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IMPACT OF IRRIGATION WATER QUALITY ON YIELD AND CONCENTRATIONS OF SOME HEAVY METALS IN RICE.

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ABSTRACT

The available water resources in Egypt are limited so; the concept of low-quality irrigation water in such location is dramatically and caused pollution by heavy metals in soils and plants. More solutions have to use to face the problem of using wastewater. The present field experiments were conducted during 2010 and 2011 summer seasons at farm of Rice Research and Training Center, Sakha, Kafr El-Shiekh, Egypt to, investigate the effect of water quality during nursery period on production of rice cultivars; Giza177 (V_1) and Giza178 (V_2) irrigated with drainage water (D_W), agronomic traits, as well as concentrations of cadmium (Cd), lead (Pb) and Ni (nickel) in rice grains and straw. Two nurseries were performed for each cultivar; the first nursery was irrigated by fresh water (F_W) and the second nursery by drainage water (D_W). Seedlings from each cultivar (30 days) transplanted under two levels of urea 0 kg N/fed (T_1) and 69 kg N/fed that recommended for their cultivars (T_2) then irrigated with D_W two weeks before harvest. The results revealed that among the eight treatments, $D_wV_2T_2$ (Drainage water + Giza178 + recommended of N fertilizers) gave the highest values of chlorophyll content in flag leaf, number of tiller, number of panicle, grains and straw yields (t/fed). Moreover, concentrations of studied heavy metals were higher in rice straw than in grains in both rice cultivars for all water quality treatments. The Cd and Ni concentrations in rice grains exceeded the permissible limits according to *World Health Organization (WHO, 1992*) at $D_WV_1T_1$ (Drainage water + Giza177 + untreated control) and $D_WV_1T_2$ (Drainage water + Giza178 + recommended dose of fertilizers) treatments. Pb concentration exceeded safety limits at $D_wV_1T_2$ (Drainage water + Giza177 + recommended dose of fertilizers) in both seasons. However concentration of these metals in grains of Giza178 rice cultivar didn't exceed permissible limits with all treatments in both seasons. The obtained results also, showed that utilization of fresh water during nursery period for both rice cultivars; Giza 177 and Giza178 led to decrease the concentrations of studied heavy metals (Cd, Pb and Ni) in grains.

INTRODUCTION

Egypt falls under arid and semi-arid zones of the world. The Nile River is the main source of water in Egypt. The water sector in Egypt is facing many challenges including water quality deterioration and water scarcity because of population increase, lack of renewable resources and wrong practices followed by human. The deterioration in river water quality is due to over 90 agricultural drains that discharge into Nile, and to industrial wastewater *Nile Basin Initiative (NBI 2005)*. The national water balance prepared for Egypt indicated that there was an overall deficit in water supplies of approximately 8 billion m^3 (Loutfy *Nagla , 2010).* The present per capita water share is below 1000 m^3/year and it might reach 600 m3/year in 2025, which would indicate severe scarcity (water poverty limit starts at 1,000 m^3/ year*) (Abdel-Gawad., 2008)*. This shortage could be compensated by raising the efficiency of available water resources through reuse of drainage water and use of ground water. Estimates indicated that; the official reuse drainage water in irrigation amounted to 4.84 billion m^3/year in 2001, and the Government of Egypt aims to reuse up to 8 billion m^3/year, unofficial wastewater reuse estimated between 2.8 and 4 billion m^3/year where the farmers use wastewater as a source to irrigate all kinds of crops if alternative irrigation water is not available *WaDImena (2008).* Reuse of wastewater and pollution by heavy metals whether in the soil or water of some areas in Egypt became reality and we should deal with it to address and overcome. Using wastewater has two effects; the positive effects of wastewater containing organic nutrients and the negative effects as it contains, heavy metal (Pb, Ni and Cd) toxic to plants, livestock and humans. Heavy metals such as Fe, Mn, Cu, and Zn…..eg are essential for normal plant growth and development since they are constituents of many enzymes and other proteins. However, elevated concentrations of both essential and nonessential heavy metals in the soil can lead to toxicity symptoms and growth inhibition in most plants (*Hall, 2002*). Toxicity may be resulting from the binding of metals to sulphydryl groups in proteins, leading to inhibition of activity or disruption of structure, or from displacement of an essential element, resulting in deficiency effects (*van Assche and Clíjsters, 1990*). Heavy metal excess may stimulate the formation of free radicals and reactive oxygen species, perhaps resulting in oxidative stress (*Dietz et al.,1999*). The most health hazards are due to heavy metals taken up from soils and bioaccumulated in crops, causing damage to plants when reach high levels and under certain conditions become toxic to humans.

In Nile Delta region has a high incident rate pancreatic cancer that is believed to be from high levels of heavy metals *(Soliman et al., 2005)*. The purposes of this study are; 1) Utilize wastewater in rice irrigation under water scarcity and water quality deterioration of River Nile. 2) Study effect of using drainage water on rice yield componens and promoting the production of rice yield because wastewater contains some organic nutrients. 3) Investigate techniques to reduce concentration s of heavy metals to permissible limits in rice plant organs (straw and grains). 4) Compare the accumulated of heavy metals in too widespread Egyptian cultivars; Giza177 and Giza178.

MATERIALS AND METHODS

This investigation was carried out at Rice Research and Training Center Farm near to drain canal No. 8, Sakha, Kafr El-Sheikh, Egypt. Two rice cultivars; Giza177 (V_1) and Giza178 (V_2) were evaluated during 2010 and 2011 growing seasons. This study aimed to 1) Investigate the effect of water quality during nursery period on rice production of transplanted rice cultivars irrigated with drainage water. 2) Concentrations of some heavy metals such as Pb (lead), Ni (nickel), (Cadmium) Cd in rice straw and grains. Two nurseries were performed for each cultivar; the first nursery irrigated by fresh water (F_W) while the second nursery irrigated by drainage water (D_W). Forty kg seeds/ fed of both cultivars were sown in nursery on 5 th of May in both seasons. All recommended cultural practices of nurseries were applied. The permanent field was well prepared and also well dry and wet leveled. Thirty days old seedlings were transplanted at 20 x 20 cm between rows and hills with 3 seedling/hill for each cultivar in both nurseries under two treatments T_1 (untreated control) and T_2 (recommended dose of urea and mono calcium phosphate). Urea (69 kg $N.fed^{-1}$) was added in two splits, 2/3 before flooding and 1/3 one month after transplanting and all amount of mono calcium phosphate (7% P) at the rate of 100 $kg.fed^{-1}$ was applied as a basal before flooding. This study was laid out in randomize complete block design (RCBD) with eight treatments with 4 replicates. All plots in the permanent field were irrigated by drainage water (D_W) up to harvest. The samples of drainage water were collected from drain canal No. 8 and soil samples were collected from different sites at 0-30 cm depth before planting and after harvest, the data of analysis of both drainage water and soil samples were presented in Tables (1 and 3 respectively). At late booting stage number of tillers/hill and chlorophyll content in flag leaf were estimated. At harvest, plant height, number of panicles, panicle length, number of filled grains per panicle and 1000 - grain weight were recorded. A guarded area of ten m^2 was harvested, air-dried, weight for estimating biomass yield and then threshed; the grain yields was measured in kg /plot (10 m^2) and adjusted to14 % moisture basis and then converted to t /fed. Straw and grain samples were collected for analysis according to *Chapman and Pratt (1961)*. Total soluble cations and anions in soil paste extract were assessed according to *Richards (1969)*. Heavy metals (Pb, Ni and Cd) in soil extracted by DTPA were determined using Atomic Absorption Spectrophotometer according to *Lindsay and Norvell (1978).* All collected data were subjected to statistical analysis according to procedure describe by *Gomes and Gomes* (1984). Means were compered at $p< 0.05$ by the reviesed least significant differences (LSD), which adapted by *Waller and Duncan (1969).* Statistical analyses were made with commercial computer software.

The tested treatments were as the fallows:

FwV_1T_1= Fresh water + Giza177 + without N fertilizers.
FwV_1T_2= Fresh water + Giza177 + Recommended dose of N fertilizers.
FwV_2T_1= Fresh water + Giza178 + without N fertilizers.
FwV_2T_2= Fresh water + Giza178 + Recommended dose of N fertilizers.
DwV_1T_1= Drainage water + Giza177 + without N fertilizers.
DwV_1T_2= Drainage water + Giza177 + Recommended dose of N fertilizers.
DwV_2T_1= Drainage water + Giiza178 + without N fertilizers.
DwV_2T_2= Drainage water + Giza178 + Recommended dose of N fertilizers.

Table 1: water chemical analysis (fresh and drainage).

Water Sample	Anions ($meq.l^{-1}$)				Cations ($meq.l^{-1}$)				Ec $ds.m^{-1}$	SAR	Water Class	Heavy metals (ppm)		
	$CO_3^=$	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+				Pb	Ni	Cd
Fresh water	-	3.66	1.02	0.69	1.77	1.52	1.83	0.31	0.53	1.42	C_2S_2	0.50	0.30	0.008
Drainage water	-	4.78	13.20	6.00	5.00	3.60	14.80	0.50	1.99	7.13	C3S2	3.70	3.87	0.050

Table 2: Critical levels of Pb, Ni and Cd (ppm) in irrigation water according to FAO *(1985) and Kabat-Pendias and Mukherejee (2007*) and in Soil according to *Alloway (1995)*.

Elements	Pb	Ni	Cd
Permissible Concentration (ppm) in irrigation water	5.00	0.200	0.01
Critical levels in soil (ppm)	100	50	3

Table 3: Some chemical analyses of soil used in study before and after experiment

Soil	pH (1:2.5)	Ec_e $ds.m^{-1}$	Anions($meq.L^{-1}$)				Cations($meq.L^{-1}$)				SAR	Available heavy metals (ppm)		
			$CO_3^{=}$	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+		Pb	Ni	Cd
Before Planting	8.20	3.33	--	5.56	9.00	18.33	10.01	5.00	1.88	16.00	0.68	10.77	3.55	2.01
After Harvest	8.08	3.70	--	6.20	10.09	19.91	11.30	7.30	2.50	15.10	0.82	15.78	4.56	2.87

RESULTS AND DISCUSSION

Number of tillers at late booting and harvest, chlorophyll content in flag leaf and plant height (cm) as affected by water quality under N-reatments in 2010 and 2011 seasons are presented in Table 4.

Number of tiller/m^2

Data in Table 4 showed the studied agronomic traits affected by drainage water (D_W) as compared with fresh water during 2010 and 2011 seasons. There was high significant increase in number of tiller per m^2 at late booting and harvest stages with $D_wV_2T_2$ (Drainage water + Giza178 + Recommended dose of N fertilizers) treatment and the highest mean value of number of tiller/m^2 were (559.60 and 565.00) at late booting stage and (531.66 and 537.33) at harvest stage in 2010 and 2011 seasons respectively.

Table 4: Agronomic traits of two rice cultivars as affected by nursery irrigation with fresh or drainage water during 2010 and 2011 seasons.

Treatments	Number of tiller/m^2 at late booting stage		Number of tiller/m^2 at harvest stage		Chlorophyll content in flag leave		Plant height (cm) at harvest	
	2010	*2011*	*2010*	*2011*	*2010*	*2011*	*2010*	*2011*
$F_WV_1T_1$	337.00 e	347.30 e	312.67 c	322.33 c	37.84 d	38.22 e	79.80 d	81.70 c
$F_WV_1T_2$	455.00 c	475.00 c	454.33 b	474.67 b	40.00 c	40.62d	95.50 b	91.80 b
$F_WV_2T_1$	350.60 de	367.30 de	319.67 c	329.00 c	41.33 abc	42.00 bcd	75.90 e	76.90 d
$F_WV_2T_2$	520.43 b	530.00 b	478.00 b	499.67 b	43.00 ab	43.33 ab	76.00 e	81.30 c
$D_wV_1T_1$	345.33 e	350.00 e	326.00 c	333.00 c	38.33 d	38.67 e	81.50 d	80.30 c
$D_wV_1T_2$	477.90 c	497.30 c	468.36 b	479.00 b	40.63 bc	41.63 cd	83.90 c	82.30 c
$D_wV_2T_1$	377.66 d	382.30 d	334.00 c	345.33 c	41.00 abc	42.66 abc	76.00 e	77.70 d
$D_wV_2T_2$	559.60 a	565.00 a	531.66 a	537.33 a	45.33 a	44.00 a	100.30 a	98.70 a

F_W = Nursery irrigated by fresh water D_W= Nursery irrigated by drainage water (drain No. 8) V_1= GIZA177 & V_2= G178 cultivars
T_1 = untreated control & T_2= Recommended dose of fertilizers (N and P).

It may be due to drainage water contained considerable amount of macro and micro- nutrients that help plant for good growth. These results agreed with *Begum et al., (2011)* who observed that when mixed water (Fresh water + Drainage water) use in rice irrigation gave the highest plant height and tillers per hill because it contained nutrients and some concentration of heavy metals that increased slightly than permissible limit in irrigation water which enhance root and shoot growth and . This enhancement will lead to higher plant height, and more tillers per hill. Also, it is clear from the data that number of tiller/ m^2 with (D_W) in nursery was higher than (F_W) treatment at the same levels of fertilizer with both rice cultivars.

Chlorophyll content

Heavy metals have effects on chlorophyll content in plants. Heavy metals are known to interfere with chlorophyll synthesis either through direct inhibition of an enzymatic step or by inducing deficiency of an essential nutrient (*van Assche and Clíjsters, 1990*). Also, *Zengin and Munzuroglu (2005)* who observed that total chlorophyll content in plant decline progressively with increasing concentration of heavy metals such as Pb, Cd, Cu and Hg.

Chlorophyll content in flag leaf according to SPAD as affected by water quality in nursery of both rice cultivars are presented in Table 4. Results demonstrated that Chlorophyll content in flag leaf increased with application recommended dose of N fertilizers (T_2) whether the nursery was irrigated by D_W or F_W with both rice cultivars as compared to T_1 (untreated control). This may be attributed to nitrogen, which is the essential constituent of chlorophyll. Leaf N concentration is closely related to the rate of leaf photosynthesis and crop biomass production *(Dobermann and Fairhurst 2000)*. Also, the results showed that the chlorophyll content in flag leaf of both rice cultivars with all treatments of D_W was higher than F_W treatments; it may be due to the positive effects of wastewater containing organic nutrients. There is a high significant increase in chlorophyll content in the flag leaf at $D_wV_2T_2$ (Drainage water + Giza178 + Recommended fertilizers) treatment (45.33 and 100.30) in both seasons. In the same time, there was no significant difference between chlorophyll content in flag leaf with $F_WV_2T_2$ (Fresh water + Giza178 + recommended fertilizers), $D_wV_2T_1$ (Drainage water + Giza178 + untreated control) and $D_WV_2T_2$ (Drainage water + Giza178 + recommended dose of fertilizers) treatments in 2010 and 2011 seasons. Also, results indicated that chlorophyll content in flag leaf in Giza178 was higher than in Giza177. This could attributed to the variation in genetic background of both rice cultivars (Giza 177; Japonica type and Giza178; Indica **/** Japonica). We can conclude that the presence heavy metals concentration especially Ni and Cd in drainage water was slightly higher than permissible limits according to (FAO 1985) as shown in Table 1. So it did not cause any harmful effects on chlorophyll content in flag leaf of both rice cultivars.

Plant height (cm)

Data in Table 4 showed a high significant increase in plant height (cm) of Giza178 rice cultivar (100.30 and 98.70 cm) for both seasons 2010 and 2011 respectively with $D_wV_2T_2$ (Drainage water + Giza178 +

recommended fertilizers) treatment as compared with other treatments whether nursery irrigated by F_W or D_W. The effect of some heavy metals such as Cd on rice plant height differed with rice cultivar and growth stage (*Liu et al.,* 2007). This means that using of drainage water under investigation to irrigate the nursery of Giza178 rice cultivar with application of recommended dose of fertilizer may have stimulated plant height as compared to Giza177 at the same treatments. These results are in harmony with those obtained by Begum *et al. (2011)* who observed that nutrients supply and presence of heavy metals within permissible limit in irrigation water enhanced root and shoot growth and thereby resulted the highest plant height.

Grain and straw yield:

Effect of irrigation rice nursery by fresh (F_W) or drainage water (D_W) of two rice cultivars; Giza177 and Giza178 on grain and straw yield are presented in Table 5. Results showed that a significant increase in grain and straw yield under recommended dose of fertilizer (T_2) for both cultivars whether the nursery was irrigated by F_W or D_W compared with unfertilized plots or control (T_1). Giza178 cultivars give a high significant increase in grain yield under recommended dose of N fertilizer (T_2) with both source of nursery irrigation (3.88 and 4.15 t.fed^{-1}) under fresh water (F_W) and (4.06 and 4.46 t.fed^{-1}) under drainage water (D_W) during 2010 and 2011 seasons, respectively. Data also, indicated that nursery irrigation by drainage water had a significant effect on straw yield (6.62 and 6.87 t.fed^{-1}) with DwV_2T_2 (Drainage water + Giza178 + recommended dose of N fertilizer) treatment during 2010 and 2011 seasons, respectively.

Table 5: Grain and straw yield and some attributes of two rice cultivars as affected by nursery irrigation with fresh or drainage water during 2010 and 2011 seasons.

Treatment	Grain yield (t/fed)		Straw yield (t/fed)		No. of panicle /m^2		Panicle length (cm)	
	2010	2011	2010	2011	2010	2011	2010	2011
$F_WV_1T_1$	2.12 d	2.32 d	4.00 e	4.21 f	320.66 e	332.30 e	18.00 c	18.40 d
$F_WV_1T_2$	2.89 c	3.09 c	4.87 d	5.17 e	455.00 b	470.00 b	18.33 c	18.40 d
$F_WV_2T_1$	3.06 bc	3.46 b	5.68 c	6.07 c	358.00 cd	367.30 cd	18.78 bc	19.78 bcd
$F_WV_2T_2$	3.88 a	4.15 a	5.93 b	6.39 b	500.00 a	510.00 a	19.83 ab	20.83ab
$D_wV_1T_1$	2.42 d	2.62 d	3.82 e	4.24 f	332.00 de	342.30 de	18.33 c	18.85 cd
$D_wV_1T_2$	3.29 b	3.49 b	4.98 d	5.41 d	476.30 ab	492.30 ab	18.28 c	19.28 cd
$D_wV_2T_1$	3.22 b	3.52 b	5.98 b	6.56 b	370.30 c	382.30 c	19.08 abc	20.08abc
$D_wV_2T_2$	4.06 a	4.46 a	6.62 a	6.87 a	495.66 a	505.00 a	20.31 a	21.31 a

F_W = Nursery irrigated by fresh water D_W= Nursery irrigated by drainage water (drain No. 8) V_1= Giza177 & V_2= Giza178
T_1 = untreated control & T_2= Recommended dose of fertilizers (N and P).

As shown in Table 5 grain and straw yield were higher with all treatments of drainage water in both cultivars. This may be due to that drainage water may contain beneficial organic nutrients for plant. These results are agree with the findings of Vivekananda Mukherjee and Gautam Gupta (2010) who indicated that using of wastewater in agriculture undoubtedly helps to recycle useful nutrients by plant uptake. Also, Rabie et al (1989) found that the addition of some heavy metals such as Ni and Cd stimulated the growth of barley and oat plants at low concentrations. El-Habet Howida (2004) observed that Pb, Ni and Cd addition at lowest concentration to Giza178 rice cultivars caused a slight increase in rice grains and straw but with increasing levels of these metals resulted in decrease in yield of rice grains and straw.

Number of panicle/m^2 and panicle length (cm)

Data in Table 5 showed the number of panicles per m^2 and panicle length (cm) of both rice cultivars as affected by water quality in nursery. There were no differences for the impact of irrigation water quality (F_W or D_W) in nursery on panicle /m^2 and panicle length in the nursery of both rice cultivars at the same level of fertilizer on the number of panicle/m^2. Also data, revealed that significant increase in number of panicle / m^2 (500.00 and 510.00) with $F_WV_2T_2$ (Fresh water + Giza178 + recommended dose of fertilizers) and (495.66 and 505.00) with $D_wV_2T_2$ (Drainage water + Giza178 + recommended dose of N fertilizers) treatments during 2010 and 2011 seasons, respectively. It could be concluded that the increase in number of panicles/m^2 and panicle length (cm) resulting from the application of N may be due to stimulation effect of branch initiation which gave more panicles/hill and increased panicle excersion. These results are harmony with those obtained by *Hemalatha and Balasubramanian (2000) and Abd El-Rahman (1999).*

1000-grain weight (g):

One thousand grain weight of both rice cultivars as affected by water quality in nursery under (T_1 and T_2 fertilizers) are presented in Table 6. Data showed that 1000-grain weight tended to decrease at T_2 (Recommended dose of fertilizers) of both rice cultivars whether nursery was irrigated by F_W or D_W. The highest values of 1000- grain weight was found with control (T_1) with both source of nursery y irrigation. This increase in 1000- grain weight control mainly due to decrease the number of spikelet per panicle with control consequently increases the weight of grains. These results are in according with those obtained by *Barnes (1985)*.

Number of filled grain /panicle

As for number of filled grain /panicle, data in Table 6 showed a significant increase in number of filled grain /panicle under T_2 (recommended dose of N fertilizers) whether nursery irrigated by (F_W) or (D_W) for both cultivars.

Table 6: Yield attributes of two rice cultivars as affect by water quality in nursery during seasons 2010 and 2011.

Treatment	1000-grain weight (g)		No. of filled grain /panicle		Filled grains %	
	2010	2011	2010	2011	2010	2011
$F_WV_1T_1$	23.88 a	26.00 a	80.00 d	83.30 d	89.38 d	91.86 cd
$F_WV_1T_2$	22.66 ab	23.00 b	98.70 c	100.70 cd	91.63 bc	92.63 cd
$F_WV_2T_1$	18.67 c	19.00 d	105.30 bc	107.30 b	90.51 bcd	93.51 bc
$F_WV_2T_2$	19.33 c	20.33 cd	124.00 a	126.00 a	92.41 ab	95.41 ab
$D_wV_1T_1$	24.26 a	26.00 a	90.70 cd	94.70 cd	86.95 e	88.45 e
$D_wV_1T_2$	22.33 ab	26.33 a	119.00 ab	121.70 ab	89.00 d	90.95 d
$D_wV_2T_1$	20.78 bc	22.33 dc	118.30 ab	123.30 ab	90.00 cd	92.28 c
$D_wV_2T_2$	18.66 c	19.33 d	130.00 a	131.00 a	93.72 a	95.72 a

F_W = Nursery irrigated by fresh water D_W= Nursery irrigated by drainage water (drain No. 8) V_1= Giza177 & V_2= Giza178

T_1 = untreated control & T_2= Recommended dose of fertilizers (N and P).

The results confirm the findings of *Kalita and Sharmah,(1992)* who found an increase in number of filled grains per panicle as the nitrogenlevels increased. Results also, indicated that the values of number of filled grain per panicle where nursery irrigated by D_W treatments was higher than F_W irrigation treatments at the same level of fertilizers may be due to the contents of drainage water from available, sufficient nutrients and some beneficial organic compound.

Filled grains %

Data in Table 6 showed the filled grains percentage (%) in both rice cultivars. It is clear from the results there is a high significant increase in filled grains % (92.41 and 95.41) with $F_WV_2T_2$ (Fresh water + Giza 178 + recommended dose of fertilizers) and (93.72 and 95.72) with $D_WV_2T_2$ (Drainage water + Giza 178 + recommended dose of fertilizers) treatments in 2010 and 2011 seasons, respectively. This means that the filled grains % in Giza 178 cultivar was higher whether nursery was irrigated with fresh water or drainage water than Giza 177 under the same treatments.

Concentrations of heavy metals in rice straw and grains:

Data in Table 7 showed the concentrations of Cd, Pb and Ni in straw and grains of two rice cultivars (Giza177 and Giza178) as affected by water quality F_W and D_W in nursery during 2010 and 2011 seasons. The concentration of heavy metals (Pb, Cd and Ni) in rice grains is one of the most important criteria of food safety or food quality for human. Results illustrate that generally, Cd, Pb and Ni concentrations in straw and grains of both rice cultivars was higher with drainage water treatments (D_W) in nursery than Fresh water (F_W) at the same level of fertilizer (T_1 or T_2) under this investigation.

Cadmium concentration (Cd):

Regular consumption of plants containing 3 ppm Cd are poisonous to humans and animal, it interferes with and other proteins. In livestock, it accumulates in kidneys, spleen and liver (Tuker *et al.,* 2003). Cadmium is known to be toxic to plants at much lower concentrations than other metals like Pb. Phytotoxicity had been observed to be dependent upon plant species as well as concentration of Cd in the substrate. Because of the highly toxic nature to plants, it is necessary to obtain information on Cd content of edible tissues of field crops. The concentrations of Cd in organs (straw and grains) of both rice cultivars as affected by water quality in nursery during 2010 and 2011 seasons are presented in Table 7. Data indicated that the concentration of Cd in rice straw was higher than in grains with all treatments of drainage water (D_W) or fresh water (F_W) in nursery for both of rice cultivars whether applied recommended dose of fertilizers (T_2) or without N fertilizers (T_1). These results are in harmony with those obtained by *Le et al., (2001)* who observed that the concentration of Cd accumulated in different parts of rice plant as a result of Cd uptake from soils. Accumulations of Cd are the highest in roots, about 20-30 times higher than in stems and leaves and about 100-200 times higher than in grains. According to the *(WHO.*, 1992) permissible limits shown in Table 8, the Cd concentration in the rice grain should not exceed 0.5 mg/kg. This means that the rice grains of Giza177 rice cultivar at all treatments of water quality in nursery (F_W or D_W) which had (0.539 and

0.562 ppm), (0.589 and 0.613 ppm), (0.585 and 0.610 ppm) and (0.801 and 0.878 ppm) at $F_WV_1T_1$ (Fresh water + Giza177 + untreated control) , $F_WV_1T_2$ (Fresh water + Giza177 + recommended dose fertilizers) , $D_WV_1T_1$ (Drainage water + Giza177 + untreated control) and $D_WV_1T_2$ (Drainage water + Giza177 + recommended dose fertilizers) treatments in 2010 1nd 2011 seasons, respectively far exceeded the *(WHO*., 1992) limit. It can be conclude that Giza178 rice cultivar was highly selective to Cd concentration than was Giza177 when using drainage water in rice irrigation under investigation.

Table 7: Concentration of Cd, Pb and Ni (ppm) in rice grains and straw of two rice cultivars as affected by water quality in nursery during 2010 and 2011 seasons.

Treatments	Cd concentration (ppm)				Pb concentration (ppm)				Ni concentration (ppm)			
	Grains		Straw		Grains		Straw		Grains		Straw	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
$F_WV_1T_1$	0.539	0.562	1.87	1.72	2.15	2.76	13.67	13.50	1.35	1.50	9.50	10.88
$F_WV_1T_2$	0.589	0.613	1.43	1.67	2.25	2.99	18.40	20.50	1.55	1.60	10.89	10.60
$F_WV_2T_1$	0.409	0.487	1.77	1.89	2.33	2.45	12.80	14.02	1.25	1.33	9.72	9.90
$F_WV_2T_2$	0.489	0.422	1.30	1.56	2.45	2.73	16.50	17.38	1.32	1.40	8.30	10.50
$D_wV_1T_1$	0.585	0.610	1.56	3.18	2.87	2.91	18.33	19.50	1.65	1.73	9.80	11.30
$D_wV_1T_2$	0.801	0.878	1.69	3.88	3.05	3.18	25.60	23.80	1.82	1.90	11.50	10.98
$D_wV_2T_1$	0.458	0.480	1.82	3.00	2.75	2.82	16.11	18.78	1.42	1.38	9.99	10.88
$D_wV_2T_2$	0.490	0.456	1.87	3.67	2.77	2.90	20.09	17.91	1.40	1.45	10.77	10.90

F_W = Nursery irrigated by fresh water D_W= Nursery irrigated by drainage water (drain No. 8) V_1= Giza177 & V_2= Giza 178 cultivars
T_1 = untreated control & T_2= Recommended dose of fertilizers (N and P).

Table 8: permissible limits (ppm) of Cd and Pb in rice grains According to (WHO., 1992).

Elements	Cd	Pb
Permissible limits	0.50	3

India safety limits of Ni in rice grains (Singh and Agrawal 2010).

Ni
1.50

Lead concentration (ppm):

High Pb concentration was found to inhibit seed germination, stomata opening, shoot transpiration, CO_2 uptake, apparent photosynthesis and photorespiration in plant (*Poskuta et al*; *1987*). So, we should determine of Pb in plant tissue, when irrigated by drainage water. The obtained results in Table 7 showed that the Pb concentrations in rice straw and grains of both rice cultivars (V_1 and V_2) increase with T_2 (recommended fertilizers) whether nursery was irrigated by F_W or D_W in Nursery. This may be due to : 1) Contents of D_W from Pb (3.70 ppm) where, rice seedling of both cultivars after transplanting irrigated by drainage water even harvest and 2) This may be due to production of organic acids by plant and chelating compounds which play a vital role in heavy metals availability and . 3) Rhizosphere acidification occur as a result of NH_4 nutrition (release from urea) due to release H^+ by root cells, this induced acidification can promote, mobilization of metals and absorption of these metals by plant *Zaccheo etal.,(2006) and Loosemore etal.,(2004.)* These results are harmony with those obtained by *Begum et al (2011)* who found that high Pb content in rice straw and grains resulted in irrigation by wastewater. Data also, showed that the Pb concentration in grains was lower than straw in two rice cultivars (Giza177 and Giza178) with all treatments, probably due to the translocation of Pb from roots to tops is greatly limited *(Kabata-pendias and Pendias 2000)*. According to the *(WHO., 1992)*, permissible limit as shown in Table 8, the Pb concentration in the rice grain should not exceed 3 mg/kg. It could be noticed that the Pb concentration (3.05 and 3.18 ppm) in grains during 2010 and 2011 seasons respectively, with DwV_1T_2 (Drainage water + Giza177 + recommended dose of fertilizers) treatment far exceeded the *(WHO*., 1992) limit. It is clear from the data that the Pb concentration in grains of Giza177 rice cultivar exceeded the permissible limits (permissible Pb limits means that the human body able to assimilation of this concentration from Pb without any side effect) of Pb while, Pb concentration in grains of G178 cultivar didn't exceed permissible limits when we use drainage water for irrigation under investigation. This means that Giza 178 was highly selective to Pb concentration than Giza177.

Nickel concentration (Ni):

Ni is an essential component of the enzyme urease and stimulation effects of Ni on the nitrification and mineralization of N compounds (Kabata – pendias and pendias 2000). Excess Ni in the medium alters various physiological processes, resulting detrimental effects on plants and causing diverse toxicity symptoms. Among these chlorosis and necrosis in rice plant (Samantaray *et al.*, 1998). As for Ni concentration in rice grains and straw of both rice cultivars as affected by water quality in nursery are presented in Table 7. The obtained results showed that Ni concentration in rice straw of both rice cultivars (Giza 177 and Giza 178) was higher than rice grains under all treatments whether nursery was irrigated by fresh or drainage water. Also, and the highest mean values of Ni concentration in straw was found with FwV_1T_2 treatment (10.89 and 10.60 ppm) and (11.50 and 10.98 ppm) with DwV_1T_2 (Drainage water + Giza177 + Recommended dose of fertilizers) treatment in both seasons. These results are in agreement with Bhattacharyya *et al.* (2008) who observed that Ni concentration in rice straw was higher than in rice grains. Also, it is noted from the results that the Ni concentration in both straw and grains in Giza177 cultivars was higher than Giza178 with all treatments (whether nursery irrigated with F_W or D_W). According to safety limits of Ni concentration in rice grains in India as shown in Table 8 should not exceed 1.50 mg/kg but it is noted that Ni concentration in rice grains of Giza177 cultivar (1.55 and 1.60 ppm) with FwV_1T_2 (Fresh water + Giza177 + recommended dose of fertilizers), (1.65 and 1.70 ppm) with DwV_1T_1 (drainage water + Giza177 + untreated control) and (1.82 and 1.90 ppm) with DwV_1T_2 (Drainage water + Giza177 + recommended dose of N fertilizers) treatments in both seasons 2010 and 2011 respectively, far exceeded permissible limits.

Conclusion

1) It can be concluded from this study that Giza 178 rice cultivar may be higher selective to some heavy metals (Cd, Pb and Ni) uptake than Giza 177.
2) In some areas, it is may be necessary to use wastewater for irrigation, in this case, irrigation the nursery, with fresh water (30 days) can to alleviate hazardous effect of heavy metals in rice plants.

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تاثير جوده مياه الرى على انتاجيه محصول الارز ومدى تركيزات بعض العناصر الثقيله به.

السيد سعد نعيم، هويدا الهابط، ابراهيم محمد الروينى و رأفت عبد اللطيف النمكى
مركز البحوث والتدريب فى الارز- معهد بحوث المحاصيل الحقليه-مركز البحوث الزراعية – سخا – كفر الشيخ – مصر.

تم اجراء تجربتيين حقليتين خلال موسمى 2010 ، 2011 فى مزرعة مركز البحوث والتدريب فى الأرز بسخا كفر الشيخ مصر، لدراسة تأثير جوده مياه الرى على الصنفين جيزه177 وجيزة 178 خلال فترة المشتل، حيث تم عمل مشتلين لكل صنف على حدى المشتل الأول يروى بمياه النيل (F_W) والأخر مروى بمياه صرف (مصرف D8)، تم نقل الشتلات (عمر 30 يوم) الى الحقل المستديم تحت مستوين من التسميد النيتروجينى م1 / صفر كجم نيروجين ، م2 / 69 كجم نيتروجين/ فدان وتم الرى فى الحقل الكادميوم والرصاص والنيكل فى كلا من الحبوب والقش لكلا الصنفين عند الحصاد وأوضحت النتائج أنة من بين الـ 8 معاملات أن المعامله $D_WV_2T_2$ (مياه الصرف + جيزة 178+ الجرعه الموصى بها من السماد) سجلت أعلى محتوى كلوفيل فى ورقة العلم و أعلى إنتاجيه لمحصول القش والحبوب مقارنة بالمعاملات الأخرى. كما اوضحت النتائج ان تركيزات بعض العناصر الثقيله (الكادميوم-الرصاص- النيكل) فى القش كانت أعلى من الحبوب لكلا الصنفين ومع كل المعاملات. اوضحت النتائج ايضا ان تركيز عنصرى الكادميوم (Cd) والنيكل (Ni) فى حبوب الارز تجاوز الحدود المسموح بها طبقا لمنظمه الصحه العالميه (WHO 1992) عند كلا من المعاملات الاتيه $D_WV_1T_1$: (مياه الصرف + جيزة 177+ بدون تسميد نيتروجينى) و $D_WV_1T_2$ (مياه الصرف + جيزة 177+ الجرعه الموصى بها من السماد) بينما تركيزعنصر الرصاص تجاوز الحدود الامنه عند المعامله $D_WV_1T_2$ (مياه الصرف + جيزة 177+ الجرعه الموصى بها من السماد النتيروجينى) فقط لكلا الموسيمين، ويمكن القول بأن رى المشتل بمياه النيل لمده 30 يوم لكلا الصنفين ادى الى تقليل تركيزات العناصر الثقيله، من هذه الدراسة يمكن القول بأنة تحت ظروف ندرة المياه الأمر الذى يتطلب منا إعادة إستخدام مياة الصرف فى زراعة الأرز، لذا يجب إختيار الصنف المناسب وذلك للحصول على أعلى محصول مع تركيزات مسموح بها من العناصر الثقيلة.

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