J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol.1 (12):1221-1236, 2010

STATUS OF SOME MICRONUTRIENTS IN HE NORTHERN WEST OF NILE DELTA, EGYPT

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ABSTRACT

This work aims to evaluate the relations between total as well as DTPA extractable Fe, Mn, Zn and Cu and each of soil texture, $CaCO_3$, organic matter (OM) and CEC of soils adjacent to lakes of Idku and Maryut in the northern west of Nile delta. Thirteen soil profiles representing the main types of soils both areas were examined. The obtained results could be summarized as follows: Total Fe ranged between 20000 and 43000 mg kg^{-1} while available Fe varied from 1.8 and 22 mg kg^{-1}. Contents of both forms decreased with depth. Total Mn ranged between 500 and 2800 mg kg^{-1} while available Mn varied from 3.0 to 35.4 mg kg^{-1}. Total Zn ranged between 75 and 275 mg kg^{-1} while available Zn varied from 0.2 to 4.6 mg kg^{-1}. Total Cu ranged between 37.5 and 225 mg kg^{-1} while available Cu varied from 1.0 to 32.2 mg kg^{-1}. Significant negative correlations occurred between total content of each of the studied micronutrients (Fe, Mn, Zn and Cu) and each of soil pH, sand %, gypsum % and $CaCO_3$ % and also between available Fe and soil pH; between available Mn and each of soil pH, ESP and sandy %; between available Zn and each of soil pH and ESP; between available Cu and each of soil pH and sand %. Significant positive correlations occurred between total contents of the micronutrients (Fe, Mn, Zn and Cu) and OM % as well as clay; between available micronutrients (Fe, Mn, Zn and Cu) and OM %, clay % and CEC. The data of the statistical measures showed that, the highest values of weighed mean (W) of total Fe, Mn and Cu were found in the soil profiles of sandy beaches, while, the highest values of W of Zn total were found in the soil profiles of recent Nile Alluvial. The trend (T) indicates that some of the soil profiles were highly symmetric distribution with respect to Fe, Mn, Zn and Cu. The calculated values of specific range (R) of the total content of all micronutrients under study revealed that, the studied soils were composed from homogenous materials. The soil fertility of the studies available micronutrients (Fe, Mn, Zn and Cu) seemed to be more than the critical levels.
Keywords: Micronutrients, Soil texture, $CaCO_3$, Organic matter, CEC and ESP.

INTRODUCTION

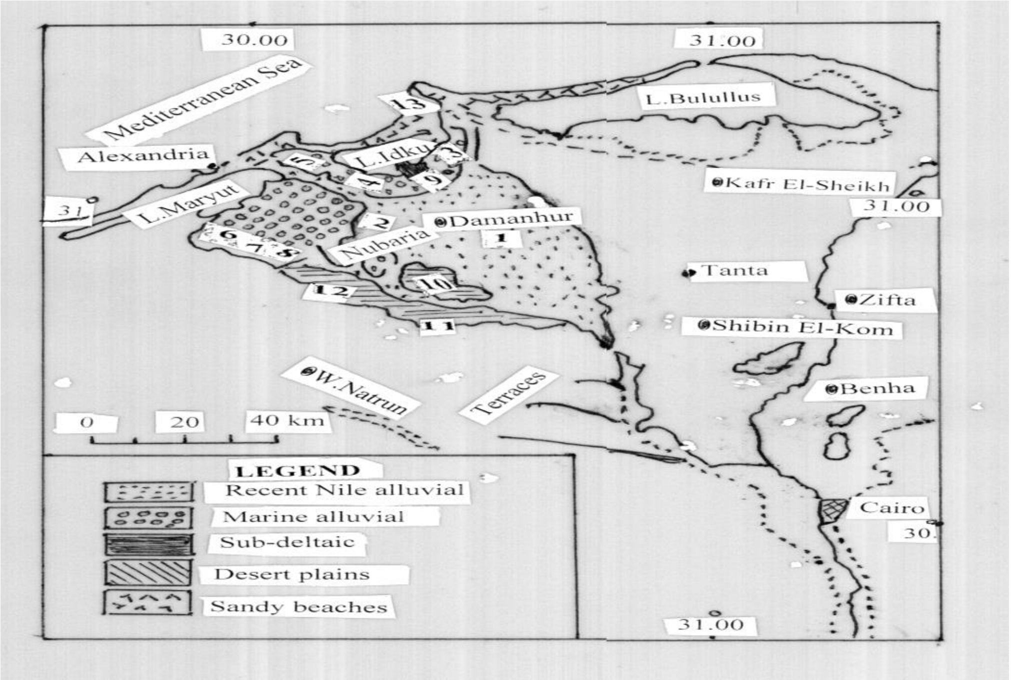
The world's population is estimated to increase from six billion to about ten billion by 2050. To meet the food demand of the growing world population, a large increase in food production is required. Meanwhile, the increases in world population will result in a serious pressure on the existing agricultural land through urbanization and intensive cultivation (Ismail, 2002). The Lake region of the Egyptian coast covers a distance of 505 km between Lake Bardwail and Lake Maryut. Most of the Lakes have an elongated shape aligned with the direction of the coast. All the lakes except Maryut are joined to the Mediterranean Sea, and therefore its area is shrinking. Ball (1939) suspected that it resulted from crustal movements, others think, it was an old Lake. Lakes Idku and Maryut were fed by Nile water via the old Canopic branch, but in the 12^{th} century, this branch was filled with silt and the connections of the Lakes with the Nile were thus cut. Land resources surrounding these two Lakes are of high importance for the survival and welfare of the people as well as the economic independence of Egypt. The rapidly increasing population needs more food production and this requires improving soil productivity to conserve soil resources for sustainable agriculture. Since the "Green Revolution" higher crop production per unit area has resulted in greater depletion of soil micronutrients, while less attention has been paid to micronutrients fertilization. Now, micronutrient deficiency has become a limiting factor for crop productivity in many agricultural lands worldwide. Furthermore, many food systems in developing countries cannot provide sufficient micronutrient content to meet the demands of their citizens, especially low-income families. Micronutrient contents of soils depend on the parent rocks from which these soils are derived by weathering processes. Many of these elements occurred by isomorphous substitution in soil materials (Krauskopf, 1972). Micronutrients are those trace elements which are essential for the normal healthy growth and reproduction of plants (Brian, 2008). The essential micronutrients for field crops are Fe, Mn, Zn and Cu. The incidence of micronutrient deficiency has increased in recent years. Iron, manganese, zinc and copper shortage or increases are paid more attention because they negatively affect both food production and human health in a major part of the world (Fageria and Stone, 2002). Thus, Soil should be checked for trace element toxicity or shortage hazards. Soil-profile distributions of extractable Fe, Mn, Zn and Cu were significantly altered with agricultural practices, especially near the soil surface due to surface-placement of crop residues. Micronutrient cations (Fe, Mn, Zn and Cu) were generally greater throughout the 0-30 cm depth. Few differences in soil-profile distributions between agricultural practices occurred with (I) Soil pH, except at 0-5 cm depth, due to greater soil organic matter accumulation leading to acidity from decomposition,(II) Extractable Ca, Mg, and Na due to their very high native levels, except for Na. Crops grown in most soils in Egypt suffer from deficiencies of one or more micronutrients, even though the soils often contain apparently adequate total amounts of the respective elements. The nature and extent of deficiencies differ with soil variables and soil type (Maha and Singh, 2008).Modern agricultural systems have to provide plant with enough micronutrients to meet all the nutritional needs of people. The DTPA-Zn concentration in more than 50% of calcareous paddy soils was less than its critical deficiency concentration (2 $mg\ kg^{-1}$), while the concentrations of DTPA- Fe, Mn, and Cu were sufficient. A significant negative correlation was found between the $CaCO_3$ content and soil DTPA-extractable Zn, Fe, Mn, and Cu (McGrath *et al.*, 2000**)**.Yu *et al.* (1991), Hafez *et al.* (1992) and El-Maghraby (1996) obtained positive correlations between soil micronutrients and each of the clay and OM content. Also, soil pH significantly, but negatively correlated with available micronutrients. Mehrotra *et al.* (1996) reported that, increase in soil pH and $CaCO_3$ were accompanied by significant decrease in the extractable soil micronutrients. Kuleedp and Nahendra (1990) found that available micronutrients decreased with depth. Sangwan *et al.* (1999) and El-Sheikh

(2003) stated that the content of available Fe, Mn, Zn and Cu in soils decreased with depth and the distribution pattern of available micronutrients in the profile might be due to the decrease of soil organic matter with depth. Ahmed (2005) found that the high values of weighed mean (W) of total Fe, Mn, Zn, and Cu were found in the surface layers. The calculated values of trend (T) showed a symmetrical distribution of total micronutrients. The calculated values of specific range (R) of the total micronutrients were composed from homogenous materials.

Therefore, the aim of the present work is to describe the status of Fe, Mn, Zn, and Cu in the soil types adjacent to Lakes of Idku and Maryut in the northern west of Nile delta. Moreover, some factors controlling their status, *i.e.,* soil texture, calcium carbonate ($CaCO_3$) and organic matter contents, salinity, soil reaction and exchange characteristics are also considered.

MATERIALS AND METHODS

The current study was carried out to investigate the status of Fe, Mn, Zn and Cu in soils adjacent to Lakes of Idku and Maryut in the northern west of Nile delta, Egypt. To fulfill this purpose, thirteen soil profiles were dug at different locations of northern west of Nile Delta to represent physiographic units in the area (Map 1). The sites of these deposits situated between longitudes 29^0 55 - 30^0 40 E, and 30^0 50 - 31^0 30 N. Meteorological data for the summer 2009 in study period are given in Table (1).Tables (2 and 3) show some physical and chemical properties, of the studied soils, determined according to the methods outlined by Jackson (1973). Total Fe, Mn, Zn and Cu in the soils were extracted by digestion in HF-$HClO_4$ acids mixture in platinum crucibles (Jackson, 1973), whereas available Fe, Mn, Zn and Cu were extracted by DTPA+ ammonium bicarbonate, according to Soltanpour (1985). Both total and extractable Fe, Mn, Zn and Cu were measured by using Atomic Absorptions Spectrophotometer, Perkin Elmer, and model 3110. Oertal and Gille (1963) suggested three measures for trace elements, namely the weighed mean (W), trend (T) and specific range (R). The weighed mean was calculated as trace element concentration of each horizon of the solum multiplied by the thickness of the horizon or layer and dividing the sum of these products by the total thickness of all analyzed horizons or layers. According to those authors the weighed mean is the most satisfactory measure of the trace element status of a soil profile. Any change in concentration of trace element with depth is called the trend and defined by $T= (W-S)/W$ and by $T= (W-S)/S$, where W=the weighed mean concentration and S=the concentration in the surface horizon or layer.They added that all values for T lie in the range from -1 to +1 and it is more symmetrical distribution when T is small. The specific range is defined by $R = (H-L)/W$, where R is the specific range, H and L are the highest and the lowest concentration in the solum and W is the weighed mean. The weighed mean concentration of a trace element is probably determined by pedogenic processes (except where the parent material is markedly heterogeneous in trace element content). Regression equations and correlation coefficients (r) between some soil properties in the investigated soil profiles with total and available content of micronutrients were calculated according to Snedecor



Map (1): Location of soil profiles in the studied soil

Table (1): Meteorological data of Alexandria, Egypt for the study period (April-September 2009)

Month / Character	April	May	June	July	August	September	Average
Rain fall (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tem. Average (^oC)	19.9	22.7	26.9	27.3	26.9	26.4	25.0
Tem. Mean max.(^oC)	24.4	26.6	30.9	30.4	30.1	30.1	28.8
Tem. Mean min. (^oC)	15.9	18.9	22.9	24.5	23.9	22.7	21.5
Day time (^oC)	21.3	23.9	28.2	28.2	27.9	27.6	26.2
Night time (^oC)	17.9	20.7	24.8	25.7	25.3	24.8	23.2
Relative humidity %)	60	61	63	71	72	67	66
Wind speed 2m /sec)	3.03	3.00	3.00	3.43	3.07	3.20	3.12
Possible sunshine duration (h)	12.8	13.6	13.9	13.8	13.2	12.2	13.3

Table (2): Some physical and chemical properties of the studied soils

Location	Prof. No.	Depth cm	Particle size distribution %				Textural class	Ph (1:2.5) Soil: water susp.	ECe dSm-1 (Soil paste ext.)
			C. Sand	F. Sand	Silt	Clay			
Recent Nile Alluvial	1	0-40	2.70	9.2	21.4	66.7	Clay	7.80	2.30
		40-70	6.00	20.3	18.3	55.4	Clay	8.00	2.30
		70-100	1.10	4.7	41.4	52.8	Silty Clay	8.00	2.70
	Mean		3.30	11.4	27.0	58.3	Clay	-	2.43
	2	0-25	2.00	14.3	33.5	50.2	Clay	8.10	3.20
		25-80	1.60	12.8	33.8	51.8	Clay	8.30	3.00
		80-100	0.50	13.7	31.8	54.0	Clay	8.40	3.00
	Mean		1.40	13.6	33.0	52.0	Clay	-	3.07
Marine Alluvial	2	0-30	3.10	14.0	20.7	62.2	Clay	7.90	2.40
		30-50	1.00	13.0	41.0	45.0	Silty Clay	8.00	4.60
		50-60	4.10	17.0	37.3	41.6	Clay	7.90	6.60
		60-90	0.50	2.10	35.7	61.7	Clay	7.80	8.30
		90-100	4.00	14.2	36.8	45.0	Clay	7.80	9.70
	Mean		2.54	12.1	34.3	51.1	Clay	-	6.32
	4	0-20	5.10	12.1	20.6	62.2	Clay	7.80	2.10
		20-50	1.60	1.50	39.3	57.6	Clay	8.10	1.50
		50-90	2.10	17.1	50.1	30.7	Silty Clay Loam	8.20	1.60
	Mean		2.95	10.2	36.7	50.1	Clay	-	1.73
	5	0-30	6.70	20.8	20.5	52.0	Clay	8.00	3.60
		30-50	2.20	15.2	37.2	45.4	Clay	8.00	3.70
		50-100	1.00	36.1	42.2	20.7	Loam	8.10	3.90
	Mean		3.30	24.0	33.3	39.4	Clay Loam	-	3.73
	6	0-25	1.00	11.8	35.1	52.1	Clay	7.90	4.80
		25-100	2.10	35.5	20.8	41.6	Loam	7.80	6.10
	Mean		1.55	23.7	28.0	46.9	Clay	-	5.45
	7	0-10	2.10	15.8	25.6	56.5	Clay	7.80	3.90
		10-35	4.20	19.3	41.0	35.5	Clay Loam	7.70	3.30
		35-50	5.10	14.9	38.2	41.8	Clay	7.80	3.50
		50-100	5.10	12.8	36.9	45.2	Clay	7.80	2.90
	Mean		4.12	15.7	35.4	44.8	Clay	-	3.40
	8	0-20	4.10	24.9	22.3	48.7	Clay	8.30	2.60
		20-45	0.50	24.7	34.1	40.7	Clay	8.30	2.90
		45-100	0.80	22.0	36.1	41.1	Clay	8.20	3.50
	Mean		1.80	23.9	30.8	43.5	Clay	-	3.00
Sub-deltaic	9	0-20	4.10	77.9	4.00	14.0	Sandy Loam	8.50	16.6
		20-55	5.00	79.9	4.00	11.1	Loamy Sand	8.70	3.50
		55-100	9.10	72.6	8.10	10.2	Loamy Sand.	8.60	1.60
	Mean		6.06	76.8	5.37	11.8	Loamy Sand	-	7.23
Desert Plains	10	0-29	5.80	11.2	41.5	41.5	Silty Clay	7.90	2.80
		29-60	4.30	11.5	41.0	43.2	Silty Clay	8.00	2.40
		60-100	4.20	16.3	39.6	39.9	Clay Loam	7.90	1.80
	Mean		4.80	13.0	40.7	41.5	Silty Clay	-	2.33
	11	0-20	7.50	10.1	35.6	46.8	Clay	8.40	1.30
		20-40	8.20	5.80	35.1	50.9	Clay	8.90	1.20
		40-60	0.50	16.9	45.8	36.8	Silty Clay Loam	9.10	1.20
		60.80	14.8	38.6	38.2	8.40	Sandy Loam	9.30	1.40
		80-100	14.2	37.4	40.0	8.40	Sandy Loam	9.40	1.50
	Mean		9.04	21.76	38.9	30.3	Clay Loam	-	1.32
	12	0-20	3.60	17.4	36.9	42.1	Clay	8.40	0.90
		20-30	3.10	15.5	40.5	40.9	Silty Clay	8.10	2.40
		30-100	5.10	22.9	31.1	40.9	Clay	7.90	4.40
	Mean		3.90	18.6	36.2	41.3	Clay	-	2.57
Sandy Beaches	13	0-35	3.00	70.6	14.1	12.3	Sandy Loam	7.90	0.70
		35-70	2.00	73.9	14.0	10.1	Sandy Loam	8.20	0.30
		70-100	2.10	70.9	16.0	11.0	Sandy Loam	8.40	0.60
		100-150	1.00	25.8	22.1	51.1	Clay	8.70	4.40
	Mean		2.00	60.3	16.6	21.1	Sandy Clay Loam	-	1.50

Table (3): Cation exchange capacity and exchangeable cations of the studied soils

Location	Prof NO.	Depth cm	OM %	CaCO3 %	Gypsum %	CEC cmolc kg-1	ESP
Recent Nile Alluvial	1	0-40	2.60	4.80	0.05	64.3	1.55
		40-70	1.20	4.60	0.02	64.9	4.01
		70-100	1.10	4.20	0.04	47.0	6.60
	Mean		1.63	4.53	0.04	58.7	3.81
	2	0-25	2.20	4.60	0.05	68.9	8.71
		25-80	1.40	4.20	0.04	47.9	11.1
		80-100	1.00	2.90	0.02	46.4	16.8
	Mean		1.53	3.90	0.04	54.4	11.7
Marine Alluvial	3	0-30	2.30	4.60	0.08	57.2	9.09
		30-50	0.87	4.20	0.08	50.0	16.8
		50-60	0.30	2.90	0.02	48.2	18.5
		60-90	1.70	3.80	0.80	59.6	21.3
		90-100	1.23	2.90	0.80	44.8	14.7
	Mean		1.28	3.68	0.07	52.0	16.1
	4	0-20	1.90	3.80	0.02	45.5	6.15
		20-50	0.60	4.20	0.02	40.3	6.45
		50-90	0.50	2.50	0.03	26.9	6.69
	Mean		1.00	3.50	0.02	37.6	6.39
	5	0-30	2.30	21.4	0.04	46.8	5.77
		30-50	1.10	12.2	0.03	26.6	10.5
		50-100	1.10	6.30	0.03	16.7	18.6
	Mean		1.50	13.3	0.03	30.0	9.56
	6	0-25	2.90	31.1	0.40	52.3	11.5
		25-100	0.90	29.8	0.40	41.3	12.8
	Mean		1.90	30.5	0.40	46.8	12.1
	7	0-10	2.60	27.3	0.30	52.8	8.71
		10-35	1.70	21.4	0.60	35.7	7. 00
		35-50	1.10	28.1	0.90	40.5	5.43
		50-100	1.00	24.8	0.01	43.2	10.6
	Mean		1.60	25.4	0.45	43.1	8.08
	8	0-20	1.80	9.20	0.03	49.2	7.32
		20-45	0.50	6.30	0.04	41.0	7.07
		45-100	0.50	4.60	0.02	47.0	5.96
	Mean		0.93	6.70	0.03	45.7	6.78
Sub-deltaic	9	0-20	0.80	1.80	0.04	18.9	29.1
		20-55	0.30	1.80	0.04	15.3	9.80
		55-100	0.03	2.80	0.04	7.90	11.4
	Mean		0.38	2.13	0.04	14.0	18.8

Table (3): Cont.

Location	Prof NO.	Depth cm	OM %	CaCO3 %	Gypsum %	CEC cmolc kg-1	ESP
Desert Plains	10	0-29	2.50	9.20	0.05	37.1	12.9
		29-60	0.90	7.90	0.07	40.0	8.25
		60-100	0.80	6.70	0.05	40.0	9.25
	Mean		1.40	7.93	0.06	39.0	10.1
	11	0-20	1.60	8.40	0.01	46.3	9.50
		20-40	0.90	7.50	0.01	40.0	21.8
		40-60	0.30	5.00	0.01	39.0	32.6
		60.80	0.30	7.10	0.01	19.4	28.4
		80-100	0.60	14.3	0.01	13.0	23.8
	Mean		0.74	8.46	0.01	31.5	21.8
	12	0-20	2.50	21.4	0.05	43.5	5.29
		20-30	1.20	20.2	0.05	39.3	3.56
		30-100	0.30	20.7	0.01	40.7	8.35
	Mean		1.33	20.8	0.04	41.2	5.76
Sandy Beaches	13	0-35	0.77	2.50	0.01	17.8	1.68
		35-70	0.05	3.40	0.01	8.90	2.25
		70-100	0.17	4.50	0.08	10.1	3.96
		100-150	1.50	4.20	0.09	52.8	39.2
	Mean		0.62	3.65	0.05	22.4	24.1

RESULTS AND DISCUSSION

Status of Fe, Mn, Zn and Cu in soils:

Data in Table (4) show the total and AB-DTPA extractable (available) contents of Fe, Mn, Zn and Cu in the studied soil profiles.

Total iron.

Table (4) set out the values of total Fe content in the investigated soils expressed as mg kg^{-1}. Although, the total content of Fe is not a good measure for the amount of Fe available to plants, yet it gives to same extent an idea about the potential supply of this content. The data reveal that total Fe content ranged between 20000 and 43000 mg kg^{-1}, the lowest value was recorded in the deepest layer of profile (12) which represents the soils of desert plains, while the highest value was detected in the surface layer of profile (13) which represents the sandy beaches soils.

From the above mentioned data, it is evident that total Fe displayed an increase in the uppermost surface layers compared with the other below ones. Also, total Fe content distribution did not follow any specific pattern particularly in the soils of profiles (3), (7) and (11), while in the soils represented by the rest profiles, total Fe content seemed to decrease with depth. This indicates that the variation in parent material as well as the depositional regime of soil sediments plays the major role in the depth wise distribution of total Fe. Computed correlation coefficients between total Fe content and soil variables indicate that total Fe was negatively and significantly correlated with soil pH (r= -0.600*), sand % (r = -0.567*), gypsum % (r = -0.575*), $CaCO_3$ % (r = - 0.619*) but, at the same time, it was positively and significantly correlated with OM % (r = 0.653*). The multiple regression equation was:

Total Fe = 32069 -0.000006 (pH) + 5273 (OM %) - 1294 (sand %) - 12222 (gypsum %) - 47 ($CaCO_3$ %). The direct correlation and joint effects of OM %, $CaCO_3$ %, pH, gypsum % and sand% on total Fe are 42.6 %, 38.3 %, 36.0 %, 33.0 % and 32.1 %, respectively.

Table (4): AB-DTPA extractable and total content of some micronutrients (mg kg^{-1}) of the studied soils

Location	Prof NO.	Depth cm	Fe			Mn			Zn			Cu		
			Av.	Classification*	To.	Av.	Classification	To.	Av.	Classification	To.	Av.	Classification	To.
Recent Nile Alluvial	1	0-40	22.00	High	37000	30.80	High	1500	4.40	High	250	17.40	High	100.0
		40-70	2.00	Low	37000	12.20	High	1500	2.80	High	225	14.40	High	75.0
		70-100	4.00	Medium	36000	12.60	High	1400	1.40	Medium	175	10.60	High	50.0
	Mean		9.33	High	36667	18.50	High	1467	2.87	High	217	14.13	High	75.0
	2	0-25	15.00	High	39000	30.40	High	1500	0.60	Low	275	32.00	High	87.5
		25-80	8.00	High	37000	12.40	High	1300	0.60	Low	250	13.20	High	87.5
		80-100	6.00	High	35000	6.80	High	1300	0.40	Low	100	3.20	High	50.0
	Mean		10.70	High	37000	16.50	High	1367	0.53	Low	208	16.13	High	75.0
Marine Alluvial	3	0-30	8.00	High	36000	35.40	High	1700	2.75	High	275	19.20	High	100.0
		30-50	6.00	High	38000	16.20	High	1600	2.05	High	200	11.20	High	100.0
		50-60	4.00	Medium	36000	14.00	High	1600	1.20	Medium	150	10.20	High	100.0
		60-90	6.00	High	34000	13.00	High	1600	1.20	Medium	150	9.60	High	75.0
		90-100	8.00	High	36000	13.40	High	1500	1.00	Medium	145	8.80	High	75.0
	Mean		6.40	High	36000	18.40	High	1600	1.64	High	184	11.80	High	90.0
	4	0-20	10.00	High	39000	35.00	High	1300	4.00	High	250	20.00	High	87.5
		20-50	2.00	Low	36000	15.20	High	1300	3.20	High	200	12.60	High	122.7
		50-90	2.00	Low	36000	11.60	High	1200	1.40	Medium	175	9.80	High	62.5
	Mean		4.67	Medium	37000	20.60	High	1267	2.87	High	208	14.10	High	90.9
	5	0-30	14.00	High	37000	27.60	High	1500	3.20	High	275	11.20	High	125.0
		30-50	4.00	Medium	35000	19.00	High	1000	1.40	Medium	210	8.60	High	100.0
		50-100	2.00	Low	35000	18.00	High	900	1.00	Medium	200	11.40	High	62.5
	Mean		6.67	High	35667	21.70	High	1133	1.87	High	228	10.40	High	95.8
	6	0-25	6.00	High	32000	26.80	High	1000	2.60	High	150	12.60	High	50.0
		25-100	2.00	Low	29000	13.40	High	700	1.60	High	125	8.20	High	37.5
	Mean		4.00	Medium	30500	20.10	High	850	2.10	High	138	10.40	High	43.8
	7	0-10	10.00	High	29000	23.00	High	1000	2.60	High	175	13.00	High	100.0
		10-35	9.00	High	25000	15.60	High	700	2.00	High	125	12.40	High	50.0
		35-50	2.00	Low	27000	13.40	High	1000	1.00	Medium	125	11.80	High	50.0
		50-100	2.00	Low	26000	10.80	High	900	0.80	Low	125	7.60	High	50.0
	Mean		5.75	High	26750	15.70	High	900	1.60	High	138	11.20	High	62.5

Note: TO.=Total *Av.=Available " mg kg-1" (Fe 0-3.0 Low, 3.1-5.0 Medium and > 5.0 High; Mn 0-0.5 Low, 0.6-1.0 Medium and > 1.0 High; Zn 0-0.9 Low, 1.0-1.5 Medium and > 1.5 High; Cu 0-0.2 Low, 0.3-0.5 Medium and > 0.5 High) According to Soltanpour (1985)

Loca tion	Prof	Depth	Fe	Mn	Zn	Cu

			Av.	Classification	To.	Av.	Classification	To.	Av.	Classification	To.	Av.	Classification	To.
Marine Alluvial	8	0-20	8.00	High	35000	27.20	High	900	1.80	High	125	9.80	High	50.0
		20-45	4.00	Medium	34000	9.80	High	1000	1.00	Medium	75	6.80	High	50.0
		45-100	4.00	Medium	28000	12.00	High	1100	0.80	Low	150	4.40	High	40.3
	Mean		5.33	High	32333	16.30	High	1000	1.20	Medium	117	7.00	High	46.8
Sub-deltaic	9	0-20	10.00	High	27000	12.80	High	1000	1.20	Medium	150	2.20	High	75.0
		20-55	4.00	Medium	26000	6.80	High	1000	1.00	Medium	125	1.40	High	62.5
		55-100	2.00	Low	22000	5.20	High	700	0.20	Low	100	1.00	High	50.0
	Mean		7.33	High	25000	8.27	High	900	0.80	Low	125	1.53	High	62.5
Desert Plains	10	0-29	10.00	High	32000	23.60	High	1200	4.60	High	200	12.00	High	150.0
		29-60	4.00	Medium	32000	14.80	High	1000	3.20	High	150	10.80	High	75.0
		60-100	4.00	Medium	31000	21.20	High	900	1.80	High	100	16.00	High	62.5
	Mean		6.00	High	31667	19.90	High	1033	3.20	High	150	12.90	High	95.8
	11	0-20	8.00	High	32000	6.20	High	1100	0.40	Low	150	8.20	High	75.0
		20-40	4.00	Medium	30000	3.00	High	800	0.60	Low	225	6.60	High	87.5
		40-60	2.00	Low	32000	3.00	High	900	2.60	High	100	4.40	High	75.0
		60.80	2.00	Low	30000	3.00	High	900	0.60	Low	125	4.00	High	50.0
		80-100	4.00	Medium	29000	3.00	High	1400	0.30	Low	75	1.80	High	62.5
	Mean		4.00	Medium	30600	3.64	High	1020	0.90	Low	135	5.00	High	70.0
	12	0-20	4.00	Medium	25000	21.00	High	600	0.60	Low	100	3.40	High	62.5
		20-30	2.00	Low	23000	14.0	High	600	0.60	Low	100	3.00	High	50.0
		30-100	1.80	Low	20000	11.2	High	500	0.40	Low	99	2.60	High	50.0
	Mean		2.67	Low	22667	15.4	High	567	0.53	Low	99.7	3.00	High	54.2
Sandy Beaches	13	0-35	16.00	High	43000	24.4	High	2500	3.00	High	275	1.90	High	225.0
		35-70	9.00	High	43000	4.8	High	2200	2.00	High	200	5.80	High	100.0
		70-100	9.00	High	42000	4.0	High	1800	1.00	Medium	200	2.40	High	100.0
		100-150	8.00	High	39000	3.6	High	1600	0.40	Low	150	12.20	High	75.0
	Mean		12.50	High	41750	9.2	High	2025	1.60	High	206	5.58	High	125.0

Table (4): Cont.

AB-DTPA extractable iron.

The distribution and levels of chemically extractable Fe content in the studied soils are represented clearly by the data presented in Table (4). The data reveal that the extractable Fe content ranged between 1.8 and 22 mg kg^{-1} in the studied soils. The lowest value was recorded in the deepest layer of profile (12) representing the soils of desert plains, while the highest value was detected in the surface layer of profile 1 representing Marine Alluvial soil. Depth wise distribution of extractable Fe indicates an increase in the uppermost surface layer in most of the studied soils and a slight decrease with depth regardless of soil type.

The statistical evaluation of available Fe content in relation to soil variables indicates that available Fe was positively, highly significantly correlated with OM % (r = 0.724**) and on the other hand, it was negatively and significantly correlated with soil pH (r= - 0.549*). The multiple regression equation between AB-DTPA extractable (available) Fe and the studied soil variables was:

AB-DTPA extractable (available) Fe = 24.9 -0.000004 (pH) + 2.96 (OM %) - 0.0951 ($CaCO_3$%) + 0.0591 (CEC) + 0.0501 (ESP) - 0.106 (sand %) + 0.0476 (clay %).

The direct correlation and joint effects of OM %, $CaCO_3$%, pH, ESP, sand %, CEC and clay % on Available Fe are 52.4%, 27.0%, 21.5%, 16.2%, 15.2%, 6.5% and 1.7%, respectively.

Depth wise distribution of total iron.

Data of weighed mean (W), trend (T) and specific range (R) in the soils under consideration are given in Table (5). From this Table, the computed weighed mean of the studied soils ranged between 21300 to 41467 mg kg^{-1}. The lowest value was recorded for the soils of profile (12) representing desert plains soils, while the highest value was found in the soils of profile (13) representing the soils of sandy beaches. Regarding the other statistical measures of Oertal and Gille (1963), *i.e.* trend (T) and specific range (R), Table (5) reveals that the highest symmetry distribution of total Fe was detected for the soil profile number (3) followed by profile numbers (1), (10), (13) and (5). Also, the symmetrical distribution of total Fe was reduced in the soil profile numbers (12), (8) and (9). On the other hand, the specific range (R) values indicated that, the different soil profiles under study are characterized by homogenous soil materials. The highest homogeneity of soil materials was found in the soil profiles of recent Nile alluvial. The arrangement of the studied soil profiles according to the R values was recent Nile alluvial > sandy beaches > marine alluvial = desert plains > sub-deltaic.

Total manganese.

Data reveal that total Mn content ranged between 500 and 2800 mg kg^{-1} in the studied soils. The lowest value was recorded in the deepest layer of profile (12) representing the soils of desert plains, while the highest one was detected in the surface layer of profile (13) representing the sandy beaches soils.

From the above mentioned data, it is evident that total Mn displayed an increase in the uppermost surface layers compared with the other below ones. Also, total Mn content distribution did not follow any specific pattern particularly in the soils of profiles (7), (8) and (11), while in the soils represented by the rest profiles, total Mn content seemed to decrease with depth. Statistical analysis was carried out to clarify the relationship between total Mn content and some soil variables in the studied soils. The obtained results indicate that total Mn was negatively and significantly correlated with soil pH (r= -0.576*), sand % (r = -0.535*), gypsum % (r = -0.550*), $CaCO_3$ % (r = - 0.634*) but positively and significantly correlated with OM % (r = 0.629*). The multiple regression equation was:

Total Mn = - 6686 - 19018 (pH) + 641 (OM %) - 52.1 (sand %) + 221 (gypsum %) - 39.4 ($CaCO_3$ %). The direct correlation and joint effects of

$CaCO_3$ %, OM %, pH, gypsum % and sand % on total Mn are 40.2%, 39.6%, 33.5%, 30.3% and 28.6%, respectively.

Table (5): Weighted mean (W), Trend (T), and specific range (R) of Fe, Mn, Zn, and Cu of the studied soils

Location	Prof NO.	Fe W	Fe T	Fe R	Mn W	Mn T	Mn R	Zn W	Zn T	Zn R	Cu W	Cu T	Cu R
Recent Nile Alluvial	1	36700	-0.008	0.027	1470	-0.020	0.068	220	-0.120	0.341	78	-0.220	0.641
	2	37100	-0.049	0.108	1350	-0.100	0.148	226	-0.178	0.774	80	-0.086	0.469
Marine Alluvial	3	35800	-0.006	0.112	1620	-0.047	0.123	197	-0.284	0.660	90	-0.100	0.278
	4	36667	-0.060	0.082	1256	-0.034	0.080	200	-0.200	0.375	88	0.006	0.684
	5	35600	-0.038	0.056	1100	-0.267	0.545	225	-0.182	0.333	89	-0.288	0.702
	6	29750	-0.070	0.101	775	-0.225	0.387	131	-0.127	0.191	41	-0.180	0.305
	7	26200	-0.097	0.153	875	-0.125	0.343	130	-0.257	0.385	55	-0.450	0.909
	8	30900	-0.117	0.227	1035	0.150	0.193	126	0.008	0.595	45	-0.100	0.216
Sub-deltaic	9	24400	-0.096	0.205	865	-0.135	0.347	119	-0.207	0.420	59	-0.213	0.424
Desert Plains	10	31600	-0.013	0.032	1018	-0.152	0.295	145	-0.275	0.690	92	-0.387	0.951
	11	30600	-0.044	0.098	1020	-0.073	0.588	135	-0.100	1.111	70	-0.067	0.536
	12	21300	-0.148	0.235	530	-0.117	0.189	99	-0.010	0.010	53	-0.152	0.236
Sandy Beaches	13	41467	-0.036	0.096	1990	-0.204	0.452	201	-0.269	0.622	121	-0.462	1.240

AB-DTPA- extractable manganese.

Data presented in Table (4) show that the values of AB-DTPA extractable Mn ranged from 3.0 to 35.4 mg kg^{-1}. The lowest value was detected in the deepest layer of profile (11) representing desert plains soils, while thee highest value was recorded for the surface layer of profile (3) representing marine alluvial soils.

From the above mentioned data, it is evident that available Mn displayed an increase in the uppermost surface layers compared with the other below ones.

Wise depth distribution of available Mn did not show any specific pattern, except for profile (8) and (10) in which Mn content tended to decrease with depth. This trend was attributed to the high rate of cations from upper layers to deeper one (Abou Hussien *et al.*, 2008). Further information about the relationship between chemically extractable Mn content and soil variables in the studied soils could be elucidated from the correlation coefficients. These coefficients reveal that there was a positively highly significant correlation between available Mn and OM% ($r=0.669^{**}$), clay % ($r=0.522^{**}$) and CEC ($r=0.476^{**}$) and highly but negatively and significant correlation with soil pH ($r= - 0.575^{**}$) and ESP ($r= - 0.471^{**}$) whereas it was negatively and significantly correlated with sand % ($r= - 271^{*}$). The multiple regression equation took the form:

AB-DTPA extractable (available) Mn= 44.9 - 4.78 (pH) + 4.82 (OM %) + 0.129 (clay %) - 0.155 (ESP). The direct correlation and joint effects of OM %, pH, clay % and ESP on available Mn are 44.8%, 33.1%, 27.3% and 22.2%, respectively.

Depth wise distribution of total manganese.

Concerning the calculated values of the statistical measures, *i.e*. W, T and R for the content of total Mn in Table (5), it can be noticed that, the highest values of weighed mean were observed in the profile number (13). The arrangement of the studied soil profiles according to the W values was 13>3>1>2>4>5>8>11>10>7>9>6>12. Regarding the trend (T) and specific range (R) measures, Table (5) reveals that the more symmetrical distribution of total Mn characterized the soil profile number 1 followed by profile numbers (4), (3) and (11), respectively. Also, the obtained values of specific range (R) revealed that, the obtained values of R were less than one. Thus, it can be suggested that, the studied soils were composed from homogenous materials. The highest homogeneity of soil materials was found in the soil profiles of recent Nile alluvial. The arrangement of the studied soil profiles according to the R values was recent Nile alluvial > marine alluvial > sub-deltaic > desert plains > sandy beaches.

Total zinc.

Data in Table (4) reveal that total Zn content ranged between 75 and 275 mg kg^{-1} in the studied soils. The lowest value was recorded in the deepest layer of profile (11) representing the soils of Desert plains, while the highest value was detected in the surface layer of profiles (2), (3), (5) and (13) representing recent Nile alluvial, marine alluvial, and sandy beaches soils, respectively. From the above mentioned data, it is evident that total Zn displayed an increase in the uppermost surface layers compared with the other below ones.

Also, total Zn content distribution did not follow any specific pattern particularly in the soils of profiles (8) and (11), while in the soils represented by the rest profiles, total Zn content seemed to decrease with depth. Further information about the relationship between total Zn content and soil variables in the studied soils could be elucidated from values of the correlation coefficients. These coefficients reveal that there is a positively highly significant correlation between total Zn and OM% (r=0.580**) and clay % (r=0.297*) and negatively significantly correlation with soil pH (r= - 0.375*), gypsum % (r = -0.258*) and $CaCO_3$ %(r= -0.296*).

The multiple regression equation took the form:

Total Zn= = 413 - 34.5(pH) + 32.7 (OM %) + 0.404 (clay %) - 34.9 (gypsum %) - 1.87 ($CaCO_3$%). The direct correlation and joint effects of OM %, pH, (clay % same $CaCO_3$%) and gypsum% on total Zn are 33.7%, 14.0%, 8.80%, 8.80 % and 6.50 %, respectively.

AB-DTPA extractable zinc.

Data presented in Table (4) show that the values of AB-DTPA extractable Zn ranged from 0.2 to 4.6 mg kg^{-1}. The lowest value was detected in the deepest layer of profile (9) representing sub-deltaic soils, while the highest value was recorded for the surface layer of profile (10) representing desert plains soils. From the above mentioned data, it is evident that available Zn displayed an increase in the uppermost surface layers compared with the other below ones. Also, available Zn content distribution did not follow any specific pattern particularly in the soils of profile (11), while in the soils represented by the rest profiles, available Zn content seemed to decrease with depth. Further information about the relationship between available Zn content and soil variables in the studied soils could be elucidated from the correlation coefficients. These coefficients reveal that there is a positively highly significant correlation between available Zn and OM% (r=0.512**) and clay % (r=0.353**) and highly but negatively significant correlation with soil pH (r= -0.388**) and negatively significant correlation with ESP (r = -0.317*).

The multiple regression equation took the form:

Available Zn = 6.32 - 0.671 (pH) + 0.598 (OM %) - 0.0590 (EC) + 0.00878 (clay %) - 0.0115 ($CaCO_3$%) + 0.904 (ESP). The direct correlation and joint effects of ESP, OM%, pH, clay % and EC on available Zn are 66.4%, 26.2%, 15.0%, 12.5% and 0.1%, respectively.

Depth wise distribution of total zinc.

Values of the statistical measures namely, W, T and R of total Zn are presented in Table (5). It can be noticed that the highest values of weighed mean were observed in the profile number (2). The arrangement of the studied soil profiles according to the W values was 2>5>1>13>4>3>10>11>6>7>8>9>12. The computed trend (T) shown in Table (5) indicated that, the high symmetrical distribution of total Zn was found in the profile number (12) followed by profile number (11), but the lowest symmetrical distribution was found in the profile number (8) followed by profile number (3). On the other hand, the specific range (R) values indicated that, the different soil profiles under study are characterized by homogenous soil materials. The highest homogeneity of soil materials was found in the soil profiles of sub-deltaic and also in marine alluvial followed by that of recent Nile Alluvial. Desert plains and sandy beaches soils displayed lowest homogeneity of soil materials for specific range.

Total copper.

The data presented in Table (4) reveal that total Cu content ranged between 37.5 and 225 mg kg^{-1} in the studied soils. The lowest value was recorded in the deepest layer of profile (6) representing the soils of marine alluvial, while the highest value was detected in the surface layer of profile (13) representing sandy beaches soils. Also, total Cu content distribution did not follow any specific pattern particularly in the soils of profiles (4) and (11), while in the soils represented by the rest profiles, total Cu content seemed to decrease with depth. Further information about the relationship between total Cu content and soil variables in the studied soils could be elucidated from the correlation coefficients. These coefficients reveal that there is a positively highly significant correlation between total Cu and OM% (r=0.495**) and ESP (r=0.313*) and negatively significant correlation with soil pH (r=- 0.257*), gypsum % (r = -0.292*) and $CaCO_3$% (r= -0.308*).

The multiple regression equation took the form:

Total Cu = 252 - 19.9 (pH) + 23.0 (OM %) - 8.6 (gypsum %) - 1.08 ($CaCO_3$%) + 8.50 (ESP).

The direct correlation and joint effects of OM%, ESP, $CaCO_3$%, gypsum %, and pH on total Cu are 24.5%, 9.8%, 9.5%, 8.5% and 6.6%, respectively.

AB-DTPA extractable copper.

Data presented in Table (4) show that the values of AB-DTPA extractable Cu ranged from 1.0 to 32.2 mg kg^{-1}. The lowest value was detected in the deepest layer of profile (9) representing sub-deltaic soils, while the highest value was recorded for the surface layer of profile (2) representing recent Nile alluvial. From the above mentioned data, it is evident that available Cu displayed an increase in the uppermost surface layers compared with the other below ones. Also, available Cu content distribution did not follow any specific pattern particularly in the soils represented by profiles (5), (10) and (13), while in the soils represented by the rest profiles, available Cu content seemed to decrease with depth. Statistical analysis was carried out to clarify the relationship between available Cu content and some soil variables in the studied soils. The obtained results indicated that available Cu was negatively and highly significantly correlated with soil pH (r= -0.440**), negatively and significantly correlated with sand % (r = -0.263*). On the other hand, it was positively and highly significantly correlated with OM % (r = 0.47**), clay % (r = 0.645**) and CEC(r = 0.664**).

The multiple regression equation was:

AB-DTPA extractable (available) Cu = 22.8 - 2.80 (pH) + 1.41 (OM %) + 0.0598 (clay %) - 0.100 ($CaCO_3$%) + 0.155 (CEC). The direct correlation and joint effects of CEC, clay %, OM % and pH on available Cu are 44.1 %, 41.6%, 22.1 % and 19.4%, respectively.

Depth wise distribution of total copper.

The statistical measures namely W, T and R of total Cu are presented in Table (5). It can be noticed that, the highest values of weighted mean were observed in the profile number (13). The arrangement of the studied soil profiles according to the W values was 13>10>3>5>4>2>1>11>9>7>12>8>6.The symmetrical distribution of total Cu in the studied soil profiles as suggested from the obtained values of trend (T) is shown by Table (5) which illustrates that the highest symmetrical distribution of total Cu was found in the profiles of recent Nile alluvial followed by profiles of desert plains, but the lowest symmetrical distribution was found in the profile representing the sandy beaches followed by the profiles representing the marine alluvial. The calculated values of R reveal that the studied soils are composed from homogenous materials. The highest homogeneity of soil material was found in the soils of sub-deltaic followed by the soils of marine alluvium. Sandy beaches displayed the lowest homogeneity of soil materials for specific range.

Conclusion

The soil fertility of the studies available micronutrients (Fe, Mn, Zn and Cu) seemed to be more than the critical levels in the soils recent Nile alluvial**,** marine alluvial, desert plains compared to sub-deltaic and sandy beaches. More information are required about the sources of micronutrients. The long-term status of micronutrients in soils requires more investigations. The statistical measures showed that, the highest values of weighed mean (W) of total Fe, Mn and Cu were found in the soil profiles of sandy beaches, while, the highest values of W of total Zn were found in the soil profiles of recent

Nile alluvial**.** The trend (T) indicates that some of the soil profiles were highly symmetric distribution with respect to Fe, Mn, Zn and Cu. The calculated values of specific range (R) of the total content of all micronutrients under study revealed that, the studied soils were composed from homogenous materials.

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حاله بعض المغذيات الصغري في شمال غرب دلتا النيل - مصر.

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يهدف هذا البحث الي دراسه حاله الحديد والمنجنيزوالزنك والنحاس في انواع الاراضي المختلفه في شمال غرب دلتا النيل وكذلك ايجاد العلاقه بين الكميات الكليه والميسره(المستخلصه كيميائيا بواسطه ال "DTPA + بيكربونات الامونيوم") وبين بعض المتغيرات (كربونات الكالسيوم ، الماده العضويه ، قوام التربه ، السعه التبادليه الكاتيونيه) في هذه الاراضي المتاخمه لبحيرتي أدكو ومريوط. ولتحقيق الهدف من البحث اختير ثلاثه عشر قطاعا ارضيا لتمثل انواع الاراضي المختلفه بالمنطقه وقدر بها بعض الخواص الطبيعيه والكيميائيه وكذلك تركيز العناصر السابقه ويمكن تلخيص النتائج المتحصل عليها فيما يلي: تراوحت كميه الحديد الكليه في الاراضي المدروسه ما بين 20000 الي 43000 ملليجرام/كجم ، والميسره ما بين 1.8 الي 22 ملليجرام/كجم. وقد تناقصت كل من الصورتين بالعمق وكذلك تراوحت كميه المنجنيز الكليه في الاراضي المدروسه ما بين 500 الي 2800 ملليجرام/كجم ، والميسره ما بين 3.0 الي 35.4 ملليجرام/كجم و تراوحت كميه الزنك الكليه في الاراضي المدروسه ما بين 75 الي 275 ملليجرام/كجم ، والميسره ما بين 4.6 الي 37.5 ملليجرام/كجم و تراوحت كميه النحاس الكليه في الاراضي المدروسه ما بين 225 الي 0.2 والميسره ما بين 1.0 الي 32.2 ملليجرام/كجم و أظهرت نتا ئج التحليل الاحصائي وجود ارتباط معنوي سالب بين الكميه الكليه من الحديد والمنجنيزوالزنك والنحاس وكل من pH، نسبه الرمل، ، نسبه كربونات الكالسيوم وأيضا بين الكميه الميسره من الحديد و الجبس pH وأيضا بين الكميه الميسره من pH ، ESP ، نسبه الرمل وأيضا بين الكميه الميسره من الزنك وكل من ESP ، pH المنجنيز وكل من ، نسبه الرمل. بينما وجد ارتباط موجب بين ESP ، pH وأيضا بين الكميه الميسره من النحاس وكل من ، الكميه الكليه من الحديد والمنجنيزوالزنك والنحاس مع نسبه الماده العضويه ونسبه الطين وأيضا بين الكميه الميسره من هذه العناصر وكل من نسبه الماده العضويه ونسبه الطين والسعه التبادليه الكاتيونيه و أيضا أوضحت نتائج قيم المتوسط الموزون للمحتوي الكلي للحديد وللمنجنيز والنحاس أعلي قيم في قطاعات أراضي الشواطئ الرملية بينما للمحتوي الكلي للزنك كانت أعلي قيم في قطاعات أراضي الرسوبيه النيليه الحديثه و أظهرت نتائج الاتجاه (T) ان أعلي توزيع متناسق موجود في أراضي الرسوبيه البحريه بالنسبه للحديد ، في أراضي الرسوبيه النيليه بالنسبه للمنجنيز، و في السهول الصحراوية بالنسبه للزنك والنحاس. وتشير قيم النطاق النوعي (R) لموقع الدراسه ان القطاعات متجانسه في مواد التربه و الخصوبه متمثله في العناصر الصغري الميسره (حديد ومنجنيزوزنك ونحاس) نجدها أعلي من الحد الحرج وبالتالي تعتبر الارض غنيه بهذه العناصر.

قام بتحكيم البحث

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