.80	1.21	1.70	0.37	0.61
	11	127.55	10.73	20.50	1.40	1.81	0.47	0.86
	12	140.14	11.14	18.50	1.50	1.93	0.73	1.06
Second	1	92.06	8.86	15.58	0.70	1.40	0.22	0.41
	2	105.80	8.95	18.50	0.78	1.55	0.26	0.42
	3	130.54	9.84	23.14	0.90	1.62	0.28	0.64
	4	169.54	11.15	26.55	1.02	1.76	0.35	0.68
	5	210.06	13.91	27.50	1.25	1.96	0.65	0.92
	6	173.46	11.23	16.50	1.14	1.86	0.37	0.71
	7	240.00	14.67	18.90	1.66	2.25	0.80	1.05
	8	295.00	15.58	20.18	1.94	2.39	0.87	1.35
	9	303.80	16.04	20.61	2.14	2.89	1.05	1.75
	10	173.50	12.84	25.50	1.20	1.90	0.45	0.75
	11	260.54	14.67	20.92	1.80	2.36	0.85	1.22
	12	300.80	15.62	19.36	1.96	2.61	0.92	1.52

- Plant growth:

The presented data in Table (6) show a wide variation of dry matter yield (g/pot) and its relative increase (RI, %) of both wheat and corn plants. The obtained dry matter yield was increased followed by irrigation by the used water sources. The high obtained dry matter yield and its RI were found in the treatments of the mixtures having a high mixed ratios of sewage water. Thus and according to the effect of the tested irrigation mixtures on the obtained dry matter yield of both plants can be arranged as follows: number: 9 > 12 > 8 > 11 > 7 > 5 > 10 > 6 > 4 > 3 > 2 > 1. This order was in harmony with the chemical composition of the evaluated water sources and its content of

nutrients and also to the effect of sandy soil properties and the content of nutrients (*Salwa and Abou El-Khir 2005, and Shaban 2005*). At different treatments of irrigation, the obtained dry matter yield of corn plants and its relative increase were higher than those of wheat plants. These results concluded that, corn plants were more tolerant to the tested water sources compared with wheat plants. These results are in agreement with the findings of *Abou Hussien et al., (1994) and Shaban (2005)*.

Table (6): Dry matter of wheat and corn plants and its relative increase (RI, %) as affected by irrigation water quality.

Mixture number	Wheat		Corn		Mixture number	Wheat		Corn	
	DMY g/pot	RI %	DMY g/pot	RI %		DMY g/pot	RI %	DMY g/pot	RI %
1	0.297	0.00	0.402	0.00	7	0.512	72.39	0.788	96.02
2	0.330	11.11	0.451	12.19	8	0.670	125.59	0.932	131.84
3	0.340	14.48	0.542	34.83	9	0.957	222.22	1.056	162.69
4	0.350	17.85	0.665	65.42	10	0.377	26.94	0.730	81.59
5	0.378	27.27	0.774	92.54	11	0.515	73.40	0.793	97.26
6	0.360	21.21	0.695	72.89	12	0.681	129.29	0.986	145.27

- Plants content of macronutrients, %:

Wheat and corn plants content rations (%) and uptake (mg/pot) and its relative increase (RI, %) which listed in Tables (7 and 8) as affected by irrigation water quality show that, at different treatments of irrigation, the content of determined macronutrients and its relative increase of corn plants were higher than those of wheat plants. Also, the content of these macronutrients was increased as a result from plants irrigation with the mixtures at high mixed ratios of agricultural drainage and sewage water, but these increases were varied from element to another depending on the mixture ratios of the evaluated water sources. Depending on the obtained increases of nutrients content, the used mixtures may be arranged as follows: number: 9 > 12 > 8 > 11 > 7 > 5 > 10 > 6 > 4 > 3 > 2 > 1 for N, P and Mg and number: 5 > 4 > 10 > 11 > 9 > 8 > 12 > 7 > 2 > 6 > 1 for K and Ca. This order of irrigation mixtures was in harmony with their content of these nutrients and also its effect on the soil content and availability of such these nutrients (*Mostafa, 2001 and Abd El-Fattah et al., 2002*). In this respect, *Abou Hussien et al., (1994), Shaban (1998 and 2005), Abou Hussien and Shaban (2008) and Ragab (2008)* obtained on similar results with other plants grown in different soils and irrigated with other irrigation waters sources of Egypt.

Table (7):

Table (8):

- Plant content of micronutrients:

The recorded data in Table (8) show wheat and corn plants contents (mg/kg) and (mg/pot) for some micronutrients as affected by irrigation water quality. These data show that, at different treatments, corn content of the determined micronutrients and Vs RIU (%) were higher than those of wheat plants. Thus, this data concluded that, at the same studied conditions, corn plants become more suitable than of wheat plants. The high contents of the determined micronutrients were found in the plants irrigated by irrigation mixtures at high mixed ratios of sewage water followed by the plants irrigated by the mixtures have a high mixed ratios of agricultural drainage water. Depending on the previous discussions, the tested irrigation mixtures can be arranged according to their effect on wheat and corn plants content of Fe, Mn, Zn, and Cu as follows: number: 9 > 12 > 8 > 11 > 7 > 5 > 10 > 6 > 4 > 3 > 2 > 1. The obtained data also show that, the arrangement of the determined micronutrients according to their content in both corn and wheat was: Fe > Mn > Zn > Cu. This order was in harmony with the content of these nutrient in the evaluated water sources and also with the soil content of these nutrients. These results are agreement with the findings of *Hafiz (2001), El Gala et al., (2003), Shaban (2005), Abou Hussien and Shaban (2008) and Ragab (2008)*.

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تأثر خواص الأرض الرملية وإنتاجيتها بنوعية مياه الري

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الملخص العربي

أجريت تجربة أصص لتقييم بعض مصادر الري في محافظة المنوفية وتأثيرها علي خواص التربة الرملية ومحتواها من المغذيات وكذلك علي نمو النباتات ومصادر الماء التي تم تقييمها هي نهر النيل ومياه الصرف الزراعي ومياه الصرف الصحي والتي تم خلطها سوياً عند إثني عشر نسبة خلط مختلفة. أما الأرض الرملية المستعملة فقد أخذت من قويسنا – محافظة المنوفية وقد أجريت التجربة في شتاء ٢٠٠٥/٢٠٠٦ علي نبات القمح وأعيدت في صيف ٢٠٠٦ علي الذرة كنبات اختبار.

ري الأرض الرملية بمصادر الماء تحت الدراسة أدي إلي زيادة محتوي الأرض من الأملاح الكلية الذائبة والأيونات الذائبة وكذلك المحتوي من المغذيات الكبري والصغري وكانت أكثر الزيادات، المعاملات التي تم ريها بالمخاليط ذات نسبة الخلط العالية من مياه الصرف الصحي وأقلها معاملات مياه نهر النيل. وتحت ظروف جميع معاملات مياه الري فإن محتوي الأرض من الأملاح الكلية الذائبة والأيونات الذائبة والمغذيات بعد موسم النمو الثاني كان أعلي من تلك الموجودة بعد موسم النمو الأول. ومن ناحية أخري فإن معاملات الري تحت الدراسة أحدثت نقصاً في رقم حموضة الأرض وكان هذا النقص أكثر وضوحاً في معاملات مياه الصرف الصحي خاصة بعد موسم النمو الثاني.

وجد أن أعلي محصول للمادة الجافة في نباتي القمح والذرة في النباتات التي تم ريها بمخاليط الري ذات نسب الخلط العالية من مياه الصرف الصحي وكانت أقل القيم مصاحبة لمعاملات ماء نهر النيل، وأوضحت النتائج كذلك أن محتوي نباتات القمح والذرة من المغذيات يكون معتمداً علي نسب الخلط لمصادر الماء الثلاثة التي تم تقييمها فقد كان أعلي محتوي

للنباتات من عناصر النيتروجين والفوسفور والمغنسيوم والحديد والمنجنيز والنحاس موجوداً في النباتات المروية بمخاليط ري ذات نسب الخلط العالية من مياه الصرف الصحي ومن ناحية أخري فكان أعلي محتوي من عنصري البوتاسيوم والكالسيوم موجوداً في النباتات المروية بمخاليط ري ذات نسب خلط عالية من مياه الصرف الزراعي. وكان أقل محتوي من جميع المغذيات المقدرة موجودة في النباتات المروية بماء نهر النيل. وتحت جميع معاملات الري فإن محصول المادة الجافة والمحتوي من جميع المغذيات المقدرة لنباتات الذرة كان أعلي من مثيلتها في نبات القمح.

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Table (7): Wheat and corn plants content (concentrations and uptake) of macronutrients and its relative increase (RIU) as affected by irrigation water quality.

Plants	Mixture number	N			P			K			Ca			Mg		
		Conc %	Uptake Mg/pot	RIU %	Conc %	Uptake Mg/pot	RIU %	Conc %	Uptake Mg/pot	RIU %	Conc %	Uptake Mg/pot	RIU %	Conc %	Uptake Mg/pot	RIU %
Wheat	1	2.45	7.28	0.00	0.19	0.56	0.00	0.10	0.30	0.00	1.00	2.97	0.00	0.45	1.34	0.00
	2	2.45	8.22	12.91	0.20	0.66	17.86	0.11	0.37	24.44	1.20	3.96	33.33	0.51	1.68	25.37
	3	2.49	8.47	16.35	0.20	0.68	21.43	0.13	0.45	51.11	2.10	7.14	140.40	0.63	2.14	29.70
	4	2.80	9.80	34.62	0.21	0.74	32.14	0.18	0.63	111.11	2.30	8.05	171.04	0.65	2.28	70.15
	5	3.43	12.96	78.02	0.22	0.83	48.21	0.20	0.75	151.11	3.35	12.66	326.26	0.70	2.65	97.76
	6	2.94	10.58	45.33	0.20	0.72	28.57	0.11	0.38	28.89	1.18	4.25	43.10	0.53	1.91	42.54
	7	3.92	20.07	175.96	0.23	1.18	110.71	0.11	0.58	93.33	1.45	7.42	149.83	0.61	3.12	132.84
	8	4.41	29.55	305.91	0.26	1.74	210.71	0.12	0.81	168.89	1.55	10.39	249.83	0.95	6.37	375.37
	9	4.90	46.89	544.09	0.30	2.87	412.50	0.13	1.21	304.44	1.80	17.23	480.13	1.20	11.48	756.72
	10	2.94	11.08	52.20	0.22	0.83	48.21	0.15	0.55	84.44	2.15	8.11	173.06	0.90	3.39	152.99
	11	4.41	22.71	211.95	0.24	1.24	121.43	0.13	0.69	128.89	2.00	10.30	249.80	0.80	4.12	207.46
	12	4.51	30.71	321.84	0.27	1.84	228.57	0.12	0.82	173.33	1.50	10.22	244.11	0.75	5.11	281.34
Corn	1	4.41	17.73	0.00	0.30	1.21	0.00	0.12	0.48	0.00	1.00	4.02	0.00	0.45	1.81	0.00
	2	4.41	19.89	12.18	0.31	1.40	15.70	0.13	0.59	22.92	1.50	6.77	68.41	0.60	2.71	49.72
	3	4.66	25.26	42.47	0.32	1.73	42.98	0.16	0.87	81.25	2.15	9.72	141.79	0.73	3.96	118.78
	4	4.66	30.29	74.79	0.33	2.19	80.99	0.18	1.20	150.00	2.50	16.63	313.68	0.77	5.12	182.87
	5	4.95	38.31	110.43	0.37	2.89	136.36	0.20	1.55	222.92	3.00	23.22	477.61	0.80	6.19	241.99
	6	4.90	34.05	92.05	0.34	2.36	95.04	0.12	0.83	72.92	1.25	8.69	116.17	0.65	4.52	149.72
	7	4.98	39.24	121.32	0.39	3.07	153.72	0.14	1.10	129.17	1.55	15.26	280.10	0.70	5.52	204.97
	8	5.39	50.23	183.31	0.41	3.82	215.70	0.15	1.40	191.67	1.75	16.31	305.72	1.00	9.32	414.92
	9	5.88	62.09	250.20	0.42	4.44	266.94	0.15	1.58	229.17	1.80	19.01	372.89	1.05	11.09	512.71
	10	4.92	35.92	102.59	0.34	2.48	104.96	0.17	1.24	158.33	2.20	16.06	299.50	0.95	6.94	283.43
	11	5.00	39.65	123.63	0.40	3.17	161.98	0.16	1.27	164.58	2.10	16.65	314.18	0.90	7.14	294.48
	12	5.40	53.24	200.28	0.41	4.04	233.88	0.14	1.38	187.50	1.60	12.61	213.68	0.88	8.68	379.56

Table (8): Wheat and corn plants concentration and uptake of micronutrients and its relative increase (RIU) as affected by irrigation water quality.

Plant type	Mixture number	Fe			Mn			Zn			Cu		
		Conc. mg/kg	Uptake mg/pot	RIU %	RIU %	Conc. mg/kg	Uptake mg/pot	Conc. mg/kg	Uptake mg/pot	RIU %	Conc. mg/kg	Uptake mg/pot	RIU %
Wheat	1	72.50	0.022	0.00	0.00	37.00	0.011	10.00	0.003	0.00	1.50	0.0004	0.00
	2	87.50	0.029	27.27	31.82	42.00	0.014	19.00	0.006	100.00	1.83	0.0006	50.00
	3	90.00	0.33	36.36	40.91	43.50	0.015	30.00	0.010	233.33	2.33	0.0008	100.00
	4	95.00	0.033	45.45	50.00	46.00	0.016	32.50	0.011	266.67	2.50	0.0009	125.00
	5	112.50	0.043	72.73	95.45	50.00	0.019	80.00	0.030	900.00	3.00	0.0011	175.00
	6	100.00	0.036	54.55	63.64	48.50	0.017	55.00	0.020	566.67	2.67	0.0010	150.00
	7	122.50	0.063	154.55	186.36	55.00	0.028	85.00	0.044	1366.67	3.17	0.0016	300.00
	8	242.50	0.162	600.00	636.36	115.00	0.077	94.00	0.063	200.00	3.33	0.0022	450.00
	9	260.00	0.249	1072.73	1031.82	135.00	0.129	99.80	0.096	3100.00	4.50	0.0043	975.00
	10	105.00	0.040	63.64	81.82	49.00	0.018	70.00	0.026	766.67	2.83	0.0011	175.00
	11	172.00	0.089	181.82	304.55	60.00	0.031	90.00	0.046	1433.33	3.30	0.0017	325.00
	12	250.00	0.155	645.45	604.55	120.00	0.082	95.00	0.065	2066.67	4.33	0.0029	625.00
Corn	1	80.00	0.032	0.00	0.00	23.00	0.009	11.00	0.004	0.00	1.83	0.0007	0.00
	2	102.50	0.046	44.00	43.75	29.00	0.013	14.00	0.006	50.00	1.85	0.0008	14.29
	3	105.50	0.057	77.78	78.13	30.00	0.016	15.00	0.006	50.00	1.87	0.0010	42.86
	4	110.00	0.073	155.56	128.13	35.00	0.023	16.00	0.011	175.00	1.89	0.0013	85.71
	5	136.00	0.105	288.89	228.13	45.00	0.035	17.50	0.014	250.00	2.17	0.0017	142.86
	6	115.50	0.080	222.22	150.00	42.00	0.029	16.50	0.011	175.00	1.90	0.0013	85.71
	7	137.00	0.108	300.00	237.50	46.00	0.036	25.00	0.020	400.00	2.19	0.0017	142.86
	8	232.50	0.217	422.22	578.13	50.00	0.047	28.00	0.026	550.00	2.33	0.0022	214.29
	9	260.00	0.275	533.33	759.37	54.00	0.054	42.00	0.044	900.00	3.00	0.0032	357.14
	10	132.00	0.096	244.44	200.00	43.00	0.031	17.00	0.012	200.00	2.07	0.0015	114.29
	11	160.00	0.127	311.11	396.88	47.00	0.037	30.00	0.024	500.00	2.27	0.0018	157.14
	12	242.50	0.239	466.67	646.88	52.00	0.051	34.00	0.034	750.00	2.67	0.0026	271.43