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Egypt. J. Soil Sci. 42, No. 1, pp. 139 - 159 (2002)

Effect of Polluted Irrigation Water on Some Crops and Their Contents of Heavy Metals*. 1-Wheat

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TWO LYZIMETER experiments were conducted at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, for two seasons, 1992/93 and 1994/95. It aimed to study the effect of water quality for long-term on productivity of eight wheat cultivars; Sakha 8, Sakha 69, Sakha 92, Giza 164, Gemmiza 1, Giza 162, Giza 163 and Giza 165 in the first season. Based on the results of the first season the four more productive cultivars; Sakha 8, Sakha 69, Sakha 92 and Giza 164 were chosen to study the content of their grains and straw of heavy metals; Pb, Cd, Ni, Mn, Zn and Cu as affected by water treatments. Lyzimeters (100 x 70 x 90 cm) were filled with clayey soil and imgated with three water treatments since 1987. They were W1, Nile water (good water quality), W3, drainage water (relatively poor water quality), and W2, mixed water, 50% W1 + 50% W3. A split-plot design with four replications was used where, water treatments and cultivars were allocated to main and sub-plots, respectively.

The obtained results showed that using poor water quality for irrigation increased ECe, SAR, soluble Na^{+}, Mg^{++}, $SO_4^{=}$ and Cl^{-} in soil paste extract and soil DTPA-extractable Pb, Cd, Ni, Mn and Zn than that of mixed or good water quality.

The results showed also that Sakha 69 was more tolerant to the mixed and drainage water when used for irrigation than Sakha 8, Sakha 92 and Giza 164.

In general, straw content of the *studied* heavy metals were higher than that of corresponding grains for all water quality treatments. Wheat straw and grain contents of Pb, Cd, Ni, Mn, Zn and Cu were

*The research work is financed through Regional Council for Research and extension, MALR, Egypt.

greater when poor water quality (W3) was used for irrigation than that of the mixed or good water quality. The grains of Sakha 69 were the lowest in their content of Pb, Cd, Ni, Mn, Zn and Cu followed by those of Sakha 8. The straw of Sakha 69 had also the lowest content of Cd, Ni and Zn when drainage water was used for irrigation.

Keywords: Wheat, pollution, heavy metals.

Pollution is defined as any change in the physical, chemical or biological conditions of the environment which may harmfully affect the quality of human life including effects upon animals and plants. The untreated industrial wastes contain little or more amount of heavy metals, which may cause enhancement of their level in the Nile and/or drainage water. When water containing these metals as pollutants used for irrigation, it will contaminate and enrich soils and crops which may be risky for human food and animal fooder (Zein et *al.*, 1998).

Reuse of wastewater in agriculture has been practiced in several countries since the beginning of the 20th century. Recent analysis of available water resources for irrigation in the Nile Delta and Valley revealed the vital need to reuse large volumes of drainage and treated sewage waters (Abdel Samie, 1995). Four billions m^3 of drainage water presently re-used in irrigation in the Delta which expected to be gradually increased to reach 7.7 billions m^3 by year 2000, of which a part will be industrial and municipal wastes discharged to the drainage system (Abu-Zeid, 1995). The most health hazards are due to chemicals in wastewater, which contaminate field crops with heavy metals. These metals are taken up from soils and bioaccumulated in crops, causing damage to plants when reach high levels and under certain conditions becoming toxic to human and animals fed on these metal-enriched plants (El-Sokkary and Sharaf, 1996).

Once the ions have been absorbed through the roots or leaves and have been transported to the xylem vessels, there is the possibility of movement throughout the whole plants, The rate and extent of movement within plants depend on the metal concerned, the plant organ and the age of plant. Chaney and Giordano (1977) classified Mn, Zn, Cd, B, Mo and Se as elements which were readily translocated to the plant tips, Ni, Co and Cu were intermediate and Cr, Pb and Hg were translocated to least extent.

Wheat is the major cereal crop grown in Egypt. Therefore, the present investigation was conducted to study the effect of irrigation with polluted drainage water on yield of some wheat cultivars planted in Nile Delta and their heavy metals uptake and accumulation in straw and grains.

Material and Methods

Two lyzimeter experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, for two sesons, 1992/93 and 1994195 to study the effect of water quality for long-term on the productivity of eight wheat cultivars; Sakha 8, Sakha 69, Sakha 92, Giza 164, Gemmiza 1, Giza 162, Giza 163 and Giza 165 in the first season. Based on these results, the four more productive cultivars, Sakha 8, Sakha 69, Sakha 92 and Giza 164 were chosen to study the content of their grains and straw of heavy metals; Pb, Cd, Ni, Mn, Zn and Cu as affected by three irrigation water treatments, The study was conducted in concrete lyzimeters (100 x 70 x 90 cm) filled with clayey soil (58.29% clay, 16.71 silt and 27.38% sand), since 1987. In the second season the four wheat cultivars were planted on 30^{th} November 1994, at the rate of 100 grains/ lyzimeter. Plants were harvested at 25^{th} May 1995. Grain and straw weights were recorded as gm/yzimeter.

Three water treatments were used for irrigation; Nile water (W_1) polluted drainage water (W_3); drain No. 7 at order after disposal of untreated oil and soap factory effluents and urban and municipal wastes discharged, which were analyzed for total soluble salts, soluble cations and anions and heavy metals content, (Table 1) and mixed water (W_2); 50% W_1 + 50% W_3.

TABLE 1. Chemical analysis and heavy metals content of Nile and drainage water.

Water sample	Anions (meq/L)				Cations (meq/L)				EC dS/m	SAR	Water class **
	$CO_3^{=}$	HCO_3^-	Cl^-	$SO_4^{=}$	Ca^{++}	Mg^{++}	Na^+	K^+			
Nile water	-	3.54	0.94	0.78	1.68	1.60	1.76	0.22	0.43	1.37	C_2-S_1
Drainage water	-	5.25	12.91	4.37	4.88	3.35	13.76	0.54	1.89	6.89	C_3-S_2

	Heavy metals content (ppm) in water samples					
	Cd	Pb	Ni	Mn	Zn	Cu
Nile water	0.004	0.300	0.021	0.011	0.010	0 012
Drainage water	0.032	0 430	5.526	0.337	0.267	0.053
Critical levels ***	0.010	5.000	0.200	0.011	0.010	0.200

* Averages of 5 samples ** According to Richards (1969) *** According to FAO (1985)

The treatments were incorporated in a split-plot design with four replicates. For all treatments, 20 kg P_2O_5/fed were added as superphosphate, before planting and 70 kg N/fed as ammonium sulphate in three doses. All other agronomic practices were followed as recommended.

At harvesting, representative grain and straw samples were collected for analysis; dry ashing technique was used for samples digestion as described by Chapman and Pratt (1961). Before planting and after harvesting, soil samples were taken from each lyzimeter for chemical analysis; total soluble salts, soluble cations and anions in soil-paste extract according to Richards (1969). Soil samples were also DTPA extracted and Cd, Pb, Ni, Mn, Zn and Cu were determined using the Atomic Absorption spectrophotometer according to Lindsay and Norvell (1978).

Statistical analysis was carried out using IRRITSTAT software, version 3/93 (Biometric Unit, International Rice Research Institute, Manila, Philippine),

Results and Discussions

Nile and drainage waters evaluation

Chemical characteristics of Nile and drainage waters used for irrigation of wheat plants, are shown in Table 1. Data showed that the average of EC of Nile water was 0.43 dS/m and its SAR value was 1.37. According to Richard's classification, Nile water is C_2-S_1; medium salinity low sodicity (Richards, 1969). While data of drainage water revealed that mean value of EC was 1.89 dS/m and SAR was 6.89. This water is high-salinity medium sodicity (C_3-S_2) according to Richards (1969); can not be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and a crop with good salt tolerance should be selected.

It can be concluded that Nile water is of good quality and drainage water is of poor quality for irrigation. The mixed water will be intermediate between them in relation to its chemical composition.

Effect of the studied irrigation water qualities on some chemical properties of clay soils

Changes in electrical conductivity of soil paste extract (dS/m), soluble

TABLE 3. Effect of water treatments on the grain and straw yields (gm/Lyz) of wheat cultivars at the first season, 1992/93.

Water treatment	Sakha 8	Sakha 69	Sakha 92	Gemmiza 1	Giza 162	Giza 163	Giza 164	Giza 165
				Grain yield gm/Lyz)				
W_1	330	429	367	198	309	269	335	224
W_2	382	386	363	288	337	254	348	290
W_3	352	390	330	247	315	287	351	233
Mean	355	402	353	244	320	270	345	249
				Straw yield (gm/Lyz)				
W_1	1031	1128	1023	728	957	834	1010	776
W_2	1048	1102	994	891	909	S71	987	888
W_3	905	1064	1033	896	893	823	910	894
Mean	995	1098	1017	838	Y20	843	969	83

b. Grain *yield (gm/Lyz)*

Data of grain yield **(gm/Lyz)** of the studied wheat cultivars in 1994195 are presented in Table 4, Mean values showed the maximum mean of grain yield was 453.58 **gm/Lyz** for Sakha 69 at W_1 water treatment and the lowest **was** 323.80 **gm/Lyz** for Giza 164 at W_3 water treatment. Data showed also that grain yield mean values generally decreased from 380.45, 453.58, **368.03** and 422.13 gm/Lyz at W_1 water treatment to 364.05, 436.23, 362.98 and **379.00 gm/Lyz** at W_2 water treatment and to 380.60, 427.10, **342.50** and 323.80 **gm/** Lyz at W_3 water treatment for Sakha 8, Sakha 69, Sakha 92 and Giza 164, respectively.

Grain yield mean values of Giza 164 significantly decreased when irrigated with drainage water (422.13 **gm/Lyz).**

Analysis of variance generally revealed that mean values of grain yield did not significantly affected by water treatments under the studied conditions. This may be attributed to slight soil salinity (ranged between 4.5 to 7.9 **dS/m)** and/or the moderate to high tolerance of the studied wheat cultivars to soil salinity, While, there were highly significant differences among grain yield mean values of wheat cultivars. Sakha 69 was the superior in grain yield, where its mean; 438.97 **gm/Lyz,** was higher with highly significant difference, than Sakha 8 and Sakha 92 and significant compared to Giza 164. Meanwhile, grain yield mean values of Sakha 69 were significantly higher than those of Sakha 92 at each of the three water treatments and than those of Sakha 8 at W_1 and W_2 water treatments and mean value of Giza 164 at W_3 .

c.Straw yield (g/Lyz)

Data of straw yield in Table 4 showed straw yield in 1994195 of Sakha 69

TABLE 4. **Effect of irrigation water treatments on grain yield (g/Lyz), and straw yield (g/Lyz) of the tested wheat cultivars, 1994195.**

Treatments		Grain yield (g/Lyz)	Straw (g/Lyz)
Irrigation water (W)			
Nile water (W_1)		406.04	1218.6
Mixed water (W_2)		385.56	1181.6
Drainage water (W_3)		368 50	1089.9
Significant		ns	ns
Cultivars (V)			
Sakha 8 (V_1)		375 03	1121.2
Sakha 69 (V_2)		438.97	1369.0
Sakha 92 (V_3)		357 83	1100.0
Giza 164 (V_4)		374.98	1063.3
LSD at	5%	35 98	165.3
	1%	48.58	222.9
Interaction (WV)			
W_1V_1		380.45	1218.0
W_1V_2		453.58	1454.5
W_1V_3		368.03	1144.5
W_1V_4		422.13	1057.5
W_2V_1		364.05	1126.0
W_2V_2		436.23	1422.0
W_2V_3		362.98	1083.0
W_2V_4		379.00	1095.5
W_3V_1		380.60	1019.5
W_3V_2		427.10	1230.5
W_3V_3		342.50	1072.5
W_3V_4		323.80	1037.0
LSD at	5%	62.31	285.9
	1%	84.15	386.2

was the highest in mean value (1369 g/Lyz) which was highly significant different from those of Sakha 8 (1121 gm/Lyz), Sakha 92 (1100 gm/Lyz) and Giza 164 (1063 gm/Lyz). The date of water (W) x cultivars (V) interactions showed that Straw mean values of Sakha 69 (1455 gm/Lyz) and Sakha 92 (1445) were significantly higher, at 1% level, than that of Giza 164 (1058 gm/Lyz) at W_1 water treatment. The data showed also that Sakha 69 when irrigated by mixed water (V_2W_3) gave straw yield of 1422 gm/Lyz which was significantly higher than those of Sakha 8, Sakha 92 and Giza 164, where their corresponding values were 2%. 339 and 327 gm/Lyz under the same water treatment.

Heavy metals content of

a. Nile and drainage waters (mg/L)

Data in Table 2 showed that the studied heavy metals Cd, Pb, Ni, Mn, Zn and Cu content of drainage water were greater than that of Nile water by 7, 13.3,

one with the bassage of time. These findings and conclusions are in agreement with those of Aboulroos et *al.* (1991) and **Zein *et al.*** (1996). Aboulroos ***et al.*** (1991) found that the behaviour of Fe, Mn, Zn, Cu and Pb differ from that of Cd, Co and Ni in soils imgated with sewage effluent, they added that in Cd, Co and Ni metals, the percentages held in primary minerals fraction were increased with time on the expense of the percentage of other fractions, especially that organically complexed. Although the studied soils were still beyond the critical levels, it could be reached these upon the continuous using of polluted drainage water.

c Studied wheat cultivars

Once the ions have been absorbed through the roots and have been transported to the xylem vessels, there is possibility of movement throughout the whole plant. The rate and extent of movement within plants depends on the metal concerned, the plant organ and the age of plant (Alloway, 1995).

The data of heavy metals concentration in grain, straw of studied wheat cultivars and coefficient of their translocation (TC) from straw to grain

$$TC = \frac{\text{Content of heavy metal in grains (mg / kg)}}{\text{Content of the same heavy metal in straw (mg / kg)}} \times 100$$

are presented in Table 6 and illustrated in Fig. 1. Data revealed generally that the studied heavy metals content; Cd, Pb, Ni, Mn, Zn and Cu mg/kg dry matter increased in grains and straw of the four studied wheat cultivars using polluted drainage water (W_3) for irrigation compared to that irrigated with mixed water (W_2) and that irrigated with Nile water (W_1). The data in the same table showed the sequence of heavy metals concentration in the straw (mg/kg), as follows:

Order	1	2	3	4	5	6	
Sequence							
1st	Mn>	Zn>	Cur	Pb>	Ni>	Cd	Nile water W_1.
2nd	Mn>	Zn>	Pb>	Cu>	Ni>	Cd	Mixed water W_2.
3rd	Mn>	Pb>	Zn>	Ni>	Cu>	Cd	Polluted drainage water, W_3.

Meanwhile, their contents in grains (mg/kg) were as the following sequence: Mn > Zn> Cu > Pb > Ni> Cd for all water treatments. It can be clearly noticed that heavy metals content sequence of grains is identical to the sequence of straw for the Nile water treatment (1st sequence) While in the 2nd and 3rd

TABLE 6. Effect of water treatments on heavy metals content of wheat plants (mg/ kg dry weight) and their translocation coefficient (TC).

Water treatment	Wheat cultivar	Heavy metal (mg/kg dry weight)					
		Cd	Pb	Ni	Mn	Zn	Cu
		Grains					
W_1	Sakha 8	0.058	0.02	0.16	35.75	4.15	0.97
	Sakha 69	0.058	0.02	0.02	35.21	3.27	0.79
	Sakha 92	0.070	0.10	0.21	35.88	4.02	1.12
	Giza 164	0.066	0.66	0.22	36.29	3.88	0.83
Mean		0.063	0.20	0.15	35.78	3.83	0.93
W_2	Sakha 8	0.077	0.36	0.28	37.90	4.21	0.98
	Sakha 69	0.061	0.12	0.26	37.50	3.70	0.81
	Sakha 92	0.079	0.66	0.48	36.69	4.58	1.20
	Giza 164	0.082	1.10	0.80	40.59	4.46	0.91
Mean		0.075	0.56	0.46	38.17	4.24	0.98
W_3	Sakha 8	0.078	1.10	0.78	38.71	4.93	1.48
	Sakha 69	0.068	1.06	0.68	38.84	4.26	1.09
	Sakha 92	0.099	1.64	1.20	42.60	5.04	1.90
	Giza 164	0.105	1.94	1.04	42.07	4.61	1.90
Mean		0.088	1.44	0.93	40.48	4.71	1.59
		Straw					
W_1	Sakha 8	0.230	6.34	1.33	64.68	16.75	6.97
	Sakha 69	0.250	5.33	0.67	50.18	14.14	7.90
	Sakha 92	0.320	5.33	1.87	58.18	18.32	7.34
	Giza 164	0.260	8.84	1.67	58.18	15.39	6.83
Mean		0.270	6.46	1.38	57.81	16.15	7.26
W_2	Sakha 8	0.320	10.50	6.17	65.01	17.75	8.20
	Sakha 69	0.280	9.50	6.34	69.35	16.85	8.75
	Sakha 92	0.290	17.67	9.17	54.34	17.24	8.44
	Giza 164	0.370	21.67	8.67	64.68	20.04	7.92
Mean		0.290	14.84	7.59	63.35	17.97	8.33
W_3	Sakha 8	0.310	28.51	15.67	77.85	19.42	9.25
	Sakha 69	0.290	22.00	6.34	78.35	17.80	9.59
	Sakha 92	0.420	18.87	11.00	59.51	21.29	9.17
	Giza 164	0.460	21.00	8.67	68.85	20.60	8.40
Mean		0.370	22.55	10.42	71.14	19.78	9.10
Critical level *		0.2-0.8	0.1-10	1.0	15-1000	15-200	4-15
		Translocation coefficient (%)					
W_1	Sakha 8	25.2	0.32	12.0	55.27	24.78	13.92
	Sakha 69	23.2	0.38	2.98	70.17	23.13	10.00
	Sakha 92	21.9	1.88	1.12	61.67	21.94	15.26
	Giza 164	25.4	7.47	1.32	62.38	25.21	12.15
Mean		23.9	2.51	4.36	62.37	23.77	12.83
W_2	Sakha 8	24.1	3.43	4.54	58.3	23.72	11.95
	Sakha 69	21.79	1.26	4.10	54.07	21.96	9.26
	Sakha 92	27.2	3.74	5.23	67.52	26.57	14.22
	Giza 164	22.2	5.08	9.23	62.76	22.26	12.64
Mean		23.8	3.38	5.78	60.66	23.63	12.02
W_3	Sakha 8	25.2	3.86	4.98	49.72	25.37	16.00
	Sakha 69	23.4	4.82	10.73	49.59	23.93	11.37
	Sakha 92	23.6	8.96	10.92	71.58	23.67	20.72
	Giza 164	22.8	9.24	11.99	61.10	22.38	22.62
Mean		23.8	6.65	9.66	57.99	23.84	17.68
The whole mean		23.8	4.18	6.6	60.34	23.75	14.18

Helal *et al.* (1984).

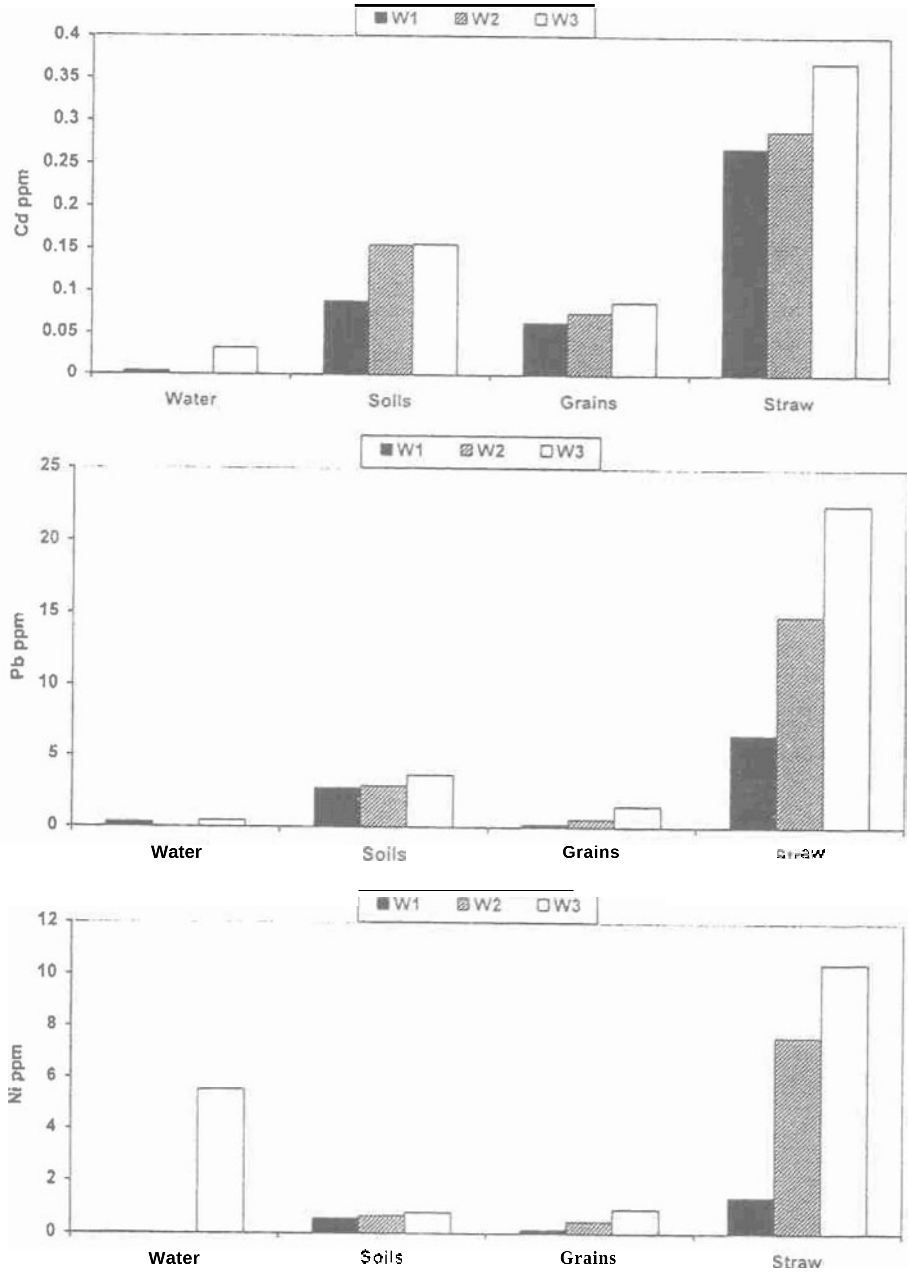
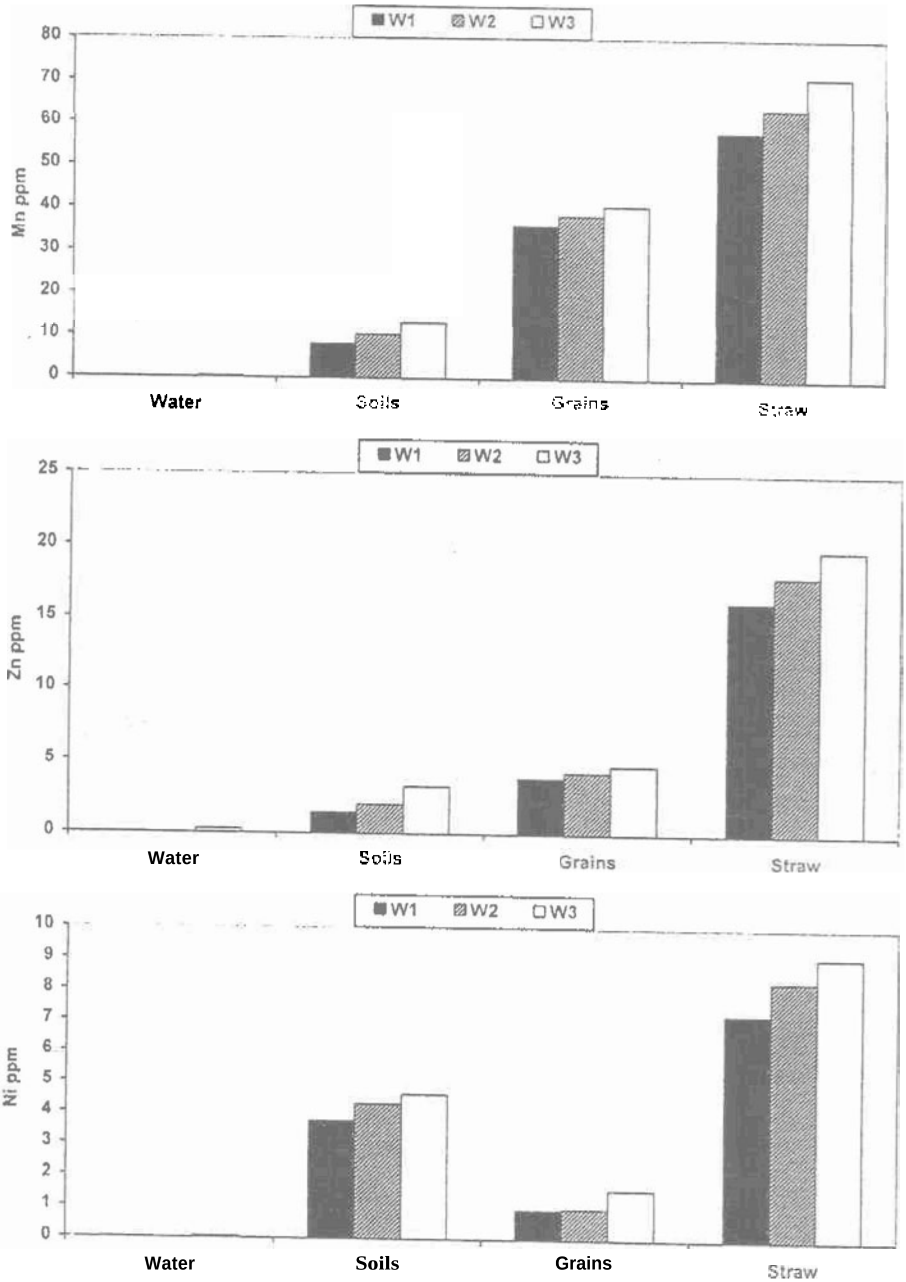


Fig. 1. Water, soil and plant grain and straw contents of studied heavy metals (ppm)
W_1 =Nile water, W_3 = drainage water.


W1
W2
W3
Mn ppm
0
10
20
30
40
50
60
70
80
Water
Soils
Grains
Straw
W1
W2
W3
Zn ppm
0
5
10
15
20
25
Water
Soils
Grains
Straw
W1
W2
W3
Ni ppm
0
1
2
3
4
5
6
7
8
9
10
Water
Soils
Grains
Straw

Pig. 1. Cont.

Concentration of Zn and Cu in the studied wheat cultivars under different water qualities and their translocation coefficients are presented in Table 6. It is clear that the two elements have the **same** trend. The mean concentration values of Zn and Mn increased in the straw of from **16.1** 5 **gm/kg** and **7.26 gm/kg** at Nile water treatment to **17.97 mg/kg** and **8.33** mg/kg at mixed water treatment and to 19.78 **mg/kg** and **9.1 mg/kg** at drainage water treatments, respectively. While the mean values were 3.83 & 0.93, **4.24 & 0.98 and 4.71 &** 1.59 **(gm/kg)** at W_1, W_2 and W_3 treatments for Zn & Cu in grains, respectively.

Data in the same table indicate that concentration of Zn values are generally higher than the corresponding Cu concentration in grain and straw of studied **wheat** cultivars, although, Cu-DTPA extractable of the studied soils were greater than that of Zn content (mg/kg). This may be due to the higher content of Ca^{+2} in drainage water (4.88 **meq/L),** studied soils (ranged between 18.9 and 25.37 **meq/L** in soil paste extract) and/or higher soil pH (ranged between 7.8 and 8.4). The data of translocation coefficient (Table, 6) showed that **Zn** values are generally, greater than that of Cu and this is in agreement with that of **Kabata** Pendias and Pendias (1992) who found that, following root absorption, the extent to which elements are translocated decreases in the following order Cd > B> **Zn>** Cu > Pb.

From data in Table 6 it seems that Mn has the highest values of all studied heavy metals content in both grain (ranged from 35.21 to **42.50 mg/kg)** and straw (ranged from **50.1** 8 **to 78.35 mg/kg)** at the three studied water treatments for all tested cultivars. The data indicated also that the grain content value were lower than those of straw.

Data revealed that mean values of Mn content in grain and straw of wheat cultivars **were** higher when irrigated with polluted drainage water **40.48** and **71.14 mg/kg)** than that irrigated with mixed water **(38.17** and 63.35 **mg/kg),** and that irrigated with Nile water (35.78 and 57.81 mg/kg). **These** results are in agreement with those obtained by Lid and **Shereif** (1996) who revealed that Mn contents in plants were significantly affected by irrigation water, crop types and part of plant, Their data demonstrated that the maximum increase of Mn amounted to 18% in plants irrigated with mixed raw waste water 1:2 with fresh water, when **compared** to control fresh water irrigation. They also concluded that manganese contents in straw in all studied plants (barley, rapeseed and broadbean) were significantly higher than that in grain and **seeds.** Data of translocation coefficient in the same table showed that Mn has the highest values of studied heavy metals and was not affected by water treatments. These results revealed the classification of **Chaney** and **Giordano** (1977) who classified Mn as one of readily **translocated** elements.

Cadmium values (Table 6) of grain and straw contents indicated that Cd has **the** lowest values in all studied heavy metals and ranged between 0.058 **mg/kg** and 0.105 **mg/kg** for grains and between 0.23 **/kg** and 0.46 mg/kg for straw. The averages of Cd content were **0.063, 0.075** and 0.088 mg/kg for grains and 0.270, 0.290 and 0.370 **mg/kg** for straw at W_1, W_2 and W_3 water treatments, **respectively.**

The data of water, soils and plants (grain and straw), in Tables 2, 5 and 6, respectively indicated that, drainage water content of Cd was greater by 30.7 & 38.4% with an average of 34.6% at W_3 treatment than that at W_1 treatment before planting and after harvesting. Cadmium mean values of grain and straw content increased also by 19.0% and 7.4% at W_2 and 39.7% and 39.0% at W_3 treatment compared to W_1. These results are in partial agreement with those obtained by **Homberg** and Bummer (1986) who found that Cd concentrations in wheat grain were linearly correlated with the total content of the soil. While, the straw data did not show the same linear trend, where mean values of Cd content of DTPA extract increased at W_2 and W_3 by 3.6% and 81.1% than at W_1 the Cd straw content increased by only 7.4 and 37.0% at W_2 and W_3 than that at W_1. This **may** be due to the high values of soil pH (7.8), higher content of soluble Ca^{++} (18.9-25.37 **meq/K** in soil past **extract) and/or** Zn-DTPA extractable (1.5-3.8 ppm). These conclusions are in agreement with those obtained by; **Alloway** (1995) who found that the uptake of Cd by rice decreased when pH was increased from 5.5 to 7.5 and wheat showed a similar response, Anderson and **Nilson (1974),** who found that the addition of CaO to soils reduced the uptake of Cd by fodder rape due to both an increase in pH and to competition between Ca^{++} and Cd^{++} ions, Oliver et *al.* (1994) who found that application of low rates of Zn fertilizer (up to 2.5 to 5.0 kg Zn ha^{-1}) markedly decreased the Cd concentration in wheat grain. They added that no further significant decreases in Cd concentration in grain occurred at higher rates of applied Zn. Page et al. (1981) who found that relative excess of Cu. Ni and Mn can reduce the uptake of Cd by plants.

Conclusion

Considering the previous discussions and conclusions, it seems that there is an obvious need for more research work to be carried out on the risk assessment of heavy metals contaminated soils. As mentioned by Eissa and El-Kassas (1999) that the danger of distribution wastes by such factories containing high concentration of heavy metals affects the survival in the suffering areas. The safest policy would appear to be minimize inputs of heavy metals to soils wherever to save our life and economy and restrict heavy metals bioavailability in the soil-plant animal pathway.

Abou El-Naga et al. (1999) recommended that attention must be earnestly given to protection of the environment and commitment to the latest law issued 1994 in Egypt, must be obligately under taken for these factories to prevent them from polluting agricultural soils by wastes. A part from the roles played by pollution control and soil chemistry, plant breading can make a vital contribution through the selection and utilization of crop genotypes which accumulate the least heavy metals.

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(Received 7/2000)

تأثير نوعية مياه الرى على بعض المحاصيل ومحتواها من العناصر الثقيلة(٠) ١- القمح

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أقيمت تجربتين بمحطة البحوث الزراعية بسخا - كفر الشيخ - مصر لموسمى ١٩٩٢/١٩٩٣ ، ١٩٩٤/١٩٩٥ وتهدف إلى دراسة تأثير نوعية مياه الرى للمدى البعيد على إنتاج ثمانية أصناف من القمح هى سخا ٨، سخا ٦٩، سخا ٩٢ ، جيزة ١٦٤ ، جميزة ١، جيزة ١٦٢ ، جيزة ١٦٣ وجيزة ١٦٥ فى الموسم الأول . وبناء على النتائج المتحصل عليها من الموسم الأول اختيرت الأصناف الأربعة التالية سخا ٨ ، سخا ٦٩ ، سخا ٩٢ وجيزة ١٦٤ وذلك لدراسة تأثير معاملات مياه الرى على محتوى الحبوب والقش من العناصر الثقيلة وهى الرصاص ، الكادميوم ، النيكل ، المنجنيز ، الزنك والنحاس .

وأجريت الدراسة فى أحواض أسمنتية (١٠٠ سم x ٧٠ سم x٩٠ سم) وضعت بها تربة طينية وتروى الأحواض بثلاثة نوعيات من المياه منذ عام ١٩٨٧ وهذه النوعيات هى ماء النيل (مياه ذات نوعية جيدة W1)، مياه صرف (ذات نوعية رديئة W3) , ومياه مخلوطة (٥٠٪W1 + ٥٠٪W3)W2 ووزعت المعاملات فى تصميم قطع منشقة بأربع مكررات حيث وضعت الأصناف في القطع الرئيسية ومعاملات الرى فى القطع الفرعية .

تشير النتائج المتحصل عليها أنه باستخدام المياه رديئة النوعية فى الرى زادت كل من التوصيل الكهربى لعجينة التربة المشبعة وقيم SAR والأيونات الذائبة Cl^- SO_4^-, Na^+, Mg^{++} والعناصر الثقيلة المستخلصة بـDTPA وهى Cd, Pb, Zn, Mn, Ni عن تلك الأرض المروية بمياه النيل.

كما أوضحت النتائج أن الصنف سخا ٦٩ كان أكثر مقاومة

(٠) هذه الدراسة تم تمويلها من المجالس الاقليمية للبحوث والإرشاد - مصر.

لاستخدام المياه المخلوطة فى الرى عن أصناف سخا ٨ ، سخا ٩٢، جيزة ١٦٤.
وبصفة عامة كان محتوى القش من العناصر الثقيلة المدروسة أكثر من محتوى الحبوب من تلك العناصر لجميع معاملات مياه الرى .

كما كان محتوى كل من القش والحبوب لعناصر الرصاص والكادميوم والنيكل والمنجنيز والزنك والنحاس أكثر عند استخدام مياه رديئة النوعية فى الرى عن محتواها عند استخدام مياه النيل فى الرى وكانت حبوب الصنف سخا ٦٩ هى الأقل فى محتواها من الرصاص والكادميوم والنيكل والمنجنيز والزنك والنحاس يليها حبوب الصنف سخا ٨، وكان قش الصنف سخا ٦٩ هو أيضا الأقل فى محتواها من الكادميوم والنيكل والزنك عند استخدام مياه الصرف فى الرى .