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ASSESSMENT OF CERTAIN MICRONUTRIENTS AND POLLUTANT ELEMENTS IN SOILS OF TUSHKA

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Fifty-two soil samples collected from eighteen soil profiles representing the studied area of Toshke were investigated to assess their contents of Fe, Mn, Zn, Cu, Pb, Co, Ni, and Cd and their conventional physical and chemical properties were determined. Total and DTPA-extractable Fe, Mn, Zn, Cu, Pb, Co, Ni, and Cd were determined. The data indicate that the soil texture varies from loamy sand to clay loam, $CaCO_3$ ranged between 1.10 and 21.76 %, while organic matter content was low. The average total contents of Fe, Mn, Zn, Cu, Pb, Co, Ni, and Cd were 2.29 %, 422.68, 41.0, 8.90, 6.46, 8.59, 17.60 and 0.24 mg/kg, respectively. Most soils have their DTPA-extractable Fe lower than the critical level, in contrast to excessive levels of Mn, while the DTPA-extractable Zn and Cu were in the range of adequacy. On the other hand, data indicate that the average contents of Pb, Co, Ni, and Cd were 0.062, 0.404, 0.192 and 0.007 mg/kg, respectively. Computation of the statistical measures (weighted mean, trend and specific range) of total and chemically-extractable elements revealed that the studied elements are somewhat lower in the surface or follows an opposite trend when increased in the surface layer than the deeper ones as indicated by the common positive or negative values for the trend, and the values of specific range indicate that pedogenic processes had acted in a uniform manner through the solum.

Keywords: total heavy metals, DTPA-extractable, iron, manganese, zinc, copper, lead, cobalt, nickel, cadmium, Tushka.

Tushka is one of the promising areas for adding new agricultural lands, it reaches 3.0 million feddan Micronutrients status in soil is dependent almost entirely on the bedrock from which soil parent material was derived. Both geochemical and pedochemical weathering processes are responsible for soil material as their final product upon time (Mitchell, 1964). However, Krauskopf (1972) reported that micronutrients seem to be strongly related to parent rock composition in early stages of soil development, but much less in later stages. He also stated that Fe, Mn, Cu and Zn are more abundant in basaltic lavas than in granites.

Considerable research work has been conducted to study the status of trace elements in the soils of Egypt. Nevertheless, none of which has tackled the soils in the area south Egypt, especially Toshke.

Therefore, this work is conducted to shed light on the status of some micronutrients and pollutant elements to help land users for establishing a suitable and sustainable land use plans.

MATERIALS AND METHODS

Soil Sampling

Fifty-two soil samples were collected from eighteen soil profiles representing the studied area which lies between longitude 30° 40\` and 32° 10\` E and latitude 22° 30\` and 23° 20\` N. The samples were air-dried, crushed, passed through a 2.00 mm sieve and subjected to the following analyses:

Particle size distribution was carried out according to Piper (1950); total salts and soluble cations and anions were determined as outlined by Richards (1954); calcium carbonate content was determined by Collin's calcimeter, Richards (1954); organic matter content was determined by rapid titration method, Walkley (1947). CEC was determined as described by Richards (1954). Amorphous inorganic alumina, silica and iron were extracted and determined as follows:

Alumina and silica gels were extracted by dissolution technique, *i.e.*, by successive washing with 5% $NaCO_3$ solution (Follett *et al.*, 1965).

Free iron oxides were extracted by the CBD method (Mitchell and Mackenzie, 1954).

The soil samples were also analyzed for total content of the studied elements in the filtered extracts obtained from samples digested by Conc. HNO_3 + Conc. H_2SO_4 + 60% $HClO_4$ as outlined by Hesse (1971), while the chemically-extractable contents of these elements were extracted using $5X10^{-3}$ M DTPA in 10^{-2}M $CaCl_2$ and 10^{-1}M triethanolamine (TEA) at pH 7.3 according to Lindsay and Norvell (1978) and modified by Norvell (1984). In all cases, the elements were determined by the atomic absorption spectrometer (Unicam 929).

RESULTS AND DISCUSSION

Soil Properties

Table (1) shows the relevant physical and chemical characteristics of the studied samples. Data show that the soils vary widely in their textural class between loamy sand and clay loam.

TABLE (1). Some physical and chemical characteristics of the studied soil samples.

Profile No.	Depth, Cm	Soil separates % Coarse Sand	Fine Sand	Silt	Clay	Textural Class	$CaCO_3$ %	pH (1:2.5)	EC ds/m	O.M %	CEC me/100g Soil	SAR	SiO_2 %	Al_2O_3 %	Fe_2O_3 %
1	0-18	17.8	58.2	14.0	10.0	SL	8.68	7.94	1.69	0.14	5.65	1.26	0.17	0.06	0.33
	18-45	19.3	60.7	8.0	12.0	SL	4.24	8.47	0.81	0.08	5.94	3.26	0.13	0.08	0.46
2	0-15	23.5	56.5	8.0	12.0	SL	3.81	8.28	1.09	0.24	6.06	1.01	0.20	0.08	0.49
	15-45	18.4	51.6	16.0	14.0	SL	2.94	7.98	3.62	0.31	7.05	6.95	0.19	0.08	0.20
3	0-15	42.2	39.8	10.0	8.0	LS	8.50	8.20	1.20	0.21	7.69	1.04	0.18	0.07	0.19
	15-55	19.4	30.6	14.0	36.0	SL	4.35	7.89	2.79	0.12	6.06	1.56	0.13	0.08	0.49
	55-80	25.0	23.0	16.0	36.0	SL	3.52	7.95	2.97	0.18	7.18	0.42	0.14	0.09	0.48
	80-150	26.2	20.8	11.0	40.0	SL	2.94	7.97	3.88	0.14	6.24	4.26	0.18	0.08	0.47
4	0-20	27.2	38.8	16.0	18.0	SL	11.47	8.41	0.51	0.29	16.98	1.99	0.15	0.07	0.25
	20-45	19.6	56.4	12.0	12.0	SL	1.88	8.37	1.52	0.16	18.92	7.76	0.30	0.09	0.50
	45-80	18.5	49.5	16.0	16.0	SL	1.76	7.96	3.93	0.11	19.40	9.05	0.21	0.08	0.52
5	0-50	45.8	40.2	6.0	8.0	LS	11.05	8.00	0.22	0.24	3.06	0.24	0.15	0.08	0.48
	50-100	55.0	31.0	6.0	8.0	LS	1.10	8.10	0.20	0.21	4.95	1.02	0.07	0.10	0.49
6	0-15	31.9	50.1	8.0	10.0	LS	9.11	7.80	0.32	0.25	5.06	1.09	0.11	0.09	0.48
	15-40	40.7	41.3	8.0	10.0	LS	7.64	8.00	0.49	0.09	6.65	2.69	0.19	0.08	0.50
	40-80	38.0	38.0	10.0	14.0	SL	4.17	7.80	2.78	0.17	4.85	2.75	0.11	0.07	0.49
	80-150	20.3	49.7	12.0	18.0	SL	10.05	8.10	0.69	0.17	4.59	4.02	0.13	0.09	0.51
7	0-15	19.5	60.5	10.0	10.0	SL	3.05	8.00	0.41	0.46	5.55	1.79	0.12	0.07	0.47
	15-70	18.2	35.8	16.0	30.0	SCL	6.17	7.87	5.36	0.32	15.85	6.96	0.15	0.09	0.52
	70-150	27.3	26.7	14.0	32.0	SCL	8.50	8.29	2.69	0.27	17.35	13.40	0.10	0.11	0.46
8	0-15	52.0	32.0	8.0	8.0	LS	3.35	7.90	0.31	0.26	4.35	0.69	0.14	0.09	0.50
	15-65	52.0	22.0	10.0	16.0	SL	1.76	8.00	0.33	0.24	12.80	3.38	0.18	0.08	0.55
	65-150	32.9	33.1	12.0	22.0	SCL	3.41	8.83	0.36	0.20	9.82	2.79	0.27	0.12	0.57
9	0-25	15.5	24.5	24.0	36.0	CL	11.47	8.58	1.52	0.30	20.22	3.21	0.33	0.10	0.54
	25-85	13.6	34.4	20.0	32.0	SCL	10.00	7.30	16.12	0.36	12.69	33.35	0.21	0.12	0.57
	85-150	11.1	40.9	18.0	30.0	SCL	21.76	7.70	5.39	0.22	7.27	17.02	0.15	0.10	0.49
10	0-25	4.4	42.0	4.0	10.0	LS	8.52	7.80	1.17	0.24	4.70	1.18	0.20	0.07	0.50
	25-70	27.5	46.5	10.0	16.0	SL	6.76	8.00	0.50	0.07	9.49	3.74	0.25	0.10	0.56
	70-150	13.2	54.8	12.0	20.0	SCL	16.05	8.10	2.47	0.16	5.52	6.67	0.22	0.11	0.51
11	0-20	27.0	55.0	8.0	10.0	LS	4.41	8.62	0.76	0.26	18.33	4.39	0.33	0.07	0.55
	20-45	25.0	41.0	12.0	22.0	SCL	2.94	7.60	4.37	0.18	9.15	11.10	0.20	0.10	0.51
	45-80	36.0	34.0	10.0	20.0	SCL	1.41	8.48	11.34	0.16	8.88	15.74	0.21	0.09	0.57
	80-150	38.0	22.0	16.0	24.0	SCL	10.29	7.10	9.85	0.13	6.57	18.97	0.20	0.11	0.54
12	0-25	61.0	23.0	8.0	8.0	LS	3.41	8.00	0.50	0.20	4.30	4.14	0.18	0.10	0.55
	25-55	35.0	47.0	8.0	10.0	LS	3.76	7.70	0.87	0.16	7.56	1.55	0.25	0.13	0.50
	55-120	30.0	44.0	12.0	14.0	SL	4.41	7.80	1.06	0.14	6.28	3.62	0.23	0.11	0.51
13	0-25	21.0	53.0	10.0	16.0	SL	6.47	7.90	0.61	0.16	14.33	1.31	0.14	0.11	0.55
	25-55	14.0	42.0	14.0	30.0	SCL	5.88	7.60	1.95	0.13	11.28	2.55	0.03	0.11	0.50
	55-120	14.5	37.5	16.0	32.0	SCL	11.47	8.00	0.58	0.08	7.27	4.24	0.01	0.09	0.57
14	0-25	35.9	46.1	8.0	10.0	LS	6.76	7.90	0.27	0.40	6.28	2.69	0.17	0.13	0.52
	25-55	33.5	48.5	6.0	12.0	SL	7.64	7.90	0.51	0.26	4.79	1.22	0.20	0.10	0.49
15	0-25	10.8	37.2	20.0	32.0	SCL	8.52	7.80	0.34	0.22	6.96	1.52	0.15	0.10	0.51
	25-60	15.3	62.7	10.0	12.0	SL	4.11	7.90	2.01	0.15	8.88	4.30	0.20	0.11	0.53
	60-110	14.6	45.4	12.0	28.0	SCL	5.88	7.50	3.18	0.11	7.27	3.95	0.19	0.09	0.48
16	0-15	29.2	18.8	16.0	36.0	SC	7.05	8.00	0.56	0.26	23.50	2.88	0.02	0.12	0.54
	15-55	35.5	42.5	8.0	14.0	SL	2.05	7.70	2.36	0.11	9.71	7.76	0.09	0.11	0.51
	55-120	27.7	21.80	11.50	39.00	SL	2.35	7.50	4.84	0.07	10.81	7.03	0.12	0.09	0.48
17	0-30	32.5	45.5	10.0	12.0	SL	1.76	8.00	0.68	0.36	14.80	1.93	0.02	0.10	0.54
	30-70	31.2	46.8	10.0	12.0	SL	5.00	8.10	0.39	0.16	12.69	3.84	0.01	0.09	0.58
	70-150	32.8	41.2	12.0	14.0	SL	4.70	8.20	0.69	0.14	14.81	3.59	0.03	0.11	0.56
18	0-25	17.7	18.3	34.0	30.0	CL	5.58	8.10	0.33	0.20	21.86	2.56	0.34	0.12	0.58
	25-60	28.8	45.2	14.0	12.0	SL	10.00	7.60	1.85	0.14	24.44	5.66	0.13	0.10	0.63

S.L. = Sandy loam SCL = Sandy clay loam LS = Loamy sand
CL = Clay loam SC = Sandy clay.

The total carbonate content was very low to moderate where it ranged between 1.10 and 21.76 % with the average of 6.11 %. The lower content was found in the deepest layer of profile 5, while the highest content was recorded in the deepest layer of profile 9. In general, soil salinity ranged from non-saline to very strongly saline. On the other hand, data in table (1) indicate that soil alkalinity ranged from neutral to strongly alkaline.

Status of the Studied Elements

Total and DTPA-extractable iron

Table (2) gives the total and DTPA-extractable Fe, Mn, Zn, Cu, Pb, Co, Ni and Cd content of soils. Values of the total Fe content ranges from 0.88 to 4.44 % with an average of 2.29 %. In most samples, the highest total Fe was found in soils where fine fractions (silt and clay) contents were high. Statistical analysis shows a significant positive correlation between total iron content and both silt and clay fractions. These results were in agreement with those of Rabie *et al.* (1989), El-Demerdashe *et al.* (1991), Hafez *et al.* (1992) and El-Demerdashe and Abdel-Rahman (2000). As reported by Schwertmann and Taylor (1989), Fe may be a structural constituent of clay minerals, may exist as an amorphous iron oxide coating on clay external surfaces, or may be bound to clay surface as an exchangeable cation.

DTPA-extractable Fe content in the studied soils ranged between 0.18 and 7.78 mg/kg with an average of 1.06mg/kg soil. The lowest and highest contents were recorded in the deepest layer of profiles 4 and 3, respectively. Viets and Lindsay (1973) and El-Gala *et al.* (1986), reported that the critical level of Fe, as determined by the DTPA method, is about 4.0 mg/kg. They added that soils, which contain available Fe below this level, are not able to provide the growing plant with their requirements of the nutrients. Accordingly, only the soil of profile 3 contain more than the critical level of Fe, while the other profiles contain lower amounts than the critical level.

Total and DTPA-extractable manganese

Table (2) shows that the total Mn content in the studied soils ranged from 135.00 to 962.00 mg/kg with the average of 422.68 mg/kg. The lowest content was found in 45-80 cm layer of profile 11, while the highest content was recorded in the surface layer of profile 10. This result was in agreement with those of El-Demerdashe and Abdel-Rahman (2000). McBride (1994) mentioned that total Mn in soils is highly variable and not closely related to the Mn content of the parent material, probably because of the tendency for cyclical reduction-oxidation to rapidly mobilize, then reprecipitate Mn as oxides in nodules and other deposit. He added that Mn tends to associate the total Mn content and any individual soil property, which was measured in this work.

TABLE (2). Total and DTPA-extractable micronutrients content of the studied soil samples (values in mg/kg except total Fe in %).

Profile No.	Depth, cm	Fe		Mn		Zn		Cu		Pb		Co		Ni		Cd	
		Total	Av.	Total	Av.	Total	Av.	Total	Av.	Total	Av.	Total	Av.	Total	Av.	Total	Av.
1	0-18	1.39	0.42	327.5	13.42	18.00	0.88	3.44	0.35	8.15	0.12	2.08	0.45	4.88	0.20	0.24	0.007
	18-45	1.32	0.57	475.0	16.01	27.15	0.43	5.75	0.38	6.13	0.08	3.90	0.81	8.05	0.33	0.20	0.005
2	0-15	1.98	0.38	375.0	9.29	25.23	0.33	4.48	0.32	7.65	0.05	4.05	0.22	9.60	0.11	0.10	0.003
	15-45	2.02	0.25	460.0	4.56	26.80	0.77	7.00	0.49	16.10	0.04	5.03	0.19	10.43	0.13	0.18	0.007
3	0-15	2.38	7.06	290.0	2.20	24.95	0.38	5.43	0.27	6.80	0.06	3.75	0.30	7.23	0.04	0.21	0.004
	15-55	2.58	5.60	235.0	1.66	24.05	0.50	8.43	0.50	7.48	0.03	10.85	0.75	11.88	0.07	0.20	0.006
	55-80	1.51	4.60	287.5	1.96	19.05	0.50	7.60	0.62	6.20	0.07	1.50	0.11	7.50	0.08	0.28	0.011
	80-150	3.22	7.78	187.5	4.13	24.25	0.78	10.25	1.00	6.10	0.06	2.60	0.20	10.50	0.16	0.39	0.015
4	0-20	3.65	0.26	675.0	9.74	50.38	0.58	8.55	0.39	5.45	0.02	4.33	0.25	17.15	0.10	0.31	0.006
	20-45	3.67	1.46	632.5	8.48	58.00	1.76	11.80	0.59	7.95	0.08	11.60	0.46	21.43	0.31	0.50	0.020
	45-80	4.44	0.18	712.5	5.36	73.78	0.80	17.50	0.68	6.50	0.05	19.15	0.38	34.73	0.27	0.40	0.013
5	0-50	0.88	1.55	275.0	5.23	13.08	0.33	2.48	0.10	5.38	0.01	1.65	0.11	3.83	0.08	0.10	0.002
	50-100	1.69	0.69	507.5	11.74	24.68	0.51	3.90	0.15	6.73	0.02	4.58	0.18	8.90	0.21	0.21	0.006
6	0-15	1.90	0.95	380.0	9.42	29.28	0.76	5.30	0.17	5.43	0.10	4.58	0.08	9.33	0.09	0.11	0.004
	15-40	2.27	0.38	427.5	5.92	40.78	0.45	7.05	0.24	5.65	0.13	5.48	0.04	13.05	0.22	0.09	0.001
	40-80	2.89	0.30	770.0	4.44	58.45	0.80	11.98	0.65	5.33	0.01	10.03	0.12	18.30	0.19	0.34	0.005
	80-150	1.78	0.55	525.0	12.72	37.13	1.02	8.25	0.45	6.28	0.06	6.73	0.61	12.75	0.25	0.27	0.003
7	0-15	2.69	0.43	555.0	15.58	49.10	0.42	6.63	0.29	5.50	0.01	7.50	0.49	16.20	0.22	0.30	0.004
	15-70	3.54	0.54	410.0	3.26	55.18	0.89	5.50	0.45	6.63	0.10	13.78	0.08	31.33	0.14	0.29	0.004
	70-150	3.46	0.64	392.5	10.48	55.08	0.62	7.88	0.39	5.00	0.14	13.13	0.38	32.50	0.43	0.41	0.006
8	0-15	1.54	2.12	380.0	4.48	28.40	0.71	3.70	0.13	5.80	0.06	4.35	0.02	6.13	0.17	0.31	0.008
	15-65	1.80	2.31	342.5	15.13	30.25	0.62	5.90	0.33	6.25	0.06	5.68	0.72	9.73	0.24	0.41	0.010
	65-150	2.00	0.43	325.0	16.51	48.28	0.56	10.08	0.45	5.73	0.07	8.55	1.01	18.25	0.53	0.50	0.012
9	0-25	2.83	0.30	570.0	7.42	65.10	0.51	10.65	0.37	5.23	0.11	9.28	0.18	20.18	0.15	0.20	0.006
	25-85	1.55	0.62	535.0	4.47	28.30	1.02	9.80	0.48	5.10	0.04	10.95	0.45	17.20	0.18	0.10	0.006
	85-150	2.80	0.41	562.5	2.21	64.73	0.93	13.33	0.42	8.60	0.14	13.20	0.04	27.03	0.05	0.11	0.003
10	0-25	2.25	0.38	962.0	16.31	36.88	2.23	7.45	0.30	6.95	0.06	8.40	0.59	13.15	0.30	0.33	0.004
	25-70	2.21	0.43	682.5	17.10	[illegible]1.80	0.71	10.30	0.26	5.43	0.11	10.95	1.39	19.48	0.49	0.29	0.004
	70-150	1.87	0.55	335.0	8.60	35.25	0.66	6.63	0.55	6.50	0.15	6.75	0.24	12.20	0.16	0.50	0.011
11	0-20	2.60	0.42	480.0	7.67	45.90	0.68	8.28	0.17	5.93	0.06	7.80	0.08	17.03	0.11	0.09	0.002
	20-45	2.24	0.26	217.5	1.19	27.73	0.88	8.43	0.35	7.33	0.01	5.25	0.05	14.35	0.06	0.11	0.005
	45-80	1.66	0.29	135.0	1.66	26.85	1.02	6.73	0.27	6.80	0.06	5.00	0.04	12.20	0.10	0.12	0.007
	80-150	1.41	0.20	147.5	2.24	14.55	0.59	6.03	0.34	7.53	0.04	4.10	0.12	9.25	0.12	0.17	0.006
12	0-25	1.42	0.77	452.5	8.60	23.15	0.25	3.15	0.16	5.20	0.10	4.00	0.06	8.15	0.08	0.10	0.004
	25-55	1.09	0.65	302.5	16.23	21.45	0.28	4.30	0.22	5.35	0.02	4.83	0.85	12.53	0.05	0.42	0.008
	55-120	1.77	0.29	325.0	12.73	32.10	0.28	6.53	0.24	6.35	0.10	6.73	0.49	17.00	0.14	0.38	0.011
13	0-25	2.09	0.55	410.0	10.65	51.80	0.38	10.20	0.28	5.53	0.05	13.35	0.27	22.00	0.15	0.31	0.004
	25-55	2.47	0.55	537.5	15.92	71.25	0.40	18.03	0.69	5.78	0.03	21.10	1.26	33.08	0.48	0.51	0.017
	55-120	1.86	0.56	165.0	13.11	43.78	0.55	11.83	0.59	7.05	0.06	10.15	8.03	27.40	0.20	0.49	0.008
14	0-25	1.89	0.50	355.0	12.91	29.68	0.17	4.73	0.21	4.43	0.01	6.13	0.37	12.13	0.16	0.09	0.003
	25-55	1.61	0.68	305.0	11.87	32.28	0.97	4.48	0.25	5.13	0.04	5.15	0.50	10.10	0.19	0.21	0.008
15	0-25	2.31	1.24	457.5	4.74	54.23	0.63	10.75	0.34	7.35	0.03	10.43	0.11	22.45	0.11	0.10	0.004
	25-60	1.46	1.50	255.0	3.37	59.73	0.74	14.73	0.64	5.93	0.08	13.38	0.25	32.40	0.20	0.25	0.016
	60-110	3.05	0.28	260.0	1.05	49.53	2.23	10.00	0.55	7.00	0.05	11.50	0.07	23.83	0.20	0.20	0.014
16	0-15	3.02	0.38	455.0	3.63	54.33	1.53	10.90	0.47	6.68	0.05	9.48	0.28	20.05	0.15	0.09	0.007
	15-55	2.59	0.72	637.5	2.36	56.90	0.89	14.78	0.79	6.40	0.06	12.13	0.53	23.85	0.17	0.21	0.011
	55-120	3.58	0.49	767.5	1.06	82.10	0.61	21.60	0.80	8.23	0.15	25.00	0.94	44.00	0.20	0.26	0.014
17	0-30	1.98	0.36	272.5	12.82	35.00	0.76	9.93	0.33	6.75	0.01	9.38	0.45	8.875	0.19	0.09	0.002
	30-70	2.29	0.30	307.5	14.46	37.18	0.65	11.55	0.43	5.68	0.07	9.85	0.73	22.95	0.26	0.08	0.005
	70-150	2.96	0.35	325.0	12.27	42.28	0.52	16.48	0.43	5.25	0.07	13.03	0.83	31.18	0.28	0.11	0.007
18	0-25	2.69	1.26	370.0	10.93	53.00	1.29	10.98	0.25	4.98	0.04	9.40	0.17	20.53	0.12	0.10	0.004
	25-60	2.78	0.32	445.0	12.48	66.25	0.52	11.40	0.67	7.35	0.07	15.33	0.95	36.78	0.40	0.31	0.016

The values of DTPA-extractable Mn are tabulated in table (2), where they ranged between 1.05 and 17.10 mg/kg with an average of 8.50 mg/kg. The lowest content was recorded in the deepest layer of profile 15, where the texture was sandy clay loam, while the highest content was found in the subsurface layer of profile 10 where the texture was loamy sand. El-Falah (1995) found that the greatest available Mn was found in the medium-textured soils followed by the coarse and heavy-textured soils. As reported by Viets and Lindsay (1973) and El-Gala *et al.* (1986), the critical level of Mn as determined by DTPA method is 1.0 mg/kg. Accordingly, it is clearly apparent that the studied soils are far higher than the critical level. It was reported by Millar (1955) that the optimum concentration ratio of Fe to Mn in the nutrient medium of plants is about 2.0. The Fe to Mn ratio in the studied soils is less than 1.0. Therefore, it may be anticipated that excessive Mn would adversely affect Fe nutrition by plants growing in the studied area.

Total and DTPA-extractable zinc

The total zinc content as given in Table 2 ranges from 13.08 to 82.10 mg/kg soil with an average of 41.05 mg/kg. The lowest content was recorded in the surface layer of profile 5, while the highest content was found in the deepest layer of profile 16. These results are in close agreement with the findings of several workers on the total zinc content such as Abdel-Hamid *et al.* (1991) and El-Falah (1995). The differences encountered among the studied samples could be attributed mainly to the parent material from which they were inherited. Based on the report of Krauskopf (1972), the parent materials of these soils may have been derived from basic igneous rocks.

With respect to the DTPA-extractable Zn, it is clear from table (2) that its values range from 0.17 to 2.23 mg/kg with an average of 0.74 mg/kg. The lowest content was found in the surface layer of profile 14, while the highest content was recorded in the deepest layer of profile 15. Kamh (1981) reported values extending from 0.1 to 5.8 mg/kg with the upper range in heavy soils. These values of the DTPA extractable Zn were in the range of adequacy according to Lindsay and Norvell (1978) and El-Gala *et al.* (1986) who reported that 0.6 and 0.7 ppm soil Zn were the critical level for sorghum and maize, respectively. The reason for this phenomenon may be related to some genetic soil factors, which are related to the quantity and thermodynamic stability of the native Zn phases.

Total and DTPA-extractable copper

Data tabulated in Table 2 show that total Cu content in the studied soil ranges from 2.48 to 21.60 mg/kg with an average of 8.90 mg/kg. In general, the highest content was found in soils where clay content is high. Statistical analysis shows a significant correlation coefficient between these two variables.

Results of DTPA-extractable Cu ranged from 0.10 to 1.00 mg/kg soil. The lowest figure recorded in the surface layer of profile 5, while the highest value was found in the deepest layer of profile 3, which contains the highest amount of clay. Accordingly to the critical value suggested by Lindsay and Norvell (1978) and El-Gala *et al.* (1986) (0.2 ppm for sorghum plants), except for profile 5 and the surface layer of profile 6, 8, 11 and 12, the other samples are within the range of adequacy of Cu.

Total and DTPA-extractable lead

The amount of total Pb in the investigated soils was given in table (2). It is quite clear that the total content of this element varies from 4.43to 16.10 mg/kg with an average of 6.46 mg/kg soil. The lowest content was found in the surface layer of profile 14 where the texture was loamy sand, while the highest content was observed in the deepest layer of profile 2 where the texture was sandy loam. In Egypt, Rashad *et al.* (1995) found that the normal level of Pb in the alluvial soils of Nile Delta ranged between 32.0 and 48.0 ppm with an average of 41.0 ppm for total content.

On the other hand, Hegazy (1993) and Abbas (1993) indicated that irrigation water by itself is not the main source of Pb polluted in soils but other factors such as the use of fertilizers, pesticides and dust full might increase Pb content in the soils.

The amount of DTPA-extractable Pb in the investigated samples was given in Table 2. The data show that its values ranged between 0.01 and 0.15 mg/kg soils with an average of 0.06 mg/kg. The lowest content was recorded in the lower layer of profile 6 and the surface layer of profile 7 and 17, while the highest content was found in the deepest layer of profile 10 and 16. Misra and Pande (1976) found that the values of Pb extracted by different methods varied between 0.2 and 2.8 ppm. Mokma *et al.* (1980) reported that the mean extractable Pb in maize soils of Michigan ranged from 0.00 to 4.20 ppm.

In Egypt, Rashad *et al.* (1995) found that the available form of Pb in the alluvial soils of Nile Delta ranged from 1.4 to 2.5 ppm with an average of 1.9 ppm. Aboulroos *et al.* (1996) recorded 0.78-2.46 ppm with an average of 1.39 ppm for DTPA extracted Pb in these soils.

Total and DTPA-extractable cobalt

Table 2 shows that the total Co content in the studied soils varied from 1.50 to 25.00-mg/kg with an average of 8.59 mg/kg. The lowest value was associated with the layer (50-80 cm) of sandy loam soil of profile 3, while the highest content was found in the deepest layer of profile 16 where the texture was sandy loam. Rabie (1984) reported that total Co content in heavy textured soils was 20.6 to 31.5 ppm, in light textured alluvial soils, 2.6 to 29.3 ppm, and ranged from 1.3 to 26.7 ppm in calcareous soils. Metwally and Rabie (1989) found that the total Co in the alluvial soils of Egypt ranged from 3.00 to 30.00 ppm according to soil texture.

The normal soil content of Co was reported to vary between 1 and 40 ppm with the highest frequency in the range of 3-15 ppm with a mean of 8.5 ppm (Kabata Pendias and Pendias, 1984). Rashad *et al.* (1995) reported that the normal levels of Co content in alluvial soils of Nile Delta ranged from 3.7 to 5.5 ppm with an average of 4.7 ppm, while those of contaminated alluvial soils of Egypt were 11.2-36.1 ppm with an average of 23.7 ppm, El-Lithi (1986) and Faiyad *et al.* (1996). These results indicate that the investigated soils have higher Co content than the normal noncontaminated soils of Nile Delta. This could be attributed to the parent materials, which inherited from it the studied soils.

With respect to DTPA-extractable Co, data tabulated in Table 2 reveal that its content ranged from 0.02 to 1.39 mg/kg soil with the average of 0.54 mg/kg soil. The lower content was associated to the surface layer of profile 8, while the highest content was found in the subsurface layer of profile 10.

DTPA-extractable Co was reported to be 0.07-0.11 ppm in alluvial noncontaminated Delta soils, Rashad *et al.* (1995). Values of 0.13-0.28 ppm Co with an average of 0.19 ppm were reported by Aboulroos *et al.* (1996) and similar values were reported by Abou-Hussien and Faiyad (1996). Recently, Mourid (1999) found that the soils of Helwan, Bahr El-Baqar and Gharbanyat have available Co ranged between 0.227 and 1.770 ppm with an average of 1.00 ppm.

Total and DTPA-extractable nickel

Table 2 shows that total Ni content varies widely from 3.83 to 44.0 mg/kg with an average of 17.60 mg/kg. The lowest content was found in the surface layer of profile 5, while the highest content was associated to the deepest layer of profile 16.

The average content of Ni in soils of England and Wales was reported to be 20 mg/kg, McGrath and Loveland (1992) with much variation between soil types. Rashad *et al.* (1995) reported that the normal levels of total Ni in alluvial soils of Egypt ranged from 21 to 44 mg/kg with an average of 32 mg/kg.

DTPA-extractable Ni ranged between 0.04 and 0.53 mg/kg with an average of 0.19 mg/kg. The lowest content was found in the surface layer of profile 3, while the highest content was associated to the deepest layer of profile 8. These results were in agreement with those of Rashad *et al.* (1995), Aboulroos *et al.* (1996) and Omran *et al.* (1996) who mentioned that the concentration of DTPA-extractable Ni in Nile Delta alluvial soil ranged from 0.38-1.04; 0.30-1.02 and 0.15-0.35 mg /kg, respectively. In contaminated alluvial soils of Egypt values of 0.44-1.34 mg/kg were found in El-Fayoum soils, 0.59-0.98 mg/kg for the soils of Helwan (El-Lithi, 1986).

Total and DTPA-extractable cadmium

Data tabulated in table (2) shows that total Cd content in the studied soils ranged from 0.081 to 0.509 mg/kg with an average of 0.243 mg/kg. The lowest content was recorded in the subsurface layer of profile 17, while the highest content was found in the subsurface layer of profile 13. Fleischer *et al.* (1974) reported that normal background levels of Cd in soil are <1.0

mg/kg, but contaminated soils may contain considerably higher amounts. Aichberger *et al.* (1982) found that Cd content was 0.07-2.40 mg/kg at different geological regions of upper Australia.

Regarding the Egyptian soils, Abdel-Karim (1994) obtained higher total Cd in the range of 8.0 to 15.5 mg/kg for some alluvial and calcareous soils, while Mohamed (1995) found that Cd ranged from 5.6 to 7.4 mg/kg and from 2.2 to 3.4 mg/kg in the lacustrine and calcareous soils, respectively. Recently, Mouride (1999) found the total Cd content in different polluted soils ranged from 0.40 to 1.78 mg/kg.

The obtained results show that total Cd content in the studied soils was below 1.0 mg/kg. On the other hand, Kabata Pendias and Pendias (1992) mentioned that the background levels of Cd were 0.06-1.10 mg/kg with a calculated worldwide mean of 0.53 mg/kg. A survey of agriculture soils of USA comprising 3045 samples representing 307 different soil series collected from sites remote from metal contamination gave a mean topsoil Cd concentration of 0.265 mg/kg and a range of <0.01-2.00 mg/kg, McGrath and Loveland (1992).

The background Cd levels in soils of Delta ranged between 0.7 and 1.4 mg/kg, Rashad *et al.* (1995). In contaminated soils, however, mean values of 3.4, 3.2, 5.5 and 1.9 ppm were reported by Abdel-Haleem (1984). El-Sabbagh (1991), Ramadan (1995) and Rabie *et al.*, (1996), respectively. The data tabulated in Table 2 show that total Cd content in the studied soils was lower than those reported for contaminated soils of Egypt. Based on these information one can conclude that the investigated soils were uncontaminated with Cd.

Table (2) shows that DTPA-extractable Cd ranged from 0.001 to 0.020 mg/kg with an average of 0.007 mg/kg. The lowest content was recorded in the subsurface layer of profile 6, while the highest content was found in the subsurface layer of profile 4. El-Sokkary (1987); Rashad *et al.*(1995) and Aboulroos *et al.* (1996) found that the normal levels of DTPA-extractable Cd were 0.03-0.06, 0.017-0.095 and 0.08-0.18 mg/kg soil, respectively. In contaminated soils, however, El-Sokkary (1987) found that the higher values ranged from 0.45 to 4.5 mg/kg soils. These results show that the soils under investigation contain values of DTPA-extractable Cd comparable with those of uncontaminated soils.

Soil Properties and Studied Elements Contents

Soil properties and iron content

Soil factors that were reported to affect heavy metal availability include pH, EC, $CaCO_3$, organic matter, cation exchange capacity, sodium adsorption ratio, clay and silt content and inorganic amorphous materials (SiO_2, Al_2O_3 and Fe_2O_3). Data presented in table (3) show that total iron content was highly significant correlated positively with CEC, while was correlated positively with silt, clay and (silt + clay). Clay minerals may contain Fe either in their crystalline structure or as exchangeable cations on their surface. Moreover, Fe in the form of oxides may be externally associated with the clay fraction of soils. This association may be a surface coating on clay particles or it may be in the form of tiny nodules and concretion especially in heavy textured soils, McKenzie (1989). On the other hand, data show that DTPA-extractable iron was negatively correlated with iron oxide.

Soil properties and manganese content

Data tabulated in table (3) show that no statistical correlation was detected between the total Mn content and any individual soil property, which was measured in this work. This result was in agreement with that of El-Falah (1995). Several reasons can be advanced to explain this result. First, some of the measured properties such as the soil pH values, O.M and clay content, vary within a limited range to be effective as far as the total Mn concerned. Second, some variables such as the total Mn and the clay contents vary along a wide range. However, this variation is usually associated with the changes in measured system. To illustrate this case, two soils with less than 135.0 and 960.0 mg/kg total Mn are not different only in their elemental contents but they may also differ in their mineralogy which lead to difference between their chemical composition.

TABLE (3). Correlation coefficients between soil variables and total and DTPA-extractable elements.

Soil Variables	Fe		Mn		Zn		Cu		Pb		Co		Ni		Cd	
	Total	Available	Total	Available	Total	Available	Total	Available	Total	Available	Total	Available	Total	Available	Total	Available
pH	0,09	0.04	- 0.01	0,30*	0.00	- 0.13	- 0.16	- 0.21	- 0.13	0.11	- 0.25	0.01	- 0.16	0.18	- 0.08	- 0.14
EC	0.02	- 0.03	- 0.08	- 0.50**	- 0.05	0.19	0.13	0.25	0.18	0.05	0.15	- 0.12	0.11	- 0.16	0.03	0.09
$CaCO_3$	- 0.04	- 0.13	0.04	- 0.03	0.09	0.02	- 0.06	- 0.09	- 0.04	0.33*	- 0.01	0.13	0.06	- 0.12	- 0.07	- 0.25
O.M	- 0.03	- 0.09	0.06	0.08	- 0.13	- 0.04	- 0.37**	- 0.38**	- 0.04	- 0.34*	- 0.23	- 0.28*	- 0.25	- 0.21	- 0.05	- 0.40**
CEC	0,60**	- 0.18	0.18	0.03	0.58**	0.19	0.44**	0.20	- 0.09	0.08	0,48**	- 0.03	0.55**	0.23	- 0.13	0.21
SAR	0.07	- 0.19	0.00	- 0.36**	0.05	0.18	0.18	0.18	0.12	0.16	0.21	- 0.05	0.21	- 0.03	- 0.06	0.05
SiO_2	- 0.02	0.02	0.06	- 0.06	- 0.03	0.15	- 0.20	- 0.21	- 0.01	0.15	- 0.19	- 0.31*	- 0.17	- 0.11	- 0.10	0.06
Al_2O_3	- 0.16	- 0.25	- 0.21	0.10	0.13	- 0.09	0.17	- 0.02	- 0.27	0.01	0.24	0.02	0.25	0.12	- 0.21	0.15
Fe_2O_3	- 0.06	- 0.29*	- 0.07	0.14	0.21	0.06	0.23	0.02	- 0.47**	0.06	0.31*	0.16	0.30*	0.20	- 0.01	0.06
Silt	0.32*	0.02	- .04	- 0.20	0.31*	0.15	0.30*	0.22	0.11	0.08	0.22	0.06	0.29*	-0.09	- 0.06	0.06
Clay	0,31*	0.27	- 0.18	- 0.34*	0.21	0.20	0.30*	0,45**	0.01	0.10	0.22	0.16	0.27	- 0.03	- 0.07	0.17
Silt+Clay	0.34*	0.20	- 0.14	- 0.31*	0.27	0.19	0.33*	0.40**	0.05	0.10	0.24	0.14	0.30*	- 0.06	- 0.07	0.14

* and ** denote significant differences at 0.05 and 0.01 levels, respectively.

DTPA-extractable Mn shows positive correlation with pH and negative correlation with clay and (silt + clay) contents, while was highly negatively correlated with EC and SAR.

Based on a strictly theoretical argument as given by Ellis *et al.* (1983) and McKenzie (1989), oxidation / reduction potential and pH control the amount of available Mn in soils.

Soil properties and zinc content

The correlation coefficients (Table 3) reveal that the total Zn content in the studied soils was significant and highly significant correlated with silt and CEC, respectively. These results are in agreement with those of El-Falah (1995). He mentioned that this correlation may be explained by the presence of Zn as a structural constituent of some clay minerals or as an exchangeable cation on clays. It may also be explained by the possible presence of some Zn bearing minerals in the clay and silt fractions. On the other hand, no statistical correlation was detected between the DTPA-extractable Zn and any individual soil property which was measured in this study.

Soil properties and copper content

Data tabulated in table (3) show that as was the case with total Fe, there is a positive correlation between total Cu and both the silt, clay and (silt + clay) contents of soils, while there is a highly significant positive and negative correlation with CEC and O.M, respectively. These results were in agreement with those of El-Falah (1995).

With regard to the DTPA-extractable Cu, data in Table 3 show that there is a highly positive correlation with both clay and (silt + clay) contents, while was negatively correlated with O.M content.

Soil properties and lead content

Data in Table 3 show that, no statistical correlation was detected between the total Pb content and any individual soil property, which was measured in this study with the possible exception of Fe_2O_3 content. This could be attributed to the limited range of the measured properties such as pH, O.M and $CaCO_3$. On the other hand, data in Table 3 reveal that DTPA-extractable Pb was correlated positively and negatively with $CaCO_3$ and O.M contents, respectively.

Soil properties and cobalt content

The correlation coefficients (Table 3) reveal that total Co content was highly significant and significant correlated with CEC and Fe_2O_3, respectively. Kabata Pendias and Pendias (1992) mentioned that numerous investigators especially have cited the roles of montmorillonitic and illitic clays as being of significance because of their great sorption capacity and their relatively easy release of Co.

With regard to DTPA-extractable Co, data in table (3) reveal that it is negatively correlated with both O.M and S_iO_2 contents. Bloomfield (1981) found that soils rich in organic matter are known to have both a low Co content and low Co availability.

Soil properties and nickel content

Table (3) show that total Ni content was highly significant correlated with CEC, while was significant correlated with Fe_2O_3, silt and (silt + clay). These results are in agreement with Mouride (1999) who obtained similar results indicating that texture was the main factor affecting total Ni content. On the other hand, Kabata Pendias and Pendias (1992) mentioned that Ni is easily mobilized during weathering and then is coprecipitated mainly with Fe oxides. No statistical correlations were observed between DTPA-extractable Ni and any soil properties measured in this study.

Soil properties and cadmium content

Data in table (3) show that no statistical correlation was detected between total Cd and individual soil properties, while DTPA-extractable Cd was highly negatively correlated with O.M content.

To draw attention to the possible use of analytical data for heavy metals, given in summarized form, and to discuss some interesting features of the results in so far as they appear to reflect the general properties of distribution of certain heavy metals in soils, their weighted mean, trend and specific range (Oertel and Giles, 1963) are employed.

Table 4 shows that, the weighted mean for total Fe, Mn, Zn, Cu, Pb, Co, Ni and Cd in the studied soils varies from 1700 to 40000; 200.58 to 685.10; 18.88 to 70.23; 3.19 to 17.99; 4.81 to 13.28; 3.06 to 18.77; 6.36 to 34.29 and 0.10 to 0.46 ppm, respectively. The variations encountered within the studied profiles may be ascribed to the chance of variation in soil formation processes or local conditions prevailing in each site.

Considering the trend (T), data in table (4) indicate variable symmetrical distribution of total Fe, Mn, Zn, Cu, Pb, Co, Ni and Cd as indicated by (T) values which range from –0.758 to 0.502; -0.995 to 0.336; -0.929 to 0.313; -0.201 to 0.540; -0.192 to 0.424; -0.562 to 0.669; -0.440 to 0.638 and –0.695 to 0.703 ppm, respectively. These results show that the studied elements are somewhat lower in the surface or follows an opposite trend when increased in the surface layer than the deeper ones as indicated by the common positive or negative values for the trend.

Specific range (R) for total content of Fe, Mn, Zn, Cu, Pb, Co, Ni and Cd is generally widely variable as it ranges from 0.020 to 0.672; 0.063 to 1.720; 0.060 to 1.317; 0.038 to 0.792; 0.089 to 0.636; 0.174 to 1.976; 0.119 to 0.909 and 0.158 to 1.033 ppm, respectively. This suggests that the pedogenic processes had acted in a fairly uniform manner through the solum.

TABLE (4). Weighted mean (W), trend (T) and specific range (R) of total elements content in the studied soils.

Profile No.	Fe			Mn			Zn			Cu			Pb			Co			Ni			Cd		
	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R
1	7920	-0.758	0.088	416.00	0.213	0.355	23.49	0.234	0.390	4.82	0.288	0.480	6.94	-0.175	0.292	3.17	0.345	0.576	6.78	0.281	0.468	0.22	-0.093	0.158
2	20100	0.502	0.020	431.67	0.131	0.197	26.28	0.040	0.060	6.16	0.273	0.410	13.28	0.424	0.636	4.70	0.138	0.207	6.95	-0.381	0.119	0.15	0.346	0.523
3	26800	0.112	0.638	227.08	-0.277	0.451	23.40	-0.066	0.252	8.84	0.386	0.546	6.55	-0.038	0.210	4.73	0.208	1.976	10.04	0.280	0.463	0.30	0.293	0.633
4	40000	0.088	0.198	678.13	0.005	0.118	63.00	0.200	0.371	13.48	0.366	0.664	6.69	0.185	0.374	13.08	0.669	1.133	26.18	0.345	0.671	0.41	0.251	0.474
5	12900	0.318	0.628	391.25	0.297	0.594	18.88	0.307	0.615	3.19	0.224	0.447	6.05	0.112	0.223	3.06	0.461	0.955	6.36	0.399	0.798	0.15	0.359	0.758
6	21700	0.124	0.512	559.58	0.321	0.697	42.64	0.313	0.684	8.75	0.394	0.763	5.83	0.070	0.163	7.18	0.363	0.759	13.94	0.331	0.644	0.24	0.537	1.033
7	34100	0.211	0.249	415.17	-0.337	0.391	54.51	0.099	0.111	6.88	0.037	0.345	5.65	0.026	0.288	12.80	0.414	0.490	30.44	0.468	0.535	0.35	0.142	0.336
8	18900	0.185	0.243	336.33	-0.130	0.164	40.28	0.295	0.493	8.05	0.540	0.792	5.91	0.018	0.089	7.17	0.393	0.586	14.20	0.569	0.854	0.45	0.324	0.435
9	23100	-0.225	0.554	552.75	-0.031	0.063	50.22	-0.296	0.733	11.47	0.071	0.307	6.64	0.213	0.527	11.65	0.204	0.337	21.95	0.081	0.448	0.12	-0.695	0.864
10	20400	-0.103	0.186	543.75	-0.769	1.153	40.49	0.089	0.409	7.87	0.053	0.467	6.25	-0.111	0.244	8.29	-0.014	0.507	14.54	0.096	0.500	0.41	0.189	0.510
11	1700	-0.469	0.672	200.58	-0.995	1.720	23.80	-0.929	1.317	6.89	-0.201	0.348	7.11	0.167	0.225	5.00	-0.562	0.463	11.83	-0.440	0.658	0.14	0.367	0.612
12	15300	0.072	0.444	345.94	-0.308	0.434	27.57	0.160	0.386	5.27	0.402	0.641	5.86	0.113	0.196	5.68	0.296	0.480	14.04	0.419	0.630	0.33	0.703	0.970
13	20600	-0.015	0.296	309.17	-0.326	1.205	52.32	0.010	0.525	13.04	0.218	0.600	6.41	0.139	0.238	13.55	0.015	0.808	27.69	0.206	0.400	0.46	0.319	0.433
14	17400	-0.086	0.161	327.73	-0.083	0.153	31.09	0.046	0.084	4.59	-0.030	0.054	4.81	0.079	0.146	5.59	-0.095	0.174	11.02	-0.100	0.184	0.16	0.414	0.758
15	23800	0.029	0.668	303.30	-0.508	0.668	53.84	0.007	0.189	11.67	0.079	0.405	6.74	-0.091	0.211	11.85	0.120	0.249	26.24	0.144	0.379	0.19	0.479	0.781
16	28000	-0.079	0.354	685.10	0.336	0.456	70.23	0.226	0.395	17.99	0.394	0.595	7.42	0.101	0.246	18.77	0.495	0.827	34.29	0.415	0.698	0.22	0.581	0.748
17	25900	0.236	0.378	309.83	0.120	0.169	39.46	0.113	0.184	13.85	0.283	0.473	5.66	-0.192	0.265	11.45	0.181	0.319	24.52	0.638	0.909	0.10	0.091	0.303
18	27400	0.018	0.033	413.75	0.106	0.181	60.73	0.127	0.218	11.22	0.022	0.038	6.36	0.218	0.373	12.86	0.269	0.461	30.00	0.316	0.542	0.23	0.544	0.929

TABLE (5). Weighted mean (W), trend (T) and specific range (R) of DTPA-extractable elements content in the studied soils.

Profile No.	Fe			Mn			Zn			Cu			Pb			Co			Ni			Cd		
	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R	W	T	R
1	0.34	-0.212	0.456	14.97	0.104	0.173	0.61	-0.437	0.729	0.37	0.051	0.084	0.09	-0.250	0.413	3.17	0.321	0.537	0.21	0.075	0.620	0.006	-0.017	0.333
2	0.29	-0.300	0.451	6.13	-0.514	0.772	0.63	0.475	0.714	0.43	0.253	0.380	0.04	-0.119	0.190	4.70	-0.080	0.120	0.13	0.103	0.159	0.006	0.500	0.667
3	6.60	-0.069	0.481	2.91	0.245	0.847	0.62	0.381	0.643	0.73	0.634	1.004	0.06	-0.073	0.764	4.73	0.121	0.642	0.11	0.664	1.118	0.011	0.636	1.000
4	0.60	0.575	2.142	7.43	-0.311	0.590	1.04	0.447	1.135	0.58	0.330	0.509	0.05	0.680	1.220	13.08	0.334	0.569	0.24	0.571	0.861	0.013	0.538	1.077
5	1.12	-0.384	0.767	8.48	0.384	0.768	0.42	0.220	0.440	0.13	0.208	0.408	0.01	0.417	0.833	3.06	0.276	0.545	0.15	0.449	0.898	0.004	0.500	1.000
6	0.50	-0.906	1.298	8.05	-0.041	0.915	0.84	0.099	0.674	0.44	0.606	1.075	0.06	-0.724	2.103	7.18	0.767	1.734	0.22	0.600	0.781	0.003	-0.333	1.333
7	0.58	0.266	0.362	8.34	-0.868	1.477	0.70	0.396	0.670	0.40	0.285	0.398	0.11	0.965	1.230	12.80	-0.761	1.489	0.32	0.294	0.915	0.005	0.200	0.400
8	1.22	-0.735	1.541	14.85	0.699	0.811	0.60	-0.187	0.244	0.38	0.669	0.857	0.06	0.141	0.188	7.17	0.978	1.215	0.40	0.572	0.909	0.011	0.273	0.364
9	0.48	0.377	0.663	3.98	-0.864	1.309	0.90	0.429	0.566	0.43	0.141	0.242	0.09	-0.172	1.054	11.65	0.203	1.824	0.12	-0.261	1.130	0.005	0.200	1.400
10	0.48	0.219	0.360	12.44	-0.312	0.684	0.94	-0.991	1.679	0.42	0.280	0.682	0.12	0.496	0.711	8.29	0.076	1.785	0.28	-0.071	1.203	0.008	0.750	0.625
11	0.26	-0.596	0.846	2.65	-0.989	2.446	0.75	0.095	0.576	0.30	0.444	0.609	0.01	-0.600	0.500	0.09	0.012	0.953	0.10	-0.068	0.524	0.006	0.667	0.833
12	0.48	-0.606	1.000	12.74	0.326	0.599	0.28	0.105	0.131	0.22	0.289	0.385	0.08	-0.218	1.013	0.49	0.887	1.632	0.11	0.267	0.829	0.009	0.556	0.778
13	0.56	0.020	0.021	13.30	0.199	0.396	0.48	0.215	0.370	0.55	0.493	0.745	0.05	0.000	0.513	4.82	0.943	1.644	0.26	0.414	1.249	0.009	0.556	1.444
14	0.60	0.162	0.287	12.34	-0.046	0.084	0.61	0.716	1.313	0.23	0.094	0.176	0.02	0.625	1.167	0.44	0.166	0.302	0.18	0.079	0.147	0.006	0.500	0.833
15	0.88	-0.405	1.386	2.62	-0.804	1.405	1.40	0.546	1.146	0.53	0.355	0.391	0.05	0.377	0.887	0.14	0.225	1.283	0.18	0.370	0.492	0.012	0.667	1.000
16	0.55	0.313	0.622	1.82	-1.000	1.406	0.82	-0.861	1.113	0.75	0.378	0.440	0.11	0.538	0.925	0.72	0.611	0.915	0.18	0.186	0.284	0.012	0.417	0.583
17	0.33	-0.076	0.182	12.96	0.011	0.169	0.61	-0.263	0.398	0.41	0.193	0.244	0.06	0.930	1.175	0.73	0.380	0.521	0.25	0.269	0.364	0.005	0.600	1.000
18	0.71	-0.777	1.325	11.83	0.076	0.131	0.84	-0.538	0.921	0.49	0.494	0.846	0.06	0.276	0.466	0.62	0.726	1.244	0.29	0.568	0.972	0.011	0.636	1.091

Further computation of the weighted mean (W), trend (T) and specific range (R) of DTPA-extractable heavy metals were then carried out, table (5). Weighted mean for DTPA-extractable Fe, Mn, Zn, Cu, Pb, Co, Ni and Cd in the studied soil profiles varies widely.

The results of (T) values show that Fe, Mn and Zn are usually higher in the surface layer than the deepest ones as indicated by the common negative values for the trend. The variations in the values of (R) are mainly attributed to inherited characteristics, modified by bedogenic processes, sedimentation regime as well as local condition of each soil profile.

The specific range for the concerned elements also ranged widely suggesting the pedogenic processes had acted in a fairly uniform manner throughout the solum in each soil profile.

REFERENCES

Abbas, H. H. (1993). Heavy metals and trace elements in soils and plants as affected by irrigation with sewage and waters. *Annals of Agric. Sci., Moshtohor*, 31: 653-666.

Abdel-Haleem, S. H. (1984). Studies on lead and cadmium in Egyptian soils. *M. Sc. Thesis*, Fac. Science, Ain Shams Univ., Cairo, Egypt.

Abdel-Hamid, E. A., F.A. Hassan, A.S.Tag El-Dein and A.M.A. Hamra (1991). Copper and zinc in some salt-affected soils of Egypt. *Egypt. J. Soil Sci.*, 31 (4): 437-447.

Abdel-Karim, A. M. M. (1994). Chemical studies of some heavy metals in desert soils and their pollution hazard. *Ph. D. Thesis*, Fac. Agric., El-Zagazig Univ., Zagazig, Egypt.

Abou-Hussien, E. A. and M.N. Faiyad (1996). The combined effect of poudrette, Zn and Co on corn growth and nutrient uptake in alluvial soils. *Egypt. J. Soil Sci.*, 36 (1-4): 47-58.

Aboulroos, S. A.; Sh. Sh. Holah and Sh. Badawy (1996). Background levels of some heavy metals in soils of Egypt and associated corn plant. *Egypt. J. Soil Sci.*, 36 (1-4).

Aichberger, K.; W. Backler and H. Pichler (1982). Content and distribution of heavy metal in soils and soil profiles from different geological region of Upper Australia. *Landwit Schftliche Forschung, Sonderheft*, 38: 350-362. (C.F. *Soil and Fert.*, 1983, 46:155).

Bloomfield, C. (1981). In "*The Chemistry of Soil Processes*: *The translocation of metals in soils*". (Greenland, D. J. and M.H.B. Hayes, Eds.), John Wiley & Sons, New York, 463pp.

El-Demerdashe, S.; E. A. Abdel-Hamid; F. M. A. Abed and H.I.El-Kassas (1991). Iron status and its relation to some soil variables in calcareous soils of Egypt. *Egypt. J. Soil Sci.*, 31(3): 357-372.

El-Demerdashe, S. and M.E. Abdel-Rahman (2000). Heavy metals in some soils south New Valley, Egypt. *Egypt. J. Soil Sci.*, (in press).

El-Falah, A. H. (1995). The status of some micronutrients in some soils of El-Sharkia Governorate. *M.Sc. Thesis*, Fac. Agric., El-Zagazig Univ., Zagazig, Egypt.

El-Gala, A. M.; A. Ismail and M.A. Ossman (1986). Critical levels of Fe, Mn, and Zn in Egyptian soils as measured by DTPA-extractable and maize plants. *Egypt. J. Soil Sci.*, 26: 125-137.

El-Lithi, A.A. (1986). Pedological studies of heavy metals in the vicinity of some industrial and highway areas in soils of Nile Delta. *Ph. D. Thesis*, Fac. Agric., Alex. Univ., Alexandria, Egypt.

Ellis, B. G.; B.D. Knezek and L.W. Jacobs (1983). In *"Chemical Mobility and Reactivity in Soil Systems: The movement of micronutrients in soils"*, (Nelson, D.W., ed.). Soil Sci. Soc. Am., Madison, Wisconsin, U.S.A., p 109-122.

El-Sabbagh, T. A. (1991). Environmental impact of industrial area "Mostrod" on the concentration of some elements in water, soil and plant. *M. Sc. Thesis*, Inst. of Environmental Studies and Research, Ain Shams Univ., Cairo, Egypt.

El-Sokkary, I. H. (1987). In "SCOPE: *Contamination of the western area of Nile Delta by cadmium, lead and mercury"*. Metaly cycling workshop conference book. Feb. 16, Delhi, India.

Faiyad, M. N.; Omran, M. S. and El- Shikha, S. H. (1996). Effect of pollution on soil and plant. 2- Effect of pollution sources on micronutrients uptake by plants. *The 6 th international conference proceedings "Environmental protection is a must", 21-23 May in Alexandria, Egypt.* p.541-561.

Fleischer, M.; A.F. Sarofim; D.W. Fassett; P. Hammond; H.T. Shacklette; I.C.T. Nisbet and S. Epstein (1974). Environmental impact of cadmium. *Environ. Health Perspect.*, 5: 253.

Follett, E. A.; W.J. McHardy; B.D. Mitchell and B.F.L.Smith (1965). Chemical dissolution techniques in the study of soil clays. *Part* 1, 11. *Clay Minerals,* 6: 23.

Hafez, I. W.; E.A. Abdel-Hamid; A.S. Tag El-Din and N.M. El-Aaser (1992). Available iron and manganese as affected by soil variables in calcareous soils. *Egypt. J. Soil Sci.*, 32(3): 423-426.

Hegazy, I. M. A. (1993). Studies on soil pollution. *M.Sc. Thesis*, Fac. Agric., Moshtohor, El-Zagazig Univ., Benha, Egypt.

Hesse, P. R. (1971). In *"A Textbook in Soil Chemical Analysis"*. William Glowe, London, U.K.

Kabata Pendias, A. and H. Pendias (1992). Trace Elements in Soils and Plants. 2nd ed., CRC Press, Baton Rouge, Florida, U. S. A. p 365.

Kabata Pendias, A. and H. Pendias (1984). In *"Trace Elements in Soils and Plants"*. CRC press. Inc. Boca Raton, Florida, 3431pp..

Kamh, R. N. (1981). Supplying power of soils of Sinai for some microelements. *Ph. D. Thesis*, Fac. Agric., Ain Shams University, Cairo, Egypt.

Krauskopf, K. B. (1972). In *"Micronutrient in Agriculture: Geochemistry of micronutrients"*.(Mortvedt J.J.; P.M. Giordano and W.L.Lindsay, Eds).Soil Sci. Soc. Am. Madison, Wisconsin, U.S.A.

Lindsay, W. L. and W.A. Norvell (1978). Development of DTPA soil test for zinc, iron, manganese, and copper. *Soil Sci. Soc. Am. J.*, 42: 421-428.

McBride, M. B. (1994). In *"Environmental chemistry of soils"*. New York. Oxford University Press.

McGrath, S. P. and B.J. Loveland (1992). In *"The soil Geochemical Atlas"*. Academic and Professional, Glasgow.

McKenzie, R. M. (1989). In *"Minerals in Soil Environments: Manganese oxides and hydroxides"*. 2nd ed. (Dixon, J.B. and S. B. Weed, eds.). Soil Sci. Soc. Am. Madison, Wisconsin, U.S.A. p 439-466

Metwally, A. I and M.H. Rabie (1989). Nickel and cobalt in soils of Egypt and in fodder plants. *Egypt. J. Soil Sci.*, 29(3): 275-284.

Millar, C. E. (1955). In *"Soil Fertility"*. Wiley, New York.

Misra, S. G. and P. Pande (1976). Evaluation of suitable extractant for available lead in soils. *Plant and Soil*, 45: 693.

Mitchell, B. D. and R.C. Mackenzie (1954). Removal of free iron oxides from clays. *Soil Sci.*, 77: 173.

Mitchell, R. L. (1964). In *"Chemistry of the Soil: Trace elements in soils"* (Bear, F., ed.), 2nd edition, Reinhold Pub., New York. Corp.

Mohamed, L. E. S. (1995). Chemical mobility and reactivity of some soil components and pollutants and their impact on crops in the western desert ecosystems. *Ph. D. Thesis,* Inst. Environmental Studies and Research, Ain Shams Univ., Cairo, Egypt.

Mokma, D. L.; B.D. Knerzek and L.S. Robertson (1980). In *"Extractable heavy metal levels in the profiles of soils used for corn production"*. Research Report. Agric. Exp. Station. Michigan State Univ., U.S.A.

Mourid, Sh. Sh. (1999). Evaluation of soil tests for predicting toxic elements status in some Egyptian soils. *M. Sc. Thesis*, Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Norvell, W. A. (1984). Comparison of chelating agents as extractants formetals in diverse soil materials. *Soil Sci. Soc. Am. J.,* 48: 1285-1292.

Oertel, A. C. and J.B. Giles (1963). Trace elements contents of some queensland soils. *Aust. J. Soil Res.*, 1: 215-222.

Omran, M. S.; M.N. Faiyad and S.H. El-Shikha (1996). Effect of pollution on soil and plant. 1- Effect of industrial activities on pollution Egyptian soil. *The 6th international conference proceedings* on

"Environmental protection is a must", 21-23 May in Alexandria, Egypt.

Piper, C. S. (1950). In "*Soil and Plant Analysis*". Interscience, New York, U.S.A.

Rabie, F.; M.Y. Khader; I.F. Rashad; A.M. Fawzy and W.H. Hussein (1996). Heavy metal distribution in the different particle sizes of soils irrigated from polluted sources. *Egypt. J. Soil Sci.*, 36(4) : 179-188.

Rabie, F.; A. El-Araby and M. El-Shazly (1989). Micronutrients status as related to soil constituents in some soils of eastern desert, Egypt. *Egypt. J. Soil Sci.*, 29(3): 331-343.

Rabie, M. H. (1984). Studies on some heavy metals in soils A. R. E., *Ph. D. Thesis*, Fac. Agric. Ain Shams Univ., Cairo, Egypt.

Ramadan, M. A. (1995). Studies on the pollution of the agricultural environment in Egypt. *Ph. D. Thesis*, Fac. Agric., Cairo Univ., Giza, Egypt.

Rashad, I. F.; A.D. Abdel-Nabi; M.E. El-Hemaly and M.A. Khalaf (1995). Background levels of heavy metals in the Nile Delta soils. *Egypt. J. Soil Sci.*, 35: 239-252.

Richards, L. A.(1954).In "*Diagnosis and Improvement of Saline and Alkali Soils*". U.S.D.A. Agric. Handbook No. 60, Washington, DC, U.S.A.

Schwertmann, U. and R.M. Taylor (1989). *In "Minerals in Soil Environments: Iron oxides"*. (Dixon, J. B. and S. B. Weed, eds.). American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, Madison, Wisconsin, U.S.A., p. 145-180.

Viets, F. G. Jr. and W.L. Lindsay (1973). In "*Soil Testing and Plant Analysis: Testing soils for zinc, copper, manganese, and iron*". (Walsh L. M. and J. D. Beaton, eds). Soil Sci. Soc. Am., Madison, Wisconsin, U.S.A., p 153-172.

Walkley, A. (1947). A critical examination of a rapid method for determining organic carbon in soils-effect of variations in digestion conditions and of inorganic soil constituents. *Soil Sci.*, 63: 251-264.

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تقييم بعض المغذيات الصغري والعناصر الملوثة في أراضي توشكى

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أجريت الدراسة علي اثنين وخمسون عينة أرضية تمثل ثمانية عشرة قطاعا أرضيا بمنطقة توشكي بهدف تقييم محتواها الكلي والميسر من عناصر الحديد، المنجنيز، الزنك، النحاس، الرصاص، الكوبالت، النيكل، الكادميوم بالإضافة إلى تقدير خواصها الطبيعية والكيميائية.

أوضحت النتائج أن قوام هذه الأراضي يتفاوت بين الطميى الطيني، الرملي الطميي ويختلف محتواها من كربونات الكالسيوم مابين ١,١٠-٢١,٧٦% في حين كان محتواها من المادة العضوية منخفضا. كذلك بينت النتائج أن متوسط المحتوي الكلي لكل من الحديد، المنجنيز، الزنك، النحاس، الرصاص، الكوبالت، النيكل، الكادميوم ٢,٢٩% ، ٤٢٢,٦٨ ، ٤١,٠٥ ، ٨,٩٠ ، ٦,٤٦ ، ٨,٥٩ ، ١٧,٦٠ ، ٠,٢٤ ملليجرام/لتر علي التوالي. كما وجد أن محتوي معظم الأراضي من الحديد الميسر أقل من المستوي الحرج في حين وجد عكس ذلك في المنجنيز ، بينما كان المحتوي الميسر لكل من الرصاص ، الكوبالت ، النيكل ، الكادميوم ٠,٠٦ ، ٠,٥٤ ، ٠,١٩ ، ٠,٠٠٧ ملليجرام/لتر علي التوالي.

وقد أظهر حساب القياسات الإحصائية (المتوسط الوزني، الاتجاه، النطاق النوعي) للمحتوي الكلي والميسر للعناصر المدروسة عدم تجانس الأراضي وأرجع ذلك إلي اختلاف مواد الأصل المشاركة في تكوين هذه الأراضي أو إلي العمليات البيدوجينية التي صاحبت تكوين الأراضي.