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EFFECT OF HEAVY AND TOXIC METALS CYCLE IN THE ENVIRONMENT ON ITS ACCUMULATION IN IRRIGATION WATER, SOILS AND GROWN PLANTS

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ABSTRACT: *Many metals have been recognized as toxins for centuries. Some metals are essential for life but if an individual's exposure exceeds as certain threshold, toxicity may develop and also they can be toxic even at low concentration. With industrial progress and civilized development of societies, there are enormous amounts of pollutants which contaminate the environment and especially soils. Environmental pollution and cultivated soil protection are considered two of the most serious problems that face mankind in the 21st century, especially in the heavily industrial area of Egypt.*

The present investigation was carried out to study the effect of pollution by industrial activities of heavy and toxic metals cycle in irrigation water, agricultural soils and grown plants, for many years.

These wastes provide heavy metals to the environment which affect badly soil properties, plant growth and animal and human health. Kafr El- Zaiyat area (El – Dalgamon), Gharbia Governorate was chosen for this research, since it is essential an agricultural area, but with extensive industrial activities. It includes many major industrial companies which have been established over nine decades i.e Oils and Soap Fertilizers, Chemical and Brick factories, the factories in this area unfortunately have been using the irrigation canals to dispose their wastes effluents, which in most cases contain heavy and toxic metals.

A survey study was carried out on area beside the sources of industrial pollution (Oils and Soap factories) along 4000 meter, content of some heavy metals i.e. Fe, Mn, Zn, Cu, Pb, Cd, Co and Ni were determined in irrigation water, soils, some plants and some industrial wastewater. The samples were collected at different distances (25 – 250 – 500 – 1000 – 2000 – 3000 – 4000 m.) from the sources of pollution in May 2003, 2004, 2005, 2006, 2007, respectively.

Obtained results indicated that samples of both soils, plants and water of 2007 contained the highest concentration of heavy metals followed by 2006, 2005, 2004 and 2003 being at the least indicating that a pronounced accumulation of heavy metals was established. Those concentrations, however, bad decreased by avoiding of the pollution source, where samples collected at 4000 m. from the source contained the lowest of heavy metals concentration.

Onion and potatoes were generally affected with the source of pollution, where roots contained higher concentration of heavy metals than shoots.

The results declared that the concentration of extracted heavy metals varied depending on major of which are distance from polluting soures, the havay metals contents in samples at 25 m. distant was exceeded that of the control (4000 m.) by about 26 fold in irrigation water, 9 – 10 fold in agricultural soils and 5 – 7 fold in grown plants. The enhancement of industrial activities through the last years led to increase of heavy and toxic metal levels in the environment, year after year (heavy metals cycle).

Key words: *Wastewater , Accumulation , Heavy metals , Soil, water, plant.*

INTRODUCTION

Discharging the aqueous wastes derived from industrial activities into water streams makes such water polluted and progressively becomes unsuitable either for irrigation purpose or as potable for human and animals (Bouwer and Chaney, 1974, Abdel – Tawab, 1985, El–Wakeel and El–Sawaby, 1988).

In Egypt, industrial activities, previously established, are mostly localized around or in the vicinity of agricultural lands. Helwan and Kafr El–Dawar are a major example, as many factories had been constructed. Several investigators have studied the impact of urbanization and industrialization on pollution of the biosphere, in air, water and soil and the consequences on the various living beings (Abdel – Tawab, 1985, Abdel Mottaleb, 1993, Ramadan, 1995 and Ahmed, 2001). Abd El – Sabour *et al*, (2000) showed that the prolonged irrigation with heavy metals contaminated wastewater increased significantly heavy metals contents of the tested soil.

Wastewater from Oils and Soap, detergent for cleaning purposes, tannery and dairy industries are charactenized by strongly alkaline industrial wastes tend to be in the range pH of (10 – 12) It is noticed that the effluents also differ from their fresh source water by their higher electrolyte concenteration, total salt concentration in the effluents is 17 to 20 m mole L^{-1} and SAR in the effluents to 5.8. In soil near sources of pollution at 500 m. T. S. S is 4.73 dSm^{-1}, SAR is 14. 39 and pH 8.6 in irrigation water, but in soil at 500 m. from source of pollution SAR 28. 92 % (Shalaby *et al*, 1996 a and Rashed 2004)

The objective of this work was to investigate the contamination of water, soil and plants, in the vicinity of factories region of kafr El- Zayat, by heavy metals.

MATERIALS AND METHODS

Wastewater samples:

Three wastewater samples were collected in May 2003, 2004 and 2005 at a point of discharge of Oils & Soap wastewater into the irrigation water. Some chemical characteristics of those wastewaters were determined according to page *et al*, (1982) and are shown in Map (1) & Table (1)

Table (1): Some chemical characteristics in industrial effluents

Years	pH (1 soil : 2.5 water)	Ec dSm^{-1}	Heavy metals (soluble) Ugg^{-1}							
			Fe	Mn	Zn	Cu	Pb	Cd	Co	Ni
2003	10.25	7.15	39.6	12.8	7.5	4.5	6.3	1.9	2.9	3.5
2004	10.50	7.60	35.8	11.2	7.2	5.8	6.8	2.1	3.3	2.9
2005	10.15	7.35	41.2	9.70	8.1	5.3	7.2	2.3	3.6	3.2

Water samples:

Water used for irrigation purpose, in this work, was derived from River Nile's. Seven water samples were collected from Egiad new canal and were taken from different sites along the distances of 4 Km., started in front of the factories (25 m.), then at distance of 250, 500, 1000, 2000, 3000 and 4000 m. far from the sources of pollution. These samples were collected in May 2003, 2004, 2005, 2006 and 2007, respectively. Irrigation samples were analyzed, according to standard methods (APHA, 1985) and presented in Map (1) &Table (2).

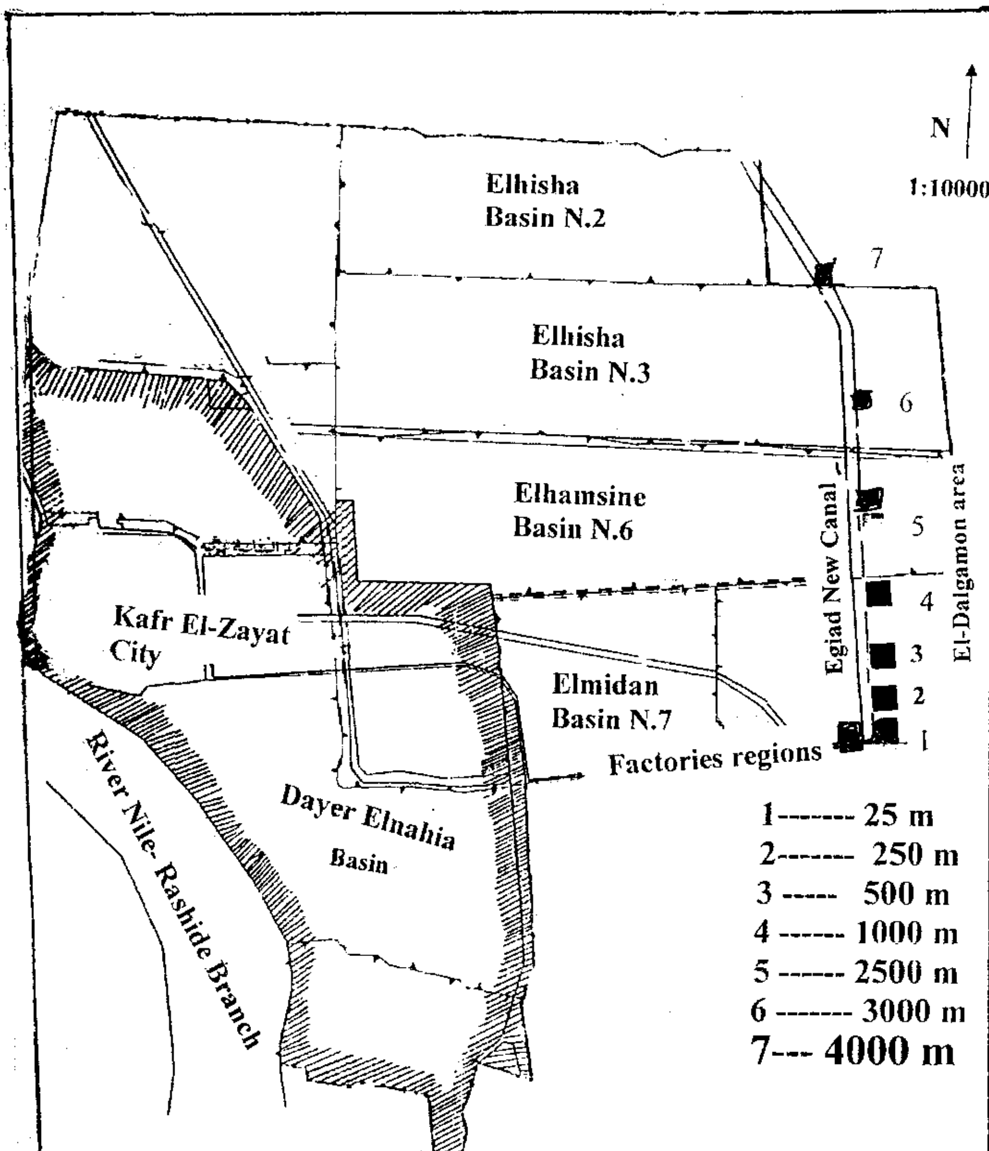
Soil Samples:

Surface alluvial soil samples (0 – 30 cm) were collected from seven sites of agricultural area beside the factories and along distance 4000 m (25, 250, 500, 1000, 2000, 3000, 4000 m) in May 2003, 2004, 2005, 2006 and 2007. The soil were air dried and ground to pass through a 2 mm sieve and some physical and chemical properties were determined according to the methods given by Page *et al*, (1982) and presented in Table (3).

Plant Samples.

Samples, representing roots and shoots of onion (*Allium Cepa, L.*) and potato (*Salanum tuberosum L.*) were taken from distances 25, 250, 500, 1000, 2000, 3000 and 4000 m started in front of the factories in May 2003, 2004, 2005, 2006 and 2007 respectively. The samples were collected, washed with tap water then with diluted HCl solution, dried at 70°C for 48 hr., ground finely and digested with 5: 2: 1 nitric acid, perchloric and sulphuric acid mixture. according to Chapman and Pratt (1961).

The concentrations of Fe, Mn, Zn, Cu, Pb, Cd, Co and Ni in wastewater, water, soil and plants samples were extracted by DTPA (Lindsay and Norvell, 1978) and determined using the atomic absorption spectrophotometer (Chapman and Pratt, 1961).



Map (1) Location of water, soil and plant samples

Table (2): Some chemical characteristics in irrigation water of samples collected at different distance from the factories region.

Distance (meter)	Years	pH 1 soil :2.5 water	Ec dS m^{-1}	Soluble heavy metals (ugg^{-1})							
				Fe	Mn	Zn	Cu	Pb	Cd	Co	Ni
25	2003	8.20	3.90	9.60	2.80	2.50	1.40	1.20	1.10	1.00	1.80
	2004	8.30	3.90	9.70	2.90	2.50	1.50	1.40	1.20	1.10	1.90
	2005	8.35	4.20	9.90	3.20	2.60	1.70	1.50	1.40	1.20	2.10
	2006	8.35	4.30	10.20	3.30	2.70	1.80	1.60	1.50	1.20	2.20
	2007	8.36	4.50	10.50	3.50	2.80	1.80	1.70	1.60	1.40	2.30
250	2003	7.70	2.10	3.80	1.29	0.95	0.73	0.66	0.60	0.55	0.81
	2004	7.75	2.10	3.80	1.41	0.98	0.75	0.67	0.60	0.56	0.82
	2005	7.85	2.20	3.85	1.45	0.99	0.76	0.78	0.62	0.58	0.85
	2006	7.88	2.30	3.88	1.46	0.99	0.77	0.71	0.63	0.59	0.87
	2007	7.90	2.40	3.90	1.50	1.02	0.78	0.72	0.65	0.60	0.88
500	2003	7.50	1.80	2.72	0.90	0.70	0.58	0.54	0.50	0.46	0.61
	2004	7.55	1.90	2.76	0.91	0.72	0.59	0.55	0.51	0.47	0.62
	2005	7.55	1.90	2.81	0.93	0.79	0.62	0.57	0.53	0.49	0.64
	2006	7.58	1.90	2.82	0.94	0.74	0.63	0.57	0.54	0.49	0.65
	2007	7.60	2.00	2.83	0.96	0.75	0.65	0.58	0.55	0.51	0.66
1000	2003	7.45	1.20	2.20	0.62	0.50	0.36	0.38	0.32	0.34	0.38
	2004	7.45	1.20	2.25	0.63	0.52	0.36	0.38	0.33	0.34	0.39
	2005	7.45	1.40	2.25	0.65	0.53	0.38	0.39	0.35	0.36	0.41
	2006	7.46	1.50	2.26	0.66	0.54	0.39	0.41	0.36	0.37	0.42
	2007	7.48	1.50	2.28	0.67	0.55	0.39	0.42	0.32	0.38	0.43
2000	2003	7.40	0.90	1.65	0.33	0.32	0.14	0.22	0.14	0.18	0.20
	2004	7.40	0.95	1.68	0.35	0.33	0.15	0.23	0.14	0.18	0.21
	2005	7.45	0.95	1.70	0.36	0.34	0.17	0.23	0.16	0.20	0.23
	2006	7.46	0.96	1.72	0.36	0.35	0.18	0.24	0.16	0.21	0.24
	2007	7.48	0.98	1.75	0.38	0.36	0.18	0.25	0.18	0.22	0.25
3000	2003	7.35	0.60	0.55	0.24	0.20	0.10	0.09	0.08	0.05	0.09
	2004	7.35	0.65	0.58	0.25	0.21	0.10	0.09	0.08	0.06	0.10
	2005	7.35	0.65	0.61	0.27	0.23	0.11	0.10	0.09	0.08	0.12
	2006	7.36	0.66	0.62	0.27	0.24	0.11	0.11	0.10	0.09	0.14
	2007	7.38	0.68	0.63	0.28	0.25	0.12	0.12	0.11	0.09	0.15
4000	2003	7.30	0.55	0.38	0.20	0.14	0.08	0.07	0.14	0.03	0.07
	2004	7.30	0.55	0.39	0.21	0.14	0.08	0.07	0.14	0.03	0.08
	2005	7.30	0.55	0.42	0.23	0.15	0.09	0.08	0.05	0.04	0.10
	2006	7.31	0.56	0.43	0.24	0.16	0.10	0.09	0.06	0.04	0.11
	2007	7.33	0.58	0.44	0.29	0.17	0.11	0.10	0.07	0.05	0.12

Table (3): Some physical and chemical analysis of the studied soil.

Distance (meter)	Organic Matter %	$CaCO_3$ %	Particle size distribution			Soil Texture	Available Nutrients (ugg^{-1})		
			Sand %	Silt %	Clay %		N	P	K
25	0.55	1.15	32.6	25.5	41.9	Clay Loam	6.5	8.2	90.6
1000	1.75	2.90	22.6	25.1	52.3	Clayey	22.8	16.7	145.2
4000	2.25	3.85	20.6	25.8	53.6	Clayey	33.4	23.9	168.9

Distance (meter)	pH 1 : 2.5 Soil:water	EC.dS/m 1 : 5 Soil:water	Soluble cations and anions $meqL^{-1}$							
			Cations				Anions			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl	SO_4
25	9.90	4.15	2.15	3.30	28.5	4.90	-	8.25	29.15	1.45
1000	8.55	1.65	4.85	2.90	4.15	2.80	-	2.80	9.25	2.65
4000	8.15	1.40	5.25	1.80	3.80	2.90	-	1.95	9.0	2.80

Distance (meter)	Heavy metals (ugg^{-1})							
	Fe	Mn	Zn	Cu	Pb	Cd	Co	Ni
25	55.8	39.2	35.6	9.3	8.2	5.2	3.6	8.7
1000	18.7	12.6	9.9	2.2	2.0	1.5	0.9	2.1
4000	11.8	8.2	5.6	1.5	1.2	0.6	0.5	1.0

RESULTS AND DISCUSSION

Heavy metals in factory effluents:

Elemental analyses of the factories liquid wastes discharged in irrigation canal of Kafr El– Zaiyat area were listed in Table (1).

Generally, these effluents are enriched with Fe, followed by Mn > Zn > Pb > Cu > Co > Ni > and Cd. Shalaby *et al*, (1996 a) found that the soluble heavy metals (ugg^{-1}) in wastewater of Oils and Soap factories were as follows: Fe (34.0) > Mn (9.6) > Zn (5.7) > Pb (5.7) > Cu (4.6) > Co (2.5) ≥ Ni (2.5) > Cd (1.2). Rashed (2004) showed that the wastewater effluent of Oil and Soap industry at Kafr El -Zeiyat was very high salinity (6.9 dS m^{-1}) and high alkalinity (SAR 25.10)

Heavy metals in irrigation water:

Concentration of Fe, Mn, Zn, Cu, Pb, Cd, Co and Ni in water samples from Egiad new canals (Table 2), revealed that the factories liquid wastes discharged in irrigation canals increased the levels of these metals in irrigation water. The concentration of metals decreased by getting far away from the sources of pollution and could be arranged, descendingly between distance at 25 m. (in May 2007) and at 4000 m. (in May 2003) (control), as the following: Fe (10.5 – 0.44) > Mn (3.5 – 0.25) > Zn (2.8 – 0.17) > Ni (2.3 – 0.14) > Cu (1.8 – 0.1) > Pb (1.7 – 0.09) > Cd (1.6– 0.06) > Co (1.4 – 0.05). Also, pH and EC decreased by getting far away from the sources of pollution.

Generally, the liquid wastes were enriched with these metals and were much higher than the maximum concentration recommended by FAO (1985) for wastewater for irrigation. Also, levels of the determined heavy metals in water samples were generally higher than which are recorded for fresh water in several studies, since the reported values (ugg^{-1}) were in the range of 0.11 – 0.77 for Fe , 0.01 – 0.11 for Mn, 0.01 – 0.09 for Zn , 0.01 – 0. 12 for Cu, 0.01 – 0.06 for Pb, 0.02 – 0.04 for Cd, 0.01 – 0.06 for Co and 0.01 – 0.02 for Ni (Ramadan, 1995, Abou – El – Naga *et al.*, 1996, Eissa and El–Kassas, 1999 and Ahmed, 2001). Abou El–Naga *et al.* (1996) stated that the concentrations of heavy metals in unpolluted Nile waster were as follows in ppm: Fe 0.77 > Mn 0.11 > Zn 0.09 > Cu 0.01 > and Pb 0.01. Also, the concentration of heavy metals (ugg^{-1}) in industrial wastewater were as follows: Fe 34.40 > Pb 3.80 Mn 2.50 > Co 1.50 > Zn 0.69 > Cu 0.47. Rashed (2004) showed that the irrigation water near oil and soap factory at Kafr El- Zeiyat region could be classified as high saline, moderate alkaline where, EC was about (4.73 dS m^{-1}) and SAR (14.32).

Available heavy metals in soils:

Data presented in Table (4) show the amounts of available heavy metals in the studied soils, according to distance from the factories region. The data clearly demonstrate large difference between polluted soil and non-polluted (control).

Table (4): Some chemical properties of the investigated soils in relation to proximately from the factories region.

Distance (meter)	Years	pH 1 soil :2.5 water	Ec dS m^{-1}	Heavy metals(ugg^{-1})							
				Fe	Mn	Zn	Cu	Pb	Cd	Co	Ni
25	2003	9.90	4.15	55.80	39.20	35.6	9.3	8.2	5.2	3.6	8.7
	2004	9.92	4.18	56.20	40.30	36.3	9.6	8.4	5.4	3.8	9.2
	2005	9.95	4.24	56.80	40.80	36.9	9.8	8.5	5.6	3.9	9.5
	2006	9.97	4.27	57.20	41.20	37.2	10.3	8.6	5.9	4.1	9.7
	2007	9.98	4.32	57.50	41.60	37..6	10.6	8.8	6.2	4.3	9.9
250	2003	9.58	3.91	48.30	29.20	24.3	7.2	5.8	3.50	2.55	6.1
	2004	9.60	3.93	84.60	29.90	24.1	7.4	6.0	3.55	2.60	6.4
	2005	9.62	3.96	49.00	30.40	25.2	7.6	6.2	3.60	2.63	6.5
	2006	9.63	3.99	49.60	30.90	25.8	7.7	6.3	3.65	2.65	6.5
	2007	9.65	4.00	49.90	32.30	26.2	7.8	6.4	3.75	2.65	6.5
500	2003	8.98	3.15	33.20	22.10	16.2	4.8	3.9	2.65	2.10	4.1
	2004	8.88	3.18	33.25	22.30	16.4	5.0	3.9	2.70	2.15	4.3
	2005	8.99	3.19	33.25	22.60	16.6	5.2	4.3	2.75	2.20	4.4
	2006	8.99	3.20	33.30	22.80	16.8	5.3	4.5	2.80	2.25	4.5
	2007	8.99	3.20	33.30	22.90	16.9	5.4	4.7	2.80	2.25	4.6
1000	2003	8.55	1.85	18.70	12.60	10.9	3.2	2.8	1.65	0.99	2.4
	2004	8.57	1.87	18.70	12.70	11.6	3.5	2.9	1.70	1.15	2.6
	2005	8.59	1.88	18.20	12.80	11.8	3.6	3.2	1.80	1.16	2.8
	2006	8.60	1.89	19.00	12.80	12.2	3.7	3.3	1.85	1.16	2.9
	2007	8.62	1.91	19.10	12.90	12.6	3.8	3.4	1.90	1.25	2.9
2000	2003	8.32	1.76	14.10	11.20	9.2	2.1	1.7	1.20	0.75	1.50
	2004	8.33	1.76	14.10	11.20	9.3	2.1	1.7	1.22	0.76	1.55
	2005	8.33	1.77	14.20	11.30	9.5	2.1	1.7	1.24	0.79	1.55
	2006	8.34	1.78	14.20	11.40	9.5	2.2	1.8	1.25	0.80	1.60
	2007	8.36	1.79	14.30	11.40	9.6	2.2	1.8	1.25	0.80	1.60
3000	2003	8.25	1.51	12.60	9.30	6.80	1.8	1.40	0.90	0.60	1.20
	2004	8.26	1.52	12.60	9.30	6.85	1.8	1.40	0.90	0.60	1.20
	2005	8.27	1.54	12.70	9.30	6.90	1.8	1.40	.0.93	0.60	1.20
	2006	8.27	1.54	12.70	9.40	6.90	1.85	1.45	0.94	0.61	1.25
	2007	8.28	1.55	12.70	9.40	6.95	1.85	1.45	0.95	0.61	1.25
4000 Control	2003	8.15	1.40	11.80	8.20	5.60	1.50	1.20	0.60	0.50	1.0
	2004	8.15	1.40	11.80	8.20	5.60	1.50	1.20	0.60	0.50	1.0
	2005	8.15	1.41	11.90	8.20	5.60	1.50	1.20	0.61	0.50	1.0
	2006	8.16	1.41	11.90	8.30	5.70	1.50	1.22	0.61	0.50	1.1
	2007	8.16	1.42	11.90	8.30	5.70	1.50	1.22	0.61	0.50	1.1
L.S.D 0.05				12.03	1.87	1.45	0.35	0.27	0.21	0.19	0.28

Levels of heavy metals were much higher in the soil near the factories. The concentration of these metals in soil samples at 25 m (in may 2007) was about 5 – 8 times higher than of these at 4000 m (in may 2003) and the concentration decreased with increasing distance from factories and could be arranged descendingly between distance 25 m (in May 2007) and at 4000 m (in May 2003) as the follows: Fe (57.5 – 8.15) > Mn (41.2 -8.2) > Zn (37.6 – 5.6) > Cu (10.6 – 1.50) > Ni (9.9 – 1.0) > Pb (8.8 – 1.20) > Cd (6.2 – 0.6) > Co (4.3 – 0.50). These results agree with those obtained by Morsy (1990), Shalaby *et al.* (1996 a), Vennii and Muthuvel (1997) and Rashed (2004). Also, Aodel – Mottaleb *et al.* (1993) , Schuhmacher *et al.* (1997) and Zein *et al* (2007) found that the higher values of Fe, Mn, Zn, Pb and Cu in soils were found beside the industrial factories.

Heavy metals contents in plants:

Plant don't take up only essential elements, necessary for their normal development, but also other ones if these are present in the growth medium in a sufficiently mobile form (Cottenie *et al.*, 1982). Plant grown in the polluted soils absorbed higher amounts of metal ions than those in normal soil. With few exceptions, the industrial aqueous wastes resulted in the greatest amounts of heavy metals taken up by plants, being above the permissible levels in most of them. (Pendias and Pendias, 1984).

As respects heavy metals contents of the onion and potatoes plants irrigated by the studied water sources, contained a marked increase in the concentration of all heavy metals in either roots or shoots of the plants grown on the studied soil. The levels of various metals differed widely according to both metal, the distance from the source of pollution, period of pollution and also to the studied plant (roots or shoots). Concentration of Fe, Mn, Zn, Cu, Pb, Cd, Co and Ni in both roots and shoots of the examined plants are shown in Tables (5 & 6).

The data clearly demonstrated that the content of these metals in plants at 25 m. from the source of pollution in May 2007 were higher than at 4000 m. in May 2003 (control) either in roots or in shoots. The metal contents decreased with increasing distance from the source of pollution and could be arranged descendingly as the following: Onion roots, Fe, (192 – 320) > Mn (36.7 – 84.8) > Zn (33.4 – 79.5) > Cu (5.2 – 16.6) > Ni (1.78 – 11.9) > Pb (1.41 – 9.8) > Co (0.85 – 6.2) > Cd (0.82 – 5.2). Onion shoots, Fe (161 – 248) > Mn (32.9 – 66.9) > Zn (24.2 – 55.2) > Cu (5.2 – 10.9) > Ni (1.25 – 6.8) Pb (0.8 – 5.6) > Co (0.55 – 3.8) > Cd (0.52 – 3.6). Shalaby *et al.* (2007) found that Ni uptake of jate followed the order : leaves > stems > roots while it was for flax mature plants : stems > leaves > seeds > cover capsules = roots .

Table (5): Heavy metals concentration in onion plants grown in soils at different distance from the factories region

Distance (meter)	Years	Heavy metals (ugg^{-1}) Fe		Mn		Zn		Cu		Pb		Cd		Co		Ni	
		Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots
25	2003	298	241	83.6	65.8	75.4	54.2	15.8	9.8	8.9	5.2	4.8	2.8	5.7	3.2	11.2	6.3
	2004	306	244	83.8	66.2	76.3	54.6	16.3	10.1	9.1	5.3	4.7	2.9	5.8	3.2	11.4	6.4
	2005	311	246	84.3	66.7	77.6	54.9	16.5	10.6	9.4	5.3	4.9	3.2	6.0	3.4	11.5	6.5
	2006	316	248	84.8	66.9	79.5	55.2	16.6	10.7	9.5	5.5	4.9	3.5	6.0	3.5	11.7	6.6
	2007	320	249	85.9	67.3	81.6	55.8	16.9	10.9	9.8	5.6	5.2	3.6	6.2	3.6	11.9	6.8
250	2003	282	215	71.6	56.7	68.7	52.4	12.8	9.0	6.3	3.8	3.3	1.9	4.2	2.3	7.6	5.1
	2004	284	218	72.2	57.4	69.2	52.6	12.9	9.2	6.4	3.9	3.4	1.9	4.3	2.4	7.6	5.2
	2005	286	218	73.3	56.2	69.4	53.3	14.6	9.3	6.5	3.9	3.5	2.0	4.3	2.5	7.8	5.3
	2006	288	220	74.2	58.9	69.8	53.9	14.0	9.5	6.5	3.9	3.5	2.0	4.4	2.5	7.8	5.3
	2007	290	222	75.5	59.7	70.2	54.8	14.2	9.6	6.6	3.9	3.5	2.1	4.5	2.5	7.9	5.4
500	2003	271	199	63.4	49.9	62.9	43.7	11.4	8.3	5.1	3.2	2.6	1.6	3.2	1.9	6.3	4.2
	2004	273	200	63.8	50.2	63.4	43.9	11.6	8.5	5.2	3.2	2.6	1.6	3.2	1.9	6.3	4.2
	2005	273	202	64.1	50.6	63.8	44.3	11.8	8.6	5.3	3.3	2.7	1.7	3.3	2.0	6.3	4.2
	2006	274	203	64.5	50.9	64.2	44.8	11.8	8.6	5.3	3.3	2.7	1.7	3.3	2.1	6.4	4.3
	2007	274	205	64.8	51.2	64.7	45.2	11.9	8.7	5.4	3.3	2.8	1.7	3.3	2.1	6.4	4.4
1000	2003	252	185	55.3	41.6	52.8	37.8	8.6	6.6	3.6	2.2	2.0	1.4	2.1	1.6	5.0	3.3
	2004	252	186	55.6	41.8	53.2	37.9	8.6	6.7	3.6	2.2	2.0	1.4	2.2	1.6	5.0	3.3
	2005	253	187	55.8	41.9	53.4	38.1	8.7	6.7	3.7	2.3	2.0	1.5	2.2	1.6	5.1	3.3
	2006	254	188	56.2	42.1	53.6	38.2	8.7	6.8	3.7	2.3	2.1	1.5	2.2	1.6	5.1	3.4
	2007	255	188	56.7	42.3	53.6	38.3	8.7	6.8	3.8	2.3	2.1	1.5	1.6	1.7	5.1	3.4
2000	2003	219	168	43.6	36.8	41.2	29.8	7.4	5.5	3.0	1.9	1.6	1.1	1.5	0.85	3.2	1.9
	2004	219	159	43.8	36.9	41.3	29.8	7.4	5.5	3.0	1.9	1.6	1.1	1.5	0.80	3.2	1.9
	2005	219	170	44.6	37.2	41.5	25.8	7.5	5.6	3.0	1.9	1.6	1.2	1.5	0.80	3.2	1.9
	2006	220	170	44.2	37.4	41.6	29.9	7.5	5.6	3.0	2.0	1.6	1.2	1.6	0.90	3.3	1.9
	2007	220	170	44.2	37.5	41.8	29.9	7.5	5.6	3.0	2.0	1.6	1.2	1.6	0.95	3.4	2.0
3000	2003	199	162	33.6	32.8	32.2	26.7	7.0	5.2	2.0	1.0	1.1	0.8	0.9	0.70	2.1	1.6
	2004	200	162	33.8	32.9	32.4	25.7	7.0	5.2	2.0	1.1	1.2	0.8	0.9	0.75	2.1	1.5
	2005	200	162	33.9	33.2	32.5	26.8	7.1	5.3	2.1	1.1	1.2	0.8	0.9	0.75	2.2	1.5
	2006	200	163	34.2	33.2	32.5	26.8	7.1	5.3	2.1	1.1	1.2	0.9	1.0	0.75	2.2	1.5
	2007	202	164	34.5	33.2	32.6	26.9	7.2	5.3	2.1	1.1	1.2	0.9	1.0	0.75	2.2	1.6
4000	2003	192	161	36.7	29.6	33.4	24.2	6.8	5.0	1.41	0.80	0.82	0.52	0.85	0.55	1.78	1.25
	2004	194	163	37.2	29.9	33.8	24.6	6.9	5.0	1.42	0.80	0.83	0.53	0.87	0.56	1.80	1.26
	2005	194	164	37.8	30.4	34.2	24.9	7.0	5.0	1.42	0.85	0.85	0.55	0.89	0.58	1.80	1.26
	2006	195	164	38.1	30.9	34.7	25.3	7.0	5.0	1.43	0.88	0.86	0.55	0.90	0.58	1.81	1.27
	2007	195	166	38.5	32.8	35.6	26.8	7.0	5.0	1.45	0.90	0.87	0.57	0.92	0.60	1.82	1.29
L.S.D 0.05		5.066	3.610	5.238	2.287	2.246	2.303	0.539	0.539	0.411	0.33	0.296	0.173	0.356	0.192	0.481	0.480

Table (6): Heavy metals concentration in potatoes plants grown in soils at different distance from the factories region.

Distance (meter)	Years	Heavy metals (ugg⁻¹)															
		Fe		Mn		Zn		Cu		Pb		Cd		Co		Ni	
		Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots
25	2003	295	276	85.2	60.2	80.5	59.2	6.9	4.5	9.9	5.2	4.30	1.90	4.20	2.80	9.50	5.60
	2004	296	276	85.5	61.0	80.7	59.3	7.0	4.6	10.0	5.2	4.35	1.92	4.20	2.85	9.60	5.70
	2005	297	276	85.7	61.2	80.9	59.6	7.1	4.6	10.1	5.2	4.45	1.93	4.30	2.88	9.70	5.80
	2006	298	277	85.8	61.5	80.5	59.8	7.1	4.6	10.1	5.3	4.50	1.93	4.50	2.92	9.75	5.85
	2007	298	277	86.3	61.8	81.1	95.9	7.3	4.7	11.2	5.3	4.60	1.95	4.80	2.95	9.80	5.90
250	2003	276	257	79.2	55.3	75.7	53.8	12.9	8.2	6.5	3.4	2.6	1.60	3.70	1.90	7.1	4.2
	2004	278	258	79.6	55.5	75.9	53.9	14.0	8.5	6.6	3.5	2.6	1.60	3.80	1.90	7.2	4.3
	2005	278	260	79.9	55.7	76.2	54.0	14.2	8.6	6.8	3.6	2.7	1.70	3.90	2.00	7.2	4.5
	2006	279	261	81.2	55.8	75.6	54.1	14.4	8.7	7.0	3.8	2.8	1.70	3.90	2.10	7.4	4.5
	2007	279	262	81.5	55.9	76.9	54.2	14.6	8.9	7.1	3.9	2.8	1.70	3.90	2.10	7.5	4.6
500	2003	268	246	71.2	51.2	68.8	48.8	10.2	7.6	4.5	2.8	1.9	1.20	2.70	1.60	5.7	2.8
	2004	269	247	72.0	51.6	69.2	49.2	10.6	7.6	4.5	2.9	1.9	1.20	2.80	1.70	5.9	2.9
	2005	270	248	72.9	51.8	70.0	49.6	10.8	7.6	4.6	3.0	2.0	1.20	2.80	1.80	6.0	3.0
	2006	270	248	73.4	51.8	70.2	49.6	11.2	7.7	4.6	3.0	2.1	1.40	2.80	1.80	6.2	3.2
	2007	271	248	74.3	52.0	71.4	49.7	11.4	7.8	4.7	3.2	2.1	1.40	2.90	1.80	6.2	3.3
1000	2003	253	228	61.5	48.2	58.6	46.5	8.9	7.2	3.3	1.9	1.4	0.90	2.1	1.10	4.3	2.3
	2004	254	229	61.7	48.4	58.9	46.6	8.9	7.2	3.4	1.9	1.4	0.90	2.1	1.10	4.4	2.4
	2005	255	230	61.9	48.4	59.5	46.8	8.9	7.2	3.4	3.0	1.5	1.00	2.1	1.20	4.4	2.4
	2006	255	230	62.2	48.5	59.7	46.8	9.0	7.3	3.4	2.1	1.5	1.00	2.2	1.20	4.5	2.5
	2007	255	230	62.3	48.6	59.9	46.9	9.0	7.3	3.4	2.1	1.5	1.00	2.2	1.20	4.6	2.5
2000	2003	232	209	50.4	38.2	49.5	34.5	7.6	5.3	2.6	1.4	0.8	0.50	1.2	0.60	2.4	1.4
	2004	236	210	50.6	38.4	49.6	34.0	7.6	5.3	2.8	1.4	0.8	0.50	1.2	0.70	2.5	1.4
	2005	236	210	50.8	39.0	49.7	34.6	7.7	5.4	2.6	1.5	0.8	0.50	1.2	0.70	2.5	1.4
	2006	237	211	51.0	39.2	49.7	34.7	7.7	5.4	2.6	1.5	0.8	0.50	1.2	0.70	2.5	1.4
	2007	237	211	51.2	39.6	49.8	34.8	7.7	5.4	2.7	1.5	0.8	0.60	1.2	0.70	2.5	1.5
3000	2003	221	196	41.2	34.5	39.2	29.9	5.9	4.4	1.85	1.25	0.75	0.45	0.90	0.55	1.80	1.2
	2004	221	196	41.2	34.5	39.6	30.2	5.9	4.4	1.85	1.25	0.75	0.46	0.90	0.55	1.82	1.2
	2005	222	196	41.3	34.5	39.8	30.2	5.9	4.5	1.90	1.25	0.75	0.46	0.90	0.55	1.85	1.2
	2006	222	197	41.3	34.6	39.9	30.3	6.0	4.6	1.90	1.25	0.76	0.49	0.90	0.56	1.85	1.2
	2007	222	197	41.5	34.6	40.1	30.3	6.0	4.5	1.90	1.25	0.78	0.48	0.92	0.57	1.85	1.2
4000	2003	201	185	38.2	32.9	35.4	27.9	5.2	4.1	1.55	0.95	0.65	0.38	0.80	0.45	1.55	1.05
	2004	202	186	38.8	32.9	35.6	28.2	5.3	4.1	1.56	0.98	0.66	0.39	0.82	0.46	1.56	1.10
	2005	202	187	39.2	33.2	35.8	28.5	5.6	4.2	1.57	1.02	0.67	0.40	0.82	0.47	1.58	1.12
	2006	203	187	39.6	33.4	36.0	28.7	5.7	4.2	1.57	1.05	0.68	0.40	0.83	0.47	1.58	1.14
	2007	203	188	39.9	33.6	36.2	28.8	5.8	4.3	1.59	1.10	0.70	0.42	0.83	0.48	1.58	1.15
L.S.D 0.05		8.04	5.75	2.534	2.33	2.446	2.625	0.79	0.41	0.557	0.588	0.315	0.192	0.258	0.229	0.40	0.396

Potatoes roots, Fe (201 – 298) > Mn (38.2 – 86.3) > Zn (35.4 – 81.1) > Cu (5.2 – 17.3) > Ni (1.55 – 9.80) Pb (1.55 – 11.2) > Co (0.80 – 4.80) > Cd (0.65 – 4.60). Potatoes Shoots, Fe (185 – 277) > Mn (32.9 – 61.8) > Zn (27.9 – 59.9) > Cu (4.1 – 4.7) > Ni (1.15 – 5.90) > Pb (0.95 – 5.3) > Co (0.45 – 2.95) > Cd (0.38 – 1.95). Abou El – Naga *et al.* (1996) showed that plant grown in the polluted soils absorbed higher amounts of metal ions than those grown in normal soils. Eissa and E- Kassas (1999) stated that the concentration of heavy metals in seven different plant species grown in the different soils near the factories were as follow: Pb (25 – 182) > Mn (19 – 73) > Zn (12 – 65) > Cu (15 – 25) > Co (2.1 – 18.8) > Ni (3.9 – 12.1) > Cd (3 – 9). Also Shalaby *et al.* (1996 b) studied the effect of irrigation with different types of wastewater on some medicinal plants and found that the contents of heavy metals in these plants were slightly or considerably enhanced according to sources and concentration of applied waste water.

It is clear from the present study that continuous irrigation with polluted water had resulted in substantial increase in the DTPA – extractable fraction of heavy metals in the soil. These elevated levels of metals in soil may be toxic to plants grown thereon or after they enter the food chain and could be harmful to animal and human being nourished with these plants. Generally this work may express a vital point about heavy metals accumulation in the environment: water- soils – plants system.

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تأثير دورة الفلزات الثقيلة والسامة فى البيئة على تراكمها فى مياه الرى والتربة والنباتات النامية

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الملخص العربى

لقد عرف عن العديد من المعادن بأنها سامه منذ قديم الأزل ،لكن بعض هذه المعادن يكون ضرورى للحياة ، ولكن إذا الشخص تعرض لزيادة عن مستوى معين فإن السمية بهذه العناصر سوف تحدث ، كما أن بعض العناصر الغير ضرورية تكون سامة حتى عند التركيزات المنخفضة . ومع التقدم الصناعى والحضارى للشعوب والمجتمعات العمرانية فإن ملوثات عديدة تلوث البيئة وخاصة التربة .

تلوث البيئة وحماية التربة المنزرعة يعتبران من المشاكل الخطيرة التى تواجه البشرية فى القرن الواحد والعشرون وخاصة فى وجود مناطق كثيفة بالمصانع فى مصر .لذلك تم إختيار منطقة زراعية هامة بناحية الدلجمون التابعة لمركز كفر الزيات محافظة الغربية ويكثر بجوارها أنشطة صناعية كثيرة ومختلفة وتم إنشائها منذ أكثر من تسعون عاماً ومنها مصانع الزيوت والصابون ومصنع الأسمدة ومصنع الكيماويات ومصانع الطوب . ولسوء حظ هذه المنطقة الزراعية الخصبة والهامة لجميع الزراعات فإن هذه المصانع تلقى بمخلفاتها الضارة فى قنوات الرى القريبة والتى فى معظم الأحيان تحتوى كميات كبيرة من العناصر الثقيلة والسامة . وقد تم إجراء حصر للمنطقة الواقعة بجوار أحد مصادر التلوث الصناعى (مصانع الزيوت والصابون) وعلى إمتداد مسافة ٤٠٠٠ متر مع إتجاه سريان الماء شمالاً أخذت عينات لمياه الرى والتربة الزراعية وبعض النباتات النامية تم تحليلها لتقدير عناصر : حديد - منجنيز - زنك - نحاس – رصاص – كادميوم – كوبلت – نيكل وكذلك فى المخلفات الصناعية السائلة وذلك خلال خمسة أعوام في مايو ٢٠٠٣و ٢٠٠٤ و ٢٠٠٥و ٢٠٠٦و ٢٠٠٧ وذلك على أبعاد ٢٥ ، ٢٥٠ ، ٥٠٠ ، ١٠٠٠ ، ٢٠٠٠ ، ٣٠٠٠ ، ٤٠٠٠ متر من مصدر التلوث .

وأوضحت نتائج الدراسة خلال هذه الفترة أن تركيزات هذه العناصر الثقيلـــة فـــى العينـــات المأخوذة لكل من التربة والنباتات والمياه فى عام ٢٠٠٧ كانت أعلى التركيـــزات يليهـــا عـــام ٢٠٠٦ ثم ٢٠٠٥ واقلها عام ٢٠٠٣ نتيجة لحدوث تراكم وتركيز هذه العناصر عاماً بعد أخـــر وكذلك وجد تناقص فى تركيزات هذه العناصر بالبعد عن مصدر التلوث الصناعى . وتم إختيـــار نباتات البصل والبطاطس الموجودة بكثرة فى هذه المنطقة لأنها من أكثـــر النباتـــات عرضـــة لخطورة التلوث وتجمعها بها وخاصة بالمجموع الجذرى الذى يستخدم بكثرة فى غذاء الإنسان وطازجا.

كما أوضحت النتائج خلال هذه الفترة أن تركيز العناصر الثقيلة فى العينات المـــأخوذة عنـــد مسافة ٢٥ متر تزيد عن كمياتها عند مسافة ٤٠٠٠ متر بمقدار يبلغ ٢٦ ضعف فى مياه الرى، ٩ – ١٠ ضعف فى الأرض الزراعية وكذلك ٥ – ٧ ضعف فى النباتات النامية .

وقد أوضحت نتائج هذه الدراسة خطورة التلوث الصناعى على محتوى البيئـــة مـــن هـــذه العناصر ومما يزيد فى خطورتها أنه ينتج عن دوره العناصر الثقيلة والسامة فى البيئة زيـــادة تركيزها فى المكونات البيئية المختلفة عاماً بعد أخر وخاصة فى المناطق القريبة مـــن التلـــوث الصناعى وصولاً للماء والغذاء بنسب ضارة وسامة. ولذلك من الضرورى وقف هـــذه الـــدورة وزيادتها بمنع وصول هذه المخلفات الصناعية الخطيرة للبيئة .