4- RESULTS AND DISCUSSION

4.1. Chemical properties of the studied soil samples

4.1.1. Soil reaction (pH)

Table (1) shows that pH values of the studied soils are variable from one sample to another. Soil reaction is generally mildly alkaline to alkaline. Table (1) indicates that these values in the calcareous soils range between 7.2 in the sample No 18 (Tamia) to 8.6 in the sample No. 15 (El- Hammam) while in the alluvial soils the values range between 7.8 in sample No. 21 (Ashmun) to 8.27 in sample No. 37 (El-Shuhada). The high pH values, which indicate mildly alkaline to alkaline soil reactions are true reflection of the prevailing aridity and soil chemical composition which contains appreciable amounts of soluble Na^+ and HCO_3^- ions.

4.1.2. Total salinity and soluble salts:

Saline soils occur mostly in the arid and semiarid regions due to poor rainfall and relatively high temperature which in turn, results in the accumulation of soluble salts. In the irrigated regions of these arid and semiarid zones, the process of soil salinization is more often connected with the rise of the water level and high evaporation rate. Data presented in Table (1) indicate that the amount of total soluble salts, as expressed by the electrical conductivity (dS m^{-1}) of the soil saturation paste extract, varies widely among the different investigated soil samples. In general, the soil samples representing the recent Nile alluvium are characterized by low salinity, rarely exceeding 4 dS m^{-1}.

In the calcareous soils, the values of electrical conductivity (dS m^{-1}) range between 0.55 in the sample No. 13 (EL-Hammam) and 81.0 in the

Table (1): Chemical composition of the saturation paste extract of the studied soil samples.

Sample No.	Location	Soil type	Depth (cm)	pH	EC (dS/m)	Soluble Cations (me/L)				Soluble Anions (me/L)			
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
1	Borg El-Arab	Calcareous	0-20	8.3	1.60	5.20	2.00	8.00	0.30	-	3.80	10.00	1.70
2	" "	"	0-20	7.8	2.49	8.20	7.10	10.00	0.70	-	4.80	14.00	1.20
3	" "	"	0-20	8.1	1.91	4.60	8.60	5.00	0.90	-	4.00	14.00	1.10
4	" "	"	0-20	7.9	60.57	31.20	194.30	305.60	0.10	-	2.50	510.90	17.80
5	Bahig	"	0-15	8.1	1.37	4.10	2.20	6.50	0.30	-	4.20	8.00	0.90
6	Dear Mina	"	0-20	8.3	3.00	9.30	6.00	14.2.00	0.50	-	4.80	17.00	8.20
7	" "	"	0-20	7.8	1.37	6.70	2.00	4.60	0.40	-	5.20	7.00	1.80
8	" "	"	0-20	8.0	1.91	8.20	5.50	4.50	0.90	-	8.80	6.00	4.30
9	El- Hammam	"	0-20	8.0	6.78	28.30	28.80	8.90	1.80	-	4.00	44.00	21.80
10	" "	"	0-20	8.3	1.12	6.20	1.50	2.90	0.60	-	3.40	6.00	1.80
11	" "	"	0-20	8.4	0.90	5.20	0.50	2.80	0.20	-	3.80	4.00	1.10
12	" "	"	0-20	8.2	1.84	7.70	3.00	7.20	0.50	-	2.60	7.00	8.80
13	" "	"	0-20	8.3	0.55	4.00	0.40	0.80	0.30	-	3.80	1.00	0.70
14	" "	"	0-15	8.3	1.80	10.80	1.40	5.10	0.80	-	3.00	12.00	3.10
15	El- Hammam	"	0-20	8.6	1.72	4.20	2.50	9.90	0.70	-	4.00	12.00	1.30
16	King Maryot	"	0-25	7.8	3.35	12.40	6.00	14.40	0.60	-	7. 40	15.00	11.00
17	" "	"	0-25	8.2	1.93	5.70	3.50	9.80	0.40	-	4.20	10.00	5.20
18	Tamia	"	0-15	7.2	17.83	28.40	27.80	183.50	3.00	-	2.60	182.00	58.10
19	"	"	0-15	7.3	71.5	27.40	246.50	269.80	5.70	-	4.50	535.30	9.60
20	Com Oshim	"	0-15	7.4	81.00	125.70	170.40	1150.00	18.80	-	4.00	1266.00	194.90

Table (1): Cont.

Sample No.	Location	Soil type	Depth (cm)	pH	EC (dS/m)	Soluble Cations (me/L)				Soluble Anions (me/L)			
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
21	Ashmun	Alluvial soils	0-20	7.80	1.56	5.20	4.00	5.85	0.78	-	3.20	10.00	2.63
22	Ashmun	"	0-25	8.08	0.56	2.60	1.48	1.72	0.10	-	2.10	2.00	1.80
23	Minuf	"	0-25	7.93	2.23	6.24	7.01	10.12	0.38	-	3.20	8.00	12.55
24	"	"	0-25	8.23	0.98	2.60	4.54	3.20	0.15	-	3.00	5.00	2.49
25	El- Bagur	"	0-25	8.18	1.18	3.12	4.53	4.12	0.40	-	3.40	6.00	2.77
26	"	"	0-25	8.02	0.68	3.12	3.51	0.83	0.10	-	2.60	3.00	1.96
27	"	"	0-25	8.19	1.02	2.08	6.08	3.49	0.35	-	4.20	4.00	3.80
28	Shibin El- Kom	"	0-25	7.98	1.10	4.16	5.01	2.42	0.50	-	5.20	4.00	2.89
29	"	"	0-25	8.06	2.24	2.60	12.70	7.75	0.40	-	2.80	9.00	11.65
30	"	"	0-25	7.93	4.45	11.45	13.02	21.75	0.50	-	2.20	20.00	24.52
31	Queweisna	"	0-25	7.82	1.62	5.72	8.57	3.15	0.57	-	3.20	7.00	7.81
32	Berket El- Sabe	"	0-25	8.06	3.29	9.37	11.03	14.08	0.38	-	3.70	9.00	22.16
33	"	"	0-25	8.17	0.69	3.12	0.96	3.14	0.10	-	3.00	4.00	0.32
34	Tala	"	0-25	8.17	1.43	5.20	3.98	3.96	0.20	-	2.60	4.00	6.74
35	"	"	0-25	7.92	3.21	22.91	7.70	2.25	0.48	-	2.00	4.00	27.34
36	"	"	0-25	8.16	1.15	4.68	2.46	3.40	0.48	-	3.20	3.00	4.88
37	El- Shuhada	"	0-25	8.27	0.71	2.60	3.01	1.98	0.40	-	3.20	3.00	1.79
38	"	"	0-25	8.21	1.49	4.68	7.05	4.00	0.40	-	3.50	7.00	5.63
39	"	"	0-25	8.11	0.92	4.68	2.46	2.20	0.57	-	2.20	3.00	4.71
40	El- Sadat	"	0-25	7.92	0.69	2.60	3.00	2.20	0.42	-	4.20	4.00	0.04

sample No. 20 (Com Oshim). The highly saline soils (samples Nos. 18, 4, 19 and 20) located at Borg El-Arab, Tamia and Com Oshim have EC values ranging between 17.83 and 81.0 dS m^{-1}. The high values of soluble salts, may be due to the absence of irrigation, poor rainfall and relatively high temperature.

With respect to the alluvial soils, the values of electrical conductivity (dS m^{-1}) vary from 0.56 in sample No. 22 (Ashmun) to 4.45 dS m^{-1} in the sample No. 30 (Shibin El-Kom).

Data in Table (1), show that the values of soluble Ca^{++} in calcareous soils vary from 4.0 (me/l) in the sample No. 13 (El-Hammam) to 121.4 (me/l) in the sample No. 19 (Tamia). In the alluvial soils, the values of soluble Ca^{++} range from 2.08 me/l in sample No. 27 (El- Bagur) to 22.91 me/l in the sample No. 35 (Tala).

The values of soluble Mg^{++} in the calcareous soils ranges from 0.4 to 229.4 (me/l), the lowest value is found in sample No. 13 (El-Hammam) while the highest one is obtained in sample No. 20 (Com – Oshim). In the alluvial soils, the values of soluble Mg^{++} vary from 0.96 to 13.02 (me/l), the lowest value is detected in sample No. 33 (Berket El- Sabe), while the highest value is obtained in sample No. 30 (Shibin El-Kom).

The values of soluble Na^{+} in the calcareous soils vary from 0.8 (me/l) in the sample No. 13 (El-Hammam) to 2850 (me/l) in sample No. 19 (Tamia), while in the alluvial soils the values of soluble Na+ ranges from 0.83 (me/l) in the sample No. 26 (El-Bagour) to 21.75 me/L in sample No. 30 (Shibin El-Kom).

In the calcareous soils, the values of soluble K^+ vary from 0.1 (me/l) in sample No. 4 (Borg El-Arab) to 18.8 (me/l) in sample No. 20 (Com Oshim). In the alluvial soils the values of soluble K^+ range between 0.1 (me/l) in the sample No. 22 (Ashmun) to 0.78 (me/l) in sample No. 21 (Ashmun).

With respect to the soluble anions, it was found that in the calcareous soils, the soluble HCO_3^- varies from 2.6 (me/l) in samples No. 12 and 18 (El-Hammam and Tamia) to 8.8 (me/l) in the sample No. 8 (Dear Mina). In the alluvial soils, the values of soluble HCO_3^- range between 2.0 (me/l) in sample No. 35 (Tala) to 5.2 (me/l) in sample No. 28 (Shibin El-Kom).

Data in Table (1), show that values of soluble Cl^- in the calcareous soils vary from 1.0 (me/l) in the sample No. 13 (El-Hammam) to 2830 (me/l) in sample No. 20 (Com Oshim). In the alluvial soils the values of soluble Cl^- range from 2.0 (me/l) in sample No. 22 (Ashmun) to 20.0 (me/l) in sample No. 30 (Shibin El-Kom).

In the calcareous soils, the values of soluble $SO_4^=$ range from 0.7 to 1109.5 (me/l), the lowest value is found in sample No. 13 (EL- Hammam) while the highest one is obtained in sample No. 19 (Tamia). In the alluvial soils, the values of soluble $SO_4^=$ vary from 0.04 to 27.34 (me/l), the lowest value is detected in sample No. 40 (El- Sadat) while the highest value is obtained in sample No. 35 (Tala).

4.2. Physical characteristics of the studied soil samples:

4.2.1. Mechanical analysis:

The results of the mechanical analysis of the studied soil samples, their textural classes, calcium carbonate and organic matter contents are given in Table (2), these data show that soil texture in the different locations varies considerably from one soil sample to another.

In the calcareous soils, the values of coarse sand content range between 1.84 % in sample No. 5 (Bahig) and 90.88 % in sample No. 1 (Borg El-Arab). With respect to the alluvial soils the values of coarse sand % vary from 4 % in the sample No. 31 (Tala) to 42.2 %, in the sample No. 40 (El-Sadat).

Data in Table (2), show that the values of fine sand % in the calcareous soils vary from 5.30 in the sample No. 14 (El-Hammam) to 46.58% in sample No. 8 (Dear Mina). In the alluvial soils, the values of fine sand % range from 12.55 in sample No. 40 (El-Sadat) to 31.50 in sample No. 28 (Shibin El-Kome).

In the calcareous soils, the values of silt range from 1.02 to 22 .7%, the lowest value is found in sample No. 1 (Borg El-Arab) while the highest value is obtained in sample No. 20 (Com Oshim). In the alluvial soils, the values of silt % vary from 15 to 35, the lowest value is detected in sample Nos. 22, 24, and 29 (Ashmun, Minuf and Shibin EL-Kome), while the highest value is obtained in sample No. 33 (Berket El-Sabe).

In the calcareous soils , the values of clay % vary from 2.1 in sample No. 1 (Borg El-Arab) to 31.09% in sample No. 5 (Bahig). While in the alluvial soils the values of clay % range between 25 in sample No. 27 (El-Bagur) to 55% in samples Nos. 30 and 37 (Shibin El-Kome and EL-Shuhada).

Table (2) also, includes the particle size distribution of Borg El- Arab (sample No. 1), El-Hammam (sample Nos. 10, 11, 12, 13, 14 and 15), which indicate that all these soils are coarse –textured (sand or loamy sand).

Table (2): Mechanical analysis, calcium carbonate and organic matter contant of the studied soil samples.

Sample No.	Location	Soil type	Depth (cm)	Particle size distribution Coarse Sand %	Fine Sand %	Silt %	Clay %	Textureal class	$CaCO_3$ %	O.M %
1	Borg El-Arab	Calcareous	0-20	90.88	6.00	1.02	2.10	Sand	94.00	0.28
2	" "	"	0-20	62.26	20.62	4.00	13.12	Sand Loam	63.49	0.35
3	" "	"	0-20	26.24	42.64	14.12	17.00	Sand Clay Loam	38.18	0.29
4	" "	"	0-25	34.60	46.28	6.09	1303	Sand Loam	34.75	0.31
5	Bahig	"	0-15	1.84	45.04	22.08	31.09	Light Clay	35.18	0.36
6	Dear Mina	"	0-20	18.20	40.68	13.94	27.18	Sandy Clay	56.20	0.29
7	" "	"	0-20	13.00	41.88	18.06	27.06	Light Clay	39.90	0.35
8	" "	"	0-25	10.30	46.58	18.00	25.12	Sandy Clay	43.76	0.31
9	EL-Hammam	"	0-20	56.20	28.68	4.50	10.62	Sandy Clay	62.21	0.28
10	"	"	0-20	74.50	12.38	2.07	11.05	Loamy Sand	65.21	0.29
11	"	"	0-20	63.56	21.32	4.00	11.12	Loamy Sand	33.46	0.26
12	"	"	0-20	70.64	18.21	4.52	6.60	Loamy Sand	36.47	0.28
13	"	"	0-20	68.10	20.75	4.00	7.12	Loamy Sand	30.03	0.13
14	"	"	0-20	85.58	5.30	2.10	7.02	Loamy Sand	33.46	0.28
15	"	"	0-20	56.84	30.04	2.59	10.53	Loamy Sand	34.75	0.26
16	King Margot	"	0-25	12.80	46.08	16.50	24.62	Sandy Clay Loam	27.89	0.37
17	"	"	0-25	12.50	44.38	17.90	25.22	Sandy Clay	42.90	0.30
18	Tamia	"	0-15	17.20	54.20	15.50	13.90	Sandy Loam	19.50	.040
19	"	"	0-15	38.10	15.90	8.50	17.10	Sandy Loam	16.60	0.77
20	Com Oshim	"	0-15	24.2	39.80	22.70	13.10	Sandy Loam	21.20	0.18

Table (2): Cont.

Sample No.	Location	Soil type	Depth (cm)	Particle size distribution: Coarse Sand %	Fine Sand %	Silt %	Clay %	Textural class	$CaCO_3$ %	O.M %
21	Ashmum	Alluvial	0-20	17.60	17.40	22.00	43.00	Clay	3.21	2.38
22	"	"	0-25	7.40	32.60	15.00	45.00	Clay	4.08	1.53
23	Minuf	"	0-25	16.10	27.90	21.00	35.00	Clay Loam	3.04	2.23
24	"	"	0-25	10.50	25.50	15.00	50.00	Clay	3.13	1.96
25	EL-Bagur	"	0-25	12.00	20.50	22.50	45.00	Clay	3.13	2.02
26	"	"	0-25	13.00	29.50	22.50	35.00	Clay Loam	2.17	1.61
27	"	"	0-25	29.95	22.55	22.50	25.00	Sandy Clay Loam	2.61	1.89
28	Shibin EL-Kome	"	0-25	10.50	31.50	20.50	37.50	Clay Loam	1.91	2.38
29	" "	"	0-25	12.80	29.70	15.00	42.50	Clay	3.30	2.06
30	" "	"	0-25	8.15	19.35	17.50	55.00	Clay	2.78	1.71
31	Quweisna	"	0-25	9.85	17.65	22.50	50.00	Clay	3.30	2.24
32	Berket EL-Sabe	"	0-25	12.75	24.75	20.00	42.50	Clay	3.21	2.25
33	" "	"	0-25	6.25	16.25	35.00	42.50	Clay	2.52	1.29
34	Tala	"	0-25	4.00	13.50	30.00	52.50	Clay	2.43	1.73
35	"	"	0-25	11.25	21.25	17.50	50.00	Clay	3.74	1.83
36	"	"	0-25	13.05	21.95	23.00	42.00	Clay	2.50	2.03
37	EL-Shuhada	"	0-25	7.80	19.70	17.50	55.00	Clay	2.69	1.74
38	"	"	0-25	10.10	17.40	20.00	52.50	Clay	2.17	1.87
39	"	"	0-25	9.50	25.00	27.50	38.00	Clay	2.61	1.85
40	EL-Sadat	"	0-25	42.20	12.55	19.00	26.25	Clay	0.69	1.48

With regard to the soils of Ashmun (samples No. 21 and 22), Minuf (sample No. 24), El-Bagur (sample No. 25), Shibin El-Kome (samples Nos. 29 and 30), Quweisna (sample No. 31), Berket El-Sabe (samples Nos. 32 and 33), Tala (samples Nos. 34, 35 and 36) and El- Shuhada (samples Nos. 37 and 38) Falues of particle size distribution indicate that they are fine textured (clayey).

4.2.2. Calcium carbonate content:

The data presented in Table (2) show distribution of total carbonate in the studied soil samples. The data indicate that the total carbonate content is generally high and varies among the different soil samples.

In the calcareous soils, the values of calcium carbonate content ranges between 16.6% in the sample No. 19 (Tamia) and 94.0 % in sample No.1 (Borg El-Arab). While in the alluvial soils the values of calcium carbonate range from 0.69 in sample No. 40 (El-Sadat) to 4.08% in sample No. 22 (Ashmun).

The data indicate that the values of calcium carbonate content in the alluvial samples are much lower than those in the calcareous soils.

4.2.3. Organic matter content:

Table (2) shows that organic matter content in the calcareous soils ranges between 0.13 % in sample No. 13 (El- Hammam) and 0.77% in the sample No. 19 (Tamia). While in the alluvial soils the values of organic matter content vary from 1.29 % in the sample No. 33 (Berket El-Sabe) to 2.38% in samples Nos. 21 and 28 (Ashmun and Shibin El-Kom). The data of organic matter contents are generally low in both types of soils (calcareous and alluvial soils).

The low content of organic matter is a common feature in the arid regions due to the high oxidation potential and low vegetative cover.

4.3. Status of soil micronutrients :

4.3.1. Total Iron:

Total iron content of the calcareous soils ranged from 0.14 to 9.56%, (Table, 3). The highest value is detected in the soil sample No. 20 (Kom – Oshim) which has a sandy loam texture, while the lowest value is found in sample No. 1 (Borg El-Arab) due to its texture which is sand. In the alluvial soils, the values of total iron ranged from 2.11 to 7.7%. The highest value is found in sample No. 21 (Ashmun) which had clay texture, while the lowest value is observed in the coarse textured sample No. 39 (El-Shuhada) due to its coarse texture.

Variations in the total iron content among the studied soils are probably due to variation in soil texture and organic matter content. The values of total iron are relatively high in clay and silt contents compared to sand content. These results are in good harmony with those of EL-Toukhy (1987) who, also found that the higher the organic matter content, the higher is the total iron content of the soils.

The statistical analysis (Table, 4) shows positively highly significant correlation between total Fe and each of silt content (r= 0.6784**), clay content (r= 0.6458**) and organic matter content (r= 0.5966**). This result is in agreement with these obtained by Barakat (1998) where he found that correlation coefficient between total iron in the alluvial soil of Egypt and clay %, silt % and organic matter content were positively highly significant. On the other hand, there is negatively highly significant correlation between total Fe and $CaCO_3$ content (r=-0.6483**). Also, there is a negatively significant

Table (3): Total micronutrient elements (Fe, Mn, Zn and Cu) of the studied soil samples.

Sample No.	Location	Soil type	Depth (cm)	Total elements			
				Fe (%)	Mn (ppm)	Zn (ppm)	Cu (ppm)
1	Borg El-Arab	Calcareous	0-20	0.14	15.83	19.17	14.0
2	"	"	0-20	2.67	175.00	30.83	28.0
3	"	"	0-20	1.67	339.00	25.00	23.0
4	"	"	0-20	0.80	255.00	10.83	12.5
5	Bahig	"	0-15	2.84	383.00	54.17	7.5
6	Dear Mina	"	0-20	3.58	2.67.00	45.00	15.0
7	"	"	0-20	1.90	315.00	56.67	19.0
8	"	"	0-25	3.20	334.00	47.50	23.0
9	El- Hammam	"	0-20	0.80	208.00	10.83	4.0
10	"	"	0-20	0.58	180.00	8.33	3.0
11	"	"	0-20	0.68	200.00	45.83	65.0
12	"	"	0-20	0.60	172.00	95.83	75.0
13	"	"	0-20	0.79	234.00	15.83	5.8
14	"	"	0-15	0.58	173	20.83	9.0
15	"	"	0-20	0.69	181	11.67	5.0
16	King Maryot	"	0-25	2.59	439	50.00	10.0
17	"	"	0-25	1.67	271	39.17	1.6
18	Tamia	"	0-15	3.30	156	85.00	7.5
19	"	"	0-15	1.53	172	70.83	2.5
20	Kom Oshim	"	0-15	9.58	749	90.0	1.7
21	Ashmun	Alluvial soils	0-20	7.70	1160	155.0	134.0
22	"	"	0-25	5.49	960	132.0	8.0
23	Minuf	"	0-25	5.28	795	95.0	70.0
24	"	"	0-25	6.15	1128	172.0	126.0
25	El- Bagur	"	0-25	4.35	890	179.0	90.0
26	"	"	0-25	3.39	795	89.0	72.0
27	"	"	0-25	3.09	673	81.0	66.0
28	Shibin El- Kom	"	0-25	3.92	760	97.0	75.0
29	"	"	0-25	3.94	73	128.0	93.0
30	"	"	0-25	2.25	563	93.0	62.0
31	Quweisna	"	0-25	4.96	1019	130.0	115.0
32	Berket El-Sabe	"	0-25	4.31	732	136.0	112.0
33	"	"	0-25	4.91	860	260.0	93.0
34	Tala	"	0-25	5.26	1130	141.0	126.0
35	"	"	0-25	5.53	960	167.0	134.0
36	El-Shuhada	"	0-25	4.64	1012	111.0	92.0
37	"	"	0-25	5.07	9.36	168.0	136.0
38	"	"	0-25	4.79	8.68	130.0	108.0
39	"	"	0-25	2.11	272	64.0	47.0
40	El-Sadat	"	0-20	3.50	689	166.0	104.0

Table (4): Correlation coefficients (r) between total and chemically extractable amount of the different elements and some soil properties .

Parameter (X) / Parameter (Y)	pH	EC (dS/m)	T. Sand (%)	Silt (%)	Clay (%)	$CaCO_3$ (%)	O.M (%)
Total Fe	-0.3208*	0.1401	0.03233	0.67843**	0.64584**	-0.64831**	0.59667**
Total Mn	-0.2857	-0.1360	-0.21640	0.68713**	0.79276**	-0.68412**	0.76094**
Total Zn	-0.0849	-0.1461	-0.29279	0.68388**	0.76190**	-0.72290**	0.72240**
Total Cu	0.1266	-0.3302	-0.45341**	0.50844**	0.74973**	-0.60594**	0.81524**
Ext. Fe-DTPA	-0.41839**	0.09397	-0.03590	0.5738**	0.54085**	-0.64650**	0.52471**
Ext. Fe-HCl	0.35592*	-0.17753	-0.15692	-0.0694	0.18312	-0.05403	0.21922
Ext. Fe-NH_4OAC	-0.07331	0.18536	0.18872	0.03256	-0.01762	0.01209	-0.13371
Ext. Fe-hydroquinone	0.21030	-0.191514	-0.33644*	-0.05868	0.09327	-0.05868	0.16191
Ext. Fe-H_2O	0.09805	0.15628	0.39499*	-0.20460	-0.19331	0.41623**	-0.33897
Ext. Mn-DTPA	-0.20606	-0.00014	0.08109	0.54577**	0.59156**	-0.51250*	0.48788**
Ext. Mn-HCl	0.05102	-0.23461	-0.35615*	0.51738**	0.74098**	-0.68944**	0.89286**
Ext. Mn-NH_4OAC	-0.10209	0.05389	-0.1028	0.25300	0.38925*	-0.25578	0.20551
Ext. Mn-hydroquinone	0.02505	-0.28288	-0.21215	0.7048**	0.83934**	-0.71373**	0.86944**
Ext. Mn-H_2O	0.04922	-0.06055	0.42197**	-0.08292	-0.12588	0.43067**	-0.32984*
Ext. Zn-DTPA	-0.13916	0.49281**	0.07886	-0.15886	-0.02110	-0.03398	0.03107
Ext. Zn-HCl	-0.019518	0.21346	-0.13954	0.45421**	0.42697**	-0.58770**	0.43527**
Ext. Zn-NH_4OAC	0.05973	0.44077**	0.13795	-0.20761	-0.15617	0.10319	-0.11419
Ext. Zn-hydroquinone	-0.08748	0.49261**	0.19423	-0.26094	-0.22398	0.14397	-0.19636
Ext. Zn-H_2O	-0.08142	0.01795	0.09626	0.32511*	0.05431	-0.13699	-0.04446
Ext. Cu-DTPA	-0.07636	-0.14250	0.31275*	0.5475**	0.80059**	-0.71627**	0.84883**
Ext. Cu-HCl	-0.08691	-0.09433	0.10164	-0.04333	0.16870	-0.09449	0.00410
Ext. Cu-NH_4OAC	-0.15361	0.00907	0.01169	0.36129*	0.51497**	-0.60901	0.54098**
Ext. Cu-hydroquinone	-0.2569	0.05299	0.07844	-0.11421	0.06613	-0.06579	0.08558
Ext. Cu-H_2O	-0.34103*	0.00793	-0.15986	0.49930**	0.64750**	0.79705**	0.79313**

* indicate significale at 5 %
** indicate significale at 1 %

correlation between total Fe and pH (r=-0.3208*). This is in agreement with the results obtained by Abdel Razik (1999) who pointed out that total Fe was negatively highly significantly correlated with total sand content. These relationships are represented graphically in Fig. (1).

4.3.2. Total Manganese :

The results of total manganese of the studied soil samples are given in Table (3). The data indicated that the values of total manganese ranged from 15.83 to 749 ppm in the calcareous soil. The highest content is detected in the sample No. 20 (Kom Oshim) while the lowest content is found in sample No. 1 (Borg El-Arab). In the alluvial soils, the values of total manganese ranged from 73 to 1160 ppm. The highest content is found in sample No. 29 (Shibin El-Kom), while the lowest value is detected in sample No. 21 (Ashmun). Variations in total manganese content are due to variation in soil texture and organic matter, where the higher the organic matter and clay content, the higher is the total Mn content of the soil. These results is in agreement with those results obtained by (El-Toukhy 1987).

The statistical analysis (Table, 4) shows positively highly significant correlation between total Mn and of silt content (r= 0.6871**), clay content (r= 0.7927**) and organic matter content (r= 0.7604**). On the other hand, there is a negatively highly significant correlation between total Mn and $CaCO_3$ content (r=-0.6841**). This is in agreement with the results obtained by Abdel-Hamid (1977) and Ahmed (1979) who reported a negative significant correlation between total Mn and both of $CaCO_3$ and pH. These relationships are represented graphically in Fig. (2).

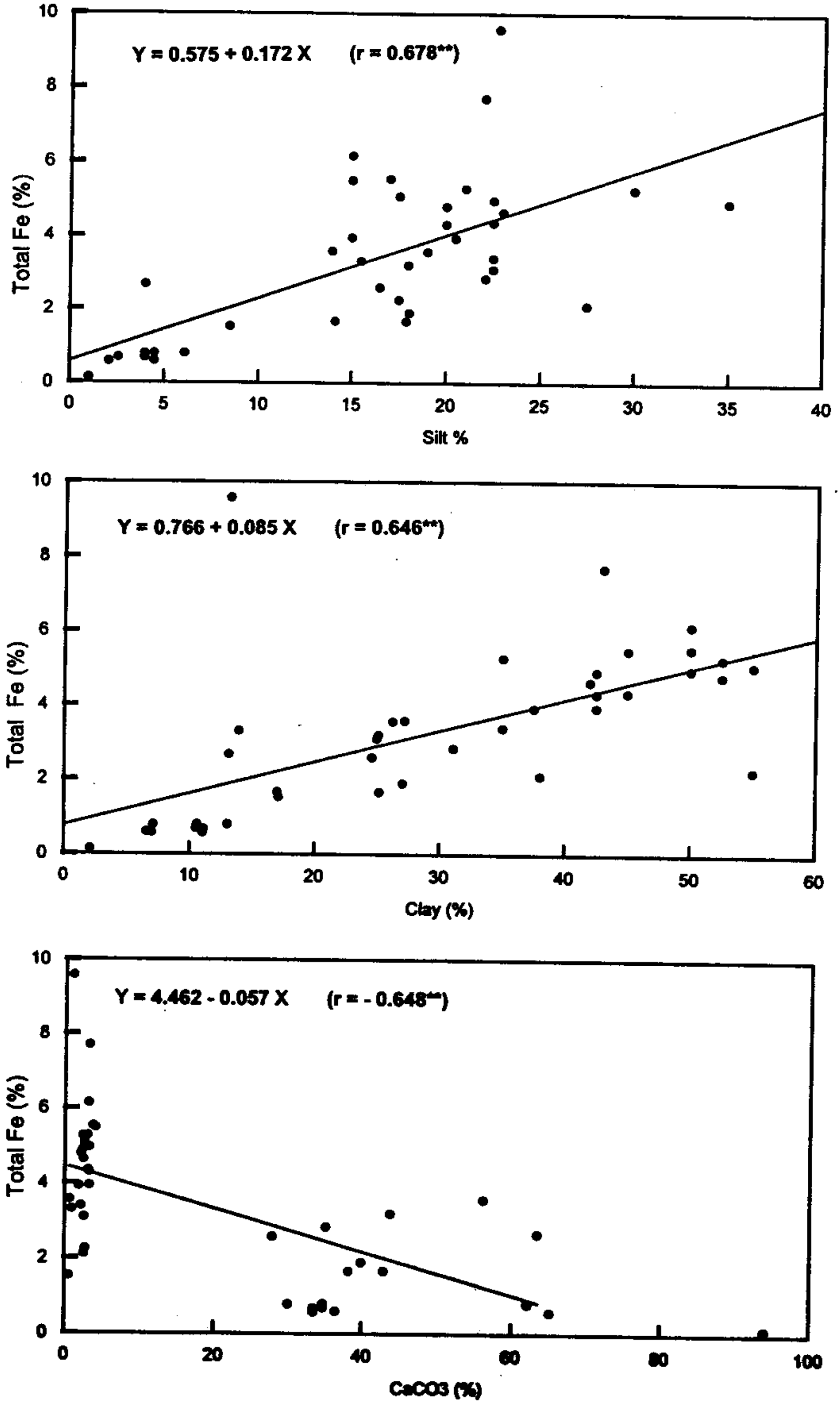
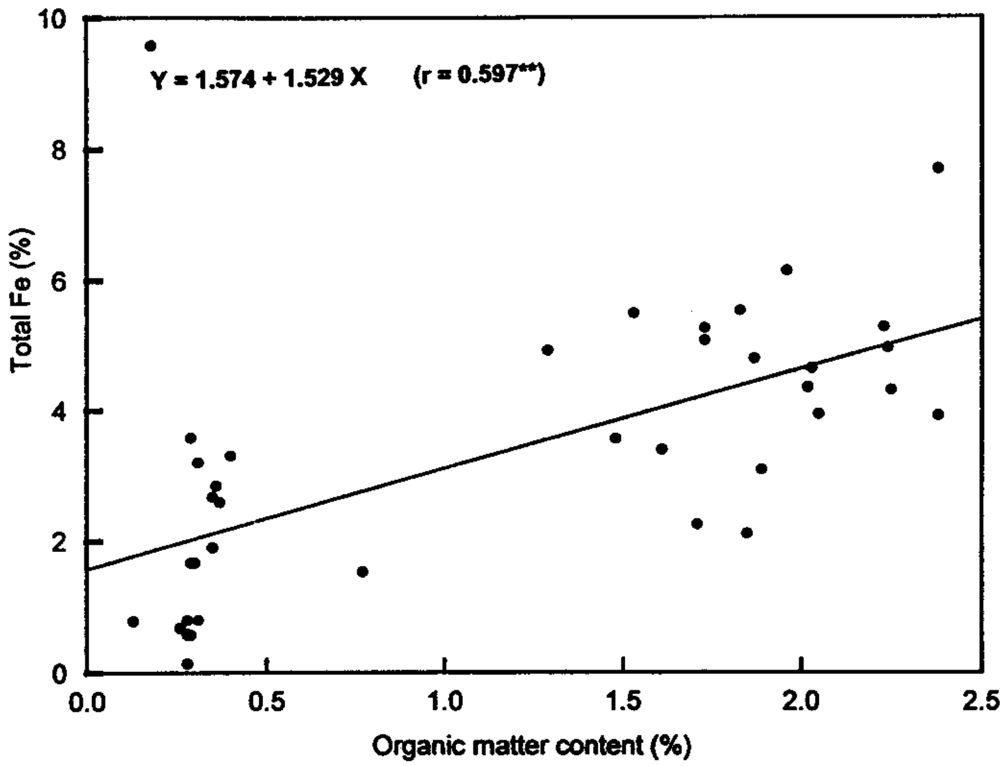


Fig. (1): Relationships between total Fe and some soil properties.


Y = 1.574 + 1.529 X (r = 0.597**)
Total Fe (%)
Organic matter content (%)
0
2
4
6
8
10
0.0
0.5
1.0
1.5
2.0
2.5

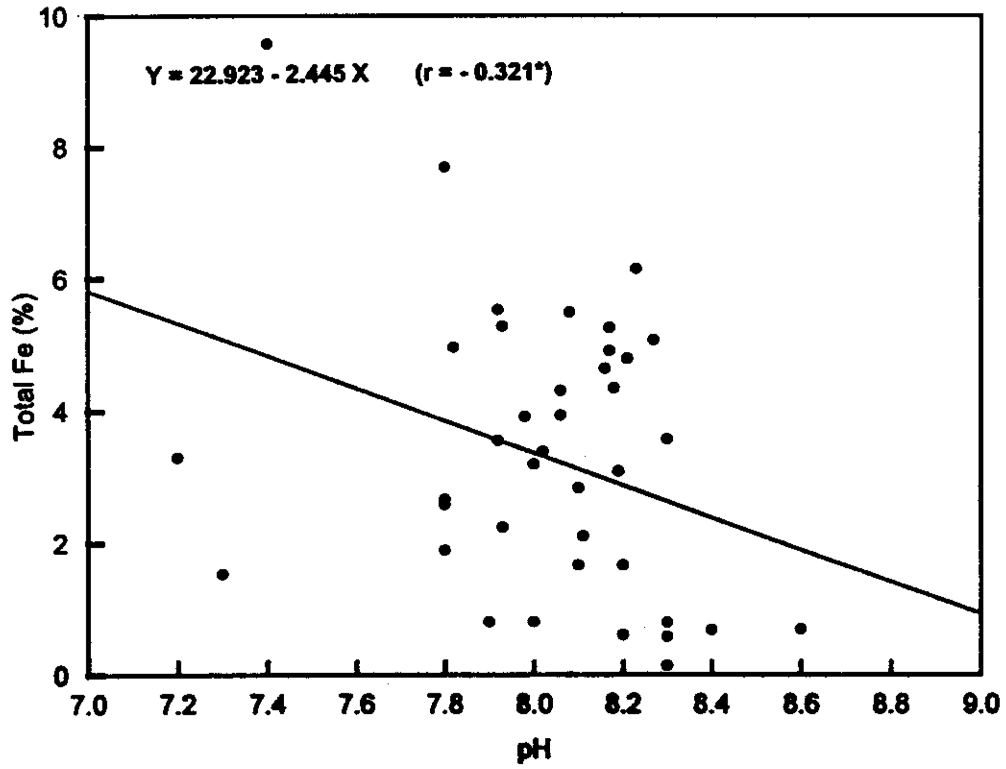

Y = 22.923 - 2.445 X (r = - 0.321*)
Total Fe (%)
pH
0
2
4
6
8
10
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0

Fig. (1): Cont.

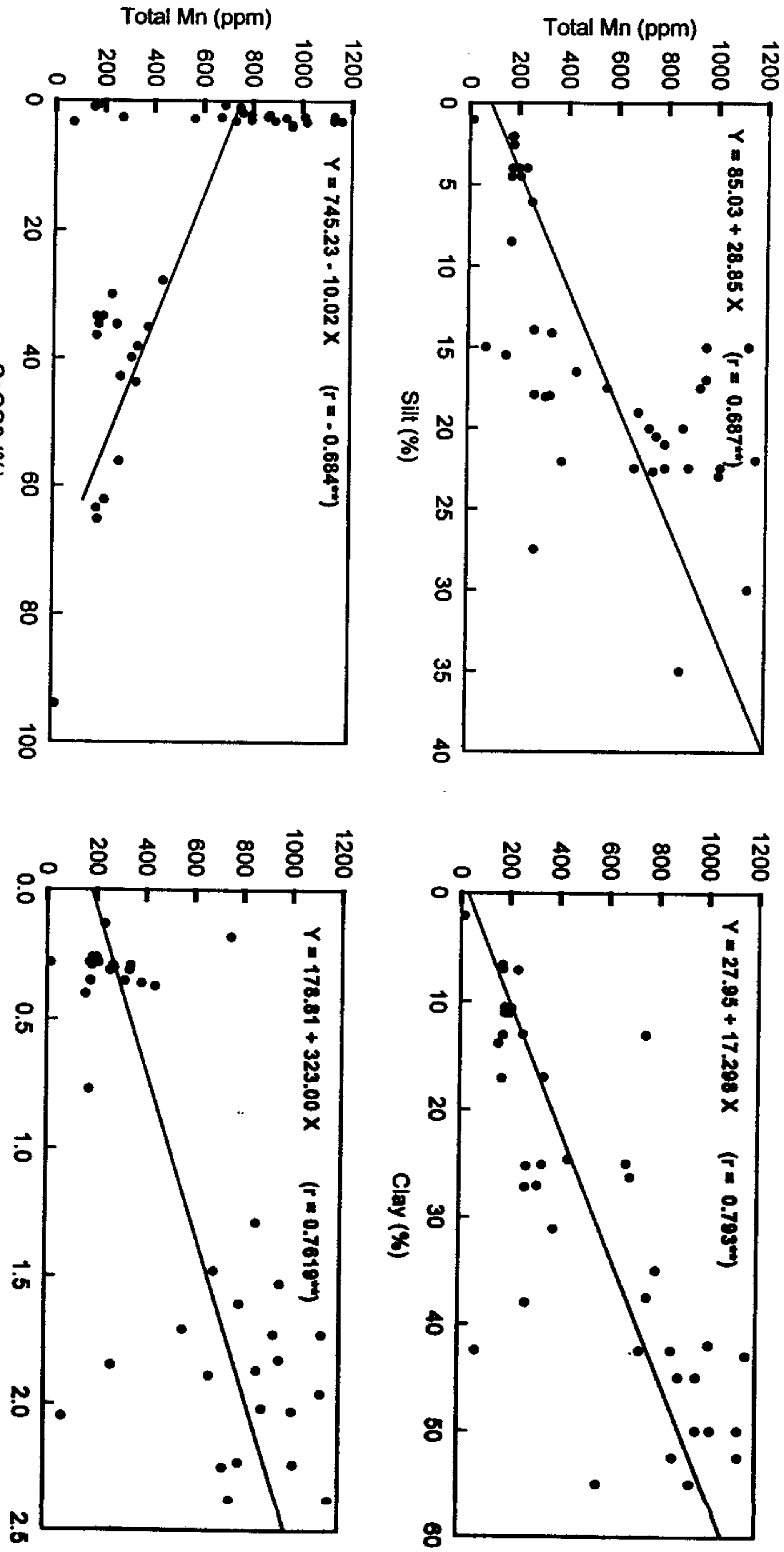


Fig. (2): Relationships between tota Mn and some soil properties.

4.3.3. Total Zinc:

Content of total zinc in the studied soils is presented in Table (3). In the calcareous soils the data indicated that it ranges from 8.33 to 95.83 ppm. The highest value is found in sample No. 12 (El- Hammam), while the lowest one is obtained for sample No. 10 (El-Hammam). In the alluvial soils, the values of total zinc ranged from 81 to 179 ppm. The highest value is found in sample No. 25 (El-Bagur) while the lowest value is detected in sample No. 27 (El-Bagur).

According to Chapman (1966), the levels of total Zn content below 50 ppm could be considered low and those above 100 ppm could be considered high. The results indicated that the values of total zinc in the calcareous soils are belonging to the medium and low level groups represented herein by 35 and 65%, respectively, while in the alluvial soils the values of total zinc are high and medium level groups represented by 10 and 30%, respectively.

The statistical analysis (Table, 4) shows positively highly significant correlations between total Zn and each of silt content (r= 0.6838**), clay content (r=0.7619**) and organic matter content (r= 0.7224**) . On the other hand, there is a negatively highly significant correlation between total Zn and $CaCO_3$ content (r=-0.7229**). Similar results were obtained by Abdel Mottaleb et al., (1989), Abdel-Hamid et al. (1991) and Abdel-Razik (1999) who suggested that total Zn was high significant and positively correlated with clay %, silt % and O.M% and highly significant and negatively correlated with $CaCO_3$% and Soil pH. These relationships are represented graphically in Fig. (3).

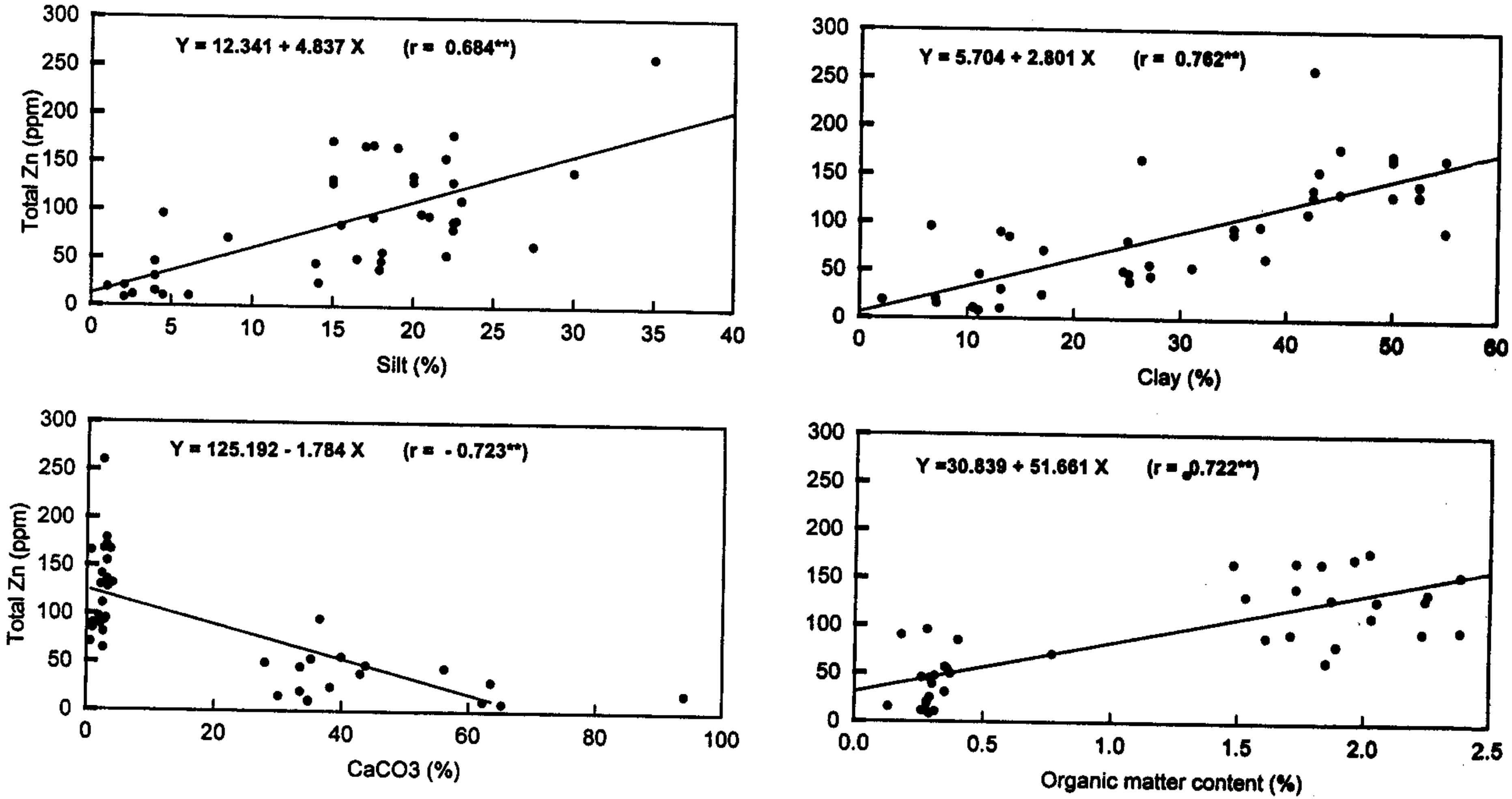


Fig. (3): Relationships between tota Zn and some soil properties.

4.3.4. Total Copper:

Table (3) represents the total Cu content of the soils under investigation. The obtained data show that total Cu ranges between 1.6 and 75 ppm in the calcareous soils. The highest value is detected in sample No. 12 (El-Hammam), which has a sandy clay texture, while the lowest one is found in sample No. 17 (King Maryot), which has a loamy sand textural grade. In the alluvial soils total Cu content ranges between 8 and 136 ppm. The highest value is observed in sample No. 37 (El-Shuhada) while the lowest one is obtained in sample No. 22 (Ashmun).

Variations in total Cu content among the studied soils are probably due to variations in soil texture, and organic matter content. It seems that the finer the texture and the higher the organic matter content, the higher is the total copper content of the soil.

The statistical analysis (Table, 4) shows positively highly significant correlations between total Cu and each of silt content (r= 0.5084**), clay content (r= 0.7497 **) and organic matter content (r=0.815**). On the other hand, there are negatively highly significant correlations between total Cu and each of sand content (r= -0.4534**) and $CaCO_3$ content (r= -0.6059**). Similar results were reported by Abdel-Kader (2000) who recorded positively highly significant correlations between total Cu and each of silt %, clay % and O.M%. On the other hand, negatively highly significant correlation were obtained between total Cu and both sand% and $CaCO_3$%. These relationships are represented graphically in Fig. (4).

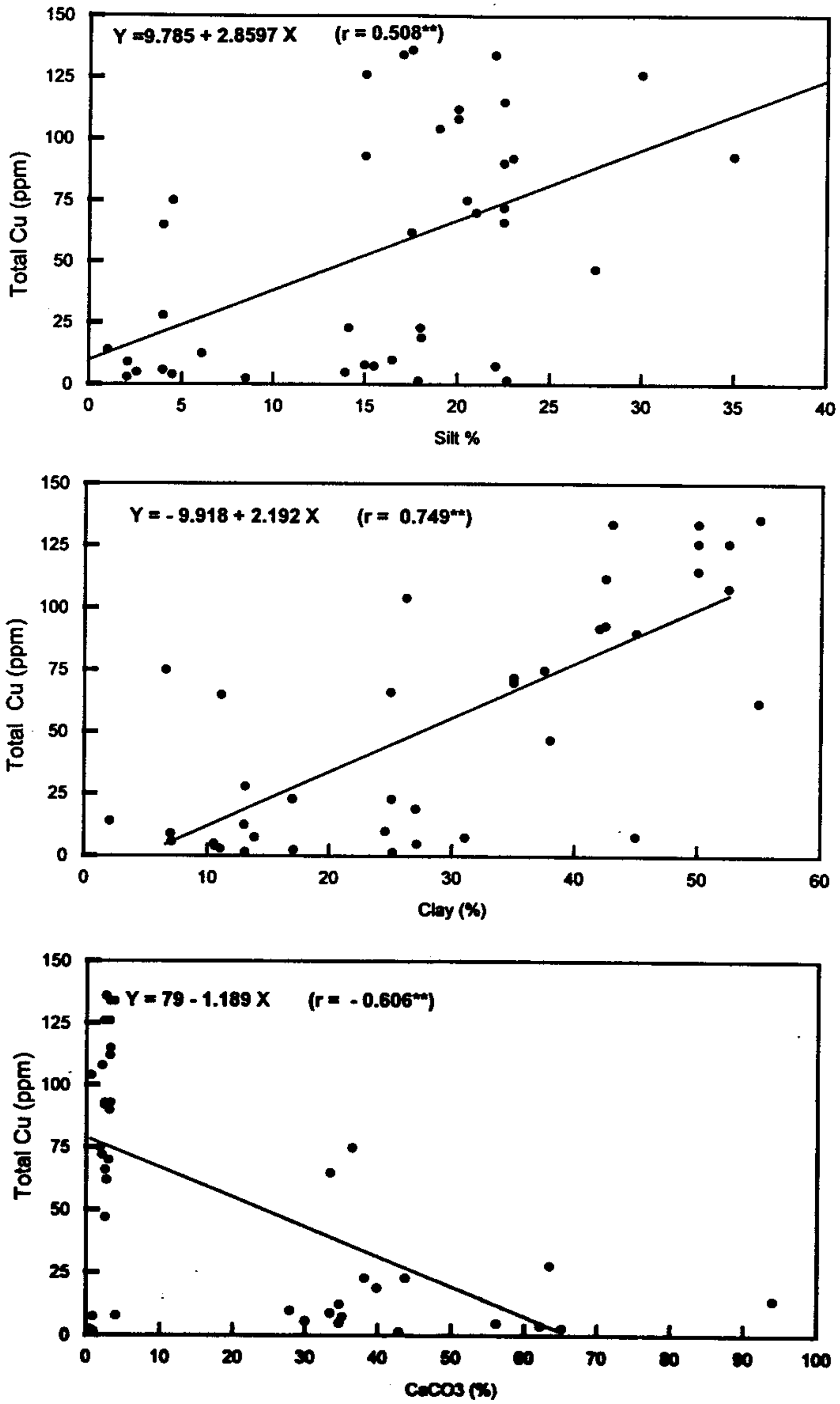
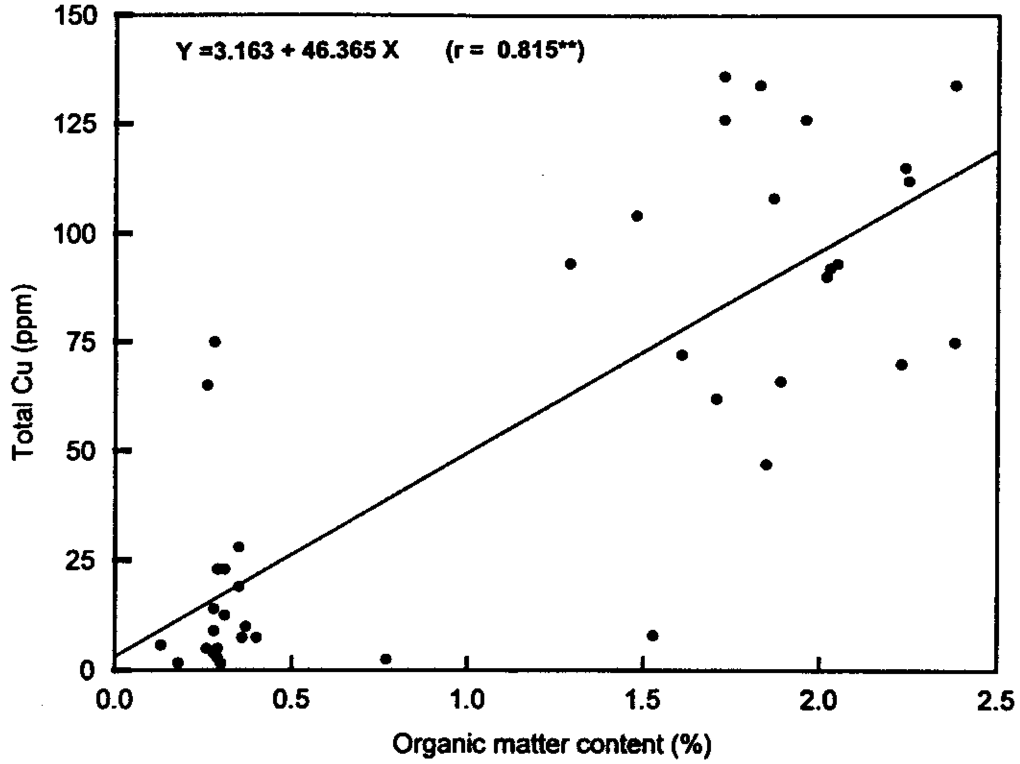


Fig. (4): Relationships between total Cu and some soil properties.


Y =3.163 + 46.365 X (r = 0.815**)
Total Cu (ppm)
150
125
100
75
50
25
0
0.0
0.5
1.0
1.5
2.0
2.5
Organic matter content (%)

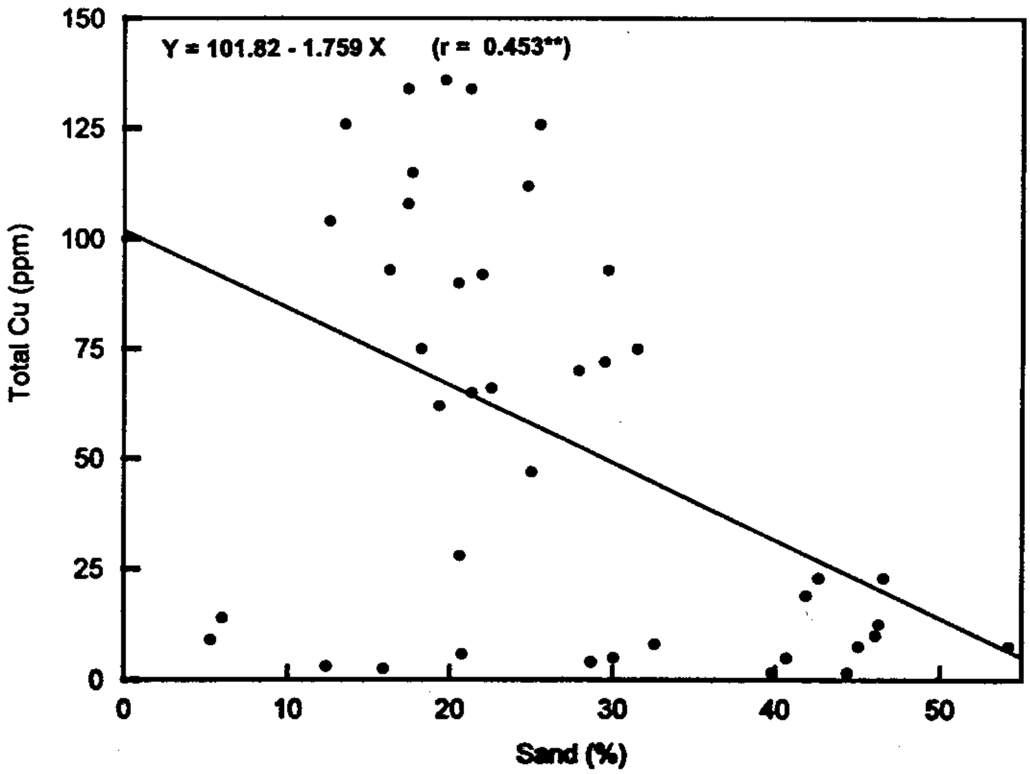

Y = 101.82 - 1.759 X (r = 0.453**)
Total Cu (ppm)
150
125
100
75
50
25
0
10
20
30
40
50
Sand (%)

Fig. (4): Cont.

4.4. Extraction of the available contents of the studied micronutrients :

Several methods have been proposed for the extraction of available manganese, zinc, copper and iron. The most important methods are DTPA, 0.1 N HCl solution , ammonium acetate of pH 7.0, 0.2% hydroquinon (H.Q) in ammonium acetate of pH 7.0 and distilled water.

4.4.1. Extraction of available Iron:

The total Fe content of temperate soils usually varies from about 1 to 5 percent (Bear, 1977). Values lower than one percent are usually found in acid coarse textured soils, in peat soils, and in the leached A horizon of podsolized soils . In most soils, Fe is bound mainly in the clay and silt fractions, (Nair and Cottenie, 1971). The total amount of Fe in soils is generally a very poor indicator of its availability to plants and deficiencies primarily due to low total content are rare. Peat soils, in general, are low in all nutrients also contain very small amounts of total Fe, this is because of their considerable thickness which prevents the surface horizons from having contact with the Fe (and other nutrients) containing ground water.

4.4.1.1. Extraction of available iron using DTPA:

Data illustrated in Table (5) represent the amounts of DTPA extractable iron from the studied soil samples. It is evident that extracted Fe ranges from 1.14 to 13.34 ppm in the calcareous soils. The lowest value is found in sample No. 1 (Borg El-Arab), it is most common in the calcareous soils as a lime induced Fe chlorosis. This soil has a high content of $CaCO_3$%, Table (2). The highest value is shown in sample No. 19 (Tamia), this may be attributed to its high content of organic matter (Table, 2). In the alluvial soils the data show that the values of available iron range from 0.24 to 11.80 ppm.

The lowest value is obtained in sample No. 24 (Minuf), this is due to its high pH value Table (1). The highest value is detected in sample No. 30 (Shibin El-Kom), this may be attributed to its heavy texture which is clay (Table, 2).

The statistical analysis (Table 4) shows positively highly significant correlations between DTPA - Ext. Fe and each of silt content (r= 0.5753**), clay content (r= 0.5408**) and organic matter content (r= 0.5247**). On the other hand, there is a highly significant negative correlation between DTPA - Ext. Fe and each of $CaCO_3$ content (r=-0.6465**) and pH (r= -0.4183**). These relationships are represented graphically in Fig. (5) and are in accordance with those of Kishk et al. (1980), Hafez et al (1992) and Abdel Kader (2000).

4.4.1.2. Extraction of available iron using dilute hydrochloric acid:

The results of iron soluble in dilute HCl of the calcareous soils are given in Table (5). The data show that soluble iron in the studied soil samples ranged from 0.04 to 0.70 ppm. The lowest value is found in samples No. 20 (Kom–Oshim). The highest value is detected in sample No. 6 (Dear Mina). The data in Table (5) also reveal a wide range of iron soluble in dilute HCl (from 0.04 to 0.60 ppm) in the alluvial soils. The lowest value is found in sample No. 22 (Ashmun), probably due to its high content of $CaCO_3$ (Table, 2). The highest value is obtained in sample No. 36 (Tala), this may be due to its high content of organic matter (Table, 2).

4.4.1.3. Extraction of available iron using ammonium acetate:

NH_4OAc–extractable Fe refers to the water soluble plus exchangeable fraction. Data in Table (5) show that the values of available iron vary from 0.1 to 1.5 ppm in the calcareous soils. The lowest value is detected in samples Nos. 1 and 19 (Borg El-Arab and Tamia), this result may be explained on the

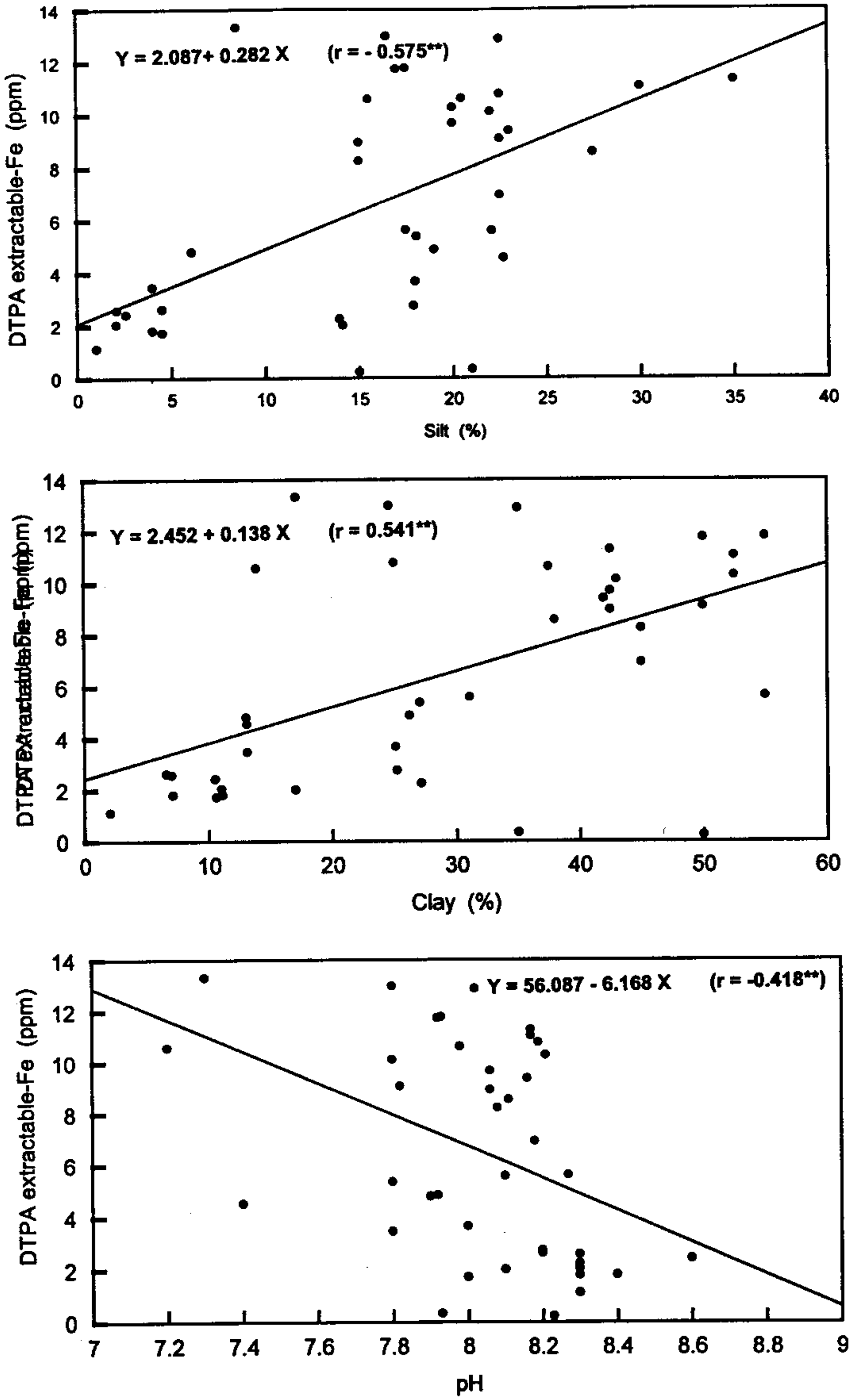
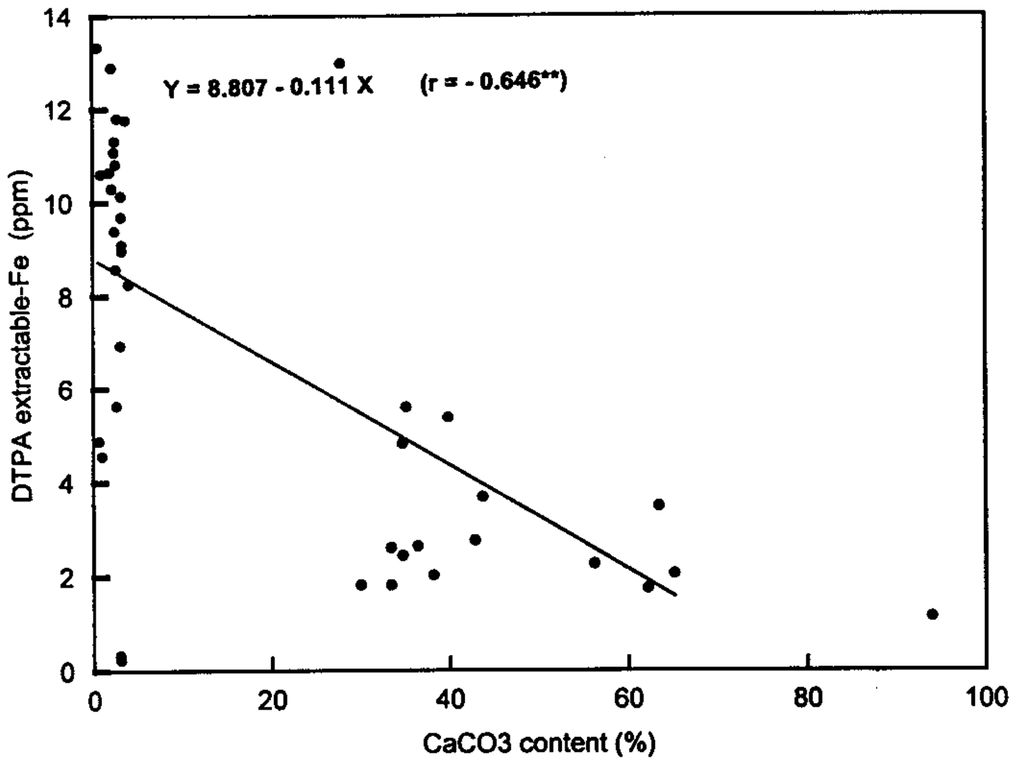


Fig. (5): Relationships between DTPA extracble Fe and some soil properties.


Y = 8.807 - 0.111 X (r = - 0.646**)
DTPA extractable-Fe (ppm)
CaCO3 content (%)
0
2
4
6
8
10
12
14
0
20
40
60
80
100

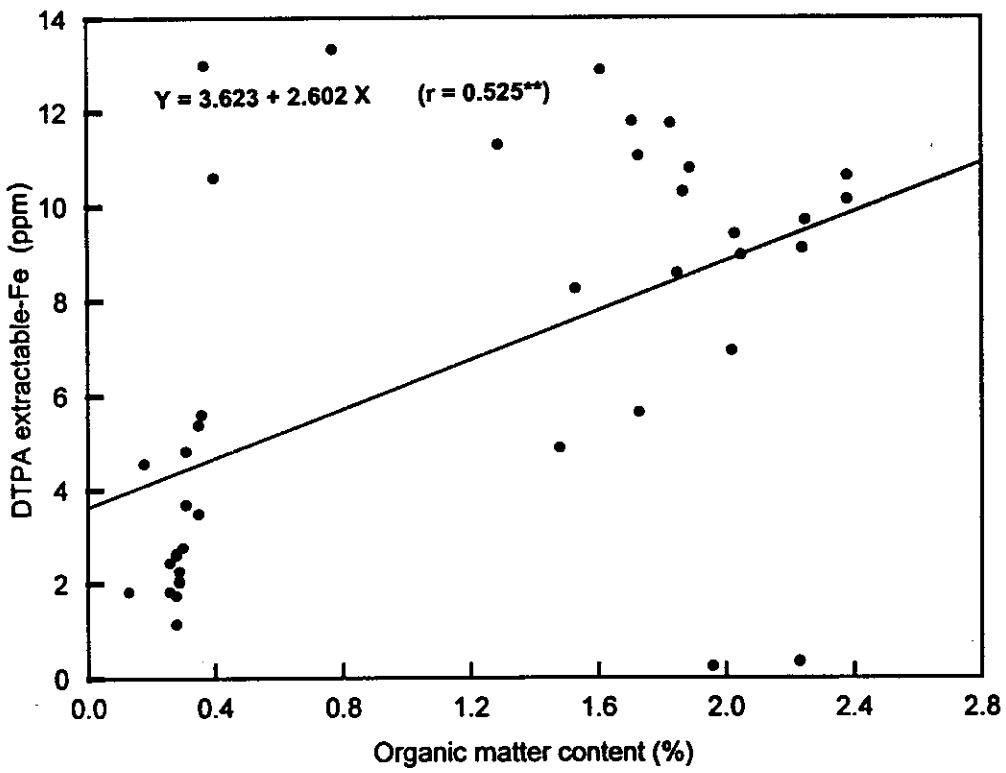

Y = 3.623 + 2.602 X (r = 0.525**)
DTPA extractable-Fe (ppm)
Organic matter content (%)
0
2
4
6
8
10
12
14
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8

Fig. (5): Cont.

basis that sample No1 contains high amount of $CaCO_3$ (Table, 2). The highest value is detected in sample No. 20 (Kom Oshim), this soil sample exhibit relatively high amount of silt (Table , 2). Data in Table (5) also show that the values of available iron extracted by ammonium acetate in the alluvial soil vary from 0.1 to 1.3 ppm. The lowest value is found in sample No. 31 (Quweisna), due to its high content of $CaCO_3$ (Table, 2). The highest value is detected in sample No. 37 (El-Shuhada), due to its high content of clay (Table, 2).

4.4.1.4. Extraction of available iron using NH_4OA_C $^+$hydroquinone:

Data in Table (5) show that the amounts of available iron in the calcareous soils range from 0.1 to 0.6 ppm. The lowest values are obtained in the samples Nos. 6, 8, 13, 16, 17 and 19 (Dear- Mina, El-Hammam, King – Maryout and Tamia). The highest value is observed in sample No. 10 (El-Hammam). In alluvial soils , data in Table (5) show that the values of available iron ranged between 0.1 to 0.5 ppm. The lowest values are found in samples Nos. 23 and 30 (Minuf and Shibin EL-Kom) while the highest value is observed in sample No. 35 (Tala).

The statistical analysis (Table 4) shows a significant negative correlation between NH_4OA_C+ hydroqunone - Ext. Fe and sand content (r= 0.3364*). This relationship is represented graphically in Fig. (6).

4.4.1.5. Extraction of available iron using distilled water:

The results of iron soluble in the distilled water of the calcareous soils are given in Table (5). The data show that soluble iron in these soil samples range from 0.45 to 4.45 ppm. The lowest value is detected in sample No. 17 (King Maryot). The highest value is found in sample No. 4 (Borg El-Arab). In alluvial soils, the data show that soluble iron ranges from 0.25 to 1.55 ppm.

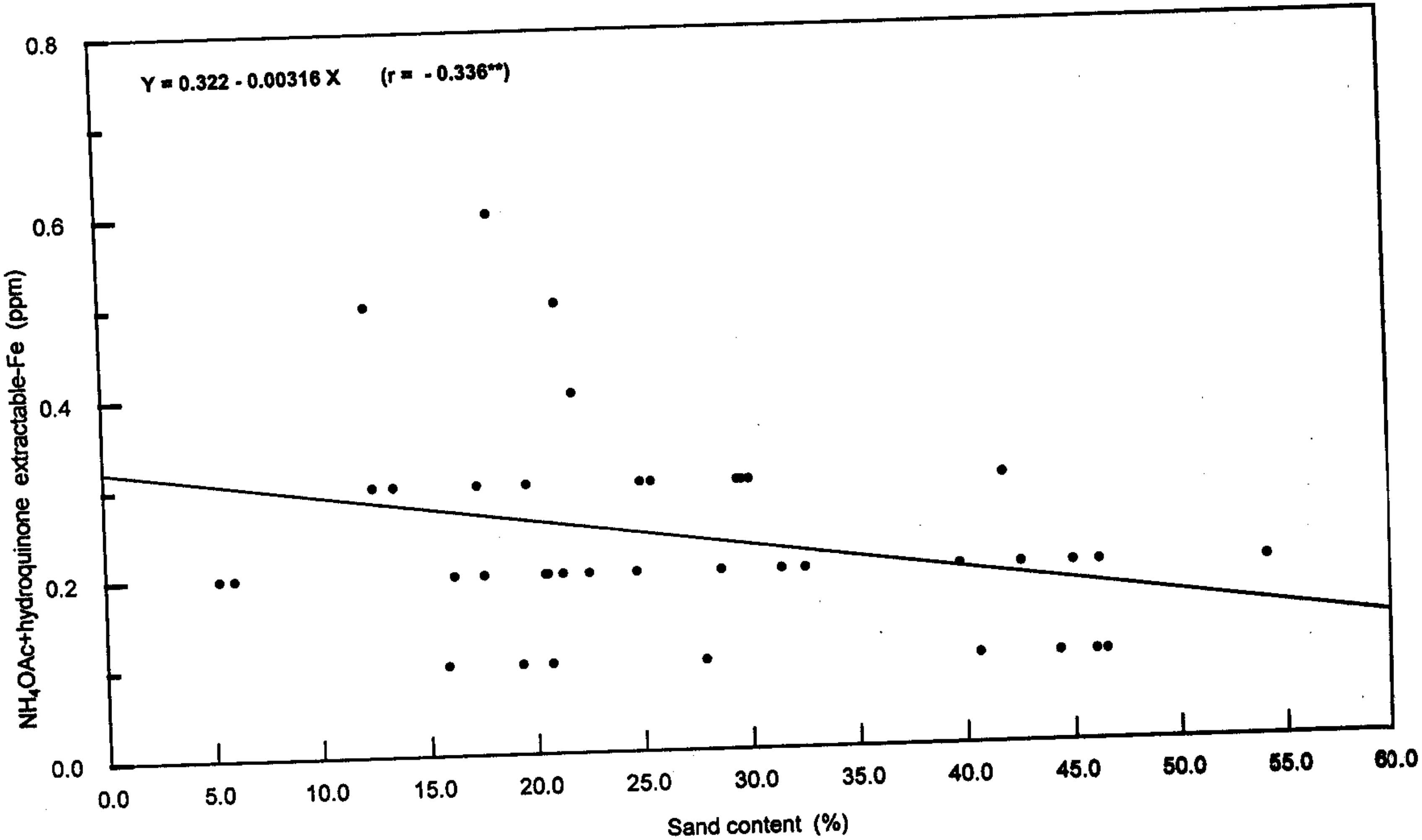


Fig. (6): Relationship between (NH_4OAc + hydroquinone) extractable- Fe and sand content of studied soils.

The lowest value is observed in sample No. 26 (El-Bagur). The highest value is found in sample No. 37 (El- Shuhada), this may be due to its texture which is clay (Table , 2) .

The statistical analysis (Table, 4) shows a positively highly significant correlation between Ext. Fe (H_2O) and $CaCO_3$ content (r= 0.4162**). This relationship is represented graphically in Fig. (7).

4.4.1.6. Efficiency (powerful) of the methods used for extracting available iron:

The techniques tested in this study for the extraction of soil available iron varied greatly. The results show that DTPA is the strongest extracting solution. Distilled water extraction gave available iron values more than those found by ammonium acetate, dilute hydrochloric acid and ammonium acetate + 0.2% hydroquinone. It is clear that ammonium acetate + 0.2% hydroqinone method gave the lowest values for determination of available iron.

The effectiveness of the extraction of available iron according to the values of the extracted iron is in the following order:

DTPA > H_2O > NH_4OAc > HCl > NH_4OAc + hydroquinone

4.4.2. Extraction of available manganese:

The availability of Mn is generally more dependent on pH than other trace elements. A reduction of exchangeable Mn content down to 1-50 to 1-20 of total Mn, due to liming has been reported (Christensesn et al., 1950). In addition, organic matter application to mineral soils increased the exchangeable Mn which is known to be available to plants (Christensen et al., 1950, Epstein and Stout, 1952; Sanchez and Kamprath, 1959). Abdel – Latif and Abdel Fattah, (1985), found that the addition of organic materials to

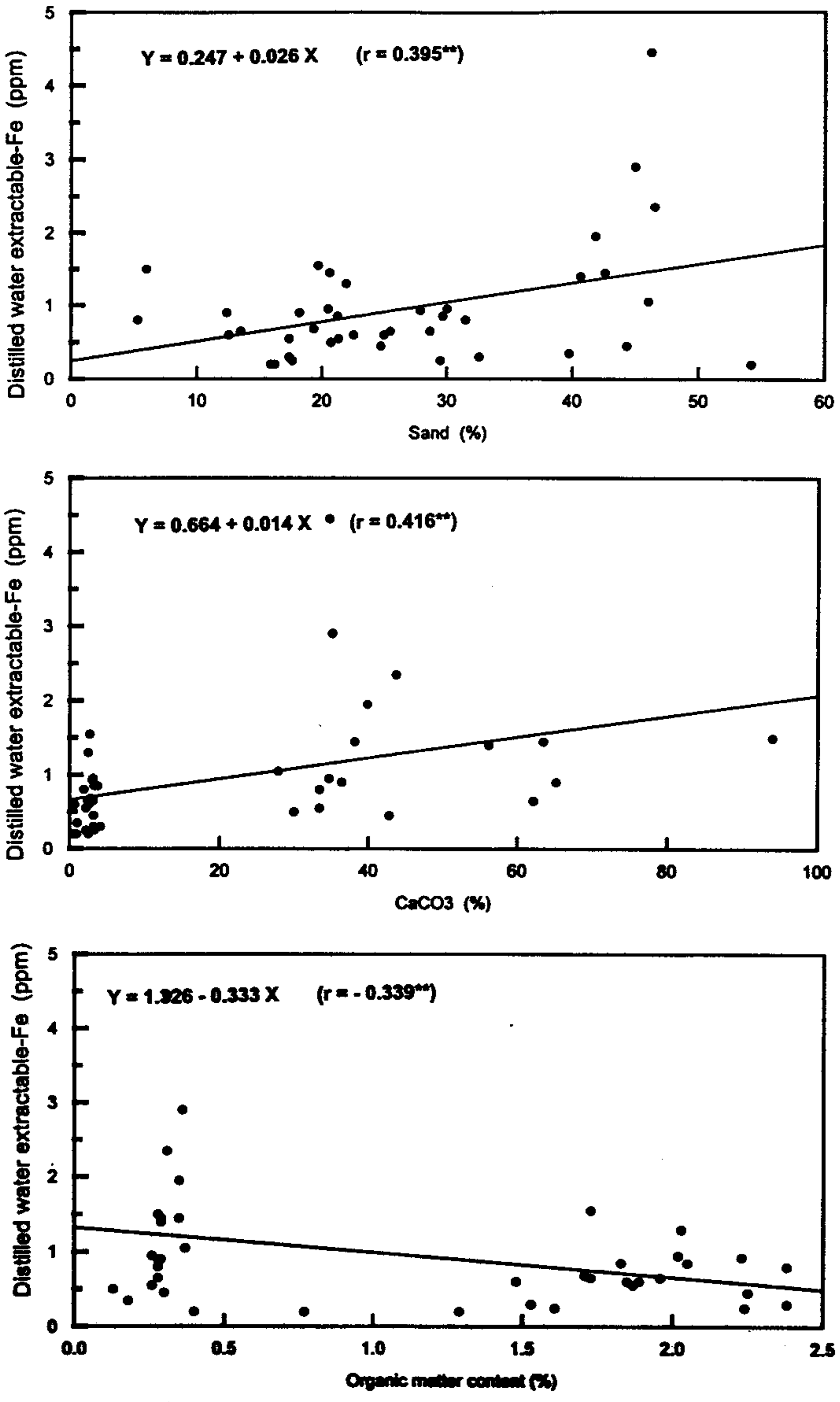


Fig. (7): Relationships between distilled water extractable-Fe and some soil properties.

calcareous soils, increased the available Mn. Total and soluble content of soil Mn mineral soils . Sandy, peat and other soils derived from calcareous materials often suffered from Mn deficiency , (Ryan, et al., 1967).

In order to determine available forms of Mn in soils using chemical methods, several proposed extractants were used. The convenience of extractant depends on its capability to extract all or a proportion of the nutrient element which is absorbable by plants.

Common procedures in current usage by the laboratories include manganese soluble in 0.005 M DTPA pH 7.3 (Lindsay and Nrovell 1978), 0.1 N HCl solution (Sorensen et al., 1971), ammonium acetate of pH 7.0 (Sherman et al., 1942), 0.2% hydroquinon in ammonium acetate of pH 7.0, (Sherman et al., 1942) and Distilled water (Page et al., 1963). Each extractant removes soil manganese by a specific mechanism .

4.4.2.1. Extraction of available manganese using DTPA:

The results of manganese soluble in DTPA from the soils under consideration are given in Table (6). The data show that soluble manganese in the calcareous soils ranges from 2.30 to 22.28 ppm. The lowest value is found in sample No. 6 (Dear-Mina), this is may be attributed to the high pH (Table, 1) which reduces availability of Mn. The highest value is shown by sample No. 5 (Bahig), because of its high content of clay (Table, 2) which is one of the factors related to the available content of Mn. In the alluvial soils, the data show that the values of available manganese range from 6.20 to 19.12 ppm. The lowest value is obtained in sample No. 28 (Shibin El-Kom) due to its relatively high pH value (Table, 1). The highest value is found in sample No. 34 (Tala), this may be attributed to the low content of $CaCO_3$ (Table 2) which reduces on the availability of Mn. Similar partially results

Table (6): Extractability of available manganese using different methods.of extraction .

Sample No.	Location	Soil type	Depth (cm)	Extractable manganese (ppm) using				
				DTPA	0.1 N HCl	NH_4 OAc pH7	NH_4 OAc+ 0.2% hydroquinone	Distilled water
1	Borg El-Arab	Calcareous	0-20	3.52	2.80	2.90	0.60	0.25
2	"	"	0-20	11.00	0.75	5.00	44.80	0.25
3	"	"	0-20	13.16	0.30	12.50	24.80	0.10
4	"	"	0-20	11.94	10.60	11.00	32.20	0.20
5	Bahig	"	0-15	22.28	0.25	21.00	53.90	0.35
6	Dear Mina	"	0-20	2.30	0.80	1.80	15.90	0.20
7	"	"	0-20	5.30	0.20	1.20	19.90	0.25
8	"	"	0-25	6.02	0.25	0.90	8.30	0.50
9	El- Hammam	"	0-20	3.40	0.30	1.30	6.00	0.15
10	"	"	0-20	3.32	4.00	6.50	10.60	0.10
11	"	"	0-20	2.40	0.40	1.80	19.00	0.15
12	"	"	0-20	2.82	0.20	1.90	11.50	0.10
13	"	"	0-20	2.38	4.90	1.40	18.10	0.15
14	"	"	0-15	5.32	1.90	2.20	4.90	0.10
15	"	"	0-20	4.72	4.90	1.50	7.20	0.15
16	King Maryot	"	0-25	13.76	0.10	1.10	63.10	0.10
17	"	"	0-25	6.28	0.10	1.40	7.90	0.50
18	Tamia	"	0-15	8.80	1.90	7.50	9.50	0.10
19	"	"	0-15	9.64	4.00	8.50	15.50	0.20
20	Kom Oshim	"	0-15	8.56	1.00	4.80	15.90	0.14
21	Ashmun	Alluvial soils	0-20	12.86	27.60	6.00	60.00	0.20
22	"	"	0-25	13.04	10.80	2.20	62.00	0.15
23	Minuf	"	0-25	12.64	29.20	4.00	70.00	0.10
24	"	"	0-25	14.20	32.10	4.20	66.00	0.15
25	El- Bagur	"	0-25	10.00	25.30	2.10	64.10	0.10
26	"	"	0-25	11.00	33.05	4.10	69.10	0.10
27	"	"	0-25	10.12	35.10	8.70	70.00	0.15
28	Sh. El-Kom	"	0-25	6.20	30.75	2.10	84.00	0.15
29	"	"	0-25	11.48	37.10	1.90	78.90	0.25
30	"	"	0-25	9.60	37.10	41.40	65.00	0.20
31	Quweisna	"	0-25	9.90	38.90	5.50	62.40	0.10
32	B. El-Sabe	"	0-25	10.20	13.00	2.40	81.90	0.10
33	"	"	0-25	6.24	17.00	3.40	80.00	0.10
34	Tala	"	0-25	19.12	12.00	18.90	81.00	0.10
35	"	"	0-25	15.37	28.55	10.10	74.00	0.15
36	El-Shuhada	"	0-25	14.88	35.20	9.30	69.00	0.10
37	"	"	0-25	10.78	32.15	10.50	78.00	0.10
38	"	"	0-25	16.19	35.10	14.70	82.00	0.10
39	"	"	0-25	13.28	31.05	11.20	81.00	0.05
40	El-Sadat	"	0-20	13.60	35.05	8.70	70.90	0.10

0

were reported by Hassanain et al . (1980) who found that the amount of DTPA extract able Mn by in some Egyptian soils ranged between 14 to 36.1 ppm.

The statistical analysis (Table, 4) shows positively highly significant correlations between DTPA extractable-Mn and each of silt content (r= 0.5457**), clay content (r= 0.5915**) and organic matter content (r= 0.4878**). On the other hand, there is a negatively highly significant correlation between DTPA extractable-Mn and $CaCO_3$ content (r= 0.5125**). These results are in agreement with those obtained by Tantawy (1966) who reported significant positive correlations between silt %, clay % and organic matter % and DTPA extractable-Mn. These relationships are represented graphically in Fig. (8).

4.4.2.2. Extraction of available manganese using dilute hydrochloric acid:

The results of manganese soluble in dilute HCl in the calcareous soils are given in Table (6). The data show that soluble manganese in the soil samples varies from 0.20 to 4.90 ppm. The lowest value is found in samples Nos. 7 and 12 (Dear–Mina and El-Hammam), which are of high pH values (Table, 1). The highest values are detected in samples Nos. 13 and 15 (EL-Hammam) this is due to its texture which is loamy sand (Table, 2). The data in Table (4) also reveal a wide range of manganese soluble in dilute HCl extraction of the alluvial soils (from 10.820 to 38.90 ppm). The lowest value is found in sample No. 22 (Ashmun), probably due to its high content of $CaCO_3$ content (Table, 2). The highest value is detected in sample No. 31 (Quweisna), due to its high content of clay (Table, 2). Abdel-Hamid (1984) reported similar results, he found that available Mn extractable by 0.1 N HCl ranged from 5.5 to 219 ppm in the alluvial soils.

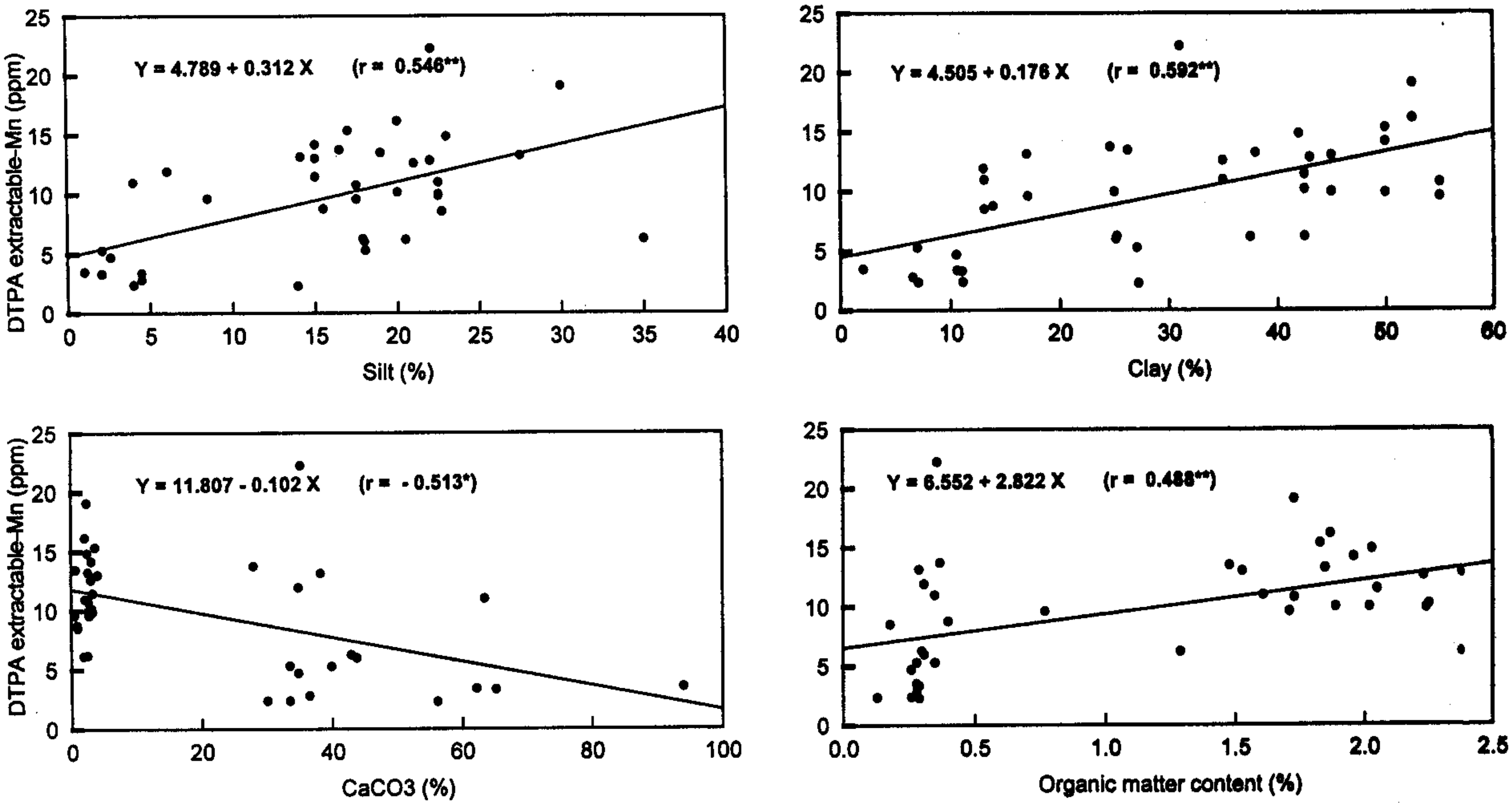


Fig. (8): Relationships between DTPA extractable-Mn and some soil properties.

The statistical analysis (Table 4) shows positively highly significant correlations between HCl extractable-Mn and each of silt content (r = 0.5173**), clay content (r= 0.7409**) and organic matter content (r= 0.8928**). On the other hand, there is a negatively highly significant correlation between HCl extractable-Mn and $CaCO_3$ content (r= -0.6894**) and negatively significant correlation between HCl extractable-Mn and sand content (r= -0.3561*). These relationships are represented graphically in Fig. (9).

4.4.2.3. Extraction of available manganese using ammonium acetate.

The values of available manganese extracted by ammonium acetate vary from 0.9 to 21.0 ppm in the calcareous soils (Table, 6). The lowest value is detected in sample No. 8 (Dear – Mina) . The lowest amount in the calcareous soils could be due to the presence of relatively high amounts of calcium carbonate which could render Mn in an unavailable form as a result of the formation of Mn carbonate (Table, 2). The highest value of available manganese in calcareous soils is obtained in sample No. 5 (Bahig). This may be due to its high content of O.M. (Table, 2). Data in Table (5) show that the values of available manganese are high in the alluvial soils vary widely from 1.9 to 18.9 ppm. (Similar result was obtained by Mulder and Gerretsen, (1952), . The lowest value is detected in sample No. 29 (Shibin El-Kom), this may be due to , this soil exhibit high amount of $CaCO_3$ content (Table 2). The highest value is found in sample No. 34 (Tala), due to , its high content of clay (Table 2).

The statistical analysis (Table 4) shows a positively significant correlation between (NH_4 OAc) extractable-Mn and clay content (r= 0.3892*). This relationship is represented graphically in Fig. (10).

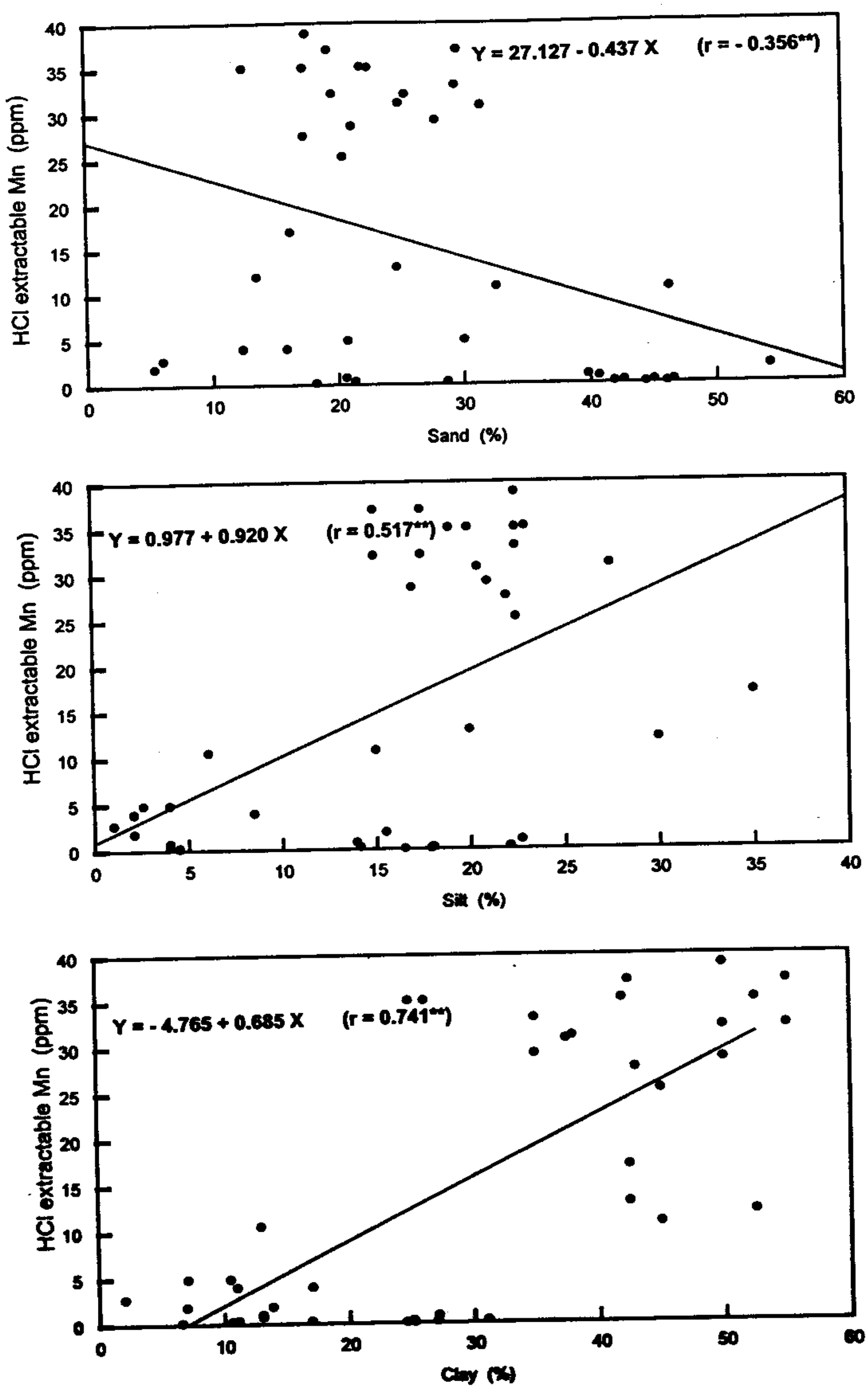
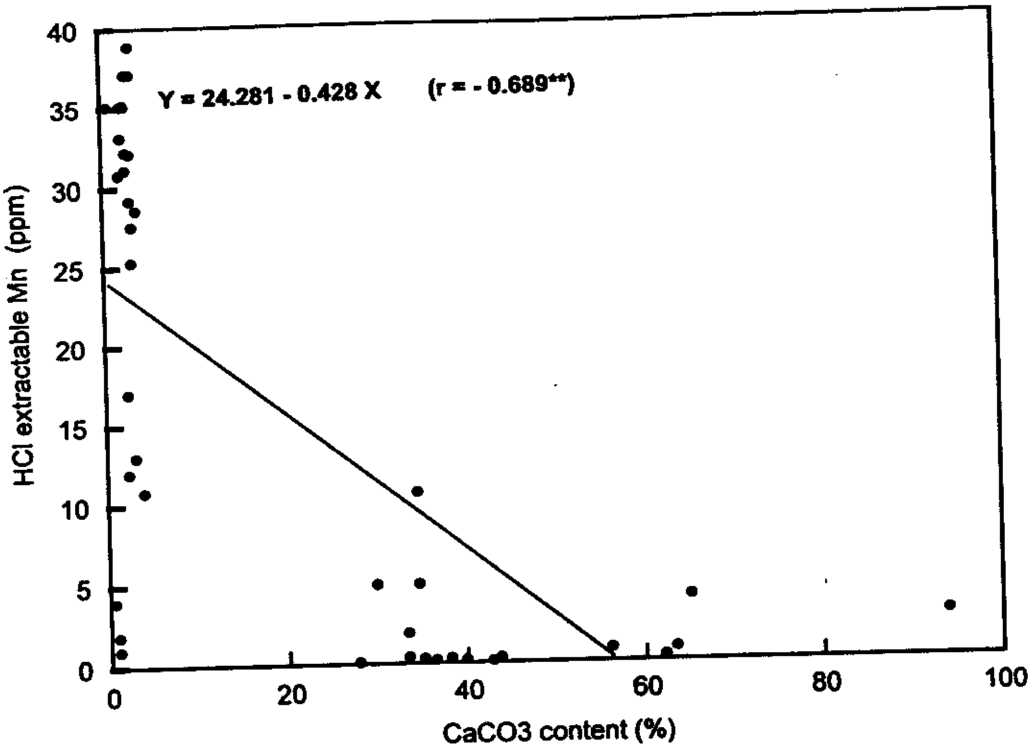


Fig. (9): Relationships between HCl extracble-Mn and some soil properties.


Y = 24.281 - 0.428 X (r = - 0.689**)
HCl extractable Mn (ppm)
CaCO3 content (%)
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100

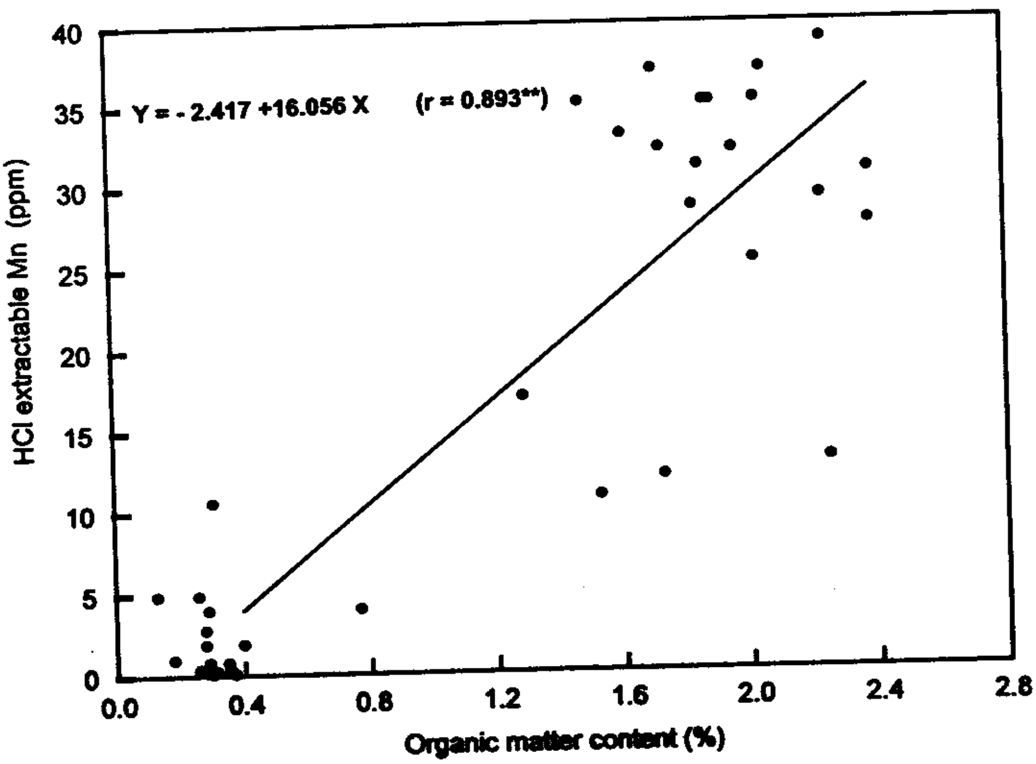

Y = - 2.417 +16.056 X (r = 0.893**)
HCl extractable Mn (ppm)
Organic matter content (%)
0
5
10
15
20
25
30
35
40
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8

Fig. (9): Cont.

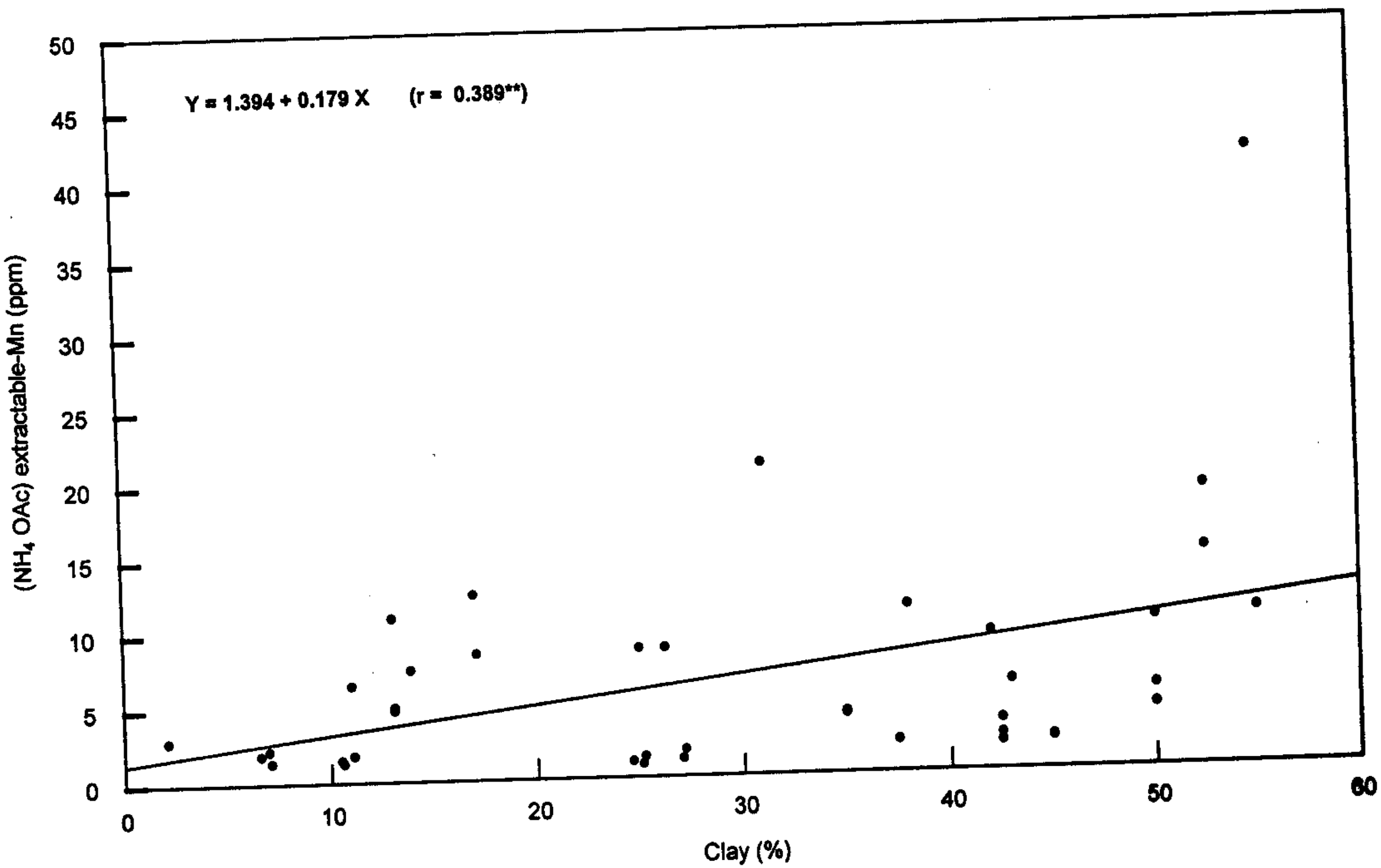


Fig. (10): Relationship between (NH_4 OAc) extractable-Mn and clay content.

4.4.2.4. Extraction of available manganese using hydroquinon:

Hydroquinon- extractable Mn refers to the easily reducible fraction. Data in Table (6) show that the amounts of Mn extracted by this method in all the studied soils range widely from 0.6 to 84.0 ppm. The highest value is found in the alluvial soils (sample No. 28- Shibin el-Kom), and the lowest value is detected in the calcareous soils (sample No. 1 – Borg El- Arab). In the calcareous soils the values of available manganese range from 0.6 to 63.1 ppm. The lowest value is found in sample No. 1 (Borg El- Arab). This may be due to its a high content of $CaCO_3$ (Table, 2). The highest value is obtained in sample No. 16 (King – Maryot). This is may be attributed to its texture which is sandy clay loam (Table, 2). In the alluvial soils, the hydroquinone extractable Mn values vary from 60.0 to 84.0 ppm. The lowest value is found in sample No. 21 (Ashmun). This is may be due to its a high amount of coarse sand (Table 2). The highest value is detected in sample No. 28 (Shibin El-Kom), this is due to its high content of organic matter (Table, 2). These results are in accordance with those reported by Taha (1980) and El-Sayad (1988) on some soils of Egypt .

The statistical analysis (Table 4) shows positively highly significant correlations between hydroquinone extractable -Mn and each of silt (r= 0.7074**), clay content (r= 0.8393**) and organic matter content (r= 0.8694**). On the other hand, there is a negatively highly significant correlation between (Hydroquinone) Extractable-Mn and $CaCO_3$ content (r= -0.7137**). These relationships are represented graphically in Fig. (11).

4.4.2.5. Extraction of available manganese using distilled water.

The results of manganese soluble in distilled water of the calcareous soils are given in Table (6). The data show that soluble manganese in the

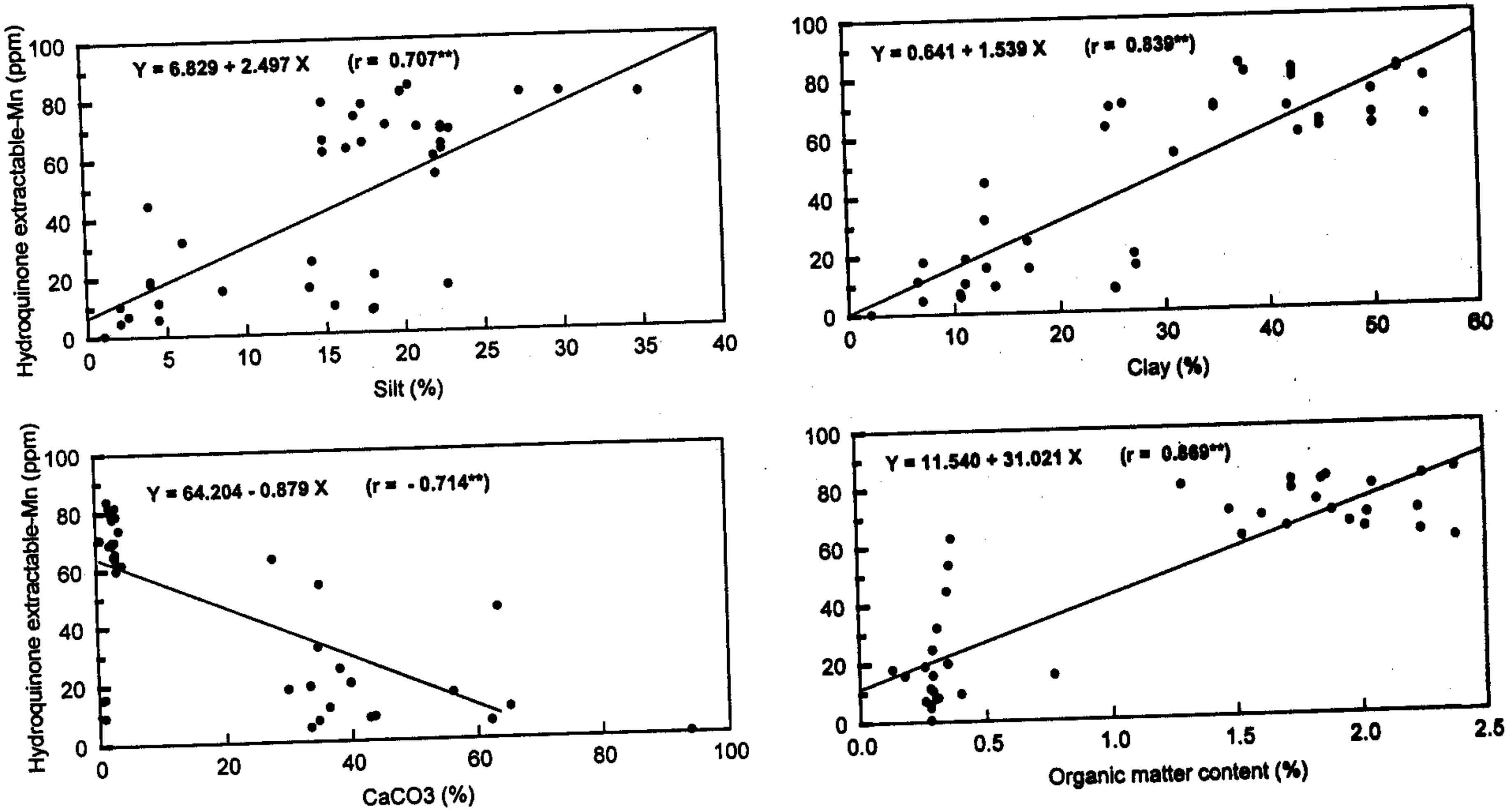


Fig. (11): Relationships between (hydroquinone) extractable-Mn and some soil properties.

studied soil samples ranges from 0.10 to 0.35 ppm. The lowest value is found in samples Nos. 3, 10, 12, 14, 16 and 18 (Borg El-Arab, El-Hammam, King Maryot and Tamia). This is due to their high pH value (Table - 1). The highest value is obtained in sample No.5 (Bahig). This is may be attributed to, its high amount of organic matter. In the alluvial soils the data show that soluble manganese ranges from 0.05 to 0.25 ppm. The lowest value is found in sample No. 39 (El-Shuhada), which is of high pH value (Table, 1). The highest value is detected in sample No. 29 (Shibin El-Kom) (Table 2). These results agreed with the data obtained by Abdel-Hamid (1984) and Hegazy et al. (1991).

The statistical analysis (Table, 4) shows positively highly significant correlations between (H_2O) extractable-Mn and each of sand content (r= 0.4219**) and $CaCO_3$ content (r= 0.4306**). On the other hand, there is a negatively significant correlation between H_2O extractable-Mn and organic matter (r= -0.3298*). These relationships are represented graphically in Fig. (12).

4.4.2.6. Efficiency (powerful) of the methods Used for extracting available Manganese :

It is clear from the data in Table (6), that the methods under investigation extracted different amounts of available manganese. The results show that 0.2% hydroquinone in ammonium acetate of pH 7.0 extraction method extracted more available manganese from all the studied samples than the other methods used for extracting manganese from the calcareous soils. Efficiency of extraction of manganese in this calcareous soils was generally in the order.

NH_4OA_c + Hydroquinone > DTPA > NH_4OA_c > HCl > distilled water

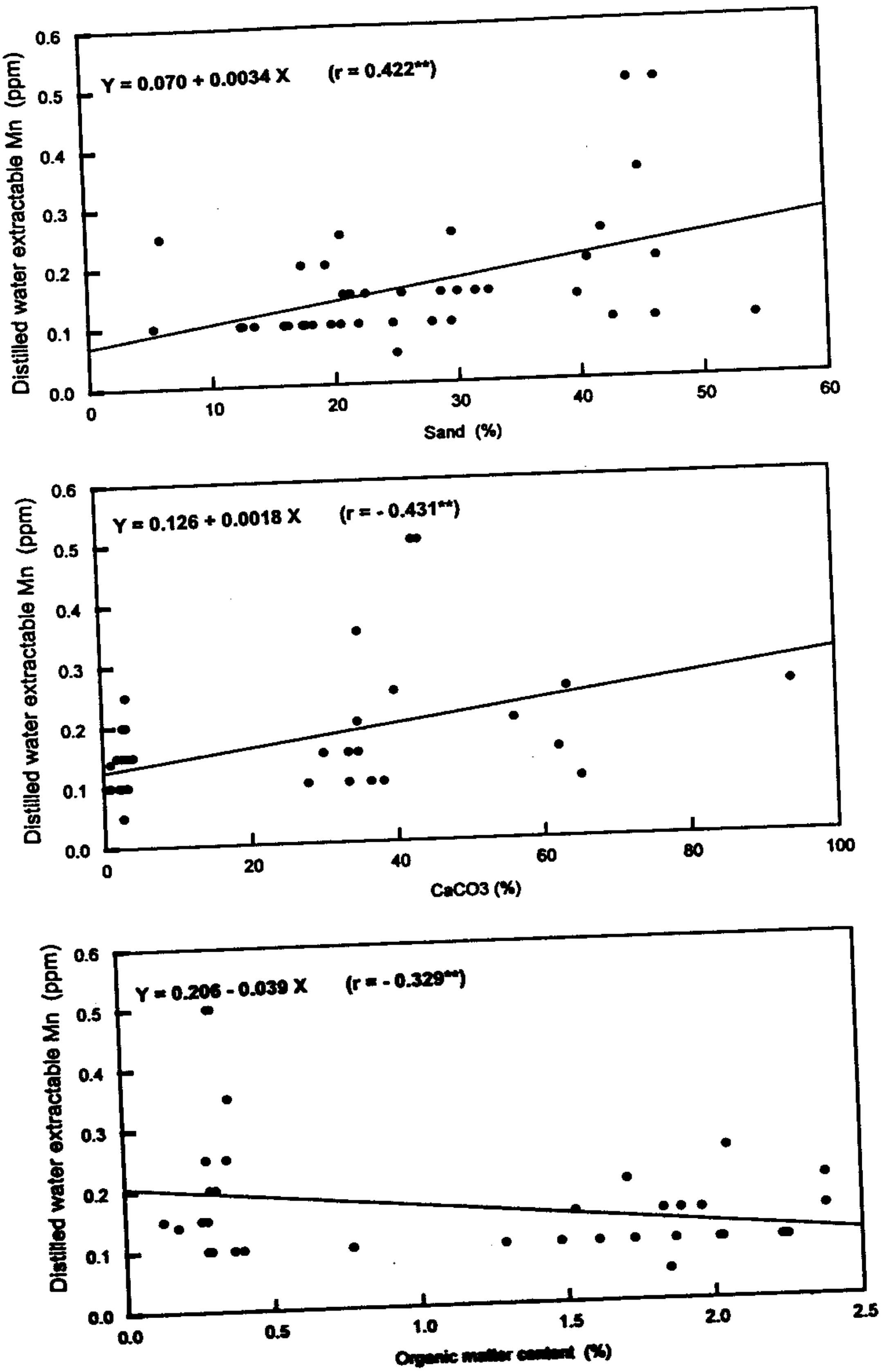


Fig. (12): Relationships between H_2O extracable Mn and some soil properties.

With respect to the alluvial soils, the results show that 0.2% hydroquninone in ammonium acetate extracted more available manganese than did the other methods. On other hand, HCl extraction method gave available manganese values more than those obtained by DTPA, NH_4OAc and distilled water. It is clear that the distilled water extraction method gave the lowest values for available manganese. The comparison between the used methods for extracting manganese in soils showed that the effectiveness of the extraction was usually in the order:

NH_4OAc + hydroquinone > HCl > DTPA > NH_4OAc > H_2O

4.4.3. Extraction of available zinc:

Soil pH can markedly affect the availability and consequently the plant uptake of trace elements. The decrease in acidity reduces the solubility and uptake of Zn. Zech, (1984) showed that Zn availability was reduced by increased soil pH and Ca^{2+} activity. Viets et al., (1957) found that Zn uptake of plants decreased to about one half when the pH of the soil was increased from 5 to 7. At high pH Zn may be less available. Liming of acid soils decreases the availability of Zn and may produce Zn deficiency (Thorne et al., 1951). On the other hand, Zn toxicity may result when Zn fertilization is continued over a long period with Zn rich materials. Patel and Dangarwala, (1984), showed that available Zn content was positively correlated with organic matter content. Sorensen, et al., (1971), reported a positive correlation between extractable Zn and organic matter content ranging from 0.4 to 2.2 percent. Jensen and Lamm, (1961), found that relative solubility of Zn is much in organic than in mineral soils. Calcium carbonate content in calcareous soils has been found to have only a minor effect on Zn availability.

4.4.3.1. Extraction of available zinc using DTPA:

The results of zinc soluble in DTPA in the soils under consideration are given in Table (7). The data show that its in calcareous soils ranges from 0.32 to 10.52 ppm.

The lowest value is found in sample No. 7 (Dear – Mina), this is may be attributed to the high pH (Table 1). The highest value is shown in sample No. 4 (Borg El-Arab). In the alluvial soils the data show that the values of DTPA- extractable -Zn range from 0.62 to 3.24 ppm. The lowest value is obtained in sample No. 21 (Ashmun). The highest value is found in sample No. 29 (Shibin El- Kom).

The statistical analysis (Table 4) shows a positively highly significant correlation between of DTPA-extricable-Zn and EC (r= 0.4928**). This relationship is represented graphically in Fig. (13).

4.4.3.2. Extraction of available zinc using dilute hydrochloric acid:

In Table (7), the data show that soluble zinc in the soil samples vary from 0.04 to 0.5 ppm in the calcareous soils. The lowest value is found in samples Nos. 4, 11, 12 and 17 (Borg El-Arab, El-Hammam and King Maryot), which are of high pH values (Table, 1). The highest value is detected in sample No. 20 (Kom Oshim). The data in Table (5) also reveal that zinc soluble in dilute Hcl ranges from 0.05 to 0.65 ppm. in the alluvial soils. The lowest value is found in sample Nos. 21 and 26 (Ashmun and El-Bagur), due to their high pH values. The highest value is detected in sample No. 38 (El-Shuhada).

The statistical analysis (Table, 4) shows positively highly significant correlations between HCl extractable-Zn and each of silt content (r=

Table (7): Extractability of available zinc using different methods of extraction .

Sample No.	Location	Soil type	Depth (cm)	Extractable zinc (ppm) using				
				DTPA	0.1 N HCl	NH_4 OAc pH7	NH_4 OAc+ 0.2% hydroquinone	Distilled water
1	Borg El-Arab	Calcareous	0-20	2.52	0.05	2.10	1.00	0.05
2	"	"	0-20	2.56	0.05	2.20	1.80	0.05
3	"	"	0-20	2.30	0.05	1.70	1.20	0.04
4	"	"	0-20	10.52	0.04	10.10	9.30	0.15
5	Bahig	"	0-15	1.30	0.05	0.80	0.40	0.10
6	Dear Mina	"	0-20	0.38	0.05	0.20	0.10	0.05
7	"	"	0-20	0.32	0.05	0.20	0.10	0.10
8	"	"	0-25	0.98	0.05	0.40	0.20	0.10
9	El- Hammam	"	0-20	0.92	0.05	0.60	0.50	0.05
10	"	"	0-20	0.94	0.10	0.60	0.30	0.05
11	"	"	0-20	1.82	0.04	1.40	1.20	0.10
12	"	"	0-20	0.72	0.04	0.60	0.40	0.17
13	"	"	0-20	0.80	0.10	0.70	0.10	0.04
14	"	"	0-15	0.96	0.05	0.80	0.70	0.04
15	"	"	0-20	1.02	0.05	0.80	0.60	0.05
16	King Maryot	"	0-25	0.88	0.15	0.60	0.10	0.05
17	"	"	0-25	0.58	0.04	0.40	0.10	0.04
18	Tamia	"	0-15	0.86	0.20	0.70	0.30	0.15
19	"	"	0-15	2.40	0.30	0.90	0.80	0.30
20	Kom Oshim	"	0-15	2.28	0.50	1.10	0.90	0.03
21	Ashmun	Alluvial soils	0-20	0.62	0.05	0.50	0.20	0.10
22	"	"	0-25	1.38	0.40	1.10	0.90	0.05
23	Minuf	"	0-25	1.84	0.10	0.80	0.60	0.10
24	"	"	0-25	2.76	0.15	0.90	0.30	0.15
25	El- Bagur	"	0-25	0.98	0.05	0.80	0.10	0.15
26	"	"	0-25	0.92	0.15	0.70	0.10	0.05
27	"	"	0-25	1.22	0.40	0.90	0.60	0.05
28	Sh. El-Kom	"	0-25	1.62	0.15	0.90	0.10	0.05
29	"	"	0-25	3.24	0.50	1.00	0.80	0.10
30	"	"	0-25	2.26	0.20	0.90	0.50	0.04
31	Quweisna	"	0-25	2.48	0.20	1.00	0.40	0.10
32	B. El-Sabe	"	0-25	2.20	0.25	1.10	0.30	0.05
33	"	"	0-25	0.94	0.45	0.80	0.50	0.75
34	Tala	"	0-25	1.68	0.20	1.00	0.40	0.05
35	"	"	0-25	1.88	0.25	1.20	0.60	0.05
36	El-Shuhada	"	0-25	1.82	0.45	0.90	0.50	0.05
37	"	"	0-25	1.56	0.15	1.30	0.30	0.05
38	"	"	0-25	2.93	0.65	1.60	0.80	0.05
39	"	"	0-25	1.04	0.70	0.70	0.60	0.04
40	El-Sadat	"	0-20	0.20	1.40	1.40	0.30	0.04

0

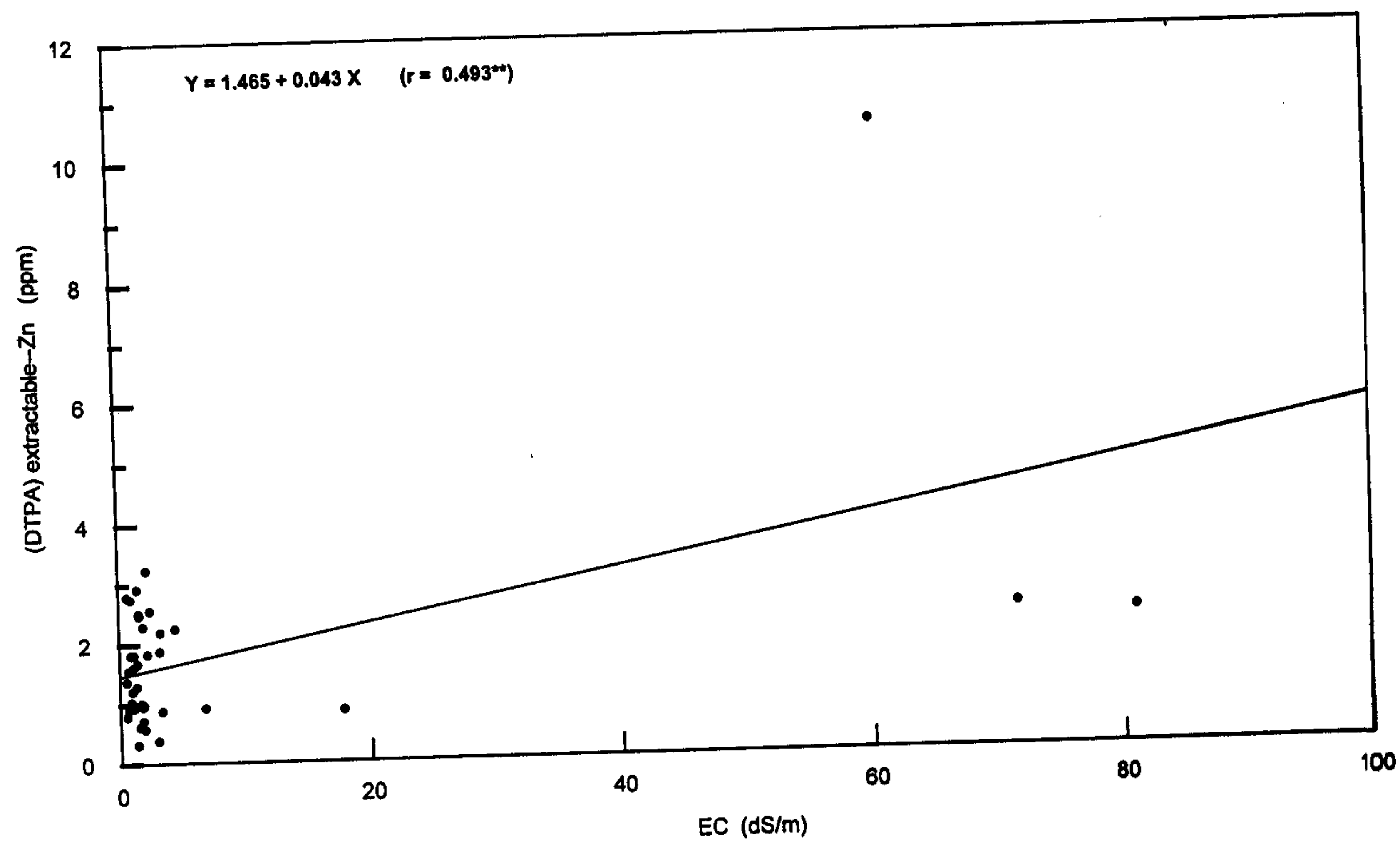


Fig. (13): Relationships between (DTPA) extractable-Zn and EC of the studied soils.

0.4542**), clay content (r= 0.4269**) and organic matter content (r= 0.4352**). On the other hand a negatively highly significant correlation between (HCl) extractable-Zn and $CaCO_3$ content (r= -0.5877**). Thise results are in agreement with those obtained by Tantawy (1966). These relationships are represented graphically in Fig. (14).

4.4.3.3. Extraction of available zinc using ammonium acetate:

Table (7) shows that available zinc extracted by ammonium acetate varies from 0.20 to 10.1 ppm in the calcareous soils. The lowest value is detected in samples Nos. 6 and 7 (Dear – Mina) due to the presence of relatively high amounts of calcium carbonate which could render Zn in an unavailable form (Table, 2). The highest value of available zinc in calcareous soils is obtained in sample No. 7 (Borg El-Arab). Data in Table (6) show that the values of available zinc in the alluvial soils vary from 0.5 to 1.6 ppm. The lowest value is detected in sample No. 21 (Ashmun), this is may be due to, this soil exhibits high $CaCO_3$ content (Table 2). The highest value is found in sample No. 38 (El- Shuhada), This is attributed to its high content of clay (Table, 2).

The statistical analysis (Table 4) shows a positively highly significant correlation between (NH_4OA_C) extractable-Zn and EC (r= 0.4407**). This relationship is represented graphically in Fig. (15).

4.4.3.4. Extraction of available zinc using ammonium acetate and hydroquinone

Data in Table (7) show the amounts of zinc extracted by this method. In the calcareous soils, the values of available zinc range from 0.1 to 9.3 ppm. The lowest value is found in samples Nos. 6, 7, 13, 16 and 17 (Dear – Mina, El-Hammam and King –Maryot). This is may be due to these soil high

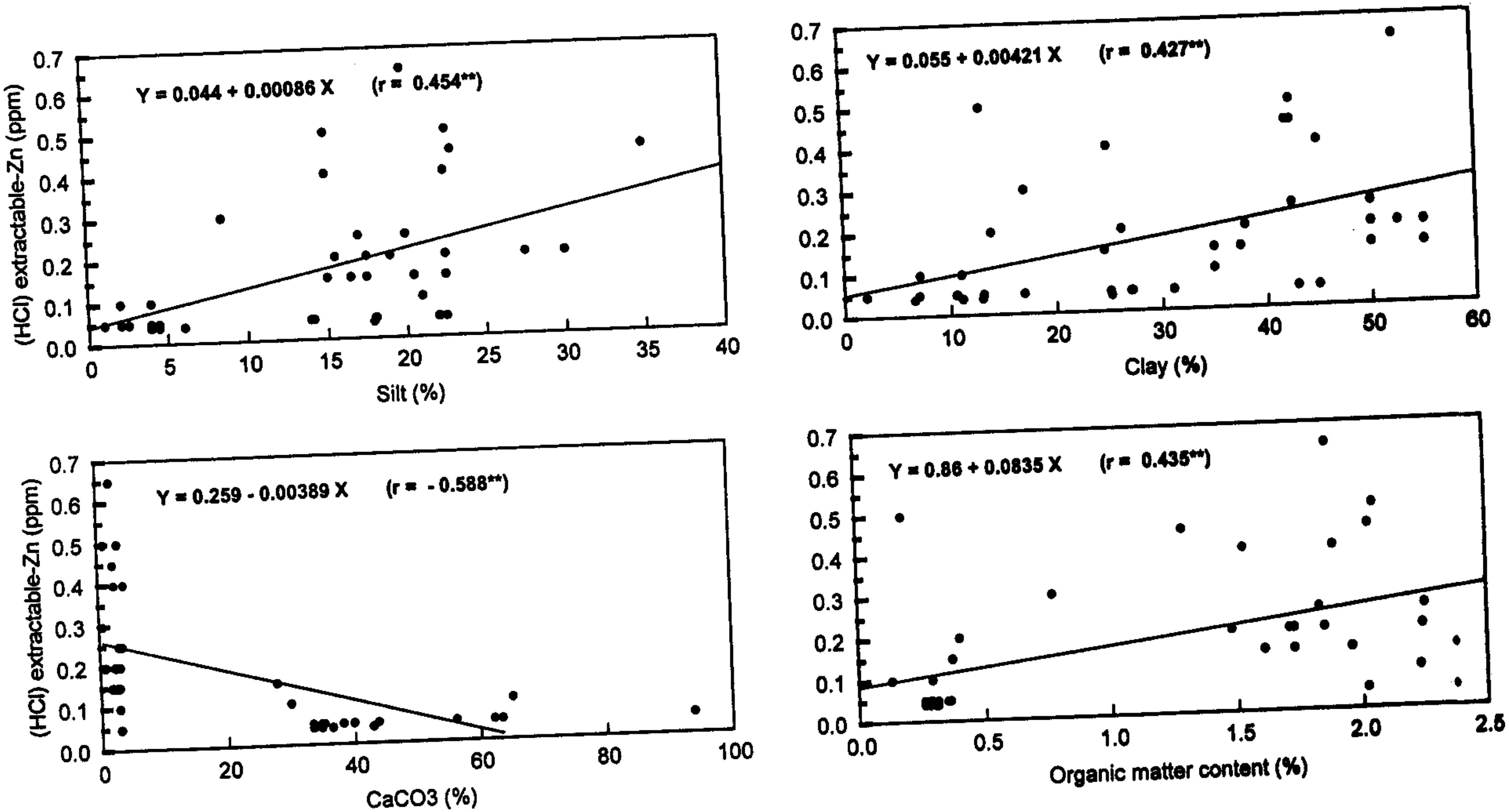


Fig. (14): Relationships between(HCl) extractable-Zn and some soil properties.

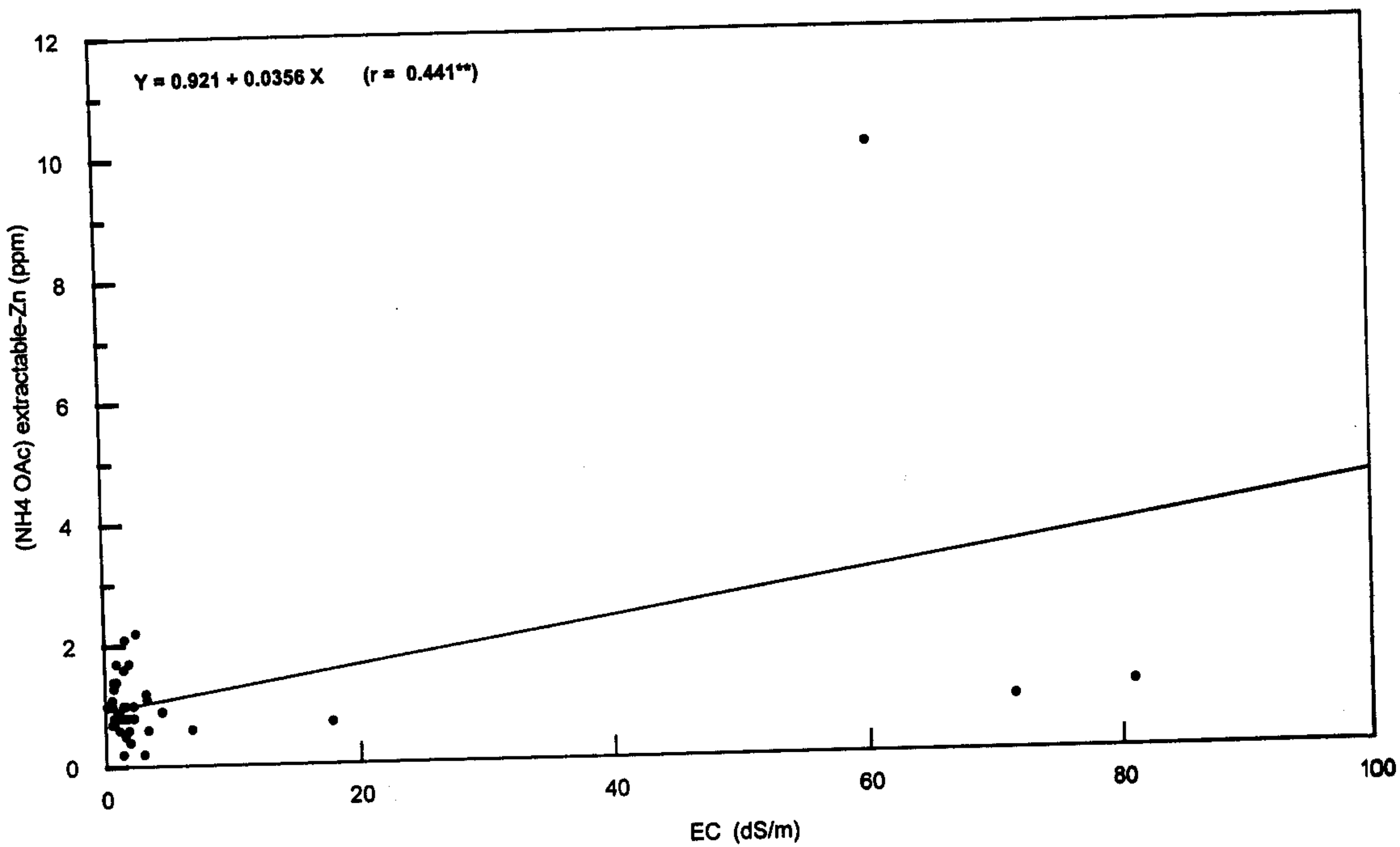


Fig. (15): Relationships between (NH4 OAc) extractable-Zn and EC of studied soils.

contents of Ca CO_3 (Table, 2). The highest value is obtained in sample No. 4 (Borg El-Arab). In the alluvial soils, the hydroquinone extractable zinc values vary from 0.1 to 0.9 ppm. The lowest value is found in samples Nos. 25, 26 and 28 (El-Bagur and Shibin El-Kom), due to their high contents of organic matter (Table, 2).

The statistical analysis (Table 4) shows a positively highly significant correlation between hydroquinone Ext. - Zn and EC (r= 0.4926**). This relationship is represented graphically in Fig. (16).

4.4.3.5. Extraction of available zinc using distilled water.

The results of zinc soluble in distilled water of the calcareous soils are given in Table (7). The data show that soluble zinc in the studied soil samples range from 0.04 to 0.17 ppm. The lowest value is found in samples Nos. 3, 13, 14 and 17 (Borg El-Arab, El-Hammam and King Maryot). This is may be due to these soils high pH values (Table, 1). The highest value is obtained in sample No. 12 (El - Hamman). This may be attributed to , its high amount of organic matter. In the alluvial soils, the data show that soluble zinc in the studied soil samples range from 0.04 to 0.75 ppm. The lowest value is found in samples Nos. 30, 39 and 40 (Shibin EL-Kom, El-Shuhada and El- Sadat). The highest value is detected in sample No. 33 (Berkt El-Sabe), this is may be due to its high content of clay (Table, 2).

The statistical analysis (Table, 4) shows a significant positive correlation between (H_2O) extractable-Zn and silt content (r= 0.3251*). This relationship is represented graphically in Fig. (17).

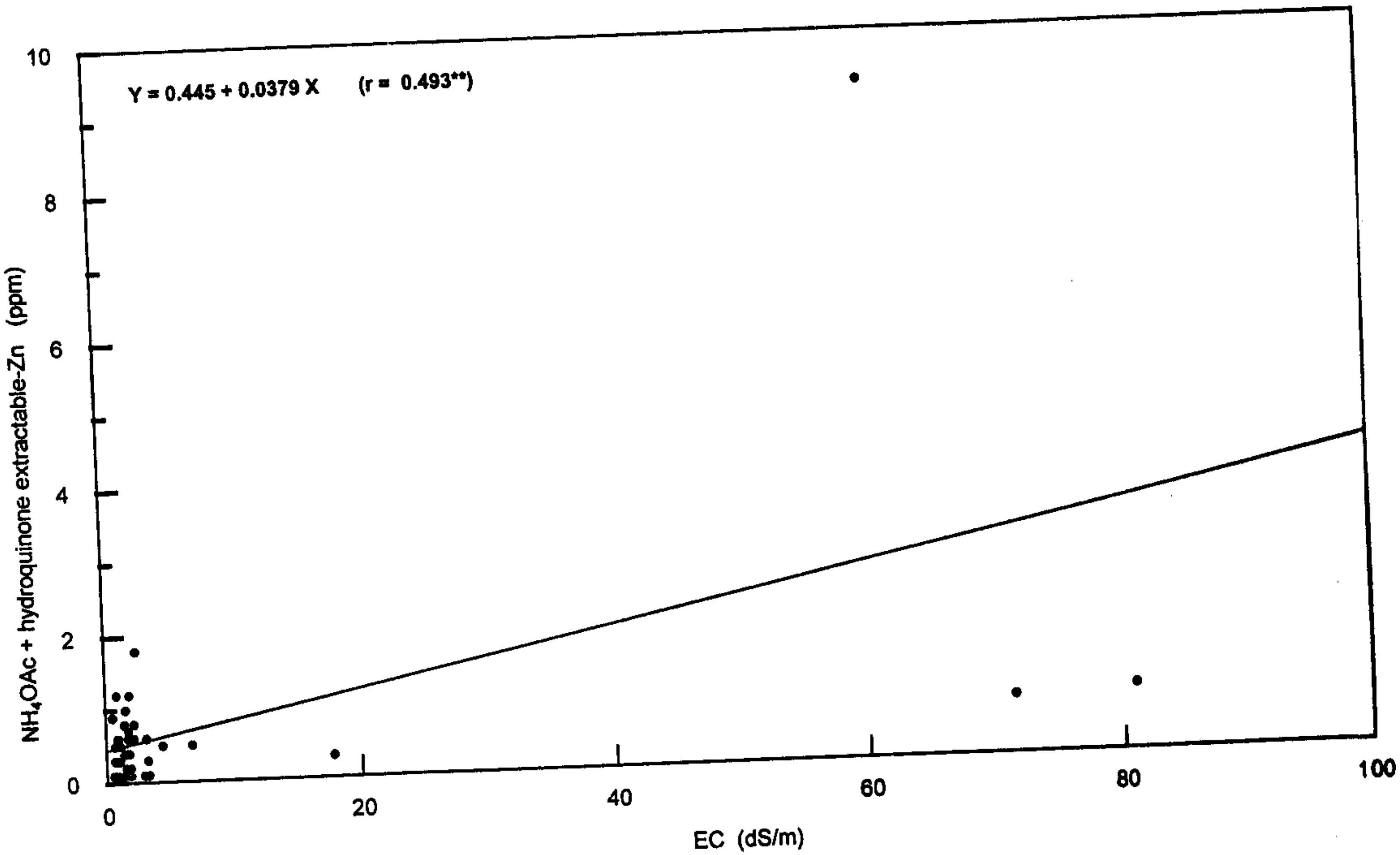


Fig. (16): Relationship between (NH_4OAc + hydroquinone) extractable-Zn and EC of the studied soils.

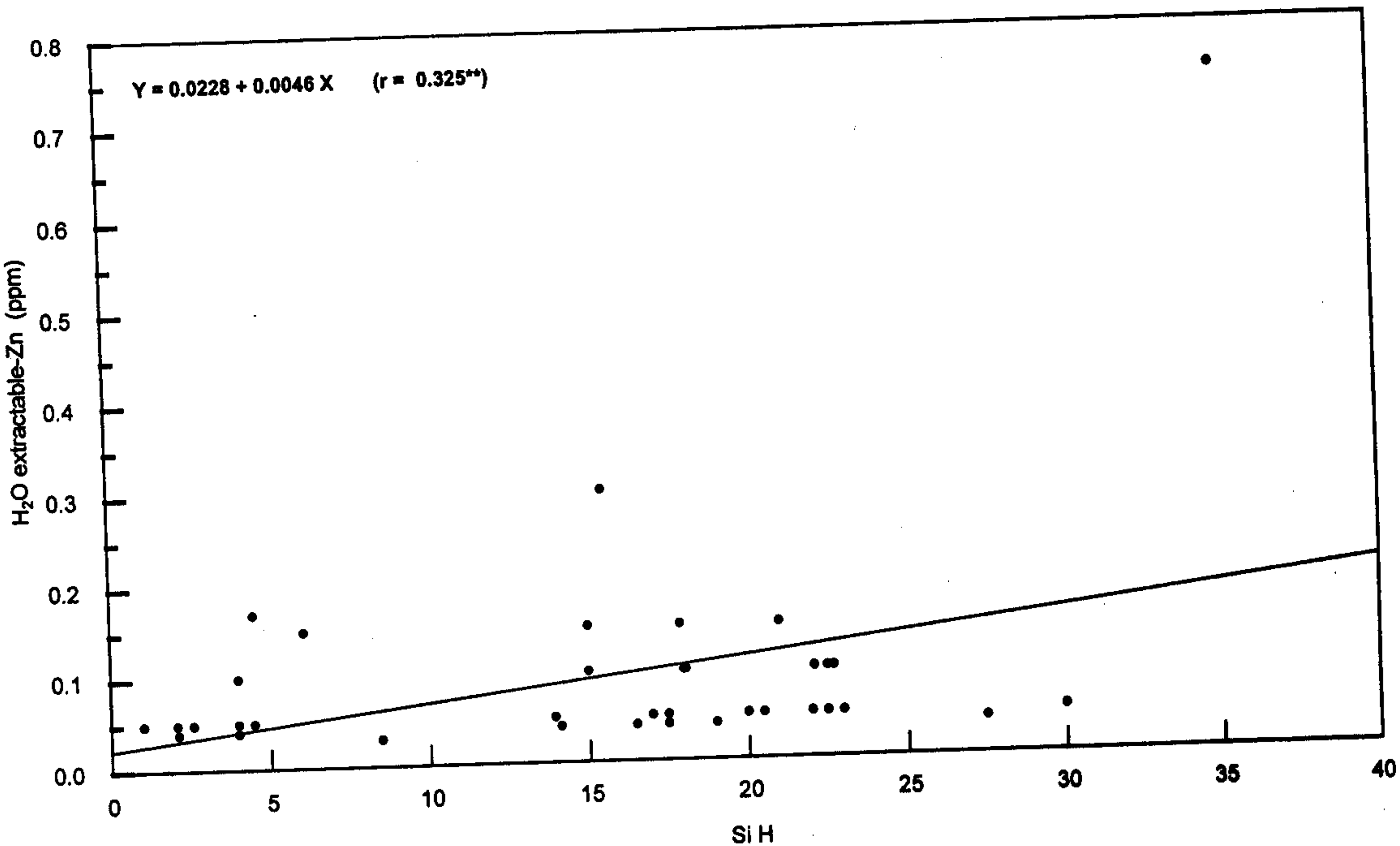


Fig. (17): Relationship between H_2O extractable-Zn and silt content of the studied soils.

4.4.3.6. Efficiency (powerful) of the methods used for extracting available zinc :

It is clear from the data in Table (7), that the methods under investigation extracted different amounts of available zinc. The results show that DTPA extraction method extracted more available zinc from all the studied samples than the other methods did in the both soil types. On the other hand, ammonium acetate extraction gave available zinc values more than those obtained by ammonium acetate 0.2% hydroquinone, dilute hydrochloric acid and distilled water. It is clear that the distilled water extraction method gave the lowest values for determination of available zinc. The comparison of these methods used for extracting of available zinc in soils Showed that the effectiveness of extraction was usually in the order :

DTPA > NH_4OAc > NH_4OAc + Hydroquinone> HCl > distilled water.

4.4.4. Determination of available copper:

The decrease in acidity reduces the solubility and uptake of Cu. Abdel-Latif and Abdel Fattah, (1985), found that the addition of organic materials to calcareous soils markedly decreased the available Cu. El-Damaty et al., (1973), found that alluvial soils contain a high amount of chemically available Cu compared with calcareous soils. The role of soil pH as a factor affecting the solubility and availability of Cu to plants is not very clear even though most results indicate that the solubility of Cu in the soil slightly decreases over the range from acid towards the neutral and alkaline pH ranges, (Katyal and Randhawa, 1983). The fixation of Cu by organic matter has often been considered the main cause of Cu deficiency in organic soils. Scharrer and Schaumloffel, (1960), showed that Cu, when added in small amounts, was more readily available in soils rich in organic matter than in mineral soils.

Table (8): Extractability of available copper using different methods. Of extraction .

Sample No.	Location	Soil type	Depth (cm)	Extractable copper (ppm) using DTPA	0.1 N HCl	NH_4 OAc pH7	NH_4 OAc+ 0.2% hydroquinone	Distilled water
1	Borg El-Arab	Calcareous	0-20	0.30	0.10	0.10	0.10	0.10
2	"	"	0-20	0.42	0.15	0.30	0.30	0.15
3	"	"	0-20	0.46	0.45	0.60	0.50	0.16
4	"	"	0-20	0.82	0.20	0.60	0.30	0.20
5	Bahig	"	0-15	1.18	0.15	0.30	0.30	0.15
6	Dear Mina	"	0-20	0.76	0.15	0.30	0.30	0.15
7	"	"	0-20	0.64	0.20	0.60	0.40	0.20
8	"	"	0-25	0.62	0.20	0.50	0.40	0.20
9	El- Hammam	"	0-20	0.84	0.15	0.50	0.40	0.15
10	"	"	0-20	0.86	0.15	0.50	0.40	0.15
11	"	"	0-20	0.78	0.20	0.50	0.40	0.20
12	"	"	0-20	0.71	0.15	0.40	0.40	0.15
13	"	"	0-20	0.80	0.20	0.50	0.30	0.20
14	"	"	0-15	0.80	0.20	0.40	0.30	0.20
15	"	"	0-20	0.94	0.20	0.50	0.30	0.15
16	King Maryot	"	0-25	1.30	0.25	0.50	0.30	0.20
17	"	"	0-25	0.56	0.25	0.50	0.30	0.20
18	Tamia	"	0-15	1.54	0.24	0.50	0.10	0.45
19	"	"	0-15	2.82	0.22	0.50	0.36	0.35
20	Kom Oshim	"	0-15	1.08	0.08	0.50	0.42	0.30
21	Ashmun	Alluvial soils	0-20	3.80	0.30	0.80	0.40	0.45
22	"	"	0-25	4.00	0.20	0.60	0.30	0.30
23	Minuf	"	0-25	4.38	0.15	0.70	0.30	0.50
24	"	"	0-25	5.46	0.30	0.60	0.30	0.40
25	El- Bagur	"	0-25	2.82	0.10	0.50	0.30	0.35
26	"	"	0-25	0.90	0.05	0.30	0.30	0.35
27	"	"	0-25	3.36	0.10	0.60	0.40	0.40
28	Sh. El-Kom	"	0-25	4.10	0.10	0.50	0.40	0.45
29	"	"	0-25	4.84	0.20	0.80	0.80	0.50
30	"	"	0-25	5.64	0.40	0.60	0.50	0.50
31	Quweisna	"	0-25	4.00	0.30	0.60	0.40	0.45
32	B. El-Sabe	"	0-25	5.62	0.10	0.60	0.30	0.45
33	"	"	0-25	3.78	0.15	0.50	0.20	0.30
34	Tala	"	0-25	5.94	0.15	0.70	0.20	0.35
35	"	"	0-25	6.70	0.15	0.60	0.30	0.35
36	El-Shuhada	"	0-25	3.42	0.25	0.50	0.30	0.40
37	"	"	0-25	2.32	0.20	0.60	0.30	0.35
38	"	"	0-25	3.02	0.25	0.60	0.30	0.40
39	"	"	0-25	3.90	0.15	0.50	0.10	0.10
40	El-Sadat	"	0-20	2.88	0.25	0.60	0.30	0.45

0

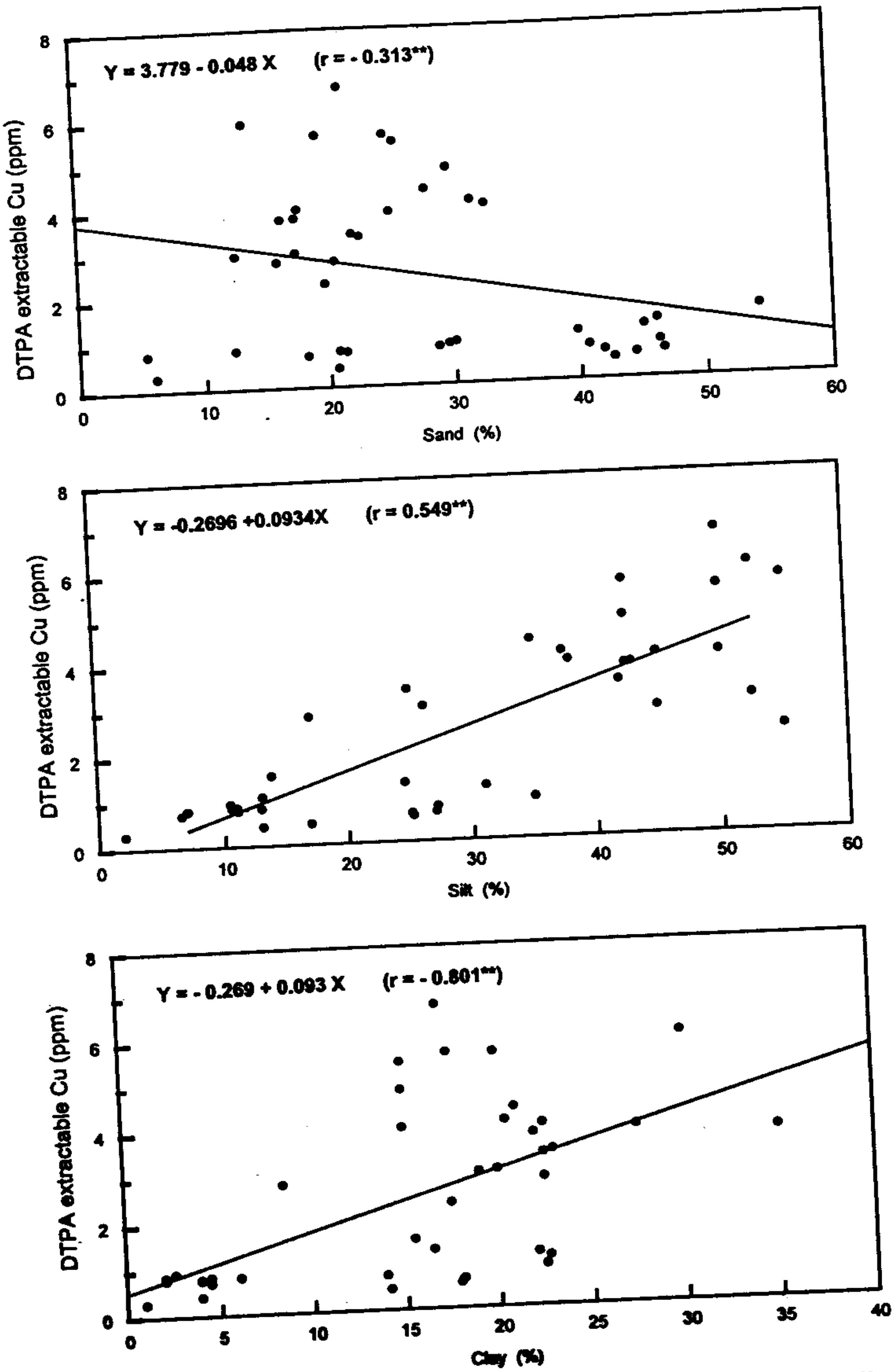
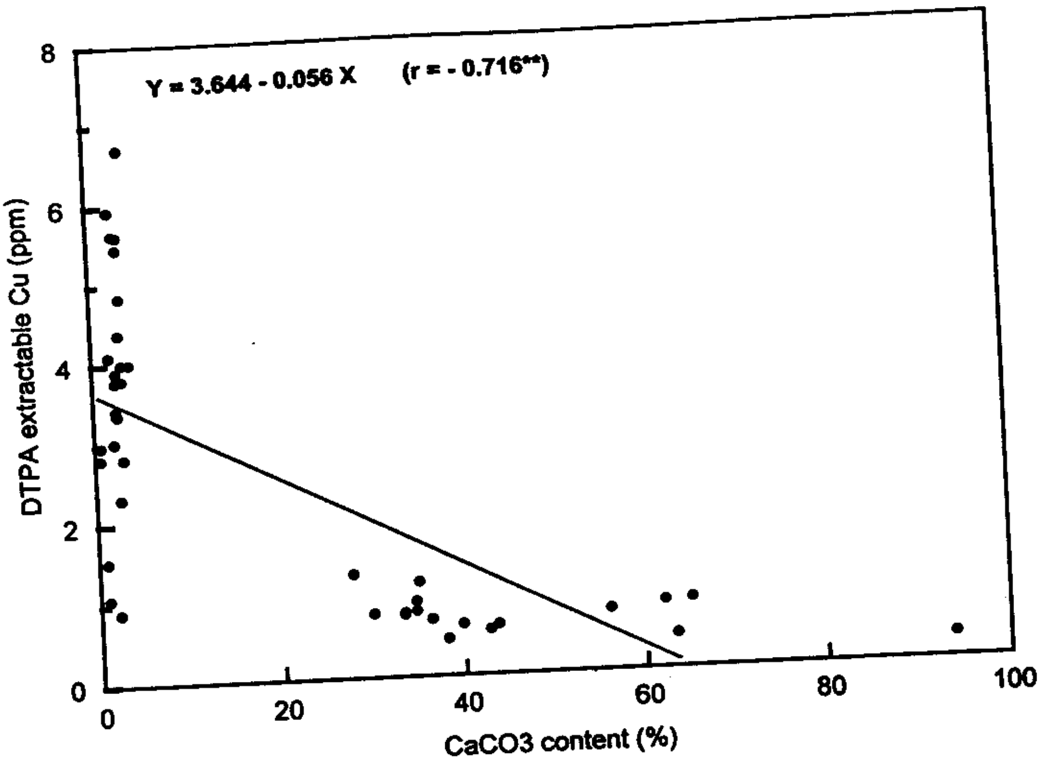


Fig. (18): Relationships between DTPA extracble Cu and some soil properties.


Y = 3.644 - 0.056 X (r = - 0.716**)
DTPA extractable Cu (ppm)
CaCO3 content (%)
0
2
4
6
8
0
20
40
60
80
100

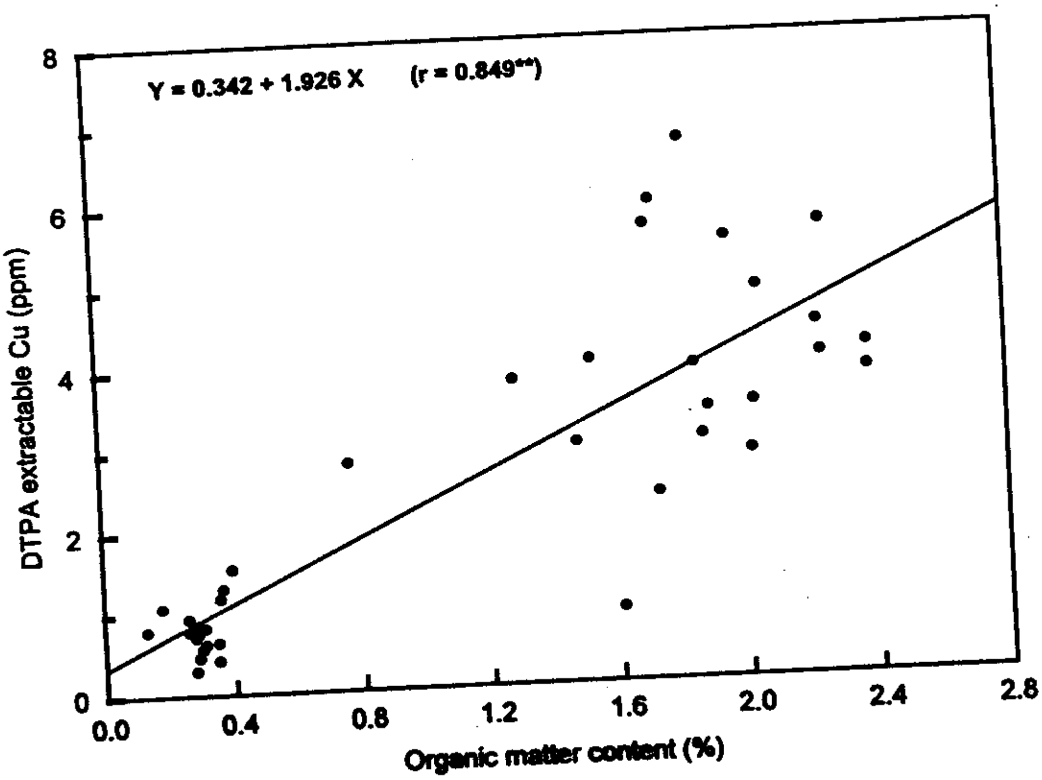

Y = 0.342 + 1.926 X (r = 0.849**)
DTPA extractable Cu (ppm)
Organic matter content (%)
0
2
4
6
8
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8

Fig. (18): Cont.

reveals that copper soluble in dilute HCl ranges from 0.05 to 0.4 PPm in the alluvial soils. The lowest value is found in sample No. 26 (El- Bagur). The highest value is detected in sample No. 30 (Shibin El-Kom), this due to its texture which is clay (Table 2).

4.4.4.3. Extraction of available copper using ammonium acetate.

The values of available copper extracted by ammonium acetate vary from 0.1 to 0.6 ppm in the calcareous soil, (Table - 8). The lowest value is detected in sample No. 1 (Borg El - Arab) , due to its high amount of coarse sand (Table, 2). The highest value is detected in samples Nos. 3, 4 and 7 (Borg El-Arab and Dear–Mina)probably due to their high contents of organic matter (table 2). Data in Table (8) show that values of available copper in the alluvial soils vary from 0.3 to 0.8 ppm. The lowest value is detected in sample No. 26 (El-Bagur). The highest value is found in samples Nos. 21 and 29 (Ashmun nad Shibin El-Kom), due to their high contents of clay (Table 2).

The statistical analysis (Table 4) shows a positively highly significant correlation between NH_4OAC Ext. - Cu and clay content (r= 0.5149**), These results are in agreement with those obtained by Tantawy (1996). On the other hand, there is a highly negatively significant correlation between NH_4OAc Ext. - Cu and $CACO_3$ content (r= - 0.6090**) and postive correlation between NH_4OAc Ext - Cu and silt content (r = 0.3612 *). Similar results Were obtained by Abdel - Mottaleb et al., (1989) and Badawy (1992). These relationships are represented graphically in Figs. (19).

4.4.4.4. Extraction of available copper using hydroquinon:

Data in Table (8) show that the amounts of available copper in calcareous soils range from 0.1 to 0.5 ppm. The lowest value is found in sample No. 1 (Borg El-Arab). This may be due to its texture which is sand (

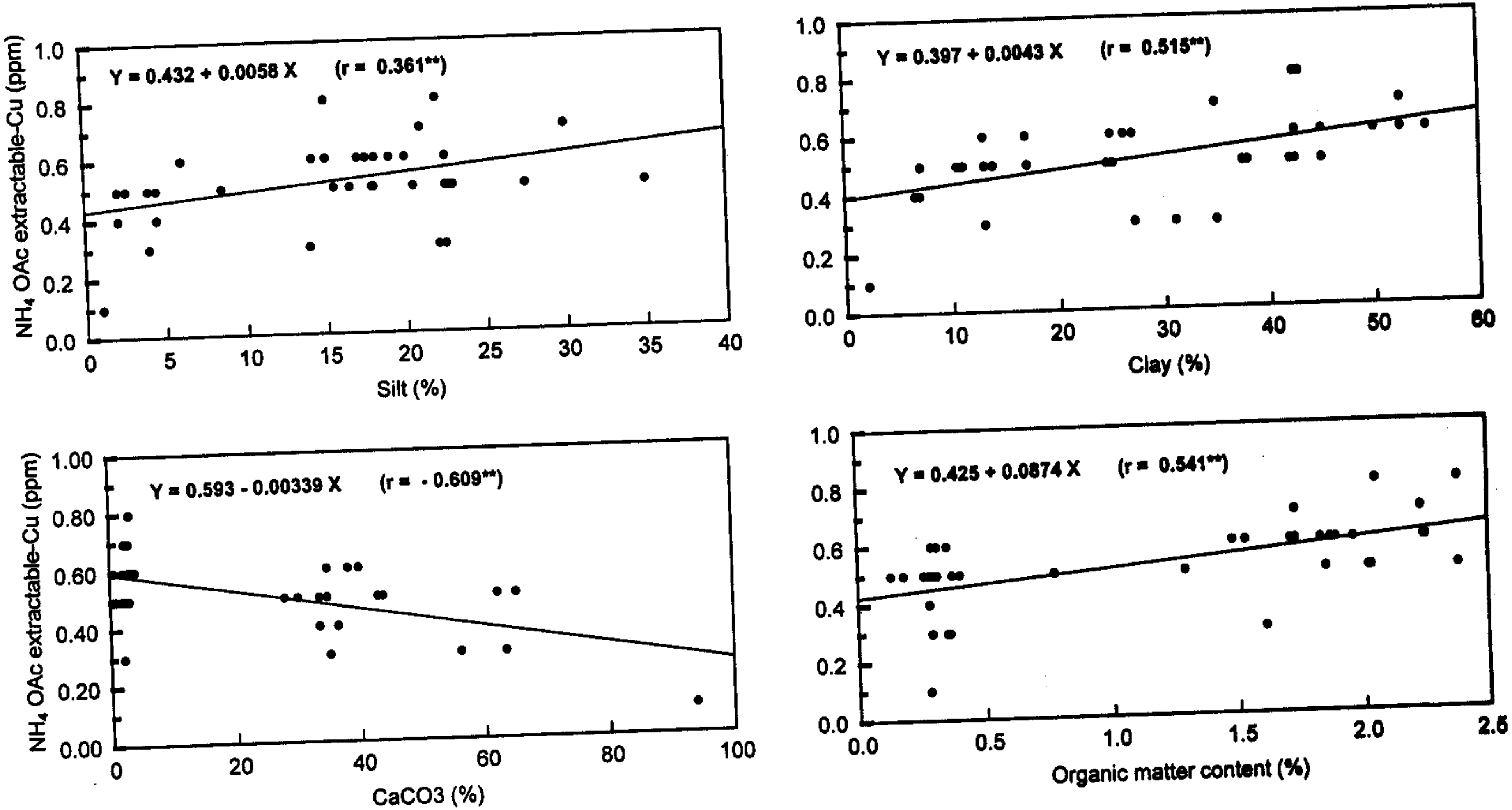


Fig. (19): Relationships between NH_4 OAc extractable-Cu and some soil properties.

Table - 2). The highest value is obtained in sample No. 3 (Borg El-Arab)due to its higher content of clay(Table, 2) . This may be attributed to its texture which is sandy clay loam (Table, 2). In the alluvial soils, the hydoquinone extractable Cu values vary from 0.1 to 0.8 ppm. The lowest value is found in sample No. 39 (El- Shuhada). The highest value is detected in sample No. 29 (Shibin El-Kom) due to its high content of clay (Table, 2).

4.4.4.5. Extraction of available copper using distilled water:

The results of copper soluble in distilled water are given in (table , 8) calcareous soils are given in(Table , 8). The data show that soluble copper in the calcareous soil samples range from 0.10 to 0.45 ppm. The lowest value is found in sample No. 1 (Borg El-Arab) due to its texture which is sand

(Table, 2). The highest value is obtained for sample No. 18 (Tamia). In alluvial soils, the data show that soluble copper in the studied soil samples range from 0.1 to 0.5 ppm. The lowest value is found in sample No. 39 (El-Shuhada). The highest value is detected in samples Nos. 23, 29 and 30 (Minuf and Shibin El-Kom), this is may be due to its high content of clay (Table 2).

The statistical analysis (Table , 4) shows a positively highly significant correlation between Ext. Cu (H_2O) and each of silt content (r= 0.4993**), clay content (r= 0.6475**) and organic matter content (r= -0.7931**). On the other hand, there is a negatively highly significant correlation between Ext. Cu (H_2O) and $CaCO_3$ content (r=- 0.7970**) and negative significant correlation between Ext. Cu (H_2O) and pH (r=-0.3410*). These relationships are represented graphically in Fig. (20).

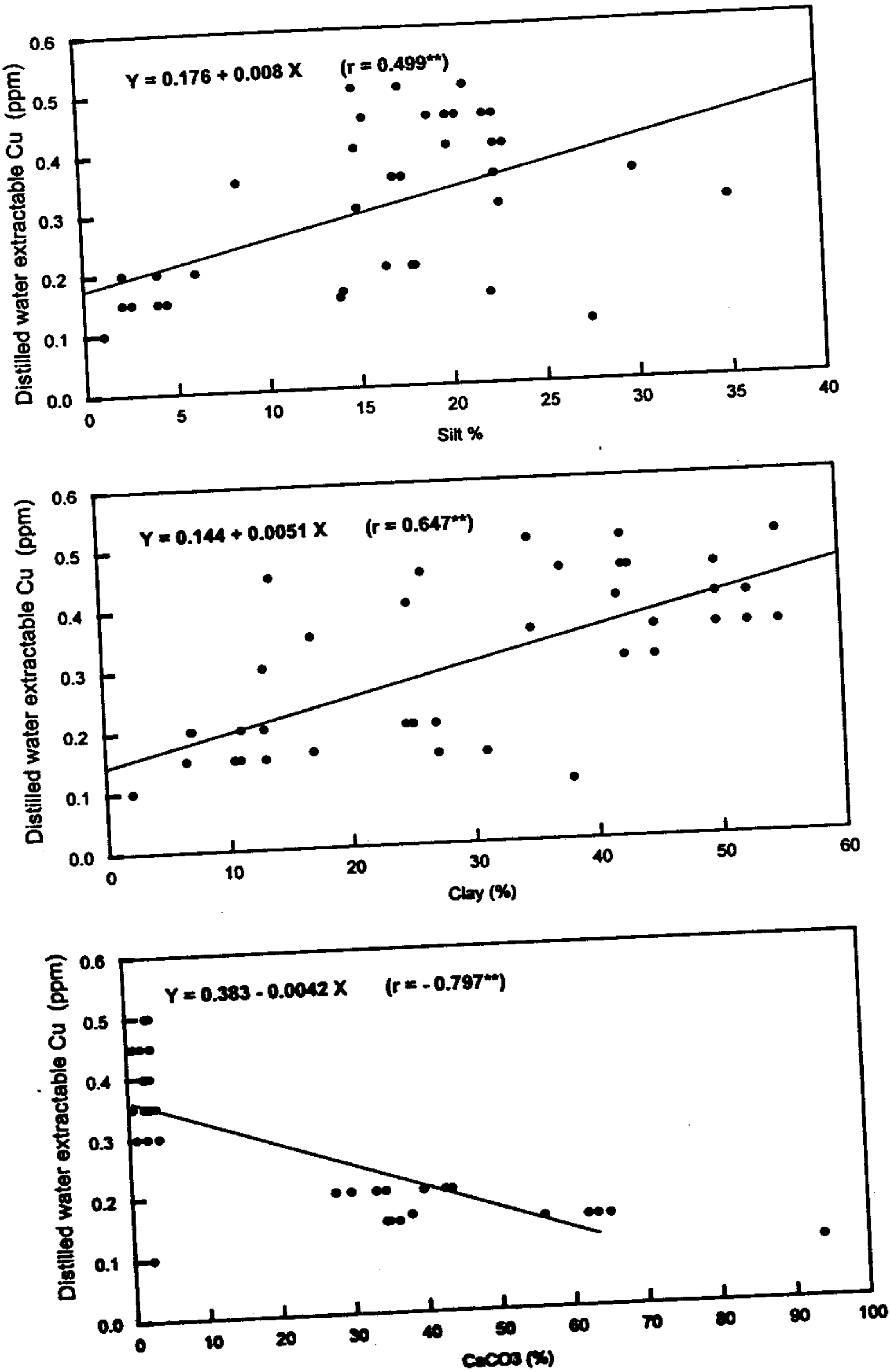
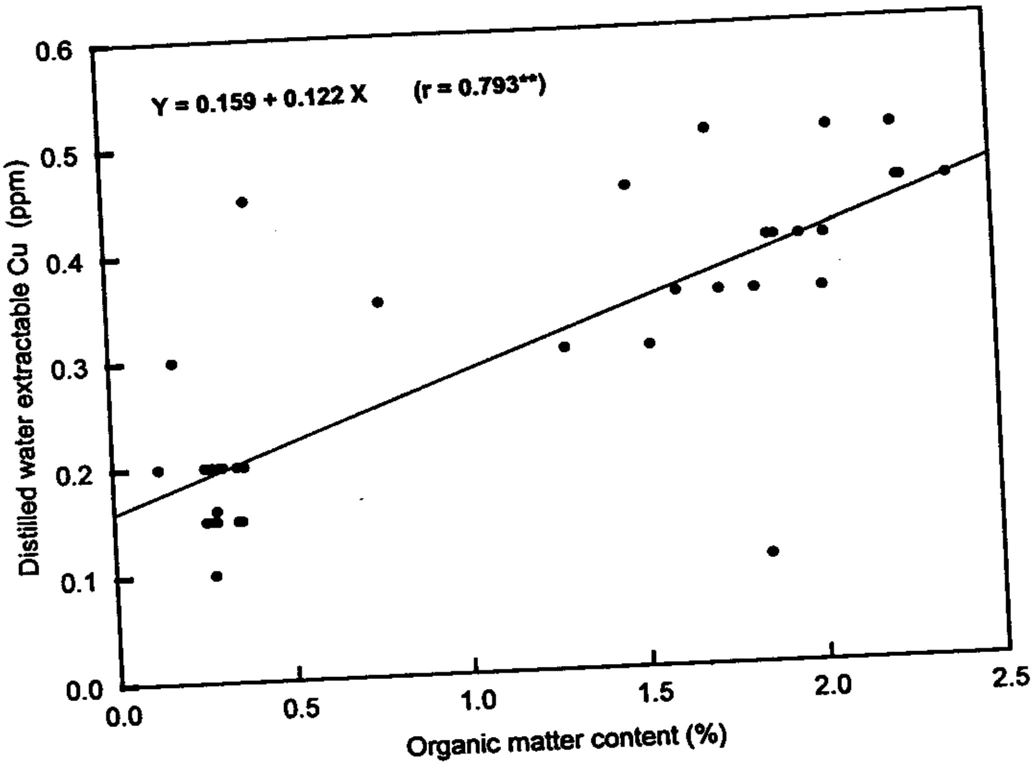


Fig. (20): Relationships between H_2O extractable Cu and some soil properties.


Y = 0.159 + 0.122 X (r = 0.793**)
Distilled water extractable Cu (ppm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.0
0.5
1.0
1.5
2.0
2.5
Organic matter content (%)

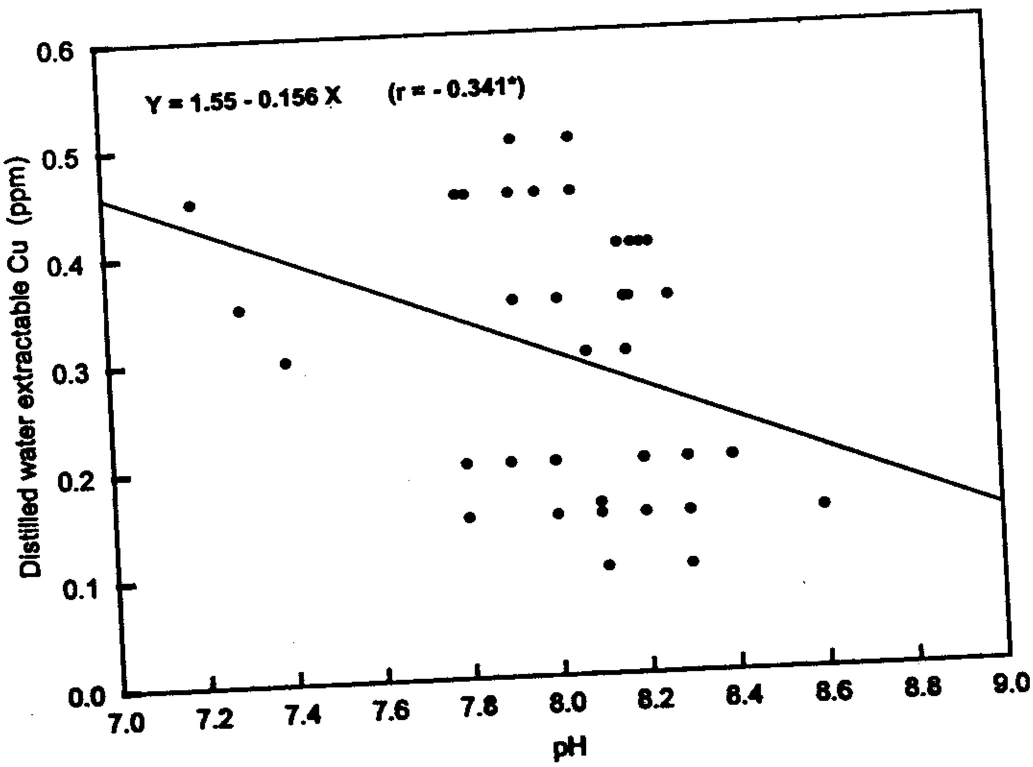

Y = 1.55 - 0.156 X (r = - 0.341*)
Distilled water extractable Cu (ppm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
pH

Fig. (20): Cont.

4.4.4.6. Evaluation(powerful) of the methods used for determining available copper:

The technique tested in this study for the extraction and determination of soil available copper varied greatly Table (8), the results show that DTPA extraction method extracted more available copper from all the studied samples than did the other methods . So DTPA could considered the strongest extracting solution. H_2O is considered the weakest extracting agent of available copper. The effectiveness of these methods in the calcareous soils is arranged in the following descending order :

DTPA > NH_4OA_C > NH_4OA_C + hydroquinone > HCl > H_2O

With respect to alluvial soils, the results show that DTPA is considered the strongest extracting solution. While dilute HCl is the weakest extracting solution. The effectiveness in the alluvial soils. Is in the following order::
DTPA > NH_4OA_C > H_2O > NH_4OA_C + hydroquinone > HCl

4.5. Plant nutrients uptake in relation to themethods used for its extraction of Fe, Mn , Zn and Cu :

To estimate the adequacy of available iron, manganese, zinc and copper in the soils under investigation, a green- house trial was conducted, using barley plants as an indicator plant. Barley plants were grown for 45 days, after plants were removed and analyzed for iron manganese, zinc and copper concentration and their uptake were salcylated as Mg / pot . µµ

The results obtained for dry matter yield of plants (shoot) and iron, manganese, zinc and copper concentrations in plant and each element uptake are shown in Table (9).

Table (9): Dry matter yield and micronutrients (Fe, Mn, Zn and Cu), (µg/g) and uptake (Mg / g) by barley plants.

No.	Location	Soil type	Dry matter (g/pot)	Fe		Mn		Zn		Cu	
				Conc. (µg/g)	Uptake (µg/pot)	Conc. (µg/g)	Uptake (µg/pot)	Conc. (µg/g)	Uptake (µg/pot)	Conc. (µg/g)	Uptake (µg/pot)
1	Borg El-Arab	Calcareous Soils	1.06	208	219	48	49	7	7	9	12
2	" "		1.13	175	197	38	43	11	12	5	5
3	" "		0.67	158	105	61	41	15	10	7	4
4	" "		-	-	-	-	-	-	-	-	-
5	Bahig		0.41	277	113	66	27	27	11	6	2
6	Dear Mina		0.50	218	109	53	26	42	21	7	4
7	" "		0.79	181	141	49	39	27	21	5	4
8	" "		0.97	158	153	48	47	26	25	8	8
9	EL-Hammam		0.37	196	72	44	16	30	11	6	2
10	"		0.30	170	50	32	10	13	4	6	2
11	"		0.48	157	75	89	43	23	11	7	3
12	"		0.50	125	62	42	21	30	15	6	3
13	"		0.30	268	79	61	18	84	25	8	2
14	"		0.45	178	86	54	24	75	34	9	4
15	"		0.53	161	83	52	29	95	50	8	4
16	King Margot		1.31	216	177	45	61	75	98	8	10
17	"		0.65	167	108	89	58	85	55	8	5
18	Tamia		1.05	300	316	39	42	93	100	11	12
19	"		-	-	-	-	-	-	-	-	-

Table (9): Cont.

No.	Location	Soil type	Dry matter (g/pot)	Fe Conc. (µg/g)	Fe Uptake (µg/pot)	Mn Conc. (µg/g)	Mn Uptake (µg/pot)	Zn Conc. (µg/g)	Zn Uptake (µg/pot)	Cu Conc. (µg/g)	Cu Uptake (µg/pot)
20	Com Oshim	Alluvial Soils	-	-	-	-	-	-	--	-	-
21	Ashmum		1.14	437	496	73	83	87	99	20	15
22	"		0.96	279	266	70	67	67	64	9	9
23	Minuf		1.51	297	447	90	135	68	103	12	17
24	"		1.49	228	341	97	145	80	119	8	9
25	EL-Bagur		1.83	216	395	66	120	66	121	9	16
26	"		1.61	503	808	68	109	84	134	10	16
27	"		1.46	458	668	75	110	75	109	9	13
28	Shibin EL-Kome		1.25	263	330	65	106	83	104	10	13
29	" "		1.35	197	266	66	90	87	117	11	15
30	" "		1.42	275	391	90	128	69	107	10	14
31	Quweisna		1.47	377	554	67	94	73	107	11	16
32	Berket EL-Sabe		1.69	179	303	71	120	75	127	10	16
33	" "		1.30	194	252	92	120	54	70	10	13
34	Tala		1.67	265	443	92	153	89	147	11	20
35	"		2.15	327	703	77	165	86	185	11	23
36	"		1.36	515	700	83	112	70	95	9	12
37	EL-Shuhada		1.46	634	926	73	107	77	112	10	15
38	"		2.03	575	1167	81	165	24	48	10	20
39	"		1.22	243	296	67	81	71	86	12	15
40	EL-Sadat		1.76	248	436	49	86	96	163	11	18

Each value is a mean of three replicates.

4.5.1. Dry matter yield of the tested plant:

Data in Table (9) show that the dry matter yield of barley plants grown on the alluvial soils was higher than the dry matter yield, of the plants grown on the calcareous ones. These results may be due to the effect of soil properties (Tables 1 and 2), such as soil texture, pH, EC and available nutrients which enhance plant growth in the alluvial soils . These results are in agreement with those obtained by Abou– Hussien (1985) who found that dry matter yield of barley grown on different soils, was at the following order: alluvial > alkali > sandy > calcareous soils. Also, EL-Shafie (1994) found that dry matter weight of broad been grown on alluvial soils was higher than that of the plants grown on calcareous soils.

4.6. Micronutrients in plants:

4.6.1. Iron in plant:

Table (9) shows the Fe uptake by barley plants. The Fe uptake were on the alluvial soil much higher than those of the plants grown on the calcareous soils , while the lowest value of Fe uptake was recorded for the plants grown on calcareous soils. Iron concentration in soil samples having different properties affects its uptake by plants.

Also, data in Table (9) show that Fe concentration in barley plants ranged from 158 to 634 ppm. The values of Fe were higher in the plants grown on the alluvial soil than the corresponding ones of the plants grown on the calcareous soils. This may be attributed to the higher content of available Fe in the alluvial soils. These results are in agreement with those obtained by Ottow et al., (1983) who found that Fe content in rice plants grown on different soils ranged from 300 to 1000 ppm. EL-Gala et al., (1990) reported that the highest values of Fe were found in sorghum plants grown on sandy loamy soil, while the lowest were found in sorghum plant grown on sandy soil. Hegazy et al., (1991) stated that the highest values of Fe content were found in plants grown on the alluvial soils and the lowest values were in plants grown on sandy soils. Fe content of the plants grown on calcareous soils came in between.

4.6.1.1. Relationship between extractable iron and its uptake by barley plant :

Data in Table (10) show that there is a linear relationship between Fe taken up by barley plants and Fe extracted from the investigated soils by various extractants. Linear equations and correlation coefficients are presented in Table (10) and could be cited as follows:

a- A high positive significant correlation between Fe uptake and DTPA extractable Fe, (r= 0.531**)

b- Insignificant correlations between Fe uptake and extractable iron by any of the other extractants.

4.6.2. Manganese in plant:

Data in Table (9) show that the Mn uptake by barley plants was recorded for plants grown on the alluvial soils , was higher than that of the plants grown on the calcareous soils.

Also, data in Table (9) show that Mn concentration in barley plants ranged from 38 to 92 ppm. The values of Mn concentration were higher found in plants grown on the alluvial soils than those of Mn concentration of the plants grown on the calcareous soils .

This is may be attributed to the influence of soil properties such as soil pH and clay content on both plant growth and Mn uptake . These results are

Table (10): Linear equations and correlation coefficients between chemical extractable iron and its uptake by barley plants.

Extracting solution	Equation	Correlation Coefficients (r)
0.005 M DTPA	Y = 120.64 + 33.809 X	0.531**
0.1 N HCl	Y = 282.59 + 224.69 X	0.166
NH_4 OA_c pH 7.0	Y = 271.42 + 132.99 X	0.140
NH_4 OA_c + Hydroquinone	Y = 196.86 + 579.92 X	0.258
H_2O	Y = 379.18 - 44.54 X	-0.103

* Significant correlation at 5 % level.

** Significant correlation at 1 % level.

Y = Iron uptake.

X = Extracting solution (0.005 M DTPA, 0.1 N HCl, NH_4 OAc pH 7.0 and H_2O).

in agreement with those of El-Leithy (1986) and Hegazy et al., (1991) who reported that the Mn content in sorghum plants grown on the soils of Egypt were 90, 69, 5 and 48.5 ppm for the alluvial, the calcareous and sandy soils, respectively. The highest values were found in the plants grown on alluvial soils and the lowest were found in the plants grown on sandy soils.

4.6.2.1. Relationship between extractable manganese and its uptake by barley plants :

Table (11) show that there are linear relationships between Mn taken up by barley plants and Mn extracted from the investigated soils by various extractants. Linear equations and correlation coefficients are presented in (Table 11) and could be cited as follows:

- Mn uptake by barley was highly positively and significantly correlated with DTPA, 0.1N HCl and NH_4OA_C + H.Q (r= 0.574, 0.782 and 0.833, respectively)**, and was significantly positively correlation with NH_4OAc (r= 0.349)*.

These results are in agreement with the results obtained by Salcedo et al., (1979); Awadalah et al., (1982); and Hegazy et al., (1991) who found that Mn uptake by flax and sorghum plants was highly correlated with Mn extracted by: NH_4OAc– hdyroqinone, EDTA + $CaCl_2$, ammonium bicarbonate + DTPA, DTPA and acid ammonium acetate + EDTA (r= 0.82, 0.968, 0.829, 0.796 and 0.77, respectively)**.

4.6.3. Zinc in plant:

Zinc is an essential element for plant. Cottenie et al., (1982) reported that the normal range of Zn concentration in plants was from 25 to 250 ppm and phytotoxic concentration was more than 400 ppm.

Table (11): Linear equations and correlation coefficients between chemical extractable manganese and its uptake by barley plants.

Extracting solution	Equation	Correlation Coefficients (r)
0.005 M DTPA	Y = 27.07 + 5.30 X	0.574 **
0.1 N HCl	Y = 39.88 + 2.37 X	0.782 **
NH_4 OA_c pH 7.0	Y = 64.57 + 2.08 X	0.349 *
NH_4 OA_c + Hydroquinone	Y = 16.64 + 1.28 X	0.833 **
H_2O	Y = 98.94 - 127.63 X	-0.284

* Significant correlation at 5 % level.

** Significant correlation at 1 % level.

Y = Manganese uptake.

X = Extracting solution (0.005 M DTPA, 0.1 N HCl, NH_4 OAc pH 7.0 and H_2O)

Data in Table (9) show Zn uptake by barley plants. The values of Zn uptake by the plants grown on the alluvial soil, were lower than those recorded for the plants grown on the calcareous soils. Also, data in Table (9) reveal that Zn concentration in barley plants ranged from 7 to 96 ppm. The values were found to be higher in plants grown on the alluvial soils, which gave the higher amounts of available Zn extracted by DTPA those of the plants grown on calcareous soils. This finding is due to the higher Zn content of the alluvial soils than the calcareous ones . These results are in agreement with those obtained by EL-Sayad., (1988); Abdel Aal, et al., (1990) and EL-Gala et al., (1990), who found that the highest values of Zn content were found in plants grown on the alluvial soils and the lowest in plants grown on the sandy soil. Significant and negative correlation was recorded between $CaCO_3$ content and available–Zn (r= -0.608)* and a positive correlation between O.M. content and available Zn. The soils having high amounts of soluble cations such as Ca^{++}, Mg^{++} and Na^{+} which may depress Zn uptake. They added that the relationship between Zn uptake by sorghum plant and Zn content in some soils of Egypt was positive (r= 0.16)*. Generally, they found that Zn content of rice plants ranged between 20 to 64.9 ppm.

4.6.3.1. Relationship between extractable zinc and its uptake by barley plant :

Data in Table (12) show that There is a high positive and significant correlation between Zn uptake by barley plants and 0.1N HCl extractable Zn (r= 0.387*). Zn uptake was insignificantly correlated with extractable Zn by other methods.

4.6.4. Copper in plant:

Table (9) shows that the Cu uptake by barley plants on the alluvial soils, is higher than that taken up by the plants grown on the calcareous soils

Table (12): Linear equations and correlation coefficients between chemical extractable zinc and its uptake by barley plants.

Extracting solution	Equation	Correlation Coefficients (r)
0.005 M DTPA	Y = 43.40 + 20.19 X	0.312
0.1 N HCl	Y = 51.87 + 127.79 X	0.387 *
NH_4 OA_c pH 7.0	Y = 73.80 - 0.11 X	-0.001
NH_4 OA_c + Hydroquinone	Y = 94.37 - 42.48 X	-0.313
H_2O	Y = 73.51 + 2.09 X	0.006

* Significant correlation at 5 % level.

** Significant correlation at 1 % level.

Y = Zinc uptake.

X = Extracting solution (0.005 M DTPA, 0.1 N HCl, NH_4 OAc pH 7.0 and H_2O)

Also, data in Table (9) show that Cu concentration in barley plants ranged from 5 to 12 ppm. The Cu concentrations of the plants grown on the alluvial soils , were higher then those of the plants grown on the calcareous soils. This is may be due to the more suitable properties of the alluvial soils for plant growth and the presence of sufficient available nutrients to the plants such as copper compared to the calcareous soils. These results are in agreement with those obtained by EL-Gala et al., (1990); Hegazy et al., (1991) and Badawy (1992) where they found that copper ranged from 3.6 to 18.8 ppm in wheat plants and from 7.0 to 12.0 ppm in sorghum plant. The amount of copper content in the plants grown on the alluvial soils were higher than those of the plants grown on the sandy soil. The Cu contented of the plants grown on the calcareous soils came in between.

4.6.4.1. Relationships between extractable copper and its uptake:

Data in Table (13) showed that there are linear relationships between Cu uptake by barley plants and extractable Cu. The linear equations as well as the correlation coefficients could be cited as follows:

a- A high positive significant correlation between Cu uptake and each of DTPA extractable-Cu NH_4OAc extractable-Cu and H_2O extractable-Cu (r= 0.751**, 0.425** and 0.7234**; respectively). While cu uptake was insignificantly correlated with extractable Cu by the other methods.

These results are in agreement with those obtained by EL-Gala et al., (1990); Hegazy et al., (1991) and Badawy (1992) who found a highly significant correlation between Cu uptake by sorghum plants grown on Ismailia and Sinai soils and DTPA, extractable-Cu while they obtained insignificant correlation between Cu uptake and HCl extractable Cu.

Table (13): Linear equations and correlation coefficients between chemical extractable copper and its uptake by barley plants.

Extracting solution	Equation	Correlation Coefficients (r)
0.005 M DTPA	Y = 4.48 + 2.38 X	0.751 **
0.1 N HCl	Y = 11.74 - 6.02 X	-0.081
NH_4 OA_c pH 7.0	Y = 0.81 + 18.71 X	0.425 **
NH_4 OA_c + Hydroquinone	Y = 12.85 - 6.93 X	-0.138
H_2O	Y = 0.65 - 33.47 X	0.723 **

* Significant correlation at 5 % level.

** Significant correlation at 1 % level.

Y = Copper uptake.

X = Extracting solution (0.005 M DTPA, 0.1 N HCl, NH_4 OA_c pH 7.0 and H_2O)