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The Relation Between The Soil Taxonomic Units Developed on The Geomorphic Units and Soil Fertility Status in The West Delta, Egypt.

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ELEVEN soil profiles represent the different geomorphic units in west Delta were chosen to study the relation between the soil taxonomic units developed on the geomorphic units and soil fertility status. The obtained results indicated that the taxonomic units are: 1) Typic Haplocalcids , Typic Calcigypsids developed on old Alluvial soils 2) Typic Torripsamment developed on windblown sand 3) Aquic Haplocalcids developed on Fluvio-Lacustrine soils . 4) Typic Torrifluvents and Typic Haplotorrerts developed on recent Nile Alluvial soils. 5) Halic Endoaquerts and Aridic Endoaquerts developed on Fluvio-marine soils and 6) Oxyaquic Torripsamments developed on coastal plain soils . The organic matter contents were relatively low ranged from 0.15 to 2.35 %. The cation exchange capacity ranged from 2.3 to 38.3 meq/100g , the lowest values were found in the windblown sand , whereas, the highest were in the clayey soils of Fluvio-marine.

The total contents of iron ranged from 0.2 to 1.2 %, whereas the available contents ranged from 2.4 to 57.6 ppm. The independent factors of both clay, silt and $CaCO_3$ contributed 37.1 to 89.7 of the variations in iron in the different studied soils. The total manganese contents ranged from 170.0 to 1048.0 ppm, whereas the available contents ranged from 0.48 to 5.28 ppm. The independent factors of both clay, silt and $CaCO_3$ contributed 22.7 to 93.4 % from the variations in Mn contents in those studied soils. The total contents of Zn ranged from 47.0 to 370.0 ppm, whereas, the available contents ranged from 0.48 to 5.28 ppm. The independent factors of clay, silt and $CaCO_3$ were responsible 49.3 to 81.0 %. The total copper contents ranged from 22.0 to 168.0 ppm, whereas the available content ranged from 0.89 to 9.9 ppm. The variations of total copper were related to the independent factors of both clay, silt and $CaCO_3$, by 10.9 to 90.0 %.

The Taxonomic unit of Typic Haplotorrerts and Endaquerts developed on the flood plain and Fluvio-marine soils was the highest fertile status in the studied area, whereas the Typic Torripsamments were the lowest fertile status.

The fertility of the soil maybe assessed by means of the potential fertility and the actual fertility. The former concerns the weathering stage of the soil material, the base saturation and exchangeable ions adsorbed at the soil's complex and the quality and quantity of organic matter. It expressed by the pH, the CEC, exchangeable cations and available P and C% (FAO, 1976)

The information of concentration of the trace elements such as iron, manganese, zinc, cupper and cadmium in the genetic horizon may be useful in estimating the degree of leaching and weathering in soil profile **(**El-Demerdashe, 1970). The contents of Zn in soils depend on the parent materials, the content of organic matter, soil texture and soil pH . He also indicated that the alluvial soils of west Delta had a high content of both boron, manganese, copper cubolat and zinc followed by the Fluvio marine soils, then the Fluvio- lacustrine.

McKenzie (1959) concluded that the concentrations of Cu, Zn and Mn are releated to the difference of soil parent materials.

Oertel and Giles (1967) showed that the concentration of trace elements varies with depth in soil profile and differs from element to element depending on the morphology and Taxonomic unit of profile.

The soils derived from clay deposits were rich in manganese contents (Vinogradov, 1959). He added that the concentration of copper in soil profiles depended on the nature of the parent materials, Fiskell (1965) indicated that Cu is found in soils as exchangeable ions bound in organic compounds and in the crystal lattice of the aluminosillicates and other mineral.

In his study on the geomorphic features in west Delta Badawi (1999) reported that the contents of both iron, manganese, zinc and copper were: 1.56, 0.34, 0.13, 0.19 to 6.23, 1.34, 168, 0.62 ppm in the river terraces and 1.86, 0.97, 0.63, 0.34 to 1.89, 1.02, 0.68, 0.65 ppm in the windblown soils.

The aim of this investigation is studying the relation between the fertility status of the soil taxonomic units developed on different geomorphic units in west Delta.

Geomorphic aspects

The studied area is located in western Delta, Egypt between latitude of 30° 21' to 31° 25' north and longitude of 30° 00' to 30° 45' east and boarded by coastal sea in the north, Rosetta branch in the east, Cairo-Alexandria desert road in the west and considered as one of the most promising areas to increase the Egyptian economic.

According to Al-Sharif *et al.* (2013), this area contains the following geomorphic units: coast plain in the north, levee in the east on the side of Rosetta branch, flood plain in the middle, old alluvial in the south, Fluvio lacustrine in the west north, fluvio marine and windblown as illustrated in Map (1).

Geology

The recent alluvial deposits of both flood plain and levee were deposited from the suspended matter of the Nile river on the Holocene age (Ball, 1939).

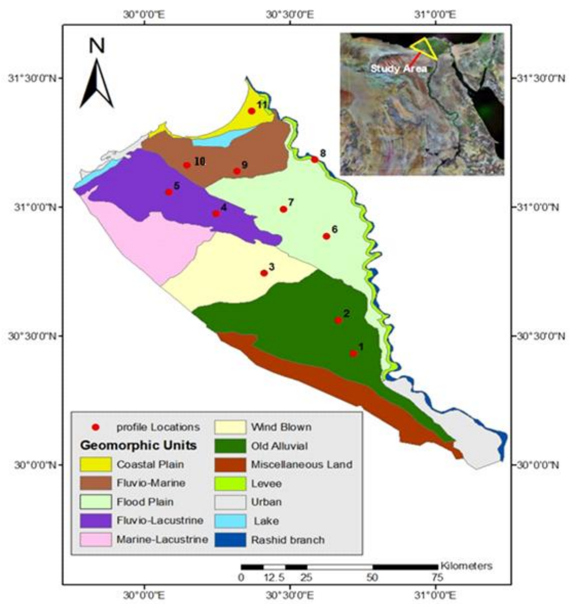
Fluvio lacustrine and fluvio marine contain two different geologic materials affected by the sea deposits in sub soil and the Nile deposits in surface mixed together forming lithological discontinuity in theses soils (El-Demerdashe, 1970).

The coastal plain was formed by the marine deposits on the Pliocene age.

The old alluvial soil in this study is considered the oldest terrace in Egypt deposits on the Pliocene age and covered by gravel pavement (Sandford and Arkell, 1939) in some places , the windblown sand covers this old alluvial.

Materials and Methods

Eleven soil profiles were chosen to represent the different geomorphic units in the studied area : The old alluvial soil (profile No. 1&2), the windblown sand (profile No. 3), the fluvio lacustrine (profile No 4 & 5), the flood plain (profile No. 6 & 7), the levee (profile No. 8), Fluvio-marine (profile No 9 & 10) and the coastal plain (profile No. 11). These profiles were dug to 150 cm from soil surface, described in the field according to FAO (2010), the soil color was performed using Munsell chart (1975). Particle size distribution was determined according to Page *et al*. (1982). The texture classification was performed using the American triangle chart. Soil pH was determined in soil paste, soluble ions, electrical conductivity (ECe) of soil paste extract calcium carbonate and gypsum contents were determined according to Page *et al*. (1982). Soil taxonomy was performed according to Soil Survey Staff (2010).



Map. 1. Geomorphic units and profiles location of the Western Delta, Egypt.

Available trace elements were extracted by the DTPA (diethylene triamine penta acetic acid) according to the method of Lindsay and Norvell (1978).

Aliquots of 0.5 to 2.0 g of dried soil samples were digested in 100 ml micro kjeldahl flasks containing 20 ml of a mixture of concentrated HNO_3 , $HClO_4$ (3: 1: 1) according to Grosuch (1959). The digestate was cooled and diluted to 100ml with deionized water.

The trace elements of Fe, Mn, Zn and Cu were determined using a Pye Unicum sp 1900 atomic adsorption spectrophotometer.

Results and Discussion

Organic matter content

The contents of organic matter in the studied area ranged from 0.15 to 2.35 % as shown in Table 1. The highest values were found in the surface horizon (Ap) of the soils developed on Fluvio-Lacustrine, Recent alluvial and Fluvio- marine and ranged from 1.67 to 2.35 % related to the added organic fertilizer. Also, these contents of organic matter decreased with soil depth except in studied profile No. 1 of the old alluvial soil due to the occurrence of the lithological discontinuity between its horizons caused by the different depositional environmental. The lowest contents were not more than 0.17% in the soils developed on windblown sand soils No. 3 due to their sandy nature.

Cation exchange capacity and exchangeable cations

Cation exchange capacity of the studied soils ranged from 2.30 to 38.3 meq/100 g. The lowest values were 2.3 and 5.4 meq/100 g, respectively in the windblown sandy soils, and coastal plain whereas the highest values were 38.3 meq/100 g as shown in the Fluvio-marine soils (Table 1).

Both the studied soils of windblown sand and coastal plain (soil profile No's 3 & 11) had the lowest values of CEC lower than 5.4 meq/100 g. This is related to their nature sandy deposits reached to more than 95.0 % sand and also to their low contents of organic matter, lower than 0.5 %. The highest values were in the Fluvio-marine soils (profile No. 9 & 10) reached to 38.3 meq/100g and flood plain reached to 38.0 meq/100g due to their clayey texture whereas clay contents reached to 60.0 % and relatively high contents of organic matter in the surface horizons. These soils followed by the studied soils of both Fluvio-lacustrine and Levee (soil profile No. 4, 5 and 8) which had moderate values of CEC ranged from 14.3 to 28.8 meq/100 g due to their medium texture; *i.e.* clay loam to sandy loam and their low contents of organic matter. On the other hand, the old alluvial soil (profile No. 1 & 2) ranged from 8.8 to 16.1 meq/100 g attributed to their relatively light to medium texture, *i.e.* loamy sand to sandy loam and very low contents of organic matter.

TABLE 1. Exchangeable cations, cation exchange capacity and exchangeable sodium percentage.

Profile No.	Depth (cm)	Exchangeable cataion (meq/100g soil)				CEC (me/100g soil)	ESP	O.M %	CEC /clay
		Ex. Na	Ex. Ca	Ex. Mg	Ex. K				
1	0-15	5.8	5.5	3.2	1.6	16.1	36.0	1.30	0.61
	15-35	3.1	5.1	3.5	0.6	12.3	25.0	0.15	0.70
2	0-10	1.3	5.3	1.5	0.7	8.8	15.0	1.10	0.95
	10-30	3.1	5.1	3.1	1.1	17.4	25.0	1.40	1.10
3	0-25	1.3	0.6	0.6	0.3	2.5	0.5	0.25	0.56
	25-80	1.0	0.6	0.6	0.3	2.3	0.5	0.21	0.53
4	0-15	0.5	11.3	6.7	0.3	28.8	13.0	2.10	0.63
	15-50	0.8	15.3	8.1	0.5	24.7	3.0	2.00	0.73
	50-80	0.9	15.1	11.5	0.7	28.2	3.0	1.80	0.71
	80-150	1.1	15.3	7.3	0.5	24.2	4.0	1.70	0.61
5	0-20	0.7	16.1	9.0	1.0	26.8	3.0	2.20	0.80
	20-40	0.7	14.3	9.7	1.1	25.8	3.0	2.00	0.77
	40-70	0.8	15.1	5.3	0.7	21.9	4.0	2.00	0.77
	70-150	0.7	15.1	3.3	0.2	19.3	8.0	1.90	0.63
6	0-20	1.3	16.0	10.3	0.8	27.4	4.0	2.35	0.70
	20-40	1.3	16.1	10.7	0.8	28.9	4.0	2.10	0.70
7	0-15	1.5	16.5	10.3	1.5	29.8	5.0	2.30	0.73
	15-40	1.5	17.3	10.1	1.3	30.2	5.8	2.20	0.71
8	0-20	0.4	11.4	12.1	0.2	24.1	3.0	2.25	0.67
	20-40	0.2	10.9	3.1	0.1	14.3	1.0	2.10	0.79
9	0-10	0.3	19.1	15.3	0.5	35.2	1.0	2.30	0.60
	10-55	0.3	13.1	13.1	0.7	27.0	1.0	2.15	0.55
	55-75	0.5	8.3	15.3	0.71	24.81	2.0	2.00	0.50
	75-150	3.0	7.0	10.1	0.5	32.6	1.0	1.70	0.66
10	0-20	3.5	15.5	13.5	1.3	35.0	10.0	2.30	0.60
	20-60	3.3	6.1	18.5	1.1	38.0	8.0	2.20	0.67
	20-110	1.0	11.3	19.3	0.7	32.3	3.0	2.10	0.62
	110-150	3.5	11.5	19.5	0.9	35.0	10.0	1.80	0.60
11	0-20	0.5	1.5	1.0	0.3	5.40	2.0	1.90	1.03

CEC/ clay

The ratio of CEC/clay of the studied soils ranged from 0.53 to 1.1 (Table 2). The highest ratios were in the old alluvial soils (soil profile No. 2) whereas the lowest were in the windblown soils (profile No. 3). All the studied soils had ratio more than 0.53 indicating the occurrence of the smectitic minerals in the clay particles. The abnormal high ratio in the soil profile No. 2 of the old alluvial reached to 1.1 which may be due to the presence of zeolite minerals which have values of CEC more than 300 meq/100 g (Al-Sharif, 1994).

TABLE 2. Morphological description of the studied soil profiles.

Profile No.	Surface features	Horizon	Depth (cm)	Soil color (Moist)	Texture	Coarse fragment	Structure	Pedogenic features	Efferesc-ence	Boundary	Soil Taxonomic units
Old Alluvial Plain											
1	+52m above sea level, Gently undulating, pavement scatter desert plants	A	0-15	7.5YR4/6	SL	f. gravel	w.f.sb	-	st	c.w	Typic Haplocalcids
		C	15-35	7.5YR5/6	SL	f. fine gravel	ma	few soft lime	st	c.w	
		C_2	35-65	7.5YR5/6	SL	do. med. gravel	ma	Com.hard lime	st	c. w	
		C_k	65-110	7.5YR5/6	SL	many.med. gravel	ma	many hard&soft lime	st	c. w	
		C_3	110-150	7.5YR5/4	LS		sg		mod.	-	
2	+48m above sea level, Almost flat, pavement, scatter desert plants	A	0-10	7.5YR4/6	SL	do. fine. gravel	w.f.sb	-	st	c.w	Typic Calcigypsids
		C_y	10-30	7.5YR5/6	SL	many.med. gravel	w.f.sb	com.hard& soft lime many gyp. crystal	st	g. w	
		C_{y2}	30-70	7.5YR5/6	LS	com.med. gravel	ma	Com. hard lime many gyp. crystal	st	g. w	
		C_K	70-150	7.5YR5/6	LS		ma	many hard& soft lime Com. gyp. crystals	st	-	
Texture C=Clay S=Sand Cl=Clay loam Sl=Sandy loam LS=Loamy sand SiC=Silty Clay		Structure w.f.sb=weak Fine sub angular w.f.an= weak Fine angular st.C.an=strong coarse angular m.f.sb=moderate fine sub angular w.c.sb= weak coarse sub angular m.med.an.= moderate medium angular m.f. an=moderate fine angular ma=massive sg=single grain					Coarse Fragment f.=few s.=small do.= dominate med.=medium ma=many com.=common		Effervescence st=strong mod=moderate		
Wind Blown Sand											
3	+27m Above sea level, flat	Ap	0-25	10 YR5/4	S	--	sg	--	St	d.w	Typic Torripssaent
		C	25-80	10YR5/4	S	--	sg	--	mod.	d.w	
		C_2	80-150	10YR5/4	S	--	sg	--	mod.	--	
Flood Plain											
6	+ 2m above sea level, Cracks in 5 cm wide, flat	A_{pss}	0-20	10YR4/2	C	-	w.f.an	Mod. slicken sides, few soft lime	mo.	c. w	Typic Haplotorrertes
		C_{ss}	20-40	10YR3/3	C	--	st. c.an	Strong slicken sides, few soft lime	mo.	d.w	
		C_{ss2}	40-90	10YR3/3	C	--	st. c.an	Strong slicken sides	mo.	c. w	
		C	90-150	10YR3/3	C	--	ma	--	mo.	--	
7		A_p	0-15	10YR4/2	C	--	w.f.sb	--	mo.	c. w	Typic Haplotorrertes
		C_{ss}	15-40	10YR2/2	C	--	st.f.an	few soft lime, strong slickensides	mo.	d.w	
		C_{ss2}	40-100	2.5YR2/2	C	--	st.f.an	few soft lime, strong slikensides	mo.	c.w	
		C	100-150	2.5YR2/2	C	--	ma	--	mo.	--	
Levee											
8	+4m above Sea Level, cracks in 2 cm wide	Ap	0-20	10YR 5/4	CL	--	w.f. sb	few soft lime		c.w	
		C	20-40	10YR 4/4	SL	--	w.f.sb	--		c.w	
		C_2	40-50	10YR4/4	CL	--	m.f.sb	few soft lime		c.w	
		C_3	50-100	10YR4/4	SL	--	ma	--		g.w	
		C_4	100-150	10YR4/3	SL	--	ma	--		--	

TABLE 2. Cont.

Profile No.	Surface features	Horizon	Depth (cm)	Soil color (Moist)	Texture	Coarse fragment	Structure	Pedogenic features	Effervescence	Boundary	Soil Taxonomic units
Fluvio- Marine Plain											
9	-2m under sea level, Flat, cracks	Ap	0-10	10YR3/3	C	--	-	--		c.w	Halic Endoaquerts
		Css	10-55	10YR4/1	C	--	m.med. an.	strong slickensides		ap.w	
		Css2	55-75	10YR3/1	C	do. shell	st. c. an.	do. shell fragment, strong slickensides		ap.w	
		2Cg	75-150	5Y3/2	SiC	--	ma	strong glyzation		--	
10	1m above sea level, Flat, cracks	Ap	0-20	10YR3/3	C		w.f.sb	Few soft lime	st	c.w	Aridic Endoaquerts
		2Css	20-60	10YR3/2	C		st.f. an	Few soft lime, fragment. strong	st	c.w	
		2Css2	60-110	10YR3/2	C		m.f. an	Slikensides	st	c.w	
		2Cssg	110-150	5Y4/1	C		m.f. an	Few soft lime, shell Fragments ,strong Slickensides, glyzation	st	--	
Coastal plain											
11	+4m above Sea Level, flat, tree leaves	Ap	0-20	2.5Y 7/4	S	--	ma	--	mo	c.w	Oxyaguic Torripsamment
		C	20-50	2.5Y 6/4	S	--	sg	--	w	d.w	
		C2	50-100	2.5Y5/2	S	--	sg	---	w	d.w	
		C3	100-150	2.5Y5/4	S	--	sg	--	w	--	
Fluvio- Lacustrine											
4	-2m under sea level, Flat, Cracks 2 cm wide	A_p	0-15	10YR3/3	CL	--	ma	Few soft lime	st	g.w	Aquic Haplocalcids
		C	15-50	10YR6/2	CL	--	w.c.sb	many soft lime	st	ab. w	
		2ck	50-80	10Y7/2	CL	--	w.c.sb	many soft lime	st	d.w	
		$2C_{kg}$	80-150	5Y7/2	CL	--	w.c.sb	many soft lime	st		
5	-1m under sea level	Ap	0-20	10YR4/4	CL	--	ma	--	st	c.w	Aquic Haplocalcids
		C	40-70	10YR5/4	CL	--	w.f.sb	Few soft lime	st	ab.w	
		2Ck2	70-150	10Y6/2	CL	--	w.m.sb	Many soft&hard lime	st	g.w	
		2Ckg	110-150	10Y5/6	SL	--	ma	Many soft lime,glyzation	st		

Soil taxonomy of the studied soils

The old alluvial soils

The field description (Table 2) and particle size distribution (Table 3) showed that these soils have sandy loam texture in the soil profile No. 1 in the control section (depth of 20-100 cm), whereas, the clay contents ranged from 18.17 to 20.53%. Also, the soil profile No.2 has loamy sand texture, whereas clay contents ranged from 8.86 to 10.66 % and silt contents reached to 15.43% both of them has many hard & soft lime in the Ck horizon, whereas the content of calcium carbonate reached 16.3 %, (Table 3) which qualified as calcic horizon (Keys to Soil Taxonomy, 2010). Therefore, it is classified as fine loamy, mixed, thermic, Typic Haplocalcids. In addition, the soil profile No. 2 has many gypsum crystal, whereas the gypsum contents reached 15.8 % (Table 4) which is qualified as gypsic horizon in the Cy & Cyz horizon and classified as sandy , mixed, thermic, Typic Calcigypsids (Table 5), and (Map 2). This is in agreement with Al-Sharif *et al*. (2013).

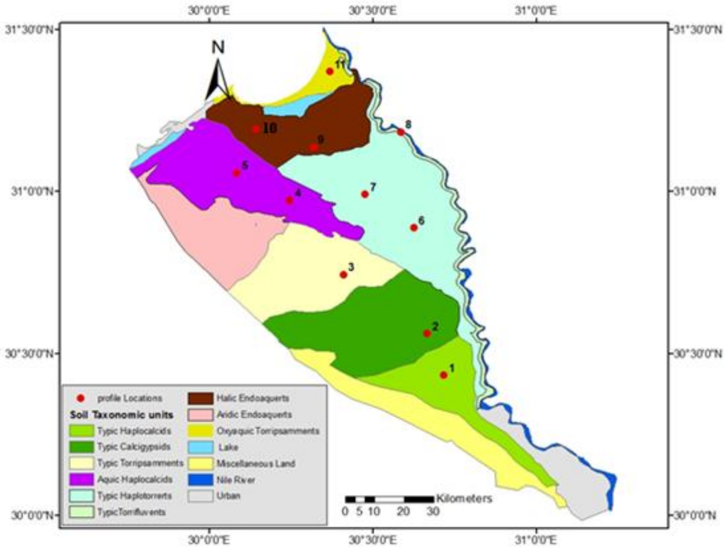
TABLE 3. Particle Size distribution, texture class and $CaCO_3$ content of the studied soil profiles.

Prof. No.	Depth Cm	Gravel %	Particle size distribution %				Text. Class	$CaCO_3$ %
			C.S	F.S	Silt	clay		
Old Alluvial Plain								
1	0-15	-	18.12	27.58	27.13	27.17	CL	5.8
	15-35	-	42.43	21.17	18.23	18.17	SL	5.5
	35-65	-	32.53	31.47	15.47	20.53	SL	10.0
	65-110	-	42.95	26.25	12.11	18.79	SL	15.9
	110-150	-	67.56	13.23	12.12	7.09	LS	4.0
2	0-10	-	14.75	62.4°	13.56	9.24	SL	8.5
	10-30	-	23.76	57.04	8.54	10.66	LS	6.0
	30-70	-	42.05	33.75	15.43	8.86	LS	6.9
	70-150	-	36.11	43.89	10.0	10.0	LS	16.3
Wind Blown Sand								
3	0-25	-	42.26	48.94	4.4	4.4	S	2.0
	25-80	-	52.34	38.06	5.2	4.4	S	1.9
	80-150	-	45.87	44.53	4.8	4.8	s	2.0
Fluvio Lacustrine plain								
4	0-15	-	4.50	21.13	37.57	36.80	CL	12.9
	15-50	-	1.27	34.73	30.49	33.51	CL	18.0
	50-80	-	2.05	20.35	38.36	39.24	CL	29.7
	80-150	-	2.70	18.47	39.23	39.60	CL	26.5
5	0-20	-	5.22	28.55	32.77	33.46	CL	8.5
	20-40	-	4.82	30.38	31.2	33.6	CL	10.0
	40-70	-	6.04	36.76	28.8	28.4	CL	19.0
	70-150		3.24	41.76	25.0	30.0	CL	23.5
Flood plain								
6	0-20	-	2.20	11.0	43.16	43.64	C	2.0
	20-40	-	1.08	10.92	43.65	44.35	C	2.5
	40-90	-	1.48	9.22	45.3	44.0	C	2.5
	90-150	-	1.30	10.11	41.49	47.10	C	2.5
7	0-15	-	1.43	12.53	40.04	46.00	C	2.5
	15-40	-	1.65	12.73	30.20	55.42	C	3.3
	40-100	-	2.40	10.10	30.74	56.76	C	2.0
	100-150	-	2.35	13.65	24.00	60.00	C	7.7
Fluvio- Marine Plain								
9	0-10	-	0.90	6.50	34.60	58.00	C	2.9
	10-55	-	0.45	7.65	32.70	59.20	C	3.6
	55-75	-	0.91	5.39	32.70	61.00	C	4.0
	75-150	-	0.70	3.94	75.96	19.40	SiL	4.0
10	0-20	-	5.50	6.90	30.40	57.20	C	4.0
	20-60	-	1.60	5.50	37.00	55.90	C	3.9
	60-110	-	7.45	5.53	35.00	52.02	C	3.2
	110-150	-	0.85	7.15	33.00	59.00	c	2.5
Coastal plain								
11	0-20	-	29.25	66.25	1.30	3.20	S	4.9
	20-50	-	46.0	45.1	4.80	4.10	S	5.2
	50-100	-	39.25	51.85	3.60	5.30	S	1.3
	100-150		35.45	57.65	1.80	5.10	S	2.9

C: Clay S: Sandy CL: Clay loam Si: Silty SL: Sandy loam LS: Loamy sand

TABLE 4. Soil chemical analysis of the studied soils and gypsum contents.

Profile No.	Depth Cm	SP %	PH	EC (dSm^{-1})	Anions (meq/L) $CO^{=}_3$	HCO^-_2	Cl^-	$SO^{=}4$	Cations (meq/L) Ca^{2+}	Mg^{2+}	Na^+	K^+	Gyp. %	SAR
1	0-15	21	7.63	24.00	-	1.69	230.0	38.74	74.25	22.29	160.2	1.19	0.12	35.95
	15-35	20	7.70	31.95	-	2.77	190.0	15.60	80.61	40.74	165.83	1.19	1.58	22.04
	35-65	19	7.84	21.91	-	1.54	240.0	59.40	91.02	37.37	171.39	1.16	0.22	21.40
	65-110	18	7.71	17.50	-	2.00	134.0	61.26	76.81	19.49	99.98	0.98	1.63	14.41
	110-150	18	7.88	16.93	-	1.54	113.0	47.47	65.35	14.86	80.94	0.86	1.57	12.79
2	0-10	21	7.43	34.50	-	1.08	200.0	130.56	80.2	82.5	200.5	1.44	3.98	26.73
	10-30	30	7.31	56.50	-	1.38	400.0	200.96	100.0	26.62	450.7	1.02	15.65	90/85
	30-70	28	7.59	79.01	-	1.54	620.0	222.40	205.13	91.16	511.1	1.28	15.81	85.95
	70-150	22	7.58	39.45	-	1.51	595.0	3.57	266.66	116.04	215.8	1.58	8.53	15.60
3	0-25	18	8.02	0.93	-	4.30	4.00	1.00	5.77	0.97	2.06	0.50	4.23	1.12
	25-80	18	8.03	1.53	-	4.30	10.0	0.13	7.68	1.58	4.76	0.41	-	2.21
	80-150	16	8.24	0.48	-	3.07	1.00	0.73	1.96	1.08	1.40	0.36	-	1.14
Fluvio Lacustrine														
4	0-15	65	8.02	1.26	-	6.15	9.0	5.33	7.05	5.29	6.98	1.16	0.25	2.81
	15-50	70	8.12	1.61	-	3.84	28.0	11.09	5.3	0.84	11.15	1.05	0.14	12.46
	50-80	60	8.06	1.46	-	3.08	9.0	2.32	1.77	3.40	9.14	1.09	-	10.58
	80-150	60	8.02	1.45	-	3.77	5.0	5.69	1.77	3.40	9.33	0.96	0.18	6.48
5	0-20	55	7.87	1.51	-	4.61	13.0	16.10	5.03	3.10	8.62	0.96	0.12	4.41
	20-40	60	7.97	1.09	-	3.38	3.00	4.25	4.33	1.16	4.66	0.48	0.26	2.33
	40-70	43	7.97	1.50	-	3.08	7.00	5.39	2.48	4.63	7.93	0.43	0.28	4.22
	70-150	47	8.00	1.27	-	3.84	4.00	4.72	2.84	4.03	5.35	0.34	0.17	2.89
Flood plain														
6	0-20	75	7.79	1.15	-	5.84	6.0	12.95	10.89	0.83	12.83	0.24	0.24	5.30
	20-40	85	8.15	1.53	-	4.61	5.0	12.48	3.84	6.03	12.19	0.03	0.13	5.49
	40-90	72	8.12	1.51	-	3.84	5.00	6.60	3.21	2.96	8.79	0.48	0.17	4.99
	90-150	65	8.01	1.45	-	4.38	5.00	5.34	3.85	1.09	9.16	0.62	0.18	5.83
7	0-15	70	7.70	3.06	-	4.15	8.0	18.05	10.46	5.68	13.45	0.61	0.31	4.73
	15-40	105	8.10	3.54	-	4.15	20.2	11.05	4.48	7.86	22.81	0.25	0.3	9.20
	40-100	105	8.17	3.79	-	4.38	12.0	18.81	4.48	6.63	23.81	0.27	0.1	10.08
	100-150	115	8.16	3.02	-	3.99	13.0	12.13	3.21	3.58	21.90	0.43	0.25	11.90
Fluvio- Marine Plain														
9	0-10	100	7.57	2.80	-	7.54	15.0	7.52	12.18	1.40	15.87	0.61	0.31	6.05
	10-55	110	7.90	3.70	-	3.34	34.0	0.25	12.18	1.40	23.17	0.84	0.08	8.88
	55-75	115	7.89	7.69	-	2.61	69.0	0.92	12.82	9.40	49.20	1.11	0.021	14.80
	75-150	115	7.87	20.25	-	4.15	215.0	5.45	11.54	10.9	200.5	2.66	0.20	84.14
10	0-20	100	8.00	1.67	-	6.15	6.0	4.32	3.21	2.34	8.99	1.93	0.16	5.42
	20-60	120	8.05	1.85	-	5.38	5.0	8.28	1.92	3.63	11.74	1.37	0.26	7.07
	60-110	120	8.30	2.44	-	4.15	12.0	7.06	1.92	3.02	17.45	0.82	0.15	11.11
	110-150	120	8.18	2.84	-	4.61	15.0	1.60	1.92	3.02	15.36	0.91	0.15	9.78
Levee														
8	0-20	65	7.71	1.15	-	4.45	4.0	3.58	8.23	0.94	2.45	0.41	0.18	1.14
	20-40	60	7.60	1.53	-	4.38	8.0	8.22	12.8	0.78	6.50	0.52	0.28	2.49
	40-50	60	7.82	0.82	-	3.08	3.0	2.38	3.21	2.04	3.01	0.20	0.18	1.86
	50-100	55	7.89	0.83	-	3.23	3.0	1.91	3.10	0.71	4.28	0.05	0.11	3.10
	100-150	60	7.91	1.69	-	3.15	10.0	1.45	3.21	0.60	9.68	1.11	0.15	7.01
Coastal plain														
11	0-20	30	7.88	1.60	-	3.84	7.0	15.16	8.88	3.80	5.57	0.75	0.33	2.97
	20-50	30	8.02	1.13	-	4.61	7.0	1.61	2.56	7.32	3.09	0.25	0.19	1.39
	50-100	33	8.12	1.33	-	3.53	8.0	3.47	6.40	1.62	6.50	0.48	0.20	3.25
	100-150	33	8.05	1.66	-	3.85	10.0	2.70	3.77	2.87	9.20	0.71	0.13	5.05



Map 2. Soil taxonomic units of the studied area in Western Delta, Egypt.

TABLE 5. Soil taxonomy of the studied area.

Pr. No.	Family	Subgreat Group	Great group	Suborder	Order
Old alluvial soils					
1	Fine-loamy, mixed, thermic	Typic Haplocalcids	Haplocalcids	Calcids	Aridisol
2	Sandy, Mixed, thermic	Typic Calcigypsids	Calcigypsids	Gypsids	Aridisol
Windblown soils					
3	Siliceous thermic	Typic Torripsamment	Torripsamment	Psamments	Entiosols
Fluvio lacustrine soils					
4&5	Fine loamy, mixed, thermic	Aquic Haplocalcids	Haplocalcids	Calcidis	Aridisol
Flood plain soils					
6&7	Fine, Smectitic, thermic	Typic Ha[lotorrerts	Haplotorrerts	Torrerts	Vertisol
Levee					
8	Coarse loamy, mixed, thermic	Typic Torrifluvents	Torrifluvents	Fluvents	Entisol
Fluvio marine					
9	Fine, Smectitic, thermic	Halic Endoaquerts	Edqauerts	Aquerts	Vertisol
10	Fine, smectitic, thermic	Aridic Endoaquerts	Edqauerts	Aquerts	Vertisol
Coastal plain					
11	Sandy, b Siliceous, thermic	Oxyaquic Torripsamments	Torripsaments	Psamments	Entisol

Windblown sand soils

The studied windblown soil (profile No.3) has sandy texture whereas the sand contents reached 91.0 and no any pedogenic features of carbonates, gypsum or salic, so this soil is classified as siliceous, thermic, Typic Torripasmments.

Fluvio-lacustrine

Studied soil profiles No. 4 & 5 have clay loam texture whereas the clay contents ranged from 23.5 to 30.% and many soft & hard lime, calcium carbonate ranged from 18.0 to 29.7 in 2Ck and 2Ck2 horizons qualified as Calcic Horizon on elevation of 0 to -2 under sea level, therefore classified as fine loamy, mixed, thermic, Aquic Haplocalcids.

Flood plain of recent Nile alluvial soils

Soil profiles No. 6 &7 had cracks more than 5 cm width and more than 50 cm in depth , clay contents ranged from 43.6 to 60.0 % and slickensides in Css and Css2 horizon qualified as fine, smectitic, thermic , Typic Haplotorrerts.

Levee (recent Nile alluvial soils)

Soil profile No. 8 has sandy loam texture alluvial nature and no any pedogenic feature, therefore it is classified as coarse-loamy, mixed, thermic, Typic Torrifluvents.

Fluvio-marine soils

Profiles No 9 & 10 have clayey texture , whereas, the clay contents ranged from 52.0 to 61.0 slickensides in the 2 Css & 2Css2 horizons, elevations of 0.0 to -2 under sea level. In addition, the soil profile No 9 had ECe of 20.25 in 2Cg horizon qualified as fine, smectitic, thermic, Halic Endaquerts. Whereas, the studied soil profile No. 10 is fine, smectitic, thermic, Aridic Endaquaerts.

Coastal plain

Studied soil profile No. 11 has a sandy texture, the sand contents reached 97.0% and some subsurface horizon are saturated with water, therefore it is classified as sandy, siliceous, thermic, Oxyaquic Torripsamments.

Trace elements contents

The surface and subsurface horizons of the studied profiles in each soil geomorphic unit were examined to study the normal distribution and variability of several trace elements, *i.e.*, Fe, Mn, Zn and Cu within and between profiles (Table 6).

The status of iron (Fe)

Total Fe contents: It ranged from 0.2 % to 1.2%. The lowest content was in C2 horizon of the windblown soil whereas, the highest contents were in the Css horizon of the (recent Nile alluvial soils), flood plain and levee soil profile No. 6 and 8, (Table 6). Almost similar iron contents in Egyptian soils were obtained by Hegazy (1980), El-Sayad (1983), El-Toukhy (1987) and Badwi (1999). It is noticeable that the high contents of Fe in the studied soils are related to both high contents of clay and its semectitic clay mineralogy which contain high contents

TABLE 6. Total and available contents of some trace elements in the studied soils in mg/kg.

Profile No.	Horizon	Depth	Fe			Mn			Zn			Cu		
			*To. %	*Av.	Av/To %	To.	Av.	Av/To %	To.	Av.	Av/To %	To.	Av.	Av/To %
Old Aluvial														
1	A	15-0	0.57	4.48	0.001	316.0	3.12	0.007	55.6	2.24	0.05	30.0	4.50	0.2
	C	35-15	0.40	2.4	0.001	292.0	1.90	0.007	58.0	1.36	0.03	46.0	4.76	0.13
	C_2	65-35	0.56	3.04	0.001	324.0	2.78	0.01	47.4	0.78	0.02	68.0	3.96	0.07
	C_k	110-65	0.36	2.40	0.001	246.0	2.32	0.01	99.4	0.48	0.01	60.0	3.06	0.02
	C_3	150-110	0.25	2.40	0.001	170.0	1.90	0.01	83.6	0.62	0.01	72.0	4.14	0.04
2	A	10-0	0.53	3.04	0.001	216.0	2.32	0.002	85.8	0.48	0.015	42.0	4.04	0.1
	C_y	30-10	0.25	4.24	0.001	154.0	1.30	0.01	132.0	0.96	0.01	60.0	4.28	0.07
	C_{y2}	70-30	0.31	2.72	0.001	246.0	2.04	0.01	106.0	1.56	0.01	50.0	3.64	0.08
	C_K	150-70	0.31	4.32	0.001	262.0	3.12	0.01	114.8	1.42	0.02	52.0	2.52	0.07
Wind Blown sand														
3	Ap	25-0	0.23	2.4	0.001	330.0	3.06	0.01	120.0	0.61	0.01	46.0	0.98	0.03
	C	80-25	0.23	3.68	0.002	230.0	2.44	0.01	139.0	0.64	0.01	48.0	1.26	0.04
	C2	150-80	0.28	2.72	0.001	216.0	3.26	0.02	123.4	0.86	0.01	36.0	0.89	0.03
Fluvio-lacustrine														
4	Ap	15-0	0.91	10.88	0.001	692.0	8.24	0.02	119.8	1.94	0.02	82.0	5.2	0.06
	C	50-15	0.89	8.80	0.001	738.0	6.46	0.03	130.6	1.24	0.02	104.0	5.76	0.05
	ck2	80-50	0.80	6.08	0.001	508.0	5.84	0.01	177.6	0.96	0.015	48.0	4.48	0.1
	Ckg2	150-80	0.84	7.68	0.001	600.0	5.38	0.01	155.0	0.48	0.05	52.0	4.84	0.1
5	Ap	20-0	0.95	14.56	0.002	894.0	6.06	0.008	166.0	0.74	0.05	42.0	3.50	0.1
	C	70-40	0.70	15.36	0.001	800.0	6.4	0.01	162.2	0.78	0.006	22.0	2.96	0.15
	Ck22	150-70	0.65	9.76	0.001	546.0	7.48	0.02	212.6	0.48	0.005	28.0	2.88	0.15
	Ckg2	150-110	0.77	8.64	0.001	524.0	10.2	0.02	213.6	0.70	0.003	50.0	2.78	0.6
Flood plain														
6	Apss	20-0	1.15	43.2	0.005	632.0	9.52	0.02	248.8	1.28	0.01	36.0	3.14	0.1
	Css	40-20	1.20	21.92	0.003	708.0	8.78	0.01	236.6	0.66	0.005	46.0	4.32	0.1
	Css2	90-40	1.21	25.2	0.002	692.0	10.88	0.08	232.0	0.96	0.005	22.0	3.32	0.15
	C	150-90	1.19	24.88	0.002	862.0	12.92	0.02	265.0	1.14	0.008	22.0	3.14	0.14
7	Ap	15-0	1.17	57.6	0.005	970.0	9.32	0.01	313.4	1.94	0.003	23.0	3.68	0.14
	Css	40-15	1.16	30.8	0.003	954.0	8.9	0.01	297.6	0.92	0.003	28.0	4.32	0.14
	Css2	100-40	1.18	23.12	0.002	908.0	5.98	0.01	253.4	0.74	0.004	56.0	3.68	0.06
	C	150-100	1.17	23.6	0.002	786.0	5.30	0.01	264.0	0.92	0.004	42.0	4.14	0.1
Levee														
8	Ap	20-0	1.20	36.8	0.004	676.0	5.50	0.01	262.0	1.48	0.01	36.0	4.22	0.1
	C	40-20	0.12	33.4	0.003	278.0	5.98	0.02	274.0	1.04	0.004	42.0	5.3	0.1
	C2	50-40	1.21	32.0	0.003	278.0	4.62	0.02	255.4	1.14	0.004	62.0	4.22	0.07
	C3	100-50	1.14	25.6	0.002	200.0	5.84	0.03	279.8	0.92	0.003	68.0	5.22	0.08
	C4	150-100	0.97	25.6	0.003	354.0	6.46	0.02	308.2	1.98	0.01	104.0	5.74	0.06
Fluvio-Marine														
9	Ap	10-0	0.85	20.4	0.003	538.0	4.9	0.01	312.6	1.78	0.01	110.0	7.56	0.07
	Css	55-10	1.05	20.6	0.003	646.0	5.92	0.01	311.0	2.34	0.01	126.0	7.28	0.06
	Css2	75-55	0.87	14.0	0.002	908.0	4.7	0.01	320.6	1.72	0.01	140.0	6.84	0.05
	Cg2	150-75	0.59	10.8	0.003	1048.0	5.72	0.01	325.4	3.68	0.01	156.0	6.10	0.05
10	Ap	20-0	0.41	22.4	0.006	554.0	4.96	0.01	553.2	3.26	0.01	140.0	8.36	0.06
	Css2	60-20	0.46	11.68	0.004	654.0	4.9	0.01	327.4	2.92	0.01	156.0	8.0	0.05
	Css22	110-60	0.47	6.24	0.003	1016.0	5.72	0.01	350.4	2.74	0.01	168.0	9.90	0.06
	Cssg2	150-110	0.29	6.88	0.003	862.0	4.96	0.01	370.4	5.22	0.01	113.0	8.04	0.1
Coastal plain														
11	Ap	20-0	0.39	8.64	0.003	570.0	6.26	0.01	358.6	0.92	0.01	83.0	3.72	0.05
	C	50-20	0.52	8.84	0.002	678.0	7.48	0.01	305.2	0.62	0.01	70.0	4.04	0.05
	C2	100-50	0.46	11.52	0.003	492.0	6.46	0.015	341.2	1.90	0.02	74.0	3.78	0.05
	C3	150-100	0.45	5.28	0.002	524.0	6.4	0.01	325.0	1.02	0.01	54.0	4.02	0.08

* To.= Total, Av.= Available

of exchangeable Fe ions between the layers of their allumonosilicates (El-Demerdashe, 1970). Whereas, both Fluvio lacustrine and Fluvio-marine soils, soil profiles No. 4 & 5, 9 and 10 contained moderate contents ranged from 0.29 to 0.90 related to their nature calcareous material; similar data were obtained by El-Tokhy (1987). Coastal plain, (soil profile No. 11) ranged from 0.39 % to 0.46%, which may be due to the presence of feldspars, (El-Demerdashe, 1970). Old alluvial soils profiles No. 1 & 2, and the windblown soils, soil profile No. 3 contained the lowest contents ranged from 0.2 to 0.57 % due to their nature sandy deposits (El-Demerdashe, 1970 and El-Tokhy, (1987).

The partial; equation of total Fe with independent factors of both clay, silt and $CaCO_3$ contents

Typic Haplocalcids and Typic Calcigypsid

Partial regression analysis was performed in order to reveal the relative distribution of total Fe between clay, silt and $CaCO_3$. The regression equation reads:

Total Fe = 88.1 + 23.8 (silt %) + 54.3 (Clay %) +50.8 ($CaCO_3$).

This means that 55.6% (R2 = 0.556) of the variations in total Fe content of the soils could be accounted for the clay, silt and $CaCO_3$ content of the soil (Table 7). The regression coefficient equation meaned that an increase of one percent of either clay or silt, $CaCO_3$ will increase total Fe by 54.3, 23.8 ppm and 50.8 ppm, respectively.

Aquic Haplocalcids

Correlation between total Fe and clay or silt or $CaCO_3$ % contents, showed the equation of partial regression for these soils as:

Total Fe = 3260.0 + 267 (Clay %) -94.65 (silt %) – 63.95 ($CaCO_3$)

This means that 39.1 % of the variations of total Fe contents could be accounted for clay, silt and $CaCO_3$ % content of these soils.

Typic Haplotorrerts

Total Fe = 1602.3 + 152.55 (clay %) + 149.5(silt %) + 78.1 ($CaCO_3$)

whereas the clay, silt and $CaCO_3$ % contribute 83.2 of the factors affecting the variation of total Fe.

Typic Torrifluvents

Total Fe = 2178.7 – 1566.2 + 1942.2 (silt %) – 626.3 ($CaCO_3$).

whereas, both clay, silt and $CaCO_3$ % contribute 89.7 % of the factors affecting the variation of total Fe.

Halic Endoaquerts and Aridic Endoaquerts

Total Fe = -43573.5 + 531.8 (clay %) + 451.4+ 1196.8 (Clay %).

The clay, slit and $CaCO_3$ % contents contribute 28.7% of the factors affecting the variations of total Fe in these studied soils.

TABLE 7. % of the variation (R2) of the studied total trace elements related to clay, silt and $CaCO_3$ % in the studied soils.

Elements	Typic Haplocalcid and Calcigypsids	Aquic Haplocalcid	Typic Haplotorrerts	Typic TorriFluvent	Halic Endoaquert and Aridic Endoaquert	Oxaquic Torripasmment
Fe	55.6	39.1	83.1	89.7	24.8	83.0
Mn	93.4	55.8	45.7	57.3	26.5	85.0
Zn	58.4	67.5	51.5	88.9	49.3	81.0
Cu	58.7	10.9	25.3	73.3	61.7	90.0
Cd	42.4	66.5	21.0	85.0	20.3	81.0

Oxyaquic Torripsamments

Total = 945.7 + 481.9 (clay %) + 226.0 (silt %) + 223.3 (CaCO3).
Whereas, both clay, silt and $CaCO_3$ associated with 83.0 % of the factors affecting the variations of total Fe.

Available Fe Contents: It ranged from 2.4 to 57.6 ppm. The highest values were in the Typic Haplotorrerts and Typic Torrifluvents, studied soil profile No. 6, 7 and 8 reached 57.6 ppm in Ap horizon of soil profile No. 7. This high content is related to the nature of these alluvial soils rich in exchangeable iron in the allumoniosilicate of the clay minerals in addition to its high CEC resulted from their heavy Aquic Haplocalcids, Halic Endoaquerts and Aridic Endoaquerts clay texture and addition of organic fertilizers. These soils followed by both then the Oxyaquic Torripsamments soils which had nearly contents of the available Fe ranged from 5.28 in C3 horizon of the studied soil profile No. 11 to 20.6 ppm in Css horizon of the soil profile No. 9. Similar values are reported by El-Sayad and El-Tokhy (1987) in these soils. Finley, both the Typic Haplocalcid and Calcigypsids, studied soil profile No. 1, 2 and Typic Torripsamments, soil profile No.3 had the lowest contents of the available Fe ranged from 2.4 to 2.48, related their sandy texture. The percent of available Fe/total Fe from relatively low ranged from 0.001 to 0.006 %. The high values were in the Typic Haplotorrerts and Endoaquerts.

The status of Manganese (Mn)

Total manganese contents: It ranged from 170.0 to 1048.0 ppm. The highest contents were in the subsurface horizon of the Typic Haplotorrerts, Aquic Haplocalcids, Aridic Endoaquerts and Halic Endoaquerts soil profile No. 4, 5,6, 7, 9 and 10 ranged from 508.0 to 1048.0 ppm (Table 6); similar contents were reported by Taha (1980) and Badwi (1999). This is due to annual deposition of the Nile suspended matter which contains 0.23% total Mn expressed manganese dioxide MnO_2 (Ball, 1952).

The coastal plain studied soil profile No. 11 contained a moderate contents of the total Mn ranged from to 492.0 to 678.0 related to their nature coastal material. On the other hand , both the old alluvial , (soil profile No. 1 & 2) and windblown sand soils, (soil profile No. 3) contained low contents of the total Mn ranged from154.0 to 330.0 ppm . The wide variation of total Mn in the studied soils is due to the variation in their clayey texture as well as entry of Mn into the crystal lattice of the allumonosilicate layers of the clay and the presence of Mn nodules and concretions and the metal organic complexes (El-Demerdashe, 1970 and Taha, 1980).

The partial; equation of total Mn with the independent factors of both clay, silt and $CaCO_3$ contents:

Typic Haplocalcid and Calcigypsid

Total Mn had a significant correlation with clay % and $CaCO_3$ in Typic Haplocalcid and Calcigypsid soils, whereas a highly significant correlation with silt. The partial regression equation was:

Total Mn = - 14.19 +2.32 (clay %) +12.34 (silt) + 6.51 ($CaCO_3$).

This means that 93.4% of the factors affecting the variation in total Mn in these studied soils, related to both contents of the independent factors of clay, silt and $CaCO_3$.

Aquic Haplocalcids

The partial regression equation was:

Total Mn = 552.3+37.3 (clay%)-27.3 (silt%)-15.8 $CaCO_3$.

The clay, silt and $CaCO_3$ % contents of the soils were responsible for 22.7 % of the factors affecting the variations of total Mn .

Typic Haplotorrerts

Total Mn = 2784.9-14.9 (clay %) -28.7 (silt)-50.7 ($CaCO_3$%).

Whereas, the independent factors of clay, silt CaCo3 contribute the 45.8% of the factors affecting the variations of total Mn.

Typic Torrifluvents

The partial regression was:

Total Mn = 1594.0 + 85.4 (clay %) -73.8 (silt)-298.5 ($CaCO_3$).

These independent components contributed 57.3 of the factors affecting total Mn in these soils.

Endoaquerts

Total Mn = 782.4-2.62 (clay %)+4.7 (silt) -3.3 ($CaCO_3$).

The studied independent factors contribute 28.8% of the factors affecting the variation of total Mn in this studied soils.

Oxyaquic Torripsamments

Total Mn = 249.0+19.5 (clay%)+21.81 (Silt%)+46.9 ($CaCO_3$).

About 85.0 were related to the independent factors clay. silt and $CaCO_3$ associated the variations of total Mn in soils.

Available Mn contents: It ranged from 1.3 to 12.92 ppm. The Typic Haplotorrerts soils studied soils No. 6, 7 had the highest levels reached 12.92, this may be related to their nature alluvial materials. On the other hand studied soils of Aquic Haplocalcids, Halic Endoaquerts, Aridic Endoaquerts and Oxyaquic Torripsamments had nearly levels whereas the studied soils of Typic Haplocalcids and Typic Calcigypsids (soil profiles No. 1, 2) and Typic Torripsamments, (soil profile No. 3) had the lowest levels ranged from 1.3 to 3.26 ppm. The percent of available Mn/total Mn ranged from 0.007 to 0.02 %. The highest values were in Endoaquerts, due to occurrence of some marine constitutes which contain Mn.

The status of zinc (Zn)

Total zinc contents

In the studied area total Zn ranged from 47.4 to 370.0 ppm. These values were closer to that obtained by El-Dermerdashe (1970), Abd El-Wahid (1976) and Badwi (1999).

Aquic Haplocalcids (soil profile No. 9 & 10) and Oxyaquic Torripsamments (soil profile No. 11) had the highest contents of total Zn ranged from 305.2 ppm in the soil profile No. 11 to 370.6 ppm in the studied soil profile No. 10 . This is due to their marine nature which contained some constituents rich in Zn, high content of clay and some Feldspar minerals (El-Demerdashe, 1970). The Aquic Haplocalcids soils (soil profile No. 4&5) had a moderate contents of total Zn ranged from 119.8 in Ap horizon of studied soil No.4 to 213.6 in the Ck horizon of studied soil profile No. 5, this is related to the calcareous nature of the lacustrine contained Zn constituents' lower than both marine and recent alluvial deposits and their moderate content of clay, *i.e.* clay loam texture (Abd El-Wahid**,** 1976). The presence of Zn in the windblown (soil No. 3) is due to the added organic matter fertilizers. On the other hand, the Typic Haplocalcids and Typic Calcigypsids (soil profile No.1& 2) had the lowest values of total Zn reached 47.4 related to their nature parent materials poor in Zn and their light texture.

Partial regression equations for total Zn with independent variable of clay, silt and CaCO3 % contents in the studied soils as:

Typic Haplocalcids and Typic Calcigypsids

Total Zn= 131.5-1.59 (clay %)- 2.05 (silt%0+1.0 ($CaCO_3$%)

Both clay, silt and CaCO3% contents in soils contribute 58.5% of the factors affecting the variation of total Mn .

Aquic Haplocalcids

Total Zn = 360.0-8.7 (clay %) +1.6 (silt %)+2.7 ($CaCO_3$).

The studied independent variables contribute 67.0% of the factors affecting the variations of total Zn in these studied soils.

Typic Haplotorrerts

The partial regression was:

Total Zn = 1790.4 -17.6 (Clay%)-17.2 (silt%)-10.0($CaCO_3$).

Whereas, 52.4 % of the factors affected the variation of total Zn in this studied soils were related to both clay, silt and CaCO3 % content in soil.

Typic Torrifluvents

Total Zn=436.7 +1.6 (clay%)-2.9(silt%)-25.0 ($CaCO_3$%).

Whereas, these independent factors contributed 88.9 of the factors affected the variation of total Zn in the soils.

Halic Endoaquerts and Aridic Endoaquerts

Total Zn = 2041.9 – 20.03 (clay%)-19.77 (silt %)-40.7 ($CaCO_3$).

Whereas, the clay , silt and CaCO3 % contents in soils contribute 49.3% of the factors affected the variation of total Zn in the studied soil.

Oxyaquic Torripsamments

Total Zn= 574-36.5 (clay%)-4.0(silt%)-19.2($CaCO_3$%).

The studied independent factors contribute 81% or all the factors affected the variations of total Zn in this studied soils.

Available Zn contents: It ranged from 0.48 to 5.22 ppm in the studied soil profiles. The Endoaquerts soils No. 9, 10 had the higher contents ranged from 1.72 to 5.22 ppm due to their marine nature material contained some of Zn constituents. On the other hand all other studied soils had low levels of the available Zn. The percent of available Zn/total Zn ranged from 0.003 to 0.05 %.

The status of copper

Total copper contents: It ranged from 22.0 to 168.0 ppm. Almost similar values were reported in some Egyptian soils by El-Demerdashe (1970), El-Tokhy (1987) and Badwi (1999). The highest contents were in the Endoaquerts soils No. 9 & 10 and surface soil (Ap) horizon of both Aquic Haplocalcids and Oxyaquic Torripsamments due to their nature marine deposits rich in Cu constituents and additional organic fertilizer. On the other hand, the other studied soils had a moderate content. These values are almost similar to which reported by El-Demerdashe (1970), Abd El-Wahid (1976) and El-Toukhy (1987).

The partial equation of total Cu with the independent factors of clay , silt and CaCO3 contents

Typic Haplocalcids and Calcigypsids

Total Cu = 91.7+1.13 (clay%)-3.03(silt%)-1.13 ($CaCO_3$%)

Therefore, 58.7 of the variations of total Cu in these soils could have accounted by clay , silt and $CaCO_3$ in the soils.

Aquic Calcigypsids

Total Cu - -30.3+5.7 (clay%)-3.3 (silt%)-3.1 ($CaCO_3$%)

So; 10.9 % of the variation of total Cu in this studied soils was related to clay, silt and $CaCO_3$ in the soils.

Typic Haplotorrerts

Total Cu = - 64.27 + 1.7 (clay %) -0.47 (silt%)-1.7($CaCO_3$%)

Whereas, 25.3% of the variations of total Cu in this studied soils were related to clay, silt and $CaCO_3$%.

Typic Torrifluvents

Total Cu= 205.3-2.7 (clay %) +2.1(silt %) -25.9 ($CaCo_3$ %)

Whereas, 73.3% of the variations of total Cu were related to clay, silt and $CaCO_3$ % contents in this studied soils.

Endoaquerts

Total Cu=438.1-4.3(clay%)-3.5(silt %) +18.2($CaCO_3$%)

Whereas, 61.8% of the variations of total Cu in this soils were be accounted to clay, silt and $CaCO_3$ %.

Oxyaquic Torripsamments

Total Cu = 220.9-28.0 (clay %) +4.3 (silt %) -11.0 ($CaCO_3$%)

Whereas, 90.0 of the variation of total Cu in this studied soils were accounted to clay, silt and $CaCO_3$% contents.

Available Cu contents: It ranged from 0.89 to 9.9 ppm. The studied Aridic, Halic Endoaquerts No. 9, 10 contained the highest levels ranged from 6.1 to 9.9 releated to their marine nature which had some constituents rich in Cu. Whereas, the other soils had a moderate levels ranged from 2.78 to 5.74 ppm.

Finally, the Typic Torripsamments soils No. 3 had the lowest levels reached 0.89 to 1.26 ppm releated to their sandy nature.

The obtained data of the total trace elements, for the studied area showed that their vertical distribution does not help in providing specific trends rating to their nature material or geomorphic unit. The differences between the levels of the top and upper subsoil are mostly irregular and thus could be ascribed to any of the local environmental which cause the occurrence of lithological discontinuity between their parent materials which agree with El-Demerdash (1970).

Soil fertility releated to soil taxonomic units

The above discussion of both total and available trace elements, *i.e.* Fe, Mn, Zn and Cu revealed that soil Taxonomic Unit of both clayey, smectitic, thermic Typic Haplotorrerts studied soil No 6,7 and the taxonomic unit of clayey, smectitic, thermic. Halic Endaquerts and Aridic Endaquerts, studied soil profile No. 9 m 10 had relatively high contents of these elements. This could be a reflection of their nature of the alluvial and Fluvial-marine material, the heavy texture contained a high clay content rich in smectitic clay mineral which possesses a high cation exchange capacity use of organic manure commercial fertilizers, microbiological enrichment and the moisture regime. Therefore this taxonomic unit is the richest in fertility.

The taxonomic unit of Typic Torrifluvents studied soil No. 8 had contents close to the Typic Haplotorrerts due to the above mentioned reasons.

On the other hand , both Taxonomic units of Fine loamy , mixed thermic Aquic Haplocalcids of the studied soil No. 4 , 5 had moderate contents of the studied trace elements related to their nature Fluvio-lacustrine affected by the calcareous characterization and medium texture lower in CEC than the above soils adsorbed lowers contents of plant nutrient.

The studied soil Oxyaquic Torripsaments had also relatively moderate contents of some studied trace elements may be due to the occurrence of some feldspar minerals.

Finally, Taxonomic unit of both sandy, siliceous, thermic, Typic Haplocalcids, and Typic Calcigypisds studied soil profile No. 1, 2 of the old alluvial and sandy, siliceous, thermic, Typic Torripasamments, studied soil profile No. 3 had the lowest contents of the studied trace elements due to their sandy texture as the quartz predominates the other constituents whereas the trace elements contents of quarts are low. Therefore this taxonomic unit is poor in fertility.

According to the previous discussion for the obtained results of this investigation the studied soil taxonomic units can be ordered according to their soil fertility as follows:

Fine, smectitic, thermic, Typic Haplotorrerts (Flood plain) and Fine smectitic thermic, Halic Endoquerts (Fluvio-marine) > Fine loamy, mixed, thermic, Typic Torrifluvents > Fine loamy , mixed, thermic, Typic Haplocalcids (Fluvio-lacustrine) > Siliceous, thermic , Oxyaquic Torripsamments (Coastal plain) > Sandy, mixed, thermic Typic Haplocalcids – Typic Haplogypsids (old alluvial) > Siliceous, thermic Typic Torripsamments (windblown).

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الوحــدات التصــنيفية للأراضــي المتكونــة علــى بعــض الوحــدات الجيومورفولوجية وعلاقتها بخصوبة التربة في غرب الدلتا ـ مصر

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لإجراء هذه الدراسة اختير احد عشر قطاعا ارضيا تمثل الوحدات الجيومورفولوجية المختلفة فى منطقة غرب الدلتا لدراسة العلاقة بين الوحدات التصنيفية الارضية وخصوبة التربة بها .

أوضحت هذه الدراسة أن الوحدات التصنيفية Typic Calcigypsids, Typic Haplocalcid تكونت على الأراضى الرسوبية القديمة . ووحدة Typic Torripasment تكونت على الأراضى الرملية المنقولة بالرياح ووحدة Aquic Haplocacid تكونت على الأراضى الفيضية البحيرية ، ووحدة .TorriFluvent Typic Haplotorrerts تكونت على الاراضى الفيضية النيلية الحديثة ووحدة Halic Endoaquert , Aridic Endoaquert تكونت على الأراضى الفيضية البحرية ، ووحدة Oxaquic Torripasmment تكونت على أراضى الشاطىء الساحلية .

محتوى المادة العضوية فى منطقة الدراسة تتراوح من 0,15 الى 2,3 % كما ان السعة التبادلية الكاتيونية تراوحت من 2,3 الى 38,3 ممليمكافىء / 100 جرام تربة . وكانت اقل القيم فى اراضى الـ Windblown الرملية فى حين كانت أعلى القيم في الأراضى الـ Fluvio-marine الطينية .

والمحتوى الكلى من الحديد يتراوح من 0,2 الى 1,2 % أما الذائب فتراوح من 2,4 الى 57,6 جزء فى المليون وساهمت عوامل المحتوى الطين والسلت وكربونات الكالسيوم من 37,1 الى 89,7 من التغيرات فى المحتوى الكلى من الحديد .

والمحتوى الكلى من المنجنيز يتراوح من 17,0 الى 1048,0 جزء فى المليون أما المحتوى الذائب فتراوح من 0,48 الى 5,28 جزء فى المليون وساهم المحتوى الطين والسلت وكربونات الكالسيوم من 22,7 الى 93,5 % من التغييرات فى المنجنيز الكلى . وتراوح الزنك الكلى من 47,0 الى 370,0 جزء فى المليون اما المحتوى الذائب فتراوح من 0,47 الى 5,29 جزء فى المليون وساهم الطين والسلت وكربونات الكالسيوم بنسبة 4,03 الى 51.0% من التغييرات المحتوى الكلى.

والمحتوى الكلى من النحاس يتراوح من 22 الى 168 جزء فى المليون والمحتوى الذائب من 0.89 الى 9.9 جزء فى المليون وساهم كل من الطين والسلت وكربونات الكالسيوم بنسبة 10.9 الى 90.0 % من التغييرات فى المحتوى الكلى من النحاس .

الوحدات التقسيمية المدروسة Typic Haplotorrerts, Endaquerts التى تكونت على الـ Flood plain, Fluvio marine كانت هي الأعلى خصوبة بينما الـ Typic Torripsaments هي الأقل خصوبة .