RESULTS AND DIACUSSION

4. RESULTS AND DISCUSSION

This work was carried out mainly to assess the status of nitrogen and its availability in some soils of Kalubia Governorate. The investigated area are represented by thi4 one soil samples collected from different locations extending along three parallel traversing lines acrossing the Governorate froth the eastern part towards Domiatta branch of River Nile.

4.1. Characterization of soils in the studied area:

4.1.1. Soil Formations of Kalubia Governorate:

The studied area occupied the southern-east portion of the matter moreover, the desertic formations which are located at the eastern rim of Governorate

Nile Delta, which is mainly formed of Nile alluvial sediments of suspended transported by the Nile water during the recent geological periods.

4.1.2. Soil texture:

Hamra (1982) studied the extended area from Toukh (Kalubia Governorate) eastward to Abu Swir, and he found the clay profiles at Toukh changed to sandy-textured profiles eastwards.

The data obtained (Table, 1) show that the studied soil samples are varying in their texture grades, i.e., clayey (13), clay loam (7), sandy clay (2), sandy loam (3), loam (1), sandy loam (2) and loamy sand (3). It would be stated that the soil content of fine particles increased towards River Nile and hence the texture became heavier. The soils in the eastern area of Ka!tibia Governorate are mainly sandy loam or loamy sand in texture, while the soils adjacent to or near the River Nile are clay ones. Such findings are in accordance with those obtained by Nashida Abdel-Aal (1983), Abdel-Hameed (1984) and Abdel Salam (2001). Abdel-Hameed (1984) stated that soil profiles adjacent to the Nile or the Delta region were heavy-textured even in the deep layers (120 cm) and attributed this fmdings to the accumulating process of fine particles lasted for long periods in these areas.

4.1.3. **Soil organic matter content (OM):**

The data obtained show that the organic matter content varies from as low as 0.4 to 5.13%, as it expected in arid zones. It increased as the soil texture became finer (clay) nearer the Nile, thus reflecting the same trend observed with clay content. Such a finding could be attributed to the longer cultivation history of land near the Nile and the remains of plants on the surface layers and normal cultivation processes. These results are in accordance with those obtained by Esmat Nofal (1984).

Soil organic matter content was significantly correlated with clay content (r = 0.445**) and cation exchange capacity (r = 0.431**).

4.1.4. **Calcium carbonate content** Eat

Calcium carbonate content was generally low and varied between 0.19 and 4.5%. Such a trend could be attributed to the

	Location		characteristics	Particle size distribution: Fine sand	nominal		Textural class	pHs	
	Abo-Zaabal	[illegible]	[illegible]	9.00	[illegible]	10.00	Loamy sand	[illegible]	[illegible]
	El-Gabal El-Asfar (A)	[illegible]	[illegible]	[illegible]	8.90	9.00	Loamy sand	[illegible]	[illegible]
	PI-Acfar (111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Sandy clay loam	[illegible]	[illegible]
	[illegible]		[illegible]		10.00	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	10.90	18.00	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Emig A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	lestfr-SaarlFlebery		[illegible]	[illegible]	[illegible]	18.00	[illegible]	[illegible]	[illegible]
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Meet iCenntia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	El-Ahraz	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MnnchantFl-Keram	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	TrmIch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Moshtohor	[illegible]	[illegible]					[illegible]	[illegible]

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nature of soil sediments and soil profile development (accumulations of secondary calcic formations in the uppermost layers of Nile alluvial sediments). Significant and positive relationship between calcium carbonate content and soil content of clay (r = 0.436**) as well as cation exchange capacity of the soil (r = 0.430**). On the other hand, a negative relation (r = -0.449**) with soil content of coarse sand fraction was obtained. The obtained correlations give further evidence of calcium carbonate dominance in the fine separates of soils in Kalubia Governorate and thus explain why the fine content of soils tends to increase with approaching towards the Nile. These results are in accordance with those obtained by Abdel-Hameed (1984).

4.1.5. Soil pH:

The data obtained show that pH values of most of the studied soils lie on the alkaline side. All soils had pH values exceeding 8.0, except for the soils of El-Gabal El-Asfar (B), which has been under irrigation with sewage effluent for the past 60 years or more where its lower pH is probably due to greater contents of nitrates and various organic acids contained in the irrigation materials. It is also a light-textured soil whose organic matter content is not low (5.13%) and CEC is not very high (21.17 me/100 g soil). This conclusion agrees well with those obtained by Abdel-Salam (2001).

4.1.6. Soil salinity (EC):

The values of soluble salts in terms of electric conductivity (EC) clearly show that almost all soils were nonsaline (normal) having low content of soluble salts, except soil No. 8 (Balaqs soil of EC 6.82 dS/m) and soil No. 29 (Meet Halfa soil of EC 5.08 dS/m). The low salinity of the studied soils reflects a positive aspect of their fertility. Highly significant correlation, but negative, between soil EC and soil pH (r = - 0.639***) was also obtained.

4.1.7. Cation exchange capacity (CEC) and exchangeable cations:

Data in Table (1) reveal that the investigated soil samples showed relatively high cation exchange capacity, except the soil locations No. 2, 3, 17 and 18 which have CEC values of 11.44, 15.41, 15.95, 10.37, 16.56 and 16.87 me/100g soil, respectively. The other soil samples showed CEC values varying between 21.7 and 43.47 me/100 g soil. Highly significant relationships were obtained between soil CEC and both of soil clay content (r = 0.950***) and silt content (r = 0.588***). The relatively high exchangeability is in accordance with the heavy texture observed in these soils as colloidal clay particles represent the main sites for exchangeable cations. Also, the high CEC may indicate that the dominance of an expanding lattice clay type. These results agree well with those obtained by Esmat Nofal (1984) and Abdel-Hameed (1984). As it expected, a significant relationship between soil CEC and OM content (r = 0.431*) was obtained. A significant relationship with CaCO3 (r = 0.430*) was also recorded.

Concerning the exchangeable cations (Cr, Na^+ and IC), data obtained are presented in Table (2). Data reveal

Table (2): Exchangable cations and CEC in the tested soil samples (me/100 g soil).

No.	Location	Ca"	Mg"			Total exch. cat^{i0115}	CEC* (me/100 g)
1	Abo-Zaabal	6.11	3.16	0.13	0.62	10.02	11.44
2	El-Gabal El-Asfar (A)	6.27	2.36	0.26	0.59	9.48	10.70
3	EI-Gabal El-Asfar (B)	12.03	5.36	0.28	0.58	18.25	21.17
4	Seriaqous	17.51	7.89	0.90	1.23	27.51	29.63
5	El-Kalag	7.00	5.21	0.96	1.37	14.54	15.41
6	E1-Marg	17.53	6.40	0.64	1.77	26.34	27.82
7	Mostorood	17.81	8.31	1.11	3.41	30.64	32.53
8	Balaqs	19.89	10.26	0.99	2.52	33.66	34.73
9	Sendowa	18.16	9.06	1.60	4.07	32.89	33.38
10	Nowa	25.79	13.02	1.57	2.20	42.58	43.47
11	Kalama	23.49	12.12	1.00	1.89	38.50	40.65
12	Kafr El-Shorafa	15.97	15.94	1.48	2.32	30.71	31.86
13	Kafr-Saad Behery	7.19	4.78	0.93	1.67	14.57	15.95
14	Kafr El.Sohby	4.65	2.59	0.88	1.21	9.33	10.37
15	Meet Kenana	13.16	5.77	0.69	1.47	21.09	22.18
16	Gezirat Billy	20.77	6.48	0.81	2.03	30.09	32.36
17	E1-Ahraz	8.89	4.05	0.87	1.58	15.39	16.56
18	Monshaat El-Keram	8.61	3.02	1.85	1.91	15.39	16.87
19	Arab Goheina	21.27	7.56	0.97	1.59	31.39	32.34
20	Meet Kenana	21.31	8.57	1.44	1.76	33.08	34.38
21	Toukh	24.80	8.96	1.33	2.04	38.13	39.84
22	El-Shomot	20.55	6.93	1.09	1.77	30.34	31.85
23	Meet El-Atar	20.15	8.00	1.78	2.72	32.65	33.57
24	Meet El-Howefein	17.08	6.72	1.22	2.19	27.21	28.53
25	Tant El-Geziera	17.01	7.38	2.08	2.09	28.56	29.64
26	Barshom El-Kubra	21.49	9.47	1.06	1.18	33.20	34.23
27	El-Kanter El-Khayria	24.68	10.94	3.23	3.01	41.86	42.52
28	Qaranfeel	23.60	8.60	3.36	4.62	40.18	41.86
29	Meet Haifa	18.11	7.64	1.47	3.75	30.97	31.28
30	Bassos	21.19	8.37	0.46	0.98	31.00	32.87
31	Moshtohor	19.67	8.56	1.54	2.57	32.34	33.64

* CEC = Cation exchange capacity

that the dominance of exchangeable cations in the investigated soils followed the descending order: Ca'' > Mg' > Na' > K^t.

The obtained pattern of exchangeable cations in such soil may reflect the following:

a relatively high exchangeability

a relatively low sodicity (ESP) and low probability of sodicity hazards.

a relatively high contents of exchangeable Ca and Mg that would depress any possible alkalization.

Statistical analysis of the obtained data (Table, 3) show that the exchangeable cation, as expected, significantly and positively correlated with fine fraction (silt and clay) of the tested soils as well as with the organic matter and calcium carbonate content.

4.2. Nitrogen status in Kalubia soils:

The current work, as previously mentioned, was carried out mainly to study the nitrogen status in soils of Kalubia Governorate and to assess their availability to growing plants as represented by rye grass which was used as an indicator plant. Also, the effects due to the indigenous soil parameters were also evaluated.

The values of different soil nitrogen fractions obtained from Kalubia soils are presented in Table (4). The different relationships between soil nitrogen fractions and soil properties are shown in Table (5).

	puesasn03	Fine sand	VS	igeo	Hd		1410	opea	330
Coarse sand	000'1								
Fine sand	- O 6Z0...	000'1							
:ES	-	- 0.0Z0	1000						
T3	- 0.689...	0.055	0.519...	1000					
pH	- 0t96	0tso	6ICO	56t0	1.000				
3a	- 0.19E	0VE O	-0.0ts	0.049	0.69E...	1.000			
NO	- 0.100	-0.065	6LF0	.5171	-	0.060	1000		
CaCO3	- 0t49..	0.1E1	8ZEO		.L117 O	0.19L	.60170	1.000	
3H3	- 0.6ZE...	0.109	0.588.	0.950	952 O	- 0.004	.1E40	.0E40	1.000
Exch. Ca		-0SL0		0.6Z6...	art°	VT0 0	180.0	.6550	1186.0
Exch. Mg	-	0.050	.0Z4' O	58C0	0.198	L10 0	Z50.0	.L9E*0	.IIEE8 0
Exch. K	-	0.06Z	.E8C0		OVECO	-0.0r0Z	£E0 0		-1295 0
Exch. Na	-	ZLO*0	..17171 0		.69r0	5 7 7	77E0•12		1.7:07

Table (4): Nitrogen stains (mg/kg) in soils of Kalobia Governorate and N-uptake barley plants.

No.	Soil location	Total N	Available N	NH4-N	NO3-N	NO_2-N	NH, fixation capacity	N-uptak (mg/pot
2	Abo-Zaabal	790	18.3	10.0	4.99	0.009	96	0.424
2	EI-Gabal El-Asfar (A)	1645	29.5	12.5	4.99	0.009	91	0.293
3	E1-Gabal El-Asfar (B)	2565	34.5	10.0	7.49	0.009	105	0.316
4	Seriaqous	1305	29.7	15.0	25.49	0.009	185	0.907
5	El-Kalag	1455	26.7	22.5	34.99	0.010	154	0.905
6	El-Mang	1435	45.3	27.5	77.49	0.015	158	0.410
7	Mostorood	1370	54.3	12.5	52.45	0.052	185	0.879
8	Balaqs	1195	34.5	15.0	272.48	0.020	171	0.450
9	Sendowa	1465	34.5	10.0	141.99	0.010	196	0.989
10	Nowa	1437	52.5	7.2	2.79	0.010	199	1.095
11	Kalama	1270	38.7	12.5	662.49	0.015	225	0.814
12	Kafr El-Shorafa	1420	61.5	12.5	27.49	0.051	185	0.818
13	Kafr-Saad Behery	1485	23.5	10.0	54.99	0.010	191	1.347
14	Kafr El.Sohby	1165	15.9	25.0	27.47	0.029	114	0.617
15	Meet Kenana	500	28.7	0.0	2.49	0.009	71	0.310
16	Gezirat Billy	740	24.3	12.5	19.99	0.010	148	0.853
17	E1-Ahraz	875	10.5	7.5	57.49	0.010	182	1.274
18	Monshaat El-Keram	1270	25.5	10.0	22.49	0.010	205	0.644
19	Arab Goheina	965	40.5	10.0	44.99	0.010	128	0.327
20	Meet Kenana	1370	25.5	5.0	2.49	0.010	192	0.624
21	Toukh	1085	31.5	12.5	12.49	0.010	199	0.585
22	EI-Shomot	1375	51.9	10.0	12.49	0.009	189	0.993
23	Meet El-Afar	555	42.3	12.5	2.49	0.009	185	0.93S
24	Meet EI-Howefein	1176	29.0	22.5	162.49	0.010	176	1.15(
25	Tant EI-Geziera	1545	42.1	30.0	209.99	0.010	185	1.114
26	Barshom El-Kubra	1220	39.1	22.5	17.47	0.030	149	0.755
27	El-Kanter El-IChayria	1266	66.9	25.0	14.99	0.010	165	1.75f
28	Qaranfeel	1485	62.7	35.0	52.47	0.028	207	0.79::
29	Meet Halfa	1350	40.0	17.5	7.48	0.018	185	1.76(
30	Bassos	840	30.3	10.0	4.99	0.009	191	0.92c
31	Moshtohor	815	39.0	12.5	12.49	0.009	177	0.58(

xa ion capacity m g so

4.2.1. Total nitrogen content:

The values of total nitrogen in the studied soils varied between as low as 500 mg/kg in light-textured soils (Meet Kenana soil, sandy clay loam) to as high as 2565 mg/kg riched organic matter soils of El Gabal El Asfar B. This finding is in accordance with those obtained by Bremner and Mulvaney (1982) who stated that the surface layer of most cultivated, soils contains between 0.06 and 0.5% N. Attia (1979) pointed out that the Nile alluvial soils are poor in total nitrogen as it r anged between 0.013% and 0.145% in the surface layers.

Concerning the relationships between total nitrogen and soil properties (Table 5), the following significant correltions were observed;

Highly significant correlations with organic matter content (r= 0.985***), $CaCO_3$ (r = 0.446**) and CEC (r = 0.459"). Similar results were obtained by Ibrahim (2001) and El-Kholy (1999).

A significant positive correlation with soil clay content (r = 0.401*). This finding is in agreement with those obtained by Ibrahim (2001).

The positive relationships between total nitrogen and organic matter content, clay content and soil CEC may ensure the increase in total nitrogen with soil becoming nearer to the Nile. Gao and Change (1996) showed that total N content in surface and sub-surface soil layers increased with increasing rates of organic manures.

- A highly significant correlation (r = 0.524**) with N-uptake by we grass plants.

4.2.2. Available nitrogen content:

Scarsbrook (1965) define the available N as N in the root zone in a chemical form readily absorbed by plant roots.

The data obtained show that the available N fraction in Kalubia soils varied between 10.5 and 66.9 mg/kg. Statistical analysis (Table 5) showed a significant positive correlation between soil available N and clay content (r = 0.588***), silt content (r = 0.393*) and soil organic matter (r = 0.742***). Similar results were obtained by Abou El-Naga et al., (1996) who stated that soil available N was increased with increasing the applied levels of organic manures. Similar results were obtained by Ibrahim (2001).

Significant correlations with exchangeable ions (Ca, Mg, Na and K) were also obtained. The relationship between available N and N-uptake as it is expected was significant (r = 0.432*).

4.2.3. Nitrogen fractions natent.-

The inorganic N in soils is predominantly NH^+ and NO3; with the exception of neutral to alkaline soils receiving NH_4^+ or $NII4^+$- producing fertilizers, $NO2^-$ is seldom present in detectable amounts (Keeney and Nelson, 1982).

Data obtained show that NH_4-N content in the tested soils ranged between 0.0 and 35.0 mg/kg soil. Barber (1984) reported

Table (5): Simp e correlation coefficient values (r) for the relationship between

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	Total N	Available N	NH_4-N	NO_3-N	NOrN	NH_4 fixation capacity
Coarse sand	0.239	-0.315	0.269	-0.213	-0.272	-0.531"
Fine sand	-0.093	-0.182	0.339*	0.056	0.365*	0.070
Silt	0.395*	0393*	-0.001	0.135	0.069	0.437**
Clay	0.401*	0.588***	0.078	0.239	0.096	0.610***
pH	-0.661***	-0.024	0.113	0.065	0.179	0.460**
EC	0.065	0.010	0.280	0.193	0.239	0.046
OM	0.985*"	0.742***	0.285	0.068	0.165	0.085
CaCO3	0.446"	0.416*	0.475"	0.365*	0.380*	0.574***
CEC	0.459**	0.685***	0.128	0.244	0.131	0.589"
Exch. Ca	-0.115	0.621"*	0.089	0.195	0.038	0.513"
Exch. Mg	0.030	0.687***	0.019	0.294	0.378*	0.516"
Exch. K	0.032	0.622***	0.478"	0.010	0.135	0.518"
Exch. Na	-0.020	0.563***	0.305	0.114	0.319	0.548***
N-uptake	0.524"	0.432*	0.218	0.017	-0.010	0.516**

that ammonium is similar in size to potassium and it is held on soil exchange sites with a similar strength. Much of the ammonium (up to 10 times) will be present as an exchangeable cation than that is found in solution; hence, solution concentration is usually low. Nitrate content ranged from 2.49 to 662.49 mg/kg soil. Reisenauer (1964) found that nitrate concentration in soil solution ranged between 50 and 150 mg/l.

Nitrite was found in minor amounts. Statistical analysis of the data show that NH_4-N was significantly correlated with fine sand (r = 0.365*) and CaCO3 content (r = 0.475**). Significant correlation with exch. K (r = 0.478*) was also obtained.

Except for CaCO3 content, which was significantly correlated with soil NO3, all of tested soil characteristics had not significant correlation with soil NO_3.

Nitrite fraction was significantly correlated with fine sand, calcium carbonate content and exchangeable sodium.

None of the nitrogen fractions (NH_4^+, NO3 and NOD were significantly correlated with N-uptake by lye grass plants.

4.3. Assessment of N availability depending on N forms. adsorption parameters:

To investigate the reliability of the adsorption relations for assessing N availability in alkaline soils of widely varying physical and chemical properties of Kalubia Governorate, three isotherms namely, Van Hauy equation (1975) as described by Pagel and VanHauy (1976), Freundlich equation (Boischot et al., 1950) and Langmuir equation as adopted by Syers et al., (1973) were tested.

4.3.1. <u>**Nitrate adsorption:**</u>

The data obtained are presented in Tables (6 & 7) and graphically illustrated in Figs. (5 & 6) which reveal that the amounts of NO_3^- sorbed by soils increased by increasing NO_3^- concentration in the equilibrium solution. Such results are in accordance with those obtained by Reynolds-Vargas et al., (1994) and Li, et al., (1995). The data obtained also indicate the superiority of Van 1-ivay and Freundlich equations over Langmuir one in evaluating NO3 adsorption on most cases of the tested soils. Unfittness of Langmuir isotherm to describe the adsorption of NO3 by the investigated soils were documented by the insignificant correlations between sorbed amount of $NO3^-$ by soils and its concentration in equilibrium solution.

4.3.1.1. <u>**Van Hauy equation parameters:**</u>

<u>**The affinity constant (n):**</u>

The affinity constant (n), which is related to the bonding energy, could be calculated from the liner form of the Van Hauy equation:

$Q = n \sqrt{I} + B$ as the slope of this linear form.

Data presented in Table (6) and illustrated in Fig (5) show that values of this constant fluctuated between 30 (in El-Gabal El-Asfar soil B) and 247 (Qaranfeel soil). It is clear also that the highest value obtained was that of the heavy textured soils, while the lowest one was that of the light textured soils.

Data of statistical analysis presented in Table (7) show that values of the constant "n" significantly correlated with silt content (r = 0.616"), clay content (r = 0.648*), $CaCO_3$ content (r = 0.699*) and cation exchange capacity (CEC) of the soils (r = 0.852**).

This is true whether the tested soils were (in most cases) heavy textured soils and such a result ensure the proportional relation between the bonding energy and the fine fraction content (silt and clay) of the soils.

Concerning the relationship between values of $NO3^-$ bonding energy and N uptake by rye garss (Fig. 6) plants, a significant correlation (r = 0.659**) was obtained.

Such a result is expected since the increase in the bonding energy of NO3 should be associated by an increase in its availability, where a little NO3 is leached and moves downwards. This is the main reason of a large capacity to take up NO3 by plant roots when the bonding energy of this ion is high.

Theoritical NOi desorption constant (b):

This constant is calculated as the intercept of the linear form of Van Huay equation. The values obtained for this constant "b" are presented in Table (6). Data obtained show that values of this constant ranged from —4.6 (El-Gabal El-Asfar soil "B", loamy sand) to —117.0 (Sendowa soil, clay).

Comparing the calculated values of NO3 desorption constant "b" with the experimently determined one may confirm the reliability of using the equation of Van Huay for calculating the phosphate desorption in such investigated soils.

Data obtained (Table, 7) show a significant, but negative, relationship with CEC (r = - 0.729**) and EC (r = -0.654*). These results may throw some light on the role of the cation exchange capacity (CEC) and soil EC as soil parameters is soil parameters limiting to a great extent, the NO_3 desorption parameters of such soil. However, the correlations were not significant with the other tested soil parameters. The insignificancy of these correlations suggests that none of these parameters could be responsible for NO_3 desorption.

Statistical analysis of these data ensure the significancy of the relation between this parameter and N uptake by"rye grass plants (Fig 6) from the tested soils (r = -0.647*).

<u>Experimental desorption of</u> <u>NOi:</u>

This constant is supposed to equal the negative values sorbed when the added amount of NO_3^- equal to zero (ng/g). Values of this parameter ranged from zero (El-Gabal El-Asfar soil "B", loamy sand) to 3.1 gWg (Sendowa soil, clay).

A significant relationship between this constant and silt content of such soils (r = 0.622*), while the relationships with other soil parameters were insignificant.

As it is expected, the relationship between this constant and N uptake by rye grass plants (Fig 6) was significant (r = 0.632*).

4.3.1.2. <u>Freundlich equation parameters:</u>

Plotting the obtained data of NO_3 adsorption isotherm (Fig 7) clearly indicate that the results fit at high level of significancy the Freundlich equation. This finding is in agreement with those obtained by Li, et al., (1995).

It is worthy to mention that Freundlich equation may represent a suitable tool for plotting NO3 sorption relations but its constants, i. e. the intercept (log k) as well as the slop (1/n) of the equation in the linear form can not provide clear valid informations that are valuable for assessing $NO3^-$ sorption relations. However, using this equation does not enable neither to calculate the NO3 adsorption maximum nor the energy by which NO_3 is bonded to the soil surfaces.

<u>The constant (log k):</u>

Data presented in Table (6) show that the values of this constant (log k) ranged between 1.153 (Abo Zaabal soil, loamy sand) and 2.296 (Qaranfeel soil, clay). A highly significant relationship between this constant and soil clay content (r = 0.735**).

Significant correlations with the other tested soil characteristics; silt content (r = 0.655*), $CaCO_3$ (r = 0.643*) and CEC (r = 0.650*) were obtained. Such results may give an evidence to the role played by the different soil components in NO3 adsorption by such soils.

On the other hand, the relationship between this constant and N uptake by rye grass plants was insignificant.

<u>The constant (1/0:</u>

Data show that values of this constant are fluctuated between 0.499 (El-Shika Salina soil, sandy) and 0.768 (Sendowa soil, clay).

Table (6): Different parameters of adsorption isotherms of NO_3 for the studied soils.

[illegible]	Parameters of Van Huay equation				Parameters of Freundlich equation			Parameters of Langumir equation		
	Affinity constant (n)	Theoretic NO_3 desorption (b) mg/kg	Experimental desorption mg/kg	Correlation coefficient (r for 41 vs. Q	[illegible]	[illegible]	Correlation coefficient for Log C vs. log x/m	Bonding energy (K1)	Sorption maximum (K2)	c for c vs. c/x/m
Abo-Zaabal	[illegible]	[illegible]	0.60	[illegible]	[illegible]	0.689	[illegible]	-	-	[illegible]
El-Gabal El-Asfar (A)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	
El-Gabal El-Asfar (B)	[illegible]	-	0.00	[illegible]	[illegible]	[illegible]	0.996***	0.081	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]
[illegible]	[illegible]	[illegible]	0.80	0*989***	1.686	[illegible]	[illegible]	-	-	0.689
Monshaat El-Keram	[illegible]	[illegible]	[illegible]	0.996***	[illegible]	0.656	[illegible]	-	-	[illegible]
Meet Kenana	[illegible]	[illegible]	[illegible]	0.998***	[illegible]	[illegible]	0.998***	-	-	[illegible]
Barshom El-Kubra	[illegible]	-	[illegible]	0.909*	[illegible]	[illegible]	[illegible]	-	-	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		-	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]

	Parameters of Van Huay equation			Parameters of Freundlich equation	
	Affinity constant (n)	Theoritical NO3 desorption (b)	Exper. desorption (11&/0	cog k	1/n
Silt %	0.616*	-0.501	0.622*	0.655*	0.367
Clay%	0.648*	-0.285	0.497	0.735**	0.251
pH	0.530	-0.550	0.448	0.480	0.356
EC	0.458	M654*	0.345	0.257	0.273
OM%	0,534	-0.440	0.444	0.459	0.520
CaCO3%	0,699*	-0.575	0.586	0.643*	0.600
CEC	0.852**	0.729**	0.248	0.650*	0.217
N-uptake	0.659*	M.647*	0.632*	0.577	0.554

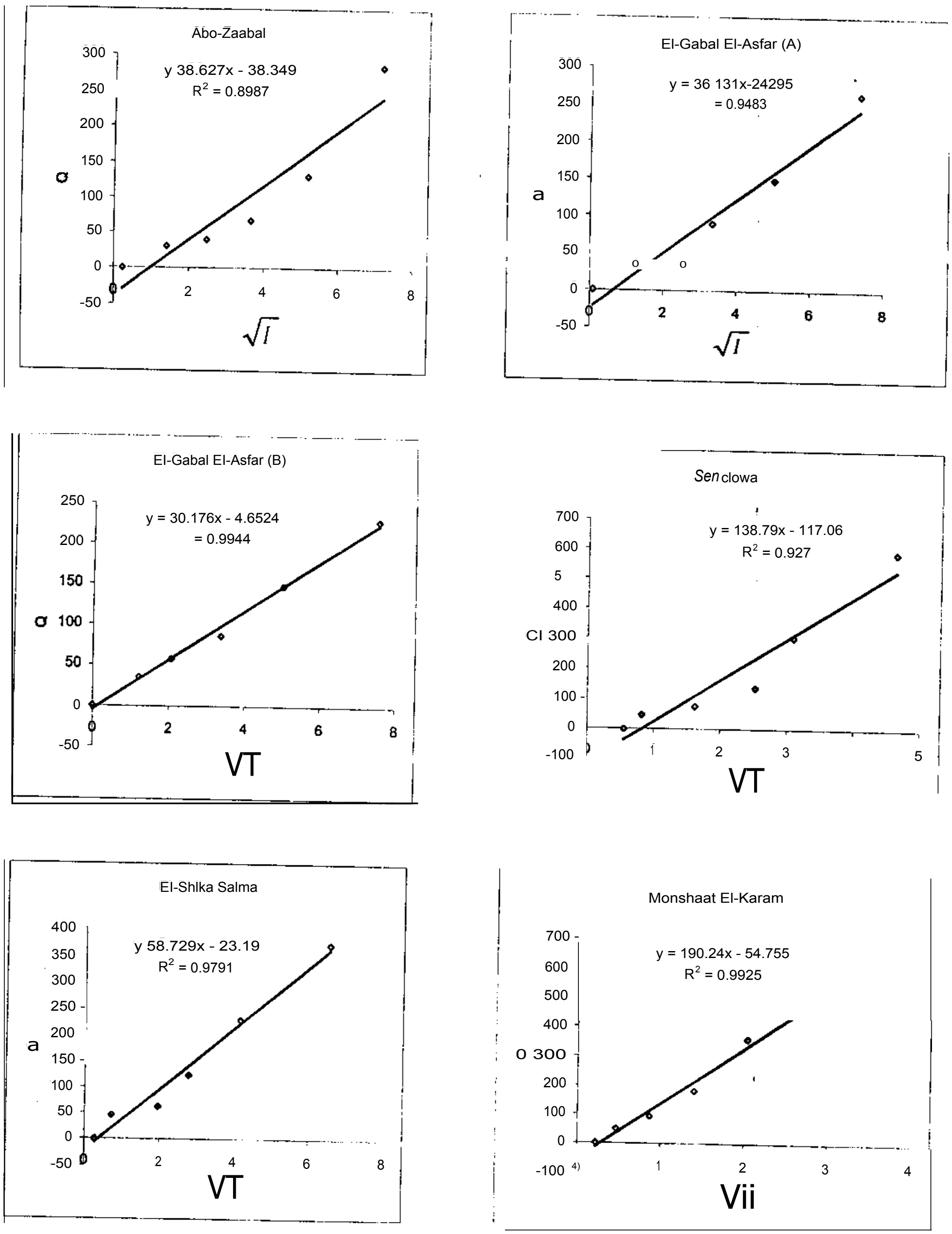


Fig. (5): Linearized form of adsorption curve according to Van Huay equation.

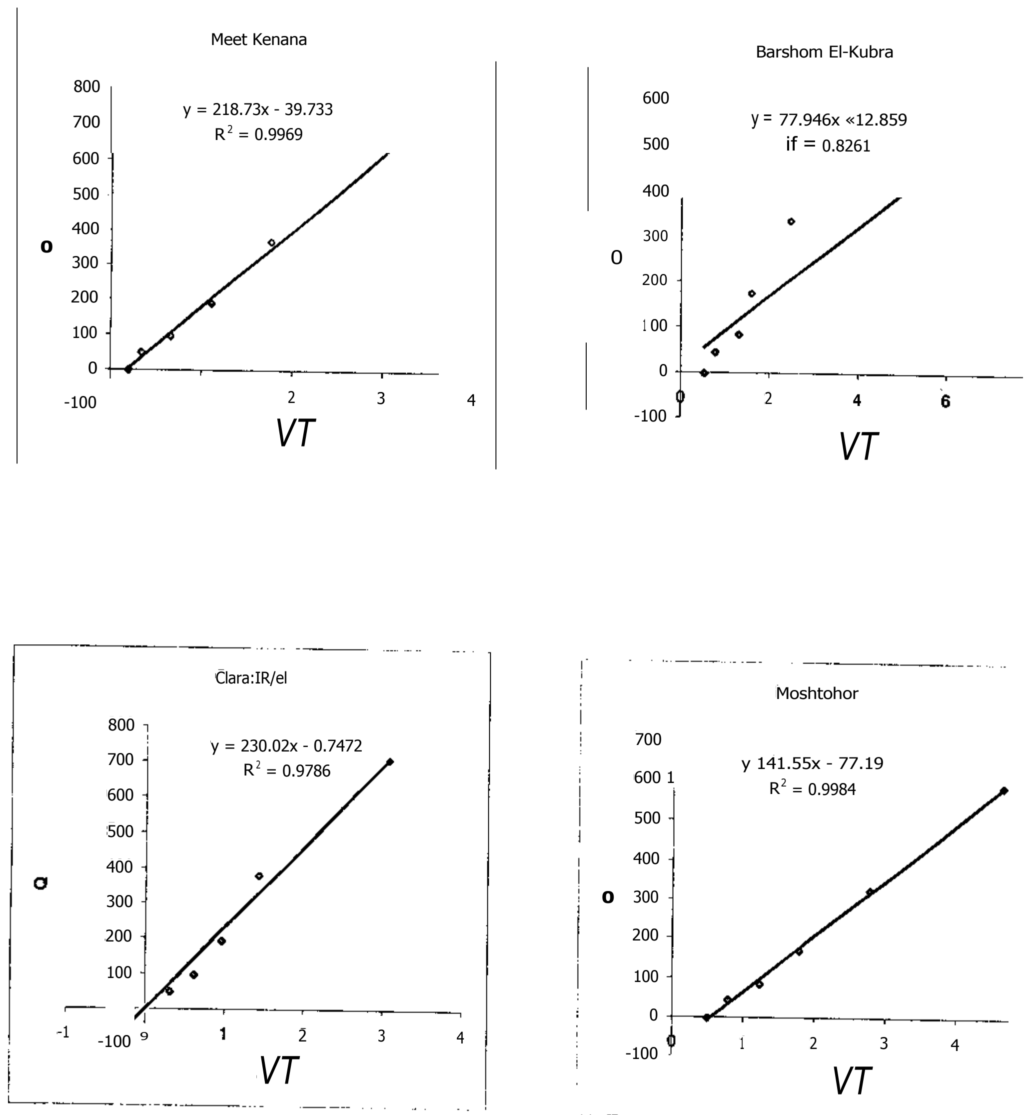

Meet Kenana
y = 218.73x - 39.733
R^2 = 0.9969
VT
Barshom El-Kubra
y = 77.946x «12.859
if = 0.8261
VT
Clara:IR/el
y = 230.02x - 0.7472
R^2 = 0.9786
VT
Moshtohor
y 141.55x - 77.19
R^2 = 0.9984
VT

Fig. (5): Cont.

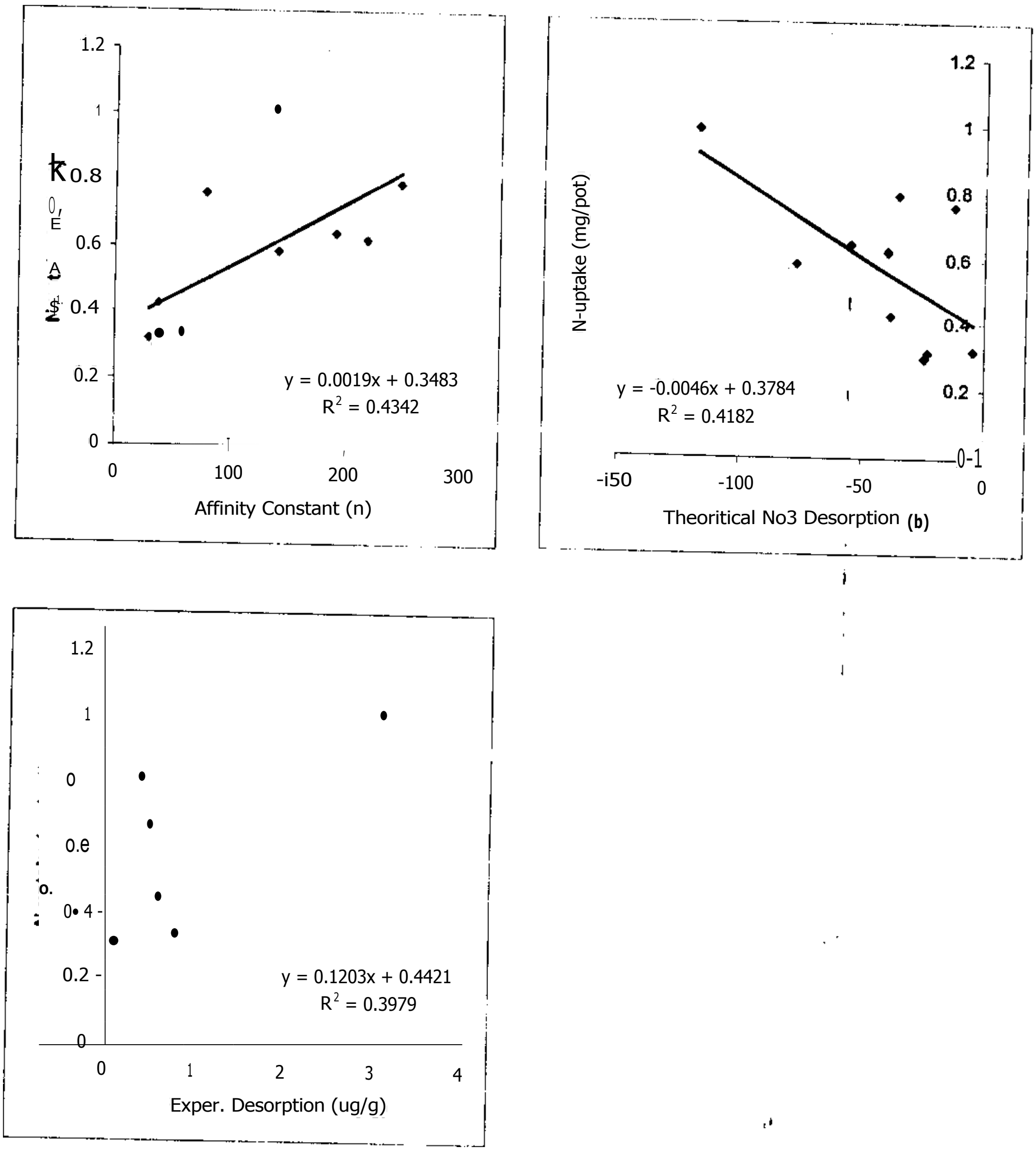


Fig.(6): The relationship between affinity constant, theoritical NO3 desorption and experimenta desorption of Van Huay equation and N- uptake by rye grass.

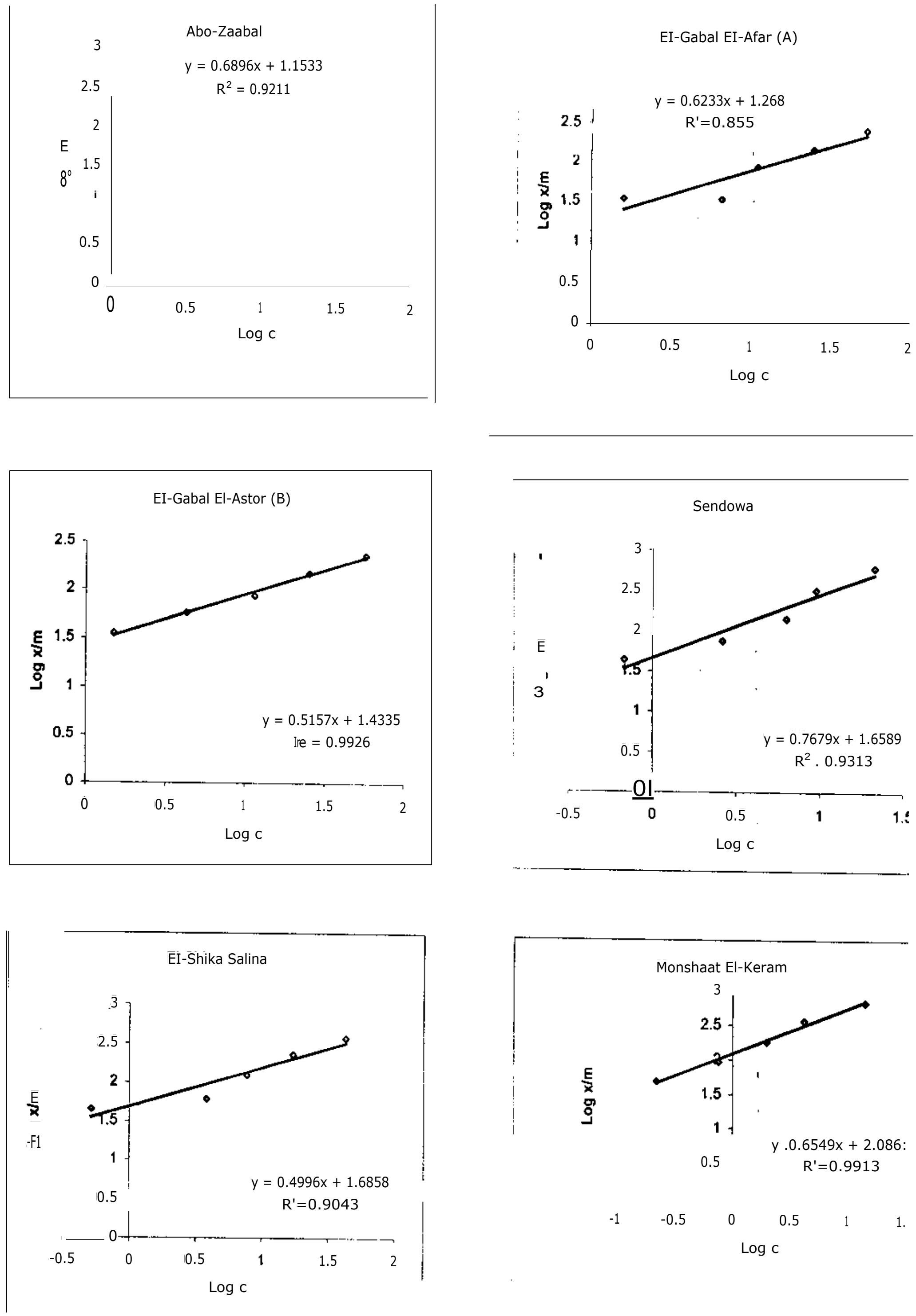
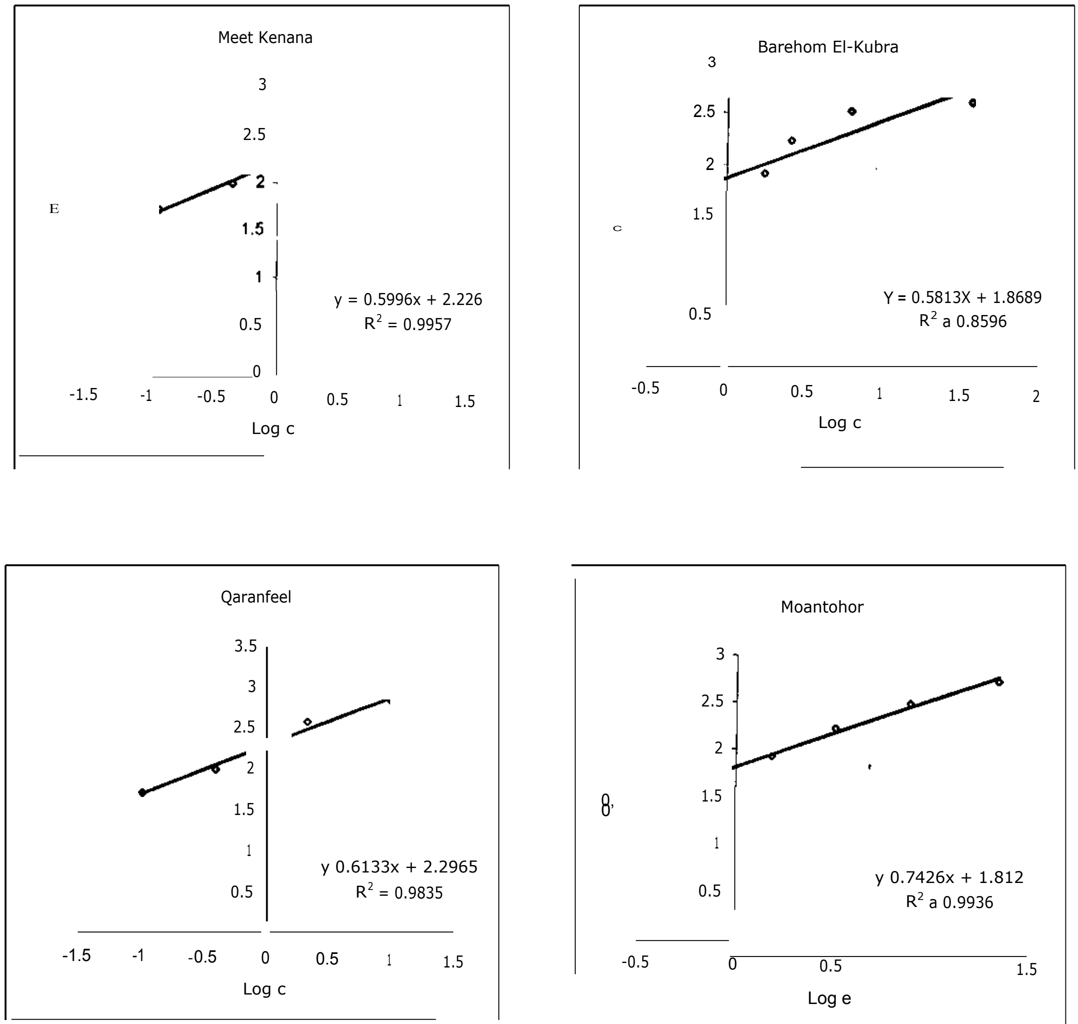


Fig. (7): Linearized form of adsorption curve according to Freundlich equation.



Meet Kenana
y = 0.5996x + 2.226
R2 = 0.9957
Log c
Barehom El-Kubra
Y = 0.5813X + 1.8689
R2 a 0.8596
Log c
Qaranfeel
y 0.6133x + 2.2965
R2 = 0.9835
Log c
Moantohor
y 0.7426x + 1.812
R2 a 0.9936
Log e

Fig. (7): Cola

Statistical analysis of the obtained data show that this constant (1/n) tends to behave differently from the log constant, where all correlations with the tested soil properties as well as N uptake by rye grass plants were insignificant.

4.3.2. <u>**Ammonium adsorption:**</u>

Ammonium adsorption on some soils of Kalubia were evaluated using the standard batch technique and the data obtained are presented in Tables (8 and 9). These data show that adsorbed amounts of N1-1$_{4}$' by tested soils were increased by increasing NI-1$_{4}^{+}$ concentration in soil solution. These results are in agreement with those of Kithome et al., (1999) and Mishra et al., (2000).

The obtained data clearly reveal that NH_4^+ adsorption can be satisfactorily described by Van Huay, Freundlich and Langmuir equations but van Huay equation being superior, where significant correlations between its adsorption parameters and different soil characteristics as well as N-uptake were obtained.

4.3.2.1. <u>**Van Huav equation parameters:**</u>

The data obtained, generally showed close fitness to Van Huay isotherm. The values of correlation coefficient expressing this relationship were always highly significant (Table, 8 and Fig 8). Treating the data according to the adsorption isotherm of an Huay in the Linear form showed the following parameters:

The affinity constant (n):

Plotting the NH_4^+ sorption data according to Van Huay isotherm yielded "n" values ranging between 5.5 (in Meet Kenana soil)and 107.1 (in Monshaat El-Keram soil). NotewOrthy referring that soils of high clay content showed the highest values of (n) whereas those of low clay content showed the lowest ones. These results are documented by highly significant correlations between this constant (n) and both of clay content (r = 0.771**) and CEC (r = 0.755**). Also, a significant relationship with CaCO3 (r = 0.630*) was obtained. A positive relationship, but insignificant, between "n" constant and N-uptake by rye grass (r = 0.562) was obtained.

Theoritical NH_4^+ desorption constant b :

This parameter represent the intercept of the linear form of Van Huay isotherm. Values of this constant (b) were positive in the light-textured soils (El-Gabal El Asfar (A) and Meet Kenana soils) and negative in the heavy-textured ones (the other tested soils).

Data of statistical analysis (Table, 9) show that significant correlation between this constant (b) and OM content (r = 0.733**), $CaCO_3$ content (r = 0.643*) and soil CEC (r = 0.679*). A negative relationship with clay content (r = -0.636*) was also obtained. The significancy of this constant (b) was ensured by the significant relationship between it and N-uptake by rye grass (r = 0.631*).

Experimental desorption of NH::

This constant fluctuated between 0.0 (in the light-textured soils) and 2.0 .tg/g in the heavy-textured ones. This constant correlated with a high level of significancy with silt content (r = 0.786**), clay content (r = 0.871**) and $CaCO_3$ content (r = 0.831**). A positive correlation was also obtained with OM content (r = 0.700*) and soil CEC (r = 0.563*).

As it expected, a significant relationship between this constant and N-uptake by rye grass (r = 0.561*) was obtained, hence one may conclude that this equation is considered 'as a most suitable mean in assessing N availability in these soils.

4.3.2.2. <u>Freundlich equation parameters:</u>

The data of NH_4^+ adsorption was also treated according to Freundlich equation, by plotting the logarithm of equilibrium NH_4 concentration (log c) against the logarithm of adsorbed amount of NH_4 log(X/m), as presented in Table (8)' and illustrated in Fig. (9).

The data show a close agreement with Freundlich equations with high levels of significancy in all of the tested soils.

<u>The constsnt (Lo2"k"):</u>

Data show that values of this constant ranged between 0.745 and 1.428. Noteworthy referring that values of this constant do not provide any information about the affinity of the adsorbate (NH_4^+) to the adsorbant (soils).

This constant did not correlated significantly with each of the tested soil characteristics, except with pH (r = 0.665*).

The constant (1/n):

This constant represents the slop of the Freundlich equation:

$$(\log x/m = \log k + 1/n \log c)$$

Values of this constant ranged between 0.322 and 0.919. The lowest values were recorded in the light-textured soils and highest values were obtained in the heavy-textured ones.

This constant (1/n) correlated significantly with OM content (0.734*), $CaCO_3$ content (r = 0.643*) and soil CEC (r = 0.679*). It also positively correlated with N-uptake but the relationship was significant (r = 0.547).

4.3.2.3. Lanamuir equation parameters:

Plotting the c/x/m values versus the equilibrium concentration of NH_4^+ (c) show the linear relationships (Fig 10), where the different parameters of Langmuir isother are extrapolated. Values of correlation coefficient were slightly lower in comparison with those obtained with Van Huay and Freundlich equations.

Poor correlations between Langmuir equation parameters (kl and k2) and the different soil characteristics as will as N-uptake by we grass may ensure the unsuitability of this equation for determing the N-availablity in these soils.

o rt o a			an Huay equation					Parameters of Langumir equation		
	A/unity constant(**n**)	Theoretical NO, desorption (b) mann,	lhuaiPtha desorption	Correlation coefficient (r)	gai	=	Correlation coefficient for	Bonding energy	Sorption maximum	I Correlation coefficient
s' 1 4 0 v	E*17Z	LI 4	0.0'0	**E£6 O	096'0	55E O	*P88 O	Zia°	LLZ	*LSW0
14 ct i4 ¢	CE/	S 8	0.0'0	**0176 O	Say I	ZZE•0	*958'0	EZ0 O	Z I Z	*818'0
W 1 'S O il1	6•9£	VI' S9 -	06 0	***886*0	517L*0	9L8'0	***666'0	1700 O	III I	**9176 0
E natOptlac	6'59	617'601-	09'I	***586'0	1601	5E8'0	***666*0	900'0	8Z171	*6L8*0
MIN RUE10	S	SO'L	000	***I86•0	0I1 _1	1'E1 O	***186•0	8170'0	8L	***8860
u MIGNI3 MYSUOMI	FLO	18*65I -	08'0	***086 O	961'1	616 O	***6661)	£00 O	0005	* Z Co ci
ig Paw U00J	E S4	85*ZI I -	00 I	***6L6*0	LW I	LbL'O	***E86 O			en GO O C1.
arstiom El- Kubra		0E1Z	00 Z	***5961)	&Et I	0179'0	***9L6 O	OE0 O	VSE	* * co an ON a
tjaranfeel	Z9'L	6Z191-	08'1	***1796 O		8E8'0	***L66•0			en en N- d
		-99.21			5br I	SZCO	***E66*0	Z 0 0	I I I	.4. O 0s 6

	Parameters of Van Huay equation			Parameters of Freundlich equation		Parameters of Langumir equation	
	Affinity constant (n)	Theoritical NH_4 desorption (b)	Exper. desorption (µg/g)	Log k	1/n	K_1	K_2
Silt %	0.289	- 0.330	0.786**	0.490	0.362	- 0.114	- 0.064
Clay%	0.771**	- 0.636*	0.871**	0.156	0.559	- 0.159	- 0.136
PH	0.288	- 0.050	0.236	0.664*	- 0.050	0.216	0.115
EC	0.253	0.500	0.455	0.083	0.500	- 0.497	0.106
OM%	0.457	0.733**	0.700*	- 0.062	0.734**	- 0.588*	0.288
CaCO3%	0.630*	0.643*	0.831**	0.541	0.643*	- 0.465	0.323
CEC	0.755**	0.679*	0.563*	0.315	0.679*	- 0.607*	0.516
N-uptake	0.562	0.631*	0.561*	0.289	0.547	- 0.414	0.241

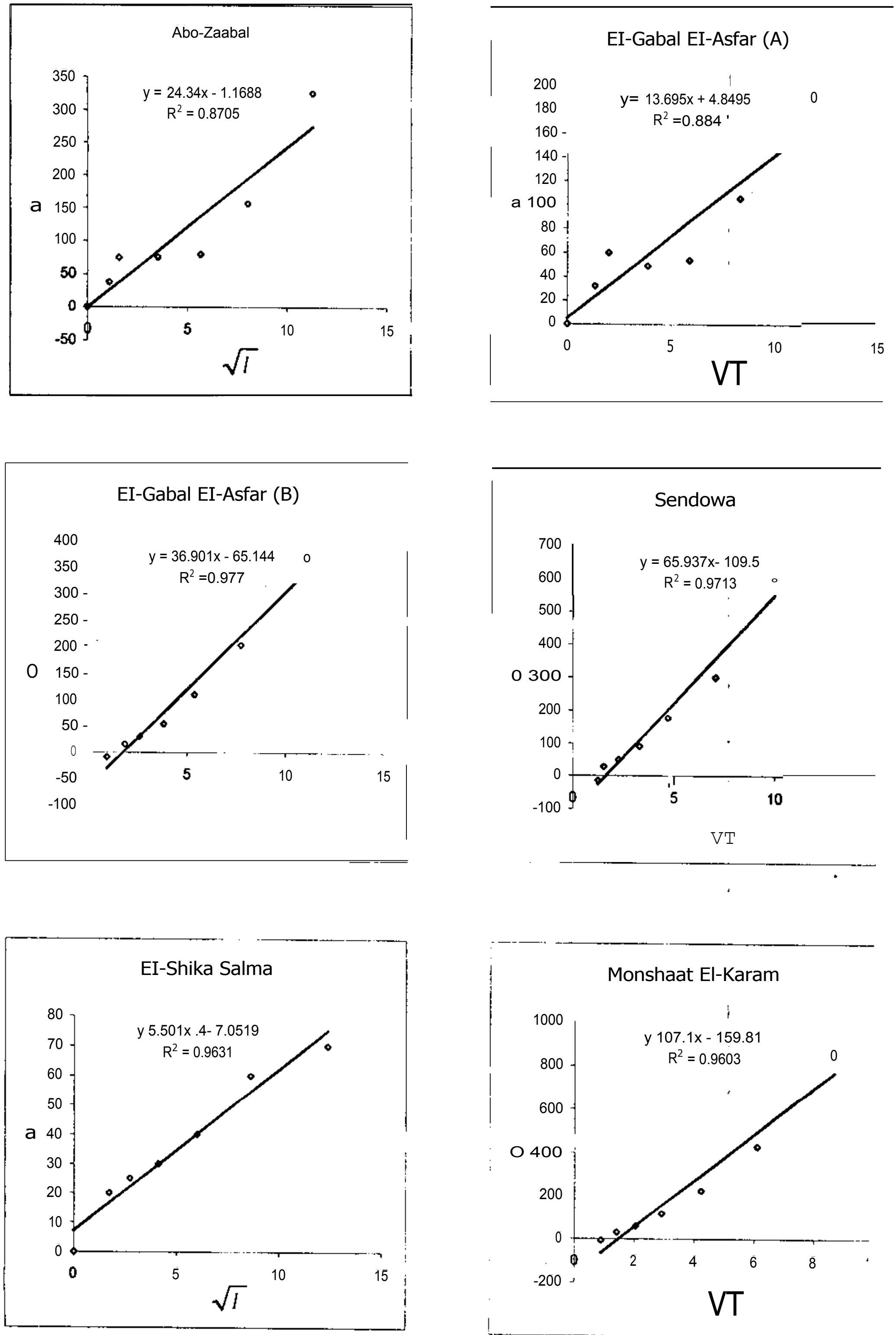


Fig. (a): Linearized form of NH4-adsorption curve according to Van Huay equation.

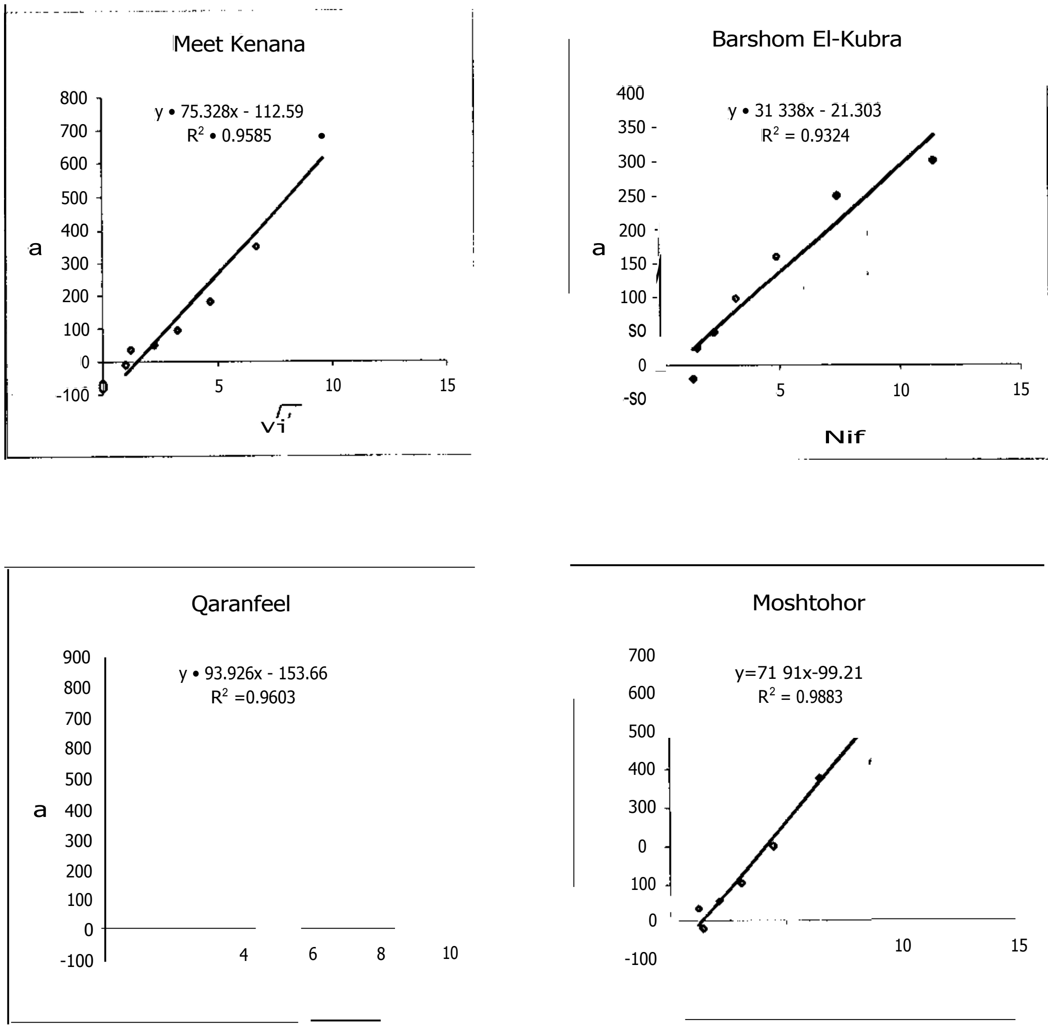

Meet Kenana
y • 75.328x - 112.59
R^2 • 0.9585
800
700
600
500
400
300
200
100
0
-100
a
0
5
10
15
V i
Barshom El-Kubra
y • 31 338x - 21.303
R^2 = 0.9324
400
350
300
250
200
150
100
SO
0
-SO
a
5
10
15
Nif
Qaranfeel
y • 93.926x - 153.66
R^2 =0.9603
900
800
700
800
500
400
300
200
100
0
-100
a
4
6
8
10
Moshtohor
y=71 91x-99.21
R^2 = 0.9883
700
600
500
400
300
0
100
0
-100
10
15

Fig. (8): Cont.

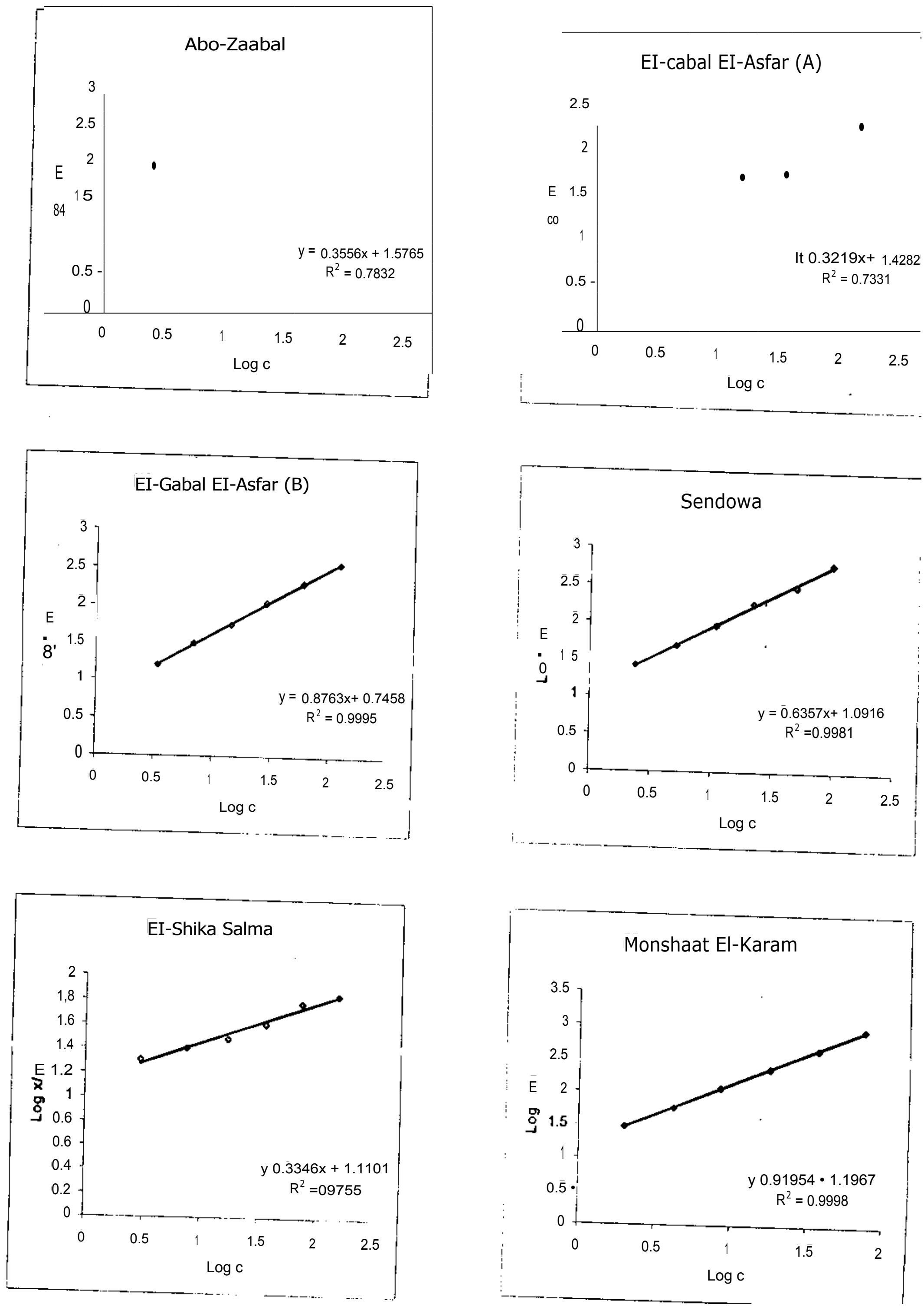


Fig. (9): Linearized form of NH4-adsorption curve according to Freundlich equation.

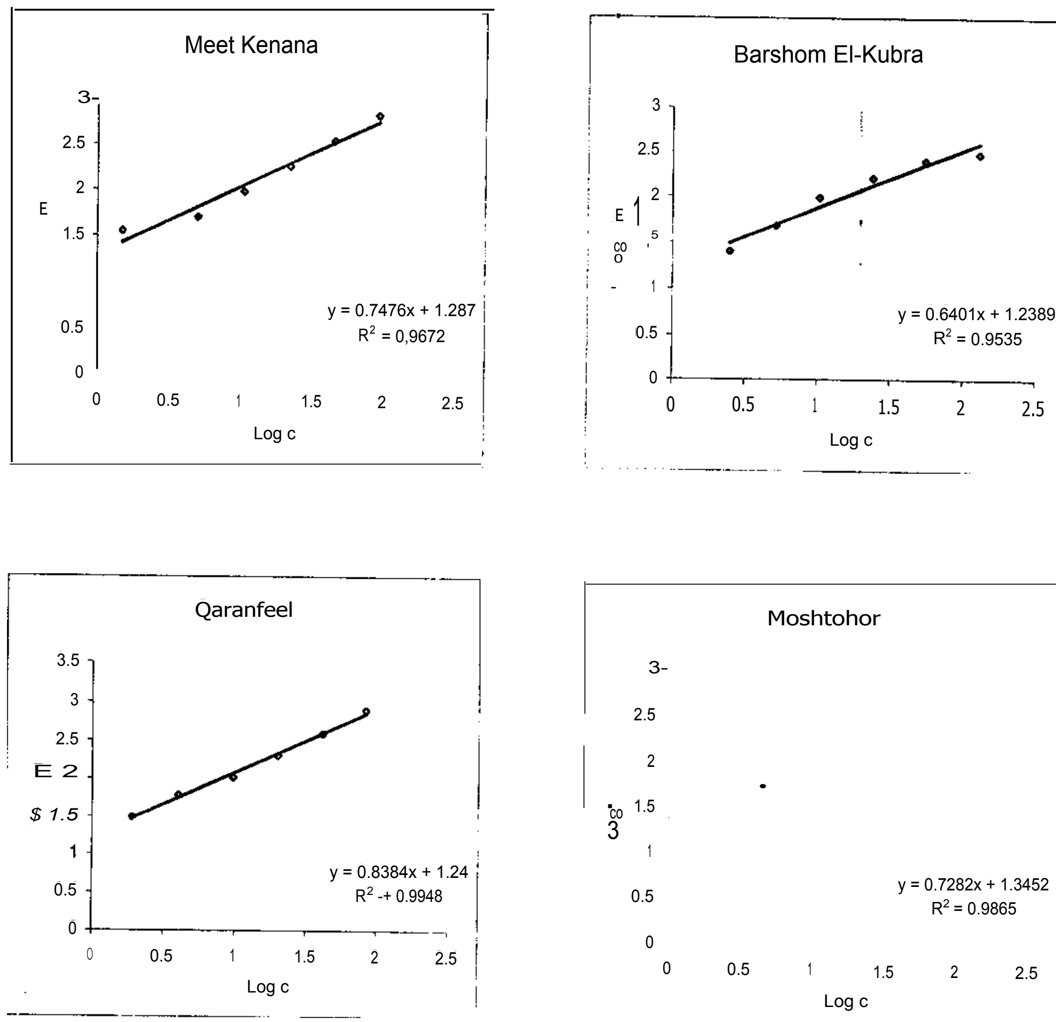

Meet Kenana
y = 0.7476x + 1.287
R2 = 0,9672
Log c
Barshom El-Kubra
y = 0.6401x + 1.2389
R2 = 0.9535
Log c
Qaranfeel
y = 0.8384x + 1.24
R2 -+ 0.9948
Log c
Moshtohor
y = 0.7282x + 1.3452
R2 = 0.9865
Log c

Fig. (9): Cont.

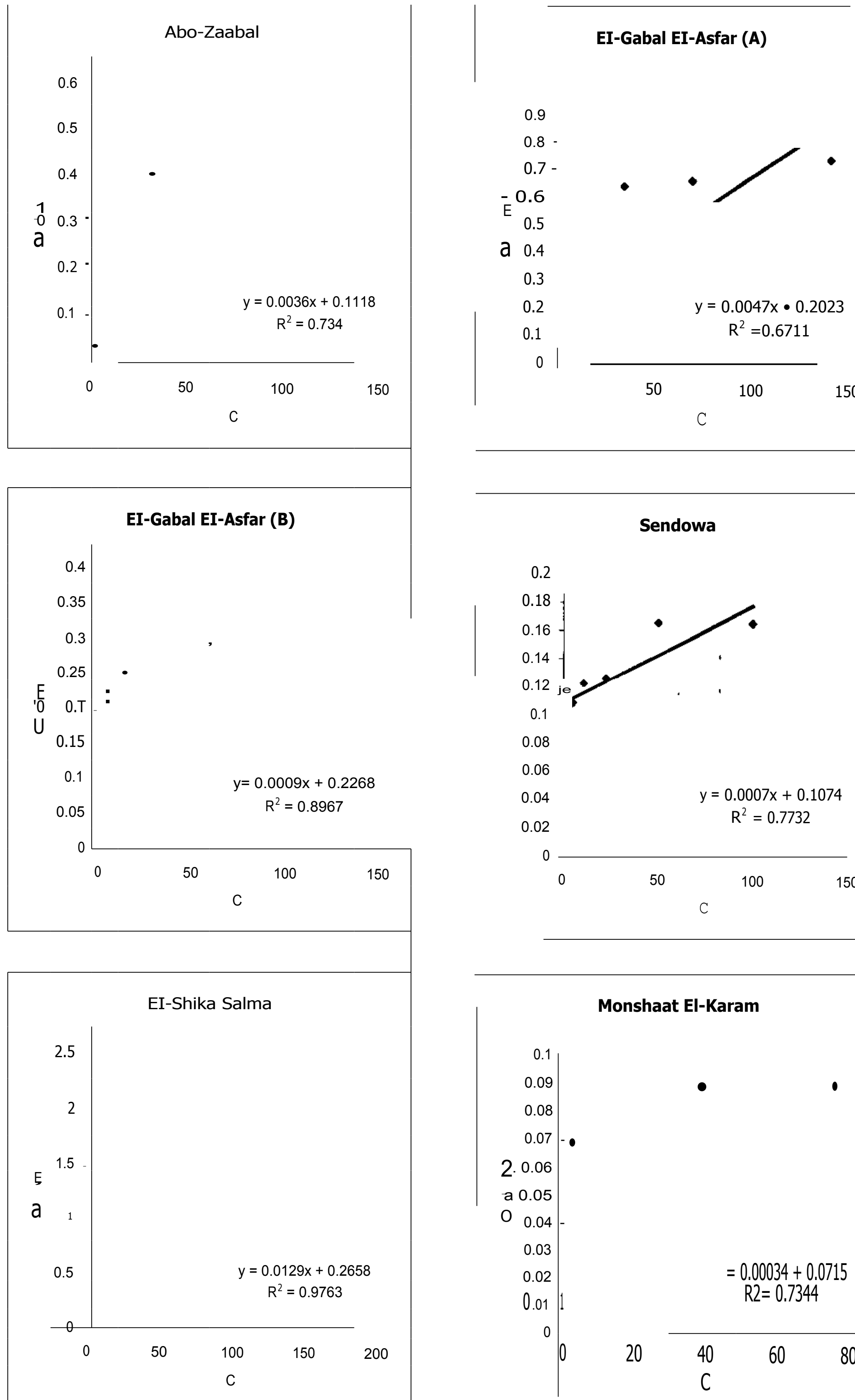


Fig. (10): Linearized form of adsorption curve according to Larigmuir equation.

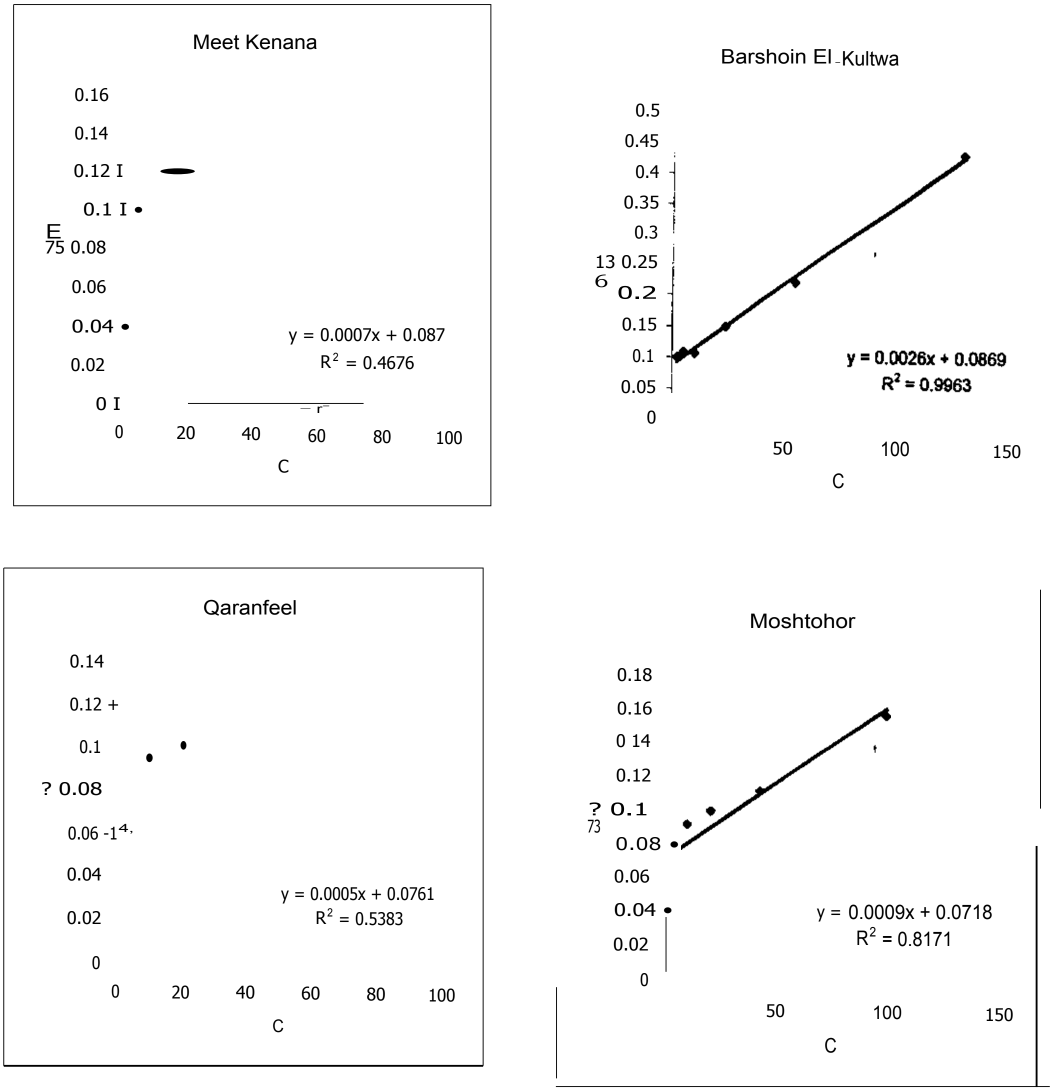

Meet Kenana
y = 0.0007x + 0.087
R2 = 0.4676
C
Barshoin El-Kultwa
y = 0.0026x + 0.0869
R2 = 0.9963
C
Qaranfeel
y = 0.0005x + 0.0761
R2 = 0.5383
C
Moshtohor
y = 0.0009x + 0.0718
R2 = 0.8171
C

Fig. (10): Cont.

4.4. Ammonium fixation capacity by soils:

Clay minerals will fix ammonium just as they do potassium; both ions are similar in dehydrated size. Fixed ammonium is defined as ammonium that cannot be readily exchanged by other cations. Two aspects of ammonium fixation are of interest; one is the amount of native fixed ammonium in the soil, and the second is the amount of ammonium fixation that occurs when ammonium fertilizers are applied (Barber, 1984).

Ammonium fixation by soils was assessed in terms of the amount of $NH4^+$ retained by soils against extraction by KC1 after supplying the soils with $NH4^+$ as NH4C1 (1000 µg Nf14/g soil). The assessment was done by determing the percentage of fixed NH_4 in relation to the amount applied.

Results obtained in Table (4) show that ammonium fixation capacity ranged from 71 me/100 g soil (in meet Kenana soil, sandy clay loam) to 225 me / 100 g soil (in Kalama soil, clay). It is obvious that soils which showed low fixation capacity of NH_4^+ are those of low clay contents and having light texture. Keeney and Nelson (1982) reported that up to 10% of total nitrogen in surface soils and 30% of total nitrogen in subsoils is reported to be adsorbed as NH_4^+ in the soil clay minerals in a nonexchangable (fixed) form.

Statistical analysis of the obtained data (Table 5 and Fig. 11) was confirmed the aforementioned data, where highly significant relationships with clay content (r = 0.589***), organic matter content (r = 0.550***) and calcium carbonate content (r = 0.581***) were obtained. A possible explanation is that NH_4^+ can be fixed relatively more strongly when expanding clay minerals shrink by drying.

Noteworthy referring that surface charge of soil constituents may represent the most important factor responsible for NH_4^+ fixation by soils where a highly significant relationship between NH_4^+ fixation and soil CEC (r = 0.902***) was obtained. Soils which showed high fixation capacity are those of high values of CEC and soils of low CEC tended to show a lower capacity of NH_4^+ fixation.

A highly significant correlation but negative between NH_4 fixation and coarse sand (r = -0.531"). This result may explained on the bases of surface area and surface charges of sand. Rates of NH_4^+ adsorption and exchange are proportional to surface areas and the surface area generally decreased' with increased particle sizes.

Data obtained show that NH_4^+ fixation was unaffected by pH changes. Almost similar results were obtained by Shen, 'et al., (1997).

Clay mineralogy of 16 soil samples representing the investigated area (Kalubia Governorate) was done by Abdel-Salam (2001). Results obtained show that montmorillonitesl were the dominant clay mineral, followed by kaolinites which were in common to moderate contents. Chlorites and vermiculites' were found in traces in some soil samples or nonexistent in the others. Palygorskites were nonexistent in the majority ofthe investigated soils. These results are in agreement with &Ise of Nommik and Vahtras (1982) and Abdallah (1985) who showed that montmorillonites were the dominant clay minerals in soils of the Nile Delta regoin.

On the basis of the aforementioned results it can be explained the high capacity of the tested soil to fix ammonium.

Concerning the relationship between NH: fixation capacity of soils and N-uptake by rye *grass* plants (Fig 12), data show a highly significant correlation (r = 0.518**) was obtained. Thompson et al., (1988) stated that the availability of NH_4^+ ions for biological and chemical processes in soils depends on the types of exchange sites they occupy. Some $NH4^+$ ions occupy adsorption sites on the exposed surfaces of soil particles and are readily available. Some are occluded within mineral structures and are considered unavailable during time scales of agronomic interest.

Green et al., (1994) stated that recently-fixed ammonium may be released during the nitrification of exchangeable ammonium.

Thompson and Blackmer (1991) showed that significant amounts of N applied to Iowa cornfields in early spring is often found as nonexchangeable NH_4^+ in late spring and then disappears form this fraction during the growing season. Such a release on nonexchangeable NH_4^+ would provide a source of slowly available N which could influence metabolic processes in plants and affect the plant growth. On the other hand, Barber (1984) reported that the information on availability of fixed NH_4^+ has to plant and microorganisms is incomplete. However, if applied $NH4^+$ fertilizer becomes fixed, it would appear that much of it becomes available. Recently, fixed NH_4^+ has been

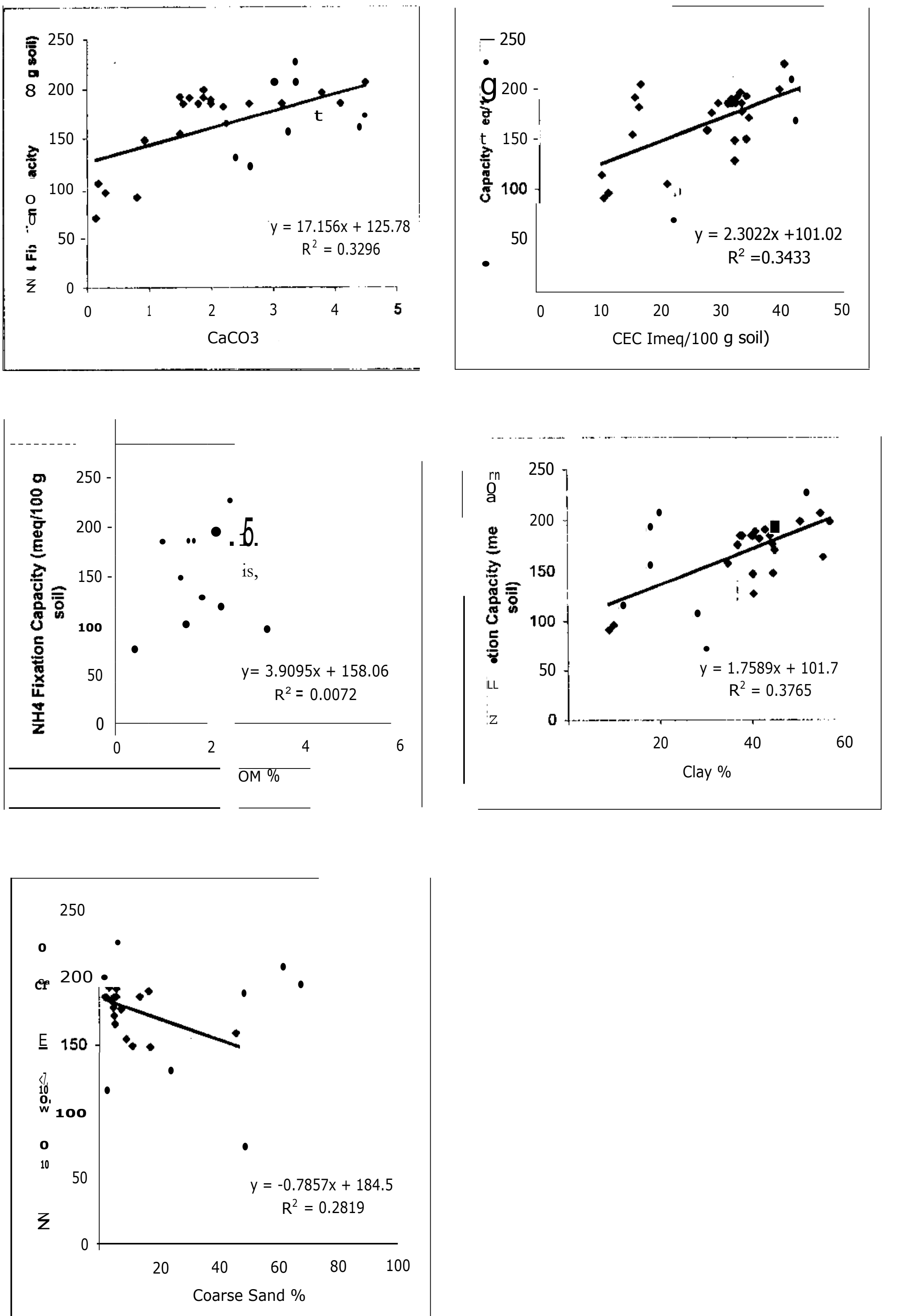


Fig.(11): The relationship between different characteristics of the tested soils and NH4 fixation capacity.

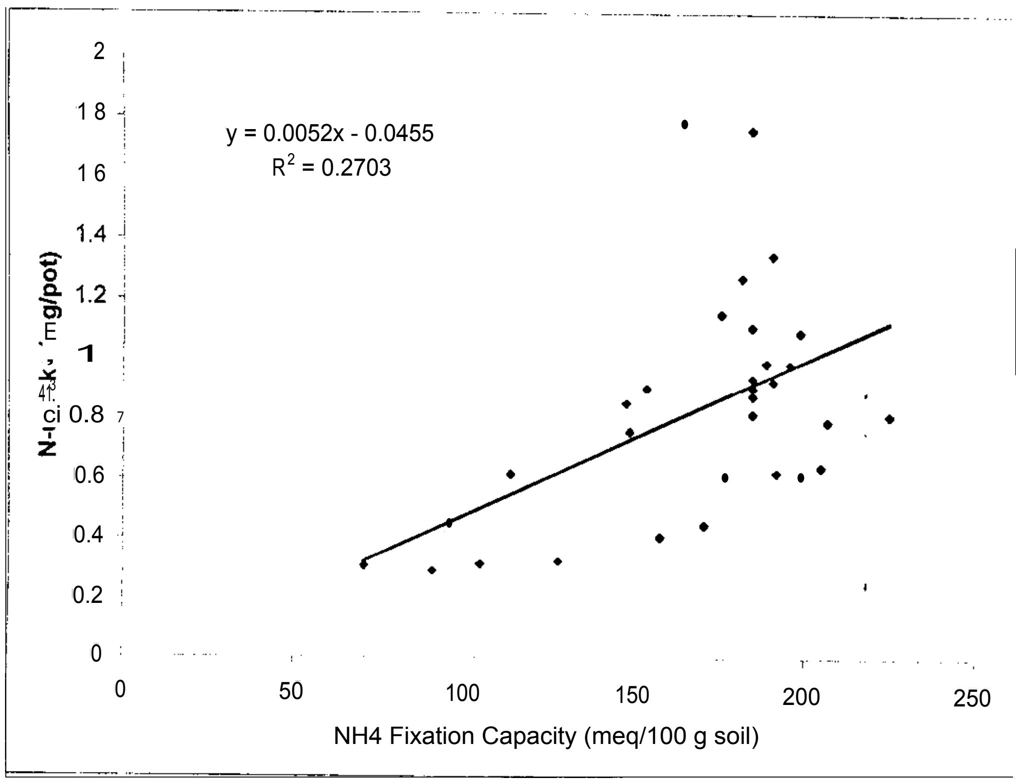


Fig.(12): The relationship between N-uptake by rye grass and NH4 fixation capacity of tested soils.

found to be less available than the exchangeable ones, but it is not certain whether this is simply a matter of rate of availability or whether some of the fixed is actually unavailable.

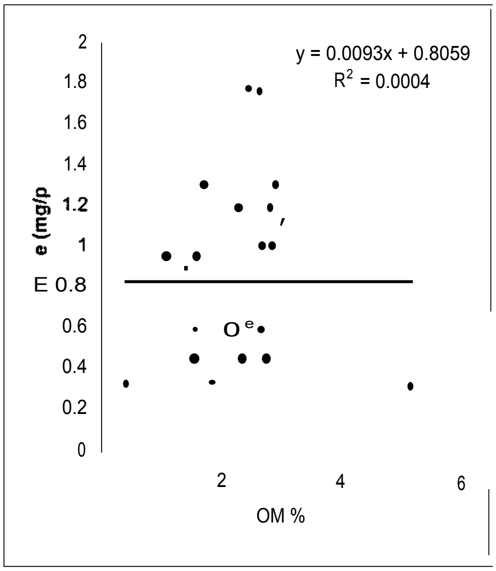
4.5. Nitrogen uptake by rye grass as a parameter for evaluating soil nitrogen availability.

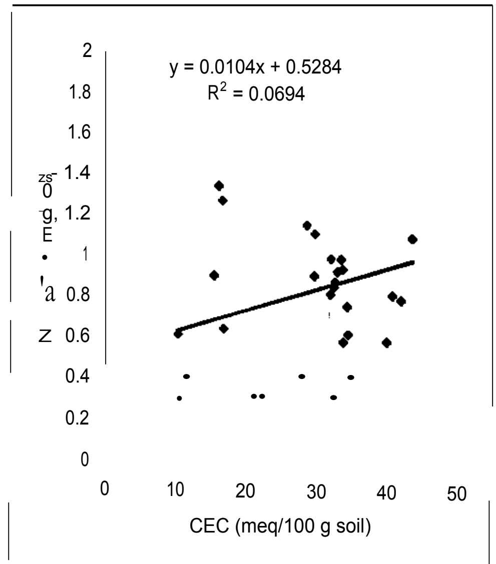
To estimate adequacy of soil nitrogen for growing plants in Kalubia soils, a Neubauer trail was conducted using rye grass as indicator plants were grown for 30 days, then after removed and analyzed for nitrogen concentration and nitrogen uptake. Nirogen-uptake by rye grass ranged between 0.293 mg/pot (in El-Gabal El-Asfar soil A, loamy sand) and 1.760 mg/pot (in Meet Halfa soil, clay loam).

The results obtained (Fig. 13) clearly indicate that soils near the River Nile bank (heavy-textured soil) tended to yield high amounts of N uptake. This finding may confirmed by the highly significant relationship between N uptake and both of percentage of clay content (r=0.435*) and soil CEC (r=0.487**). Also, a highly significant correlation with silt content (r = 0.471**) was obtained. These results may suggest that most soils of Kalubia are fertile and nearly similar in their level of fertility, especially those are located near the Nile.

Concerning the relationship between N-uptake and the soil characteristics (Fig. 13), data of the statistical analysis show that a highly significant correlation with organic matter content (r = 0.523**) was also obtained.

This relationship may be explained on a basis of soils near the river Nile are rich in organic matter (animals and plants remains) and significant amounts of soil organic N are





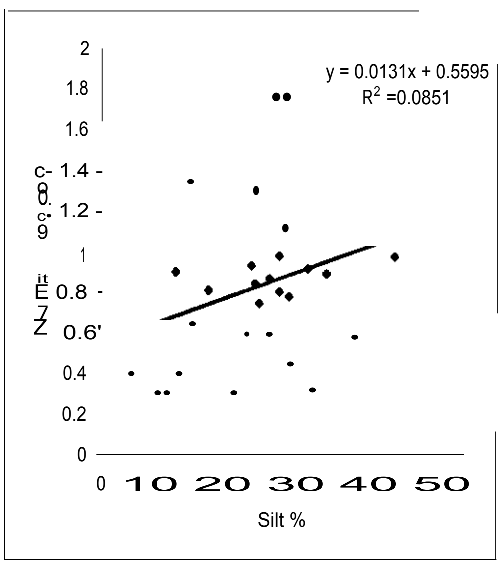


Fig.(13): The relationship between different characteristics of the tested soils and N- uptake by rye grass.

mineralized during a growing season through a biological decomposition process. Such explaintations are in agreement with those of Keeney and Nelson (1982).

Significant relationships, but negative with both of coarse sand (r = -0.411*) and soil pH (r = -0.373*) were also obtained. Junk (1970) stated that ammonium absorption increases as pH increases, whereas nitrate uptake tends to decrease , with increasing soil pH.

It is worthy to mention that N uptake by rye grass was significantly affected by soil salinity (r = 0.397*). This result may suggest that the clay fraction in soils reduces or dilutes the deteriorative effect of soil salinity on plant growth as well as N-uptake by plants in such soils. This findings and conclusions are in agreement with those of El-Agrodi et al., (1991); El-Ghanam (1996) and Soltan et al., (1996).

Concerning the nitrogen uptake by rye grass and nitrogen status of the tested soils, the results obtained (Table 5) and graphically illustrated in Fig. (14) show that the relationship between N-uptake and total N in soils was highly significant (r = 0.524**). Soil available nitrogen, which represent the chemical form readily absorbed by plant roots, was significantly correlated with N-uptake by rye grass (r = 0.414*). Each of the other N status (NH_4', $NO3^-$ and NO2) did not correlated significantly with N-uptake by rye grass.

This result may be explained on the basis of the amount of each fraction of NH4', NO_3^- and NOi alone is seldom sufficient for the needs of agronomic crops.

Accordingly, the obtained results may suggest that nitrogen uptake by rye grass could be considered an accurate reflection of the nitrogen status in the investigated soils.

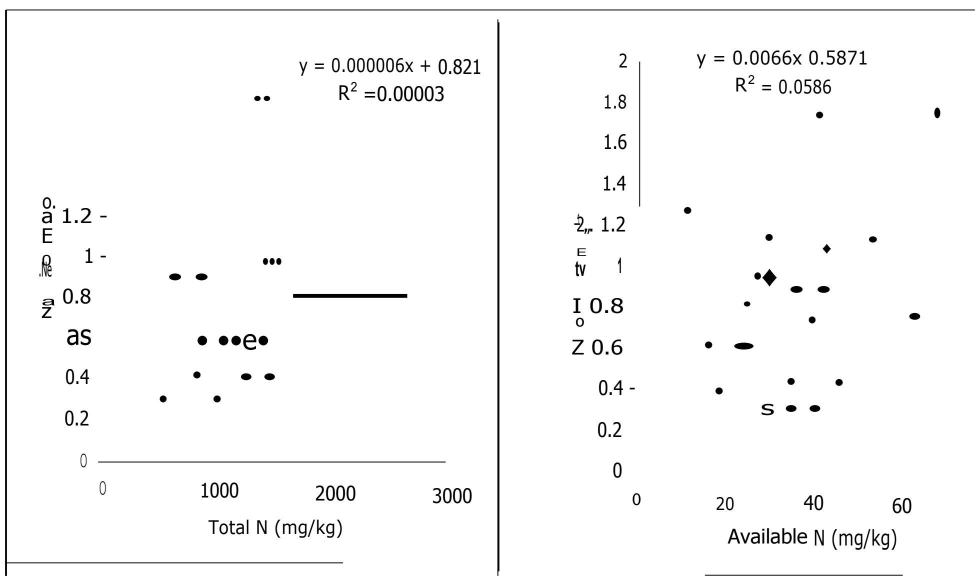


Fig.(14): The relationship between N- uptake by rye grass and both of total and available N in soils.