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Compare the Effect of Polluted and River Nile Irrigation Water on Contents of Heavy Metals of Some Soils and Plants

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Abstract: The objective of this study is to compare the effect of polluted in the El-Saff soils are irrigated from El-Khashab canal which is a mixture of domestic and industrial effluents and Nile water which is taken for comparison. Samples of water, soils and plants were collected from two sites of El-Khashab canal and site of Nile water for analyses. Results showed that salinity levels, pH and heavy metals were in the permissible level in all water and soils samples. It was noticed that values of No_3^- in El-Khashab canal higher than that Nile water, which due to the disposal of domestic and industrial effluents in El-Khashab canal. The values of heavy metals (Fe, Mn, Co, Zn, Cu, Ni, Pb and Cd) in water and extractable soil samples were lower than the maximum permissible limits. The data revealed large different between trace elements content in different soils. The highest content of trace elements (Fe, Mn, Co, Zn, Cu, Ni, Pb and Cd) in El-Khashab sites compared to that of Nile site. In soils irrigated with El-Khashab canal water, the average content of these elements was 80.8, 33.8, 0.19, 22.5, 6.39, 14.6, 23.2 and 0.26 ppm, respectively. On the other hand, the irrigated soils with Nile water, contains 2.8, 8.7, 0.09, 3.44, 2.78, 0.63, 2.3 and 0.03 ppm of Fe, Mn, Co, Zn, Cu, Ni, Pb and Cd, respectively. It was noticed that corn plant grown in the vicinity of El-Khashab canal, have taken up much higher Fe, Mn,Co, Zn, Cu, Ni, Pb and Cd compared to are plant grown on Nile lands. The contents of Fe and Mn in leaves were several times higher than that of stems. On the other hand, decrease in Co in leaves was most probably due to non translocation from stems. Also, Zn, Cu and Ni uptake by corn in Nile land was lower than that of corn in El-Khashab sites. Because uptake of Zn at the relatively polluted are of El-Khashab sites was higher than that of Nile land samples. Shoots uptake of Pb and Cd in corn of Nile land were very far below that concentrations in corn of El-Khashab sites. Growing forage are El-Khashab sites or using been residue for feeding dairy animals is dangerous for animals and human being.

Key words: Irrigation water - Pollution - River Nile - Soil - Corn - Heavy metals.

INTRODUCTION

The most possible sources of soil, water and plant pollutions are: Sewage sludge, residues of industrial factories and intensive fertilization.

Ibrahim *et al.* [1] indicated that the EC in sewage water of El-Gabal Elasfer ranged from 0.79 to 0.90 dsm^{-1}, whereas HCO_3^- was the dominating soluble anion as it ranged from 3.98 to 5.17meq/l followed by chlorides and sulfates as their values ranged from 2.27 to 3.4 and 0.42 to 1.49 meq/l, respectively. They added that Na^+ was the predominant cation followed by Ca, Mg and K as, where they ranged between 2.15- 4.24, 1.87-2.80, 1.17-2.83 and 0.39-0.92 meq/l, respectively.

Abd El-Hady [2] show that Pb values of water samples along El-Saff canal were higher compared with the content of water samples of Zn, Cu and Ni. Abdel Sabour *et al.*, [3] indicated that the use of Cairo sewage effluent for 12 and 50 years resulted in an increase in soil Zn content by about 10 to 14 folds. Also, Tahoun and Abd El-Bary [4] mentioned that the concentrations of some heavy metals in the sewage effluent of the city of El-Zagazig take the following order: Fe > Pb > Zn> Mn > Co> Cd = Ni = Cu. El-Gendi [5] showed that the levels of (Zn, Fe, Ni, Cd) in Nile water (0.012, 0.02, 0.001and 0.001 ppm), respectively, are below the critical levels reported for these metals in waters for irrigation use. Meanwhile, the sewage effluent water contains measurable quantities of Zn (0.70 ppm), Fe (1.05 ppm), Ni (0.40) and Cd (0.12 ppm).

Abd El-Tawab [6] showed that the liquid wastes produced by industrial complex at Helwan increased Fe, Zn and Mn content in the Nile water by 3 times than their normal contents. Also, Abd El-Aal *et al.*, [7] found that the concentration of heavy metals in El-Hager and El-Khashab canals were much higher than in the Nile water by about 4 to 7 times. They showed that the concentrations of Fe, Mn and Zn in the Nile water at Helwan segment were 4 times higher than normal concentrations. Abd El-Hady [8] showed a wide variation in heavy metals content of water samples at shoubra El-Kheima due to the type and

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distance of pollution sources as well as the climatic season. Ismail *et al.* [9] indicated that the annual load discharged of heavy metals at outlets of cement factory at torra area, fertilizer company at Abo-Zabal city and Boleter Textile company at Mostored, was 425, 111 and 44 kg Zn/year, 231, 49 and 28 kg Cu/year and 439, 33 and 24 kg Pb/years, respectively. Farida Rabie *et al.* [10] reported that sewage waste contained higher concentrations of Zn and Cu, compared to the iron and steel industrial factory wastes, while sewage waste contained low concentrations of Fe and Mn, compared to the iron and steel industrial factory wastes. They reported that the suspended matter of both sources contained 160 and 155 ppm Pb, 2.75 and 1.95 ppm Cd, respectively.

Ibrahim *et al.* [1] observed that Mn, Cu, Zn, Cd, Pb, Ni and Co increased in the upper soil layer (0, 10 cm) as time due to using sewage water for irrigation. El-Hassanin *et al.* [11] indicated that prolonging the irrigation periods was associated with significant increases in the total and available forms of Pb, Cd, Zn and B. Also, they concluded that the concentrations of these elements have not accumulated to toxic levels even after 67 yrs with sewage irrigation. Also, Abd El-Hady [12] show that the extractable values of heavy metals in soil samples at El-Saff were in the permissible levels and did not reach the toxicity levels.

With respect to the phytotoxicity of sludge application, Chumbley [13] proposed a general statement about the relative toxicity of three metals, that Zn was the least toxic, while Cu was twice and Ni was eight times as toxic as Zn. He recommended that a total of 250 mg Zn-equivalent /g soil are the maximum level that can be safely added to the soil over a 30 year period. On this basis, Ibrahim *et al.* [1] found that total Mn, Cu, Zn, Cd, Pb, Ni and Co contents were lower than Zn equivalent levels in all soils in El-Gabal Elasfer area irrigated with sewage water for different years. Rabie *et al.* [14] mentioned that the maximum rate of sludge to be added to the tested sandy soil is 94.7 tons of Suez sludge /fed and 78.13 tons Giza sludge fed before the safe limits is exceeded.

Dahdoh *et al*., [15] showed that the extractable Pb in both cultivated and uncultivated soils increased by increasing Pb addition to soil. Badawy and El-Motaium [16] showed that the concentrations of DTPA-extractable metals (Cu, Zn, Cd, Pb) in soil increased with the increase in sludge application rate. Kandil *et al.* [17] found that highly significant correlations (r) between the chemical composition of irrigation water used and soil chemical properties (whole profile), which predict the soil contamination due to irrigation with low quality water.

Aboulroos *et al*., [18] mentioned that Zn content of leaves of corn increased with increasing levels of extractable Zn in the soils. Abd-El-Fattah *et al.* [19] found that the concentration and uptake of elements were higher for plant irrigated with municipal sewage water compared to river water. El-Naim and El- Houseini [20] sewage sludge caused lightly increase in the crop yields of corn and sunflower and in the contents of heavy metals in the edible parts of most cultivated crops. Moreover, Abdel-Sabour and Rabie [21] revealed that irrigation with different wastewater significantly increased the concentration of heavy metals (Zn, Cu, Ni, Pb, Cd and Co) in vegetable plants (Spinach, Rocket and Jew's mallow) especially the leafy species. Badawy and El-Motaium [16] found that the concentrations of Cu, Zn, Cd and Pb in tomato leaves and fruits increased with sewage sludge application rate. Kandil *et al.* [17] found that highly significant correlations (r) between the soil content of macro, micro-nutriets and heavy metals and its accumulation in shoots of Berseem and shoots and grains of Zea maize. Aganga *et al.* [22] reported that the sewage water, soils and forage mineral concentrations were within the internationally allowable heavy metal concentration with respect to irrigation, soil loadings and animal feeds.

The aim of this study is to evaluate the potential risk of pollution in the El-Saff soils which are irrigated from El-Khashab canal and compared with that for Nile water.

MATERIALS AND METHODS

Water samples representing Nile water and El-Khashab canal were collected from the studied area. Surface soil samples were collected at two sites along El-Khashab canal and Nile site. The soil samples were air dried, crushed in 2 mm sieves and put in glass containers for analysis. Chemical analysis for irrigation water and soil extracts were done according to Jackson [23]. Available macro; micro-nutrients and heavy metals, were extracting by AB-DTPA according to Soltanpour [24] and atomic absorption spectrophotometer (Perken-Elmer-2380).

Plant samples were collected from three locations.The obtained plant samples from the different locations was separated to stems and leaves then cleaned by distilled water. Thereafter, the separated parts were weighed as fresh parts and then the samples were dried at 70°C and then reweighed. The dried plant samples were ground by micro-mill and then digested by a mixture of sulphuric and perchloric acids, according to the method of Black *et al*., [25].

RESULTS AND DISCUSSIONS

Data reported in Table (1) show that the EC values of water samples collected from El-Khashab canal were higher than that Nile water and generally EC values of water samples are in the permissible level for using water in irrigation.

Table 1: Some chemical properties of water samples, collected at different locations long El-Khashab canal.

Location			Cations concentration of water (meq/L)			Anions concentration of water (meq/L)			Nutrients concentration (ppm)				
Water source	PH	EC	Na+	Ca++	Mg++	Cl^-	$SO4^=$	HCO_3^-	Total N	$NH4^+$	$NO3^-$	P	K^+
Nile	7.3	0.37	0.89	1.66	0.95	0.56	1.31	1.8	4.5	0.54	1.43	0.17	1.9
Site 1	8.39	1.26	8.6	2.7	1.2	8.2	4.0	0.4	22.1	4.48	16.8	6.84	3.91
Site 2	8.22	2.21	13.5	5.82	2.6	14.7	6.93	0.5	19.0	2.72	16.8	6.3	3.13

Table 2: Some physical and chemical properties of surface soil samples (0-30 cm), collected at different locations.

	Partial size distribution %								Cations of soil meq/kg			Anions of soil meq/kg			Nutrients concentration (ppm)				
Location	Sand	Silt	Clay	Texture class	CaCO3 %	OM %	PH 1:2.5	EC ds/m^{-1} 1:01	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4	HCO-	Total N	NH_4	$NO_{3=}$	P	K+
Nile	78.2	5.8	16	Sandy loam	13.97	0.14	7.9	2.5	11.6	7.1	6.5	10	12.9	2.6	500	20	65.7	2.18	13.3
Site 1	27.3	67.7	5	Silty loam	18.8	1.39	8.4	3.15	22.7	5.55	2.9	21.6	9.4	0.5	2200	51	155	11.7	10.2
Site 2	15	81.2	3.8	Silt	19.8	2.2	8.23	5.53	35.6	15.3	3.63	34.3	17.7	1	1800	44	123	23.5	21.5

With regard to the effect of the source of water quality on the soluble cations and anions, the obtained data show that Sodium was the dominant cation followed by calcium and magnesium in two sites of El-Khashab canal, while soluble cations at Nile water site were calcium the dominant cation followed by magnesium and sodium at studied locations. On the other hand, Chloride and Sulphate were the dominant anions in the same trend above. It can be concluded that, the increase in EC values in two sites of El-Khashab canal compared with Nile water site may be due to the disposal of domestic and industrial effluent in El-Khashab canal. Generally the previous results indicate that cations concentration in water samples were in the following descending order: Na > Ca> Mg. The obtained results are in accordance with those obtained by Ibrahim *et al.* [1] and AbdEl-Hady [2]. They found that the same previous arrangement for Na, Ca and Mg on water samples collected from El-Gabal El-Asfer sewage station and El-Saff canal. On the other hand, the amounts of anions of water samples were in the following descending order: $Cl^- > SO_4^= > HCO_3^-$ This is in agreement with those of [2, 10]. They found that anions distribution of sewage water samples followed the decreasing order: $Cl^- > SO_4^= > HCO_3^-$.

Data shown in Table (1) reveal that total N content in El-Khashab canal was more than double that of Nile water. This is expected due to the fact that El-Khashab canal water is mixed with sewage water. Average values of NO_3^- water samples greatly exceeded those of NH_4^+ values with about 28.4%. P values of water samples collected of El-Khashab canal exceeded that Nile water. Potassium average values of water samples collected at El-Khashab canal exceeded that at Nile water with about 25%. Generally, it appears that amounts of water nitrate content are considered higher than the safe level, this agrees with the founding of [26]. They reported that the hazard level of water nitrate content begin at 10 ppm.

Salinity of irrigation water plays an important role on soil salinization. However, for macronutrients (NPK), water content is far less than the irrigated soil due to intensive application of fertilizers and manures.

Data reported in Table (2) show a slight variation in texture and calcium carbonate content of surface soil samples collected from two sites of El-Khashab canal and Nile water site. The organic matter content of soil samples fluctuated from El-Khashab sites contained about 1.5 times of organic matter compared to that of Nile water site.

The results in Table 2 show that the EC of soil samples collected from El-Khashab sites are approximately twice these collected from Nile Delta site. This may attributed to the secondary and/or annually addition. of soluble salts as a result of irrigation with mixed water. On the other hand, the highest soluble cation was Na^+ while Cl^- and So_4^{--} were the highest soluble anions. From the above mentioned results, it can be concluded that the most soluble salts are in the form of chloride and sulfates. Generally, it is clear that soluble Na^+, Ca^{++} and Mg^{++} have followed the same trend of water $Na^+ > Ca^{++} > Mg^{++}$. This is in accordance with the findings of [4, 10].

It is worthy to mention that soil samples collected from El-Khashab sites, mostly contained the maximum magnitude of both cations and anions, compared with Nile Delta site. This is clear, where its EC value reached 5.53 m. mohs/cm which more exceeded those of other soil sample.

The average values of total soil N collected at El-Khashab sites exceeded those collected at Nile Delta site with about 33%. The different values of total

Table 3: Soluble heavy metals of water samples at different locations at Nile water and El-Khashab canal (ppm)

		Water analysis							
Location	Grown crop	Fe	Mn	Co	Zn	Cu	Ni	Pb	Cd
Nile water	Corn	0.06	0.01	0.01	0.01	0.01	0.01	0.03	0
Site 1	Corn	1.33	0.05	0.01	0.03	0.01	0.01	0.03	0.01
Site 2	Corn	1.73	0.08	0.01	0.03	0.01	0.02	0.05	0.01

(1) In front of El-Minya village (2) 3 km distance from site 1

Table 4: Extractable heavy metals of soil samples at El-Khashab and Nile sites

		Soil analysis NH4-HCO3-DTPA extractable heavy metals								
location	Grown crop	Fe	Mn	Co	Zn	Cu	Ni	Zn equivalent	Pb	Cd
Nile	Corn	2.8	8.7	0.09	3.44	2.78	0.63	14.04	2.3	0.03
Site 1	Corn	78.4	29.4	0.18	22.2	6.3	14.1	147.6	7.95	0.19
Site 2	Corn	80.8	33.8	0.19	22.5	6.39	14.6	152.1	23.2	0.26

(1) In front of El-Minya village (2) 3 km distance from site 1

N depend on many factors, such as soil O.M. content, soluble N added annually from sewage water irrigation, plant N uptake, loss of N due to leaching, denetrification, addition of N fertilizers. The previous results agree with those obtained by Shalaby *et al.*[27].

A small increase in extracted NH_4^+ from soil samples collected at El-Khashab sites than those collected at Nile Delta site was observed. Also show that amount of extractable NO_3^- from El-Khashab sites exceeded that of Nile Delta site with about 112%. Also, it is clear that mostly as the total soil N increased, the extracted NO_3^- increased. This indicates that NO_3^- of soil samples dominated as compared with NH_4^+. The variation of available P in different soil samples depends on many factors such as soil texture, organic matter, $CaCO_3$ and fertilization with P fertilizers. Also, the values of Soluble K of soil samples are considered relatively low, compared with those of soluble Na, Ca and Mg. The previous results agree with those obtained by Farida Rabie *et al.*, [10]. They found that cation distribution follows the decreasing order: $Na^+ > Ca^{++} > Mg^{++} > K^+$ in El-Saff soils.

Heavy Metals of Hazard Effects in Water Collected from Nile Water and El-Khashab Canal: The results, show that values of Fe, Mn and Co in water samples were in the following descending order Fe > Mn> Co. The obtained results agree with those obtained by Ibrahim *et al.* [1] and Tahoun and Abd El-Bary [4]. They mentioned that the concentrations of Fe, Mn and Co in sewage effluent were lower than the maximum permissible limits and in the order Fe > Mn > Co.

Data reported in Table (3) indicate that water samples contained traces of Zn, Cu, Ni, Pb and Cd where the values fluctuated between 0.01 to 0.05 ppm. Zinc values of water samples collected at El-Khashab sites were similar. Copper and Ni values of water samples collected in both two sites were similar and relatively small. Pb values of water samples were a slight difference between values of Zn. Also, Cd values of water samples were similar. The concentration of heavy metals (ppm) in the Nile water at El – Khashab area were 0.11, 0.03,0.06,0.00 and 0.00 for Zn, Cu, Pb, Ni and Cd, respectively. The results agreement with Farida Rabie *et al*, [10] indicated that the content of heavy metals (ppm) in the Nile water at El- Saff were 0.09, 0.02, 0.05 and 0.00 for Zn, Cu, Pb and Cd, respectively. Abdel-Shafy and Aly [28] reported that the downstream direction the water quality gradually deteriorates due to the poorly treated wastewater discharges from both domestic and industrial activities and uncontrolled mixing with water from drains. Therefore, they contain high levels of various pollutants. Generally, values of different heavy metals of water samples could be arranged in the following descending order: Pb> Zn> Cu> Ni> Cd. The previous arrangement was obtained by Abd El-Hady [2] and Rashed *et al.* [29].

Heavy Metals Content of DTPA Soil Extract from Different Locations: Table (4) show that the difference between values of extractable Fe from both El-Minya village and that El-Shobac village was relatively small. Generally, the extractable Fe from soil samples depends on many factors such as total Fe, addition of Fe as a result of irrigation of sewage water and/or fertilization and oxidation reductions in soil. The previous results are in accordance with those obtained by Ibrahim *et al.* [1] and El-Hassanin *et al.* [11].

Data reported in Table 4 also, show that values of extractable Mn from soil sample collected from El-Shobac village exceeded that of Mn extracted from soil collected from El-Minya village with about 15%. It is also, clear that values of extractable Mn from soil samples mostly were higher than values of extractable Fe at Nile Delta site. The values of extractable Mn from soils depend on minerals bearing Mn, weathering factors and oxidation reduction reactions as well as biological factors. The previous results agree with those obtained by Farida Rabie *et al.* [10] and Rashed *et al.* [29].

Data in Table (4) also indicate that the variation between values of extractable Co from different soil samples from both sites were relatively higher than that at from Nile Delta site. Generally, values of different extractable heavy metals from soil samples were in the following descending order: Fe>Mn>Co. The previous results are in accordance with the findings of Abd El-Hady [2], Shalaby *et al.*, [27] and Rashed *et al.* [29]. They mentioned that heavy metals from soils were in the following descending order: Fe > Mn > Co.

Data in Table (4) Show that the magnitudes of extractable Zn from soil samples ranged between 3.44 and 22.5 ppm. On the other hand, Rashed *et al.* [29] reported that extractable Zn from soil collected from Nile Delta ranged between 18 to 104 ppm. The obtained results in Table (4) were within the range obtained by the previous investigators. Toxicity level of this element was reported at around (300 ppm) [30].

Values of extractable Cu from soil samples ranged between 2.78 and 6.39 ppm. The variation in the values of extractable Cu in both two sites is due to irrigation of soil with El-Khashab canal water, plant uptake as well as migration of Cu to deeper layers and its transformation to other forms. In general the obtained results are in accordance with those obtained by Ibrahim *et al.* [1]. Also, the obtained results agree with the findings of Rashed *et al.* [29] who reported that the extractable Cu of soil collected from Nile Delta ranged between 10 to 81 ppm. Toxicity level of this element was reported at around (100 ppm) [30].

Data in Table (4) show that the magnitudes of extractable Ni from soil samples fluctuated between 0.63 and 14.6 ppm. This range agrees with the results obtained by Rashed *et al.* [29], where extractable Ni of soil Nile Delta fluctuated between 8 to 44 ppm. Data also show that the difference between values of extractable Ni from El- Khashab villages and Nile Delta soils was high. Toxicity level of this element was reported at around (100ppm) [30].

Zn equivalent was proposed as a relative toxicity value of Ni, Zn and Cu by calculating the sum of the concentration of the three metals according to the equation suggested by Chumbley, [13] "Zn equivalent" = (Zn) + (2 x Cu) + (8 x Ni) $ug.g^{-1}$ dry matter. It has been recommended that a total of 250 ug/g^{-1} "Zn equivalent"/ soil is the maximum that can be safely added provided that there have been no previous additions to the soil and that pH is maintained at not less than 6.5. No doubt that the previous maximum value of Zn equivalent differed from place to another according to the soil type, plant species and to conditions of environment. Values of Zn equivalent as shown in Table (4) is shown to range between 14.04 to 152.1 ug. g^{-1} for sampling sites. It reached 152.1 at El-Khashab canal. According to the obtaine data and the values of the previous equation, it appears that the values of Zn equivalent are in the safe level. As for as the critical value of chumbley (250 ug/g). However the percentage of Zn-equivalent values of the most polluted samples reache (5.62 to 60.8 %) as related to toxic level while the maximum concentration of heavy metals as percentage of toxic levels were relatively very low table (5).

Table 5: Heavy metals maximum concentrations as percentage of toxicity levels

Parameter	Percentage from toxicity level Nile	 El-Khashab
Cd	0.03	8.7
Pb	2.3	23.2
Zn	3.44	7.5
Cu	2.78	6.39
Ni	0.63	14.6
Zn equivalent	5.62	60.8

Under Egyptian conditions Hilal *et al.* [26] found out that Zn equevalent values of only 100 µg/g were of great negative effect on N-fixing bacteria. Besides negative effect on yield for values of Zn equivalent much lower than 250 µg/g will be demonestrated in the following section.

Data in Table (4) Show that values of extractable Pb from soil samples fluctuated between 2.30 and 23.2 ppm. It is worthy to mention that the value of extractable Pb from El- Shobac village increased that of Nile Dilta site with about 11 times. The previous data show that values of extractable Pb from soil of El-Shobac village are considered high and limitations might be taken for plant growing in this area (23.2 ppm). Generally, the obtained results are in accordance with those by Rashed *et al.* [29], where they showed that the extractable Pb from soil Nile Delta ranged between 16 to 48 ppm. Toxicity level of this element was reported at around (100 ppm) [30].

The values of extractable Cd from soil samples ranged between 0.03 and 0.26 ppm. The extractable amounts of Cd are in the same levels which were obtained by Rashed *et al.* [29] where they showed that the extractable Cd from soil Nile Delta ranged between

Table 6: Average dry weight and heavy metals concentration and uptake of plants at El-Khashab sites and Nile Delta site.

	Dry matter g/plant		Fe mg/g		Mn		Co ppm		Fe mg/plant	Mn	Co ug/plant
Location	stems	leaves	stems	leaves	stems	leaves	stems	leaves		Shoots	
Nile Delta	10.8	6.10	0.26	1.50	32.0	51.5	0.16	0.31	11.96	0.66	3.62
Site (1)	14.0	8.00	0.39	1.99	36.3	60.1	3.40	1.70	21.4	0.99	60.0
Site (2)	16.0	8.80	0.42	2.17	36.3	139	3.00	2.60	25.9	1.39	71.0

(1) El-Minya village (2) El shosbac (near coke factory)

Table 7: Average heavy metals concentration and uptake of plants at El-Khashab sites and Nile Delta site.

	Dry matter			Zn		Cu		Ni		Zn	CuNi
	g/plant		ppm						Ug/plant		
Location	stems	leaves	stems	leaves	stems	leaves	stems	leaves	shoots		
Nile Delta	10.8	6.10	19.0	29.6	3.10	5.60	1.40	4.00	386	67.6	176
Site (1)	14.0	8.00	21.7	35.0	3.44	6.22	11.1	27.8	584	97.9	377
Site (2)	16.0	8.80	27.7	52.1	3.80	6.00	5.56	50.0	901	113	528

(1) El-Minya village (2) El shobac (near coke factory)

0.15 and 1.6 ppm. In the same time there was slight increase of extractable Cd from soil of El-Shobac village, compared with that extracted Nile Dilta soil. Generally values of Cd of soil samples are considered low compared with Pb values. Toxicity level of this element was reported at around (3 ppm) Kloke, [30]. Abd El-Hady [2] and Shalaby *et al.* [27] found that heavy metals from soils could be arranged in the following descending order: Fe> Mn> Zn > Ni> Pb>Cu> Co. In general, the obtained results in this study agree with these obtained by the former investigators, also, it appears from previous data table (4) that the extractable values of heavy metals from soil samples are in the permissible levels.

Uptake of heavy metals and micronutrients by corn plants in relation sampling sites and soil content of such metals:

It is well established that plant growth is controlled by soil properties, water quality and type of plant. In this evaluation study of crop performance two sites on El-Khashab canal were selected for better evaluation of the effect of heavy metals concentration in soil and Nile Delta site as control.

Data in Table (6) represent the dry weight of stems, leaves and the average concentration of Fe, Mn and Co in stems and leaves of corn plant. Fe, Mn concentrations in leaves were several times higher than that of stems, but the rate of increase of Mn in leaves was much lower than in Fe leaves. On the other hand, decrease in Co in leaves was most probably due to non translocation from stems since Co concentration in stems clearly increased while Co in leaves decreased.

It was noticed that corn plant grown in the vicinity of khashab canal (beside the coke factory), have taken up much higher Fe, Mn and Co compared to plants grown on Nile lands.

Uptake of Hazard Metals and Their Content in Leaves and Stems of Plant: Data in Table (7) show that Zn, Cu and Ni uptake by corn in Nile land was lower than that of corn in El-Khashab sites. Because uptake of Zn at the relatively polluted are of El-Khashab sites was higher than that of Nile land samples.

Effect of Zn Equivalent and Soil Content of Ni, Cu and Zn on the Uptake These Elements: Zn equivalent which is an expression for the triple pollution effect of Ni, Cu and Zn was shown to reduce plant growth when exceeding 90 ug. g^{-1} soil.

On the other hand, it appears very clear that increasing Zn equivalent above 90 has increased uptake of both Zn and Ni, similarly increasing extractable soil Ni above 9.5 mg/g has increased Ni concentration in shoots of plants. Values of extractable Cu higher than 6 ppm caused very sharp reduction in Cu concentration in shoots. It thus appears that critical values of extractable heavy metals namely: Ni, Zn and Cu, when present in combination together differ greatly than those limits previously specified by other anthers Abd El-Hady[2], chumbley [13], Hilal *et al.*, [26] and Kloke [30]. Chumbley [13] the critical level of Zn equivalent was 250 mg/g soil treated with sludge. On the other hand, kloke, [30] reported that toxicity levels of heavy metals in soils were 300 ppm for Zn, 100 ppm for Cu and 100 ppm for Ni.

Table 8: Average heavy metals concentration and uptake of plants at El-Khashab and Nile Delta locations.

	Dry matter		Pb		Cd		Pb	Cd
	g/plant		ppm				ug/plant	
Location	stems	leaves	stems	leaves	stems	leaves	shoots	
Nile Delta	10.8	6.10	1.40	0.70	0.20	0.06	19.4	2.53
Site (1)	14.0	8.00	5.46	10.9	0.50	0.26	164	9.1
Site (2)	16.0	8.80	10.9	21.8	0.91	1.30	366	26.0

* (1) El-Minya village ** (2) El shobac (near coke factory)

Comparing three sites, table (7) indicate that Zinc concentrations in stems and leaves consistently higher at site 2 than that of Nile site. On the other hand, Cu content in shoots of Nile site was lower as compared to shoots of two sites of El-Khashab. Nickel it considerably decreased in stems but sharply increased in leaves of Nile site as compared to 1 and 2 sites. In that respect, (Chumbley, [13] and Hilal *et al.*,[26] reported that application of Zn and /or Cu facilitate the penetration of Ni through membranes which is reflected on leaves uptake; increasing Ni activity and penetration through plant tissues increase Ni toxicity several folds.

Lead Uptake and Concentration: Variations in Pb concentration in leaves and stems of corn were rather limited. It should however by added that surface soil sample of shobac site was much polluted with Pb. Growing forage in such area or using been residue for feeding dairy animals is dangerous for animals and human being.

Shoots uptake and leaves and stems concentrations of Pb in corn of Nile land was very far below that concentrations in Corn of El-Khashab lands Table (8). Using mixed forage is though to be more safe to use for animal feeding in Pb polluted areas.

It can be concluded that except for one site the areas irrigated with Nile water is very safe for plant growth and animal feeding. On the other hand, the industrial location of Khashab sites resembles a threat for soil fertility, plan production and for animal production.

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