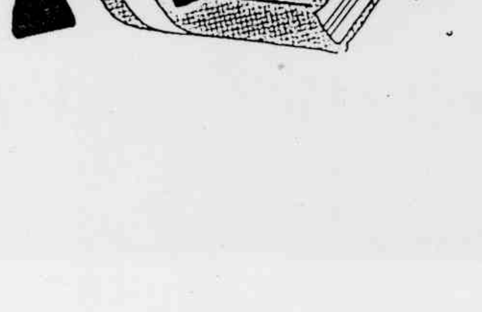
RESULTS AND DISCUSSION



4- Results and Discussion

Discussion of results obtained in this investigation is dealing , principally, with the characterization of soils , organic residues and the seperated humic and fulvic acids.The effects of organic residues and /or mineral fertilizers on soil nutrients availability, plant growth and utilization of such nutrients .

4.1 Characterization of the materials under study

4.1.1 Characterization of the tested soils

Data in Table (1) may give indicative signs for characterizing the two tested soils as claimed in the following :

Soil No.1 which was collected from Meet Kenana contains about 88.08 sand, and so it is denoted as (sandy soil) . This soils is nonsaline i.e normal as it is of EC value less than 4 (3.6 dsm^{-1}) . However, the electric conductivity of this soil is higher than that of the clayey textured one (2.6 dsm^{-1}) . Soil No. 2 which obtained from Moshtohor contains higher amount of the clay fraction (57.58%) and is ranked as clay textured soil, it is denoted by the clay soil through this text . Both soils are relatively of low $CaCO_3$ contents . Analysis revealed clearly that the clayey soil is characterized with higher contents of organic matter, total N, moisture at the field capacity and DTPA - extractable nutrients (Fe,Mn ,Zn and Cu) , also its exchange capacity is very much surpassing that of the sandy soil .

4.1.2 Characterization of the tested manures

The tested manures are originated from biogas residues, town refuse, chicken litter and poudratte, thus, they are denoted by BM, TR, CLM and PM, respectively .

Table (2) indicates that the total content of the macro and micronutrients in the tested residues could be arranged descendingly in the orders :

N : BM (2.40%) >CLM (2.00%) > PM (1.05%) > TR(0.97%) .

P : PM (1.04%) >BM (0.82%) >CLM (0.75%) >TR (0.58%).

Fe : PM (0.91%) >TR (0.83%) >CLM (0.81%) > BM (0.75%) .

Mn : TR (0.076%) >BM (0.064%) >CLM (0.038%) >PM (0.037%) .

Zn : CLM (0.15%) >PM (0.099%) >BM (0.034%) >TR(0.031%).

Cu : BM (0.11%) >PM (0.078%) >CLM (0.046%) >TR (0.007%) .

Such results indicate that the biogas manure is of the highest content of total N whereas poudratte is of the highest P content . The town refuse manure is of the highest contents of total Mn and is ranked in the 2nd class with respect to its content of Fe . The highest levels of total Zn and Cu are shown by chicken litter and biogas manures , respectively.

4.2. Characterization of humic acids derived from different organic residues

In general, the humic acids may be defined as amorphous, brown to black, hydrophilic, acidic, polydisperse substances of molecular weights ranging from several hundreds to tens of thousands (Schnitzei and Khan, 1978) . Humic, fulvic and hymatomylanic acids as well as humin are differing in their molecular weights and contents of functional groups .

4.2.1. Elementary analysis of humic and fulvic acids

Elementary analysis of humic and fulvic acids (Tables 4 & 5) provides information on their content of C, N, H, O and S as indicated later . Fulvic acid has the higher oxygen and lower nitrogen contents as compared with humic acid ***(Flaig et. al., 1975)*** .

4.2.1.1. Total organic carbon

Carbon is the major element in organic structures, it is metabolized initially in the form of carbon dioxid and it is converted to organic carbon mainly through the photosynthetic activities of the higher plants and to a lesser extent by microorganisms . About 90% of the dry matter of plants is composed of carbohydrate levels of varying complexities ***(Stevenson, 1964)*** .

4.2.1.1.1 Humic acids

Data show that the total organic carbon of humic acids ranges between 49.5 and 57.5% . The greatest value of total organic carbon content of humic acid was observed in the humic acid isolated from poudratte manure, whereas the lowest one was observed in humic acid derived from chicken litter manure . Such results stand in accordance with the values reported by ***Schnitzer (1977), Preston and Rauthan (1982), Preston and Blackwell (1985) and Taha (1985)*** . Their results reveal that the carbon content of humic acids ranges from 44.6 to 60% . However, it seems likely acceptable that such variations are mainly dependent on the initial composition of decomposing organic sources and also on the level of decomposition and accumulation of the individual components of these manures .

4.2.1.1.2 Fulvic acids

Results show that the total carbon of fulivic acids ranges between 40.9 and 48.6% which stands in accordance with the results reported by ***Abd EL-Latif (1973) and Abou- seeda (1988)*** who found that the carbon content of some types of fulvic acids ranges from 41.02 to 46.9% .

The greatest value of total carbon content of fulvic acid was observed in that isolated from biogas manure , whereas the lowest one

Table (4) Elementary Composition of humic acids derived from different organic residues

Organic residues	C %	N %	C/N ratio	H %	O %	S %	C/H ratio	C/O ratio	O/H ratio	N/H ratio
Chicken manure	49.6	5.1	9.72	4.40	39.9	1.0	11.30	1.24	9.00	1.16
Town refuse	53.0	2.2	2 4	4.70	38.0	2.10	11.32	1.40	8.00	0.47
Biogas manure	57.1	7.9	7.90	3.85	30.7	0.45	14.83	1.86	7.97	2.00
Poudratte	57.5	3.4	16.90	4.0C	33.1	2.00	14.40	1.73	8.30	0.85

was observed in that derived from chicken litter manure . The other types of fulvic acid showed intermediate values .

4.2.1.2 Total nitrogen and C/N ratio

4.2.1.2.1 Humic acids

The total N contents of humic acids tested range between 2.2 to 7.9% which agree with the findings of ***Preston and Blackwell (1985), Taha (1985) and Badran (1994)*** who reported that N levels were in the range of 1.9 to 6.99% .

The highest value of total N content of humic acid was observed in that derived from biogas manure, whereas the lowest one was observed in humic acid originated from town refuse . The arrangement of humic acids according to their C/N ratios agree with those of the original organic carbon and nitrogen contents in the organic residues .

Also, the C/N ratio of humic acids originated from town refuse exceeded greatly those obtained from biogas, chicken litter and poudratte manures . Such results could be related to the higher carbon and relatively lower nitrogen content of humic acids derived from town refuse compared with the other types of the tested humic acids . The C/N ratios of the studied humic acids differ according to the nature of the organic residues ***Abd EL-Latif, (1973) and Taha (1985) El-Ghozoli (1994)*** .

4.2.1.2.2 Fulvic acids

The total N content of fulvic acids isolated from the different studied manures ranges between 1.1 to 2.1 % . The highest value of total N content of fulvic acid was obtained from chicken manure, whereas the lowest one was observed in fulvic acid isolated from the town refuse . These findings agree well with the findings of ***Abd EL-Latif (1973) and***

Table (5) Elementary composition of Fulvic acids derived from different treatments

organic residues	C %	N %	C/N ratio	H %	O %	S %	C/H ratio	C/O ratio	O/H ratio	N/H ratio
Chicken manure	40.9	3.10.	13.2	3.30.	50.5	2.20.	12.4	0.80.	15.3	0.94
Town refuse	41.0.	2.10.	19.5	2.30.	50.8	3.8	17.8	0.81	22.1	0.91
Biogas manure	48.6	2.80.	17.4	4.30.	42.0.	2.30.	11.3	1.16	9.77	0.65
Poudratte	45.9	3.00.	15.3	4.90.	43.4	2.80.	9.37	1.06	8.86	0.61

AboEl-Fadl (1993) who found that the N content of some fulvic acid types ranges from 1.1 to 4.0% .

Also, the C/N ratio of fulvic acid isolated from the town refuse (19.5) exceeded greatly than those derived from chicken litter (13.2), poudratte (15.3) and biogas manure (17.4) . These results also stand in accordance with the original composition of the tested residues, since the town refuse showed the highest C/N ratio as compared with the other residues .

4.2.1.3 <u>Hydrogen content and C/H ratio</u>

4.2-1.3.1 <u>Humic acids</u>

The differences observed between the values of hydrogen content in isolated humic acids are relatively small as these values range from 3.85 to 4.70% . These results are in accordance with those obtained by ***Taha (1985) and Badran (1994)*** who found that the hydrogen content of some humic acid types ranges from 2.78 to 6.71% .

The variations among the C/H ratio of humic acids derived from the tested sources under the different treatments are relatively small and ranging from 11.3 to 14.8 .

The C/H ratio of humic acid derived from biogas manure comprised about 1.31 times that of chicken litter manure . Thus the obtained results may indicate that the variations in the degree of aromatization of humic acids derived from chicken litter manure and twon refuse are relatively small . However, the aromatization of humic acid derived from biogas manure exceeded that of humic acids prepared from town refuse, chicken litter and poudratte manures .

4.2.1.3.2 Fulvic acids

The hydrogen content of tested fulvic acid samples ranges between 2.3 to 4.9%, which is coincided with results obtained by ***Sposito et al.(1982) and Header (1987)*** who found that the hydrogen content of fulvic acids ranged from 4.60 to 4.85% .

The C/H ratio of fulvic acids originated from the town refuse (17.8) exceeded clearly those in fulvic acids derived from poudratte (9.37), biogas (11.3) and chicken litter manures (12.4) .

The obtained results may be ascribed to that the aromatization of fulvic acids derived from town refuse surpassed those of acids derived from the other residues .

4.2.1.4 Total oxygen, C/O ratio and O/H ratio

4.2.1.4.1 Humic acids

The total oxygen content of humic acids investigated, generally fluctuated between 30.7 and 39.9%, where the greatest value occurred in chicken litter manure humic acid . While the lowest value of O content was observed in humic acid originated from biogas manure . Such results indicate that humic acid originated from chicken litter manure has more oxidized function groups as compared with those originated from the other types of residues . These findings are in accordance with those of ***Schnitzer (1977) and Preston and Rauthan (1982)*** who found that the oxygen content of some types of humic acid ranges from 30 to 40 % .

The C/O ratios of humic acids originated from biogas manure exceeded those derived from town refuse, chicken litter and poudratte manures . Such a trend could be attributed to the relatively higher carbon content and lower oxygen contents of humic acid derived from biogas manure as compared with the other types of tested humic acids (Tabel 4) .

Also, the variations through the O/H ratios of humic acids derived from the different residues are relatively small, ranging from 7.97 to 9.0 . The O/H ratio of humic acid derived from chicken manure exceeded those of humic acids derived from town refuse, biogas and poudratte manures , indicating a relatively more oxidation for CL - HA as compared with the other tested HA types .

4.2.1.4.2 <u>Fulvic acids</u>

The total oxygen content of fulvic acids tested ranges between 42.0 to 50.8 % . The greatest value being recorded in the acid derived from town refuse, while the lowest one was observed in biogas fulvic acid . These results are in accordance with those obtained by ***Header (1987), Abou-Seeda (1988) and Abo El-Fadl (1993)*** who found that the oxygen contents of some fulvic acid types fluctuate between 43.01 and 61.83 % . This indicates that fulvic acid isolated from the town refuse could be of more oxidized function groups as compared with the acids originated from the other residues .

The C/O ratios of fulvic acid derived from the biogas manure (1.86) exceeded those of acids obtained from the town refuse (1.40),chicken litter (1.24) and poudratte manures (1.73) . Such results could be related to the higher carbon content combined with lower oxygen contents of fulvic acid derived from biogas manure as compared with the other types of tested fulvic acids .

Also, the O/H ratio of fulvic acid prepared from the town refuse surpassed those of biogas, chicken litter and poudratte manures .

4.2.1.5 N/H ratio

4.2.1.5.1 Humic acids

Data reveal also that the N/H ratios of humic acids tested range between 0.47 to 2.0 . The highest value was observed in humic acid derived from biogas manure, whereas the lowest one was observed in humic acid isolated from the town refuse . The N/H ratio of humic acid derived from biogas manure is amounting to about 4.25 times that of the town refuse . Such results could be related to the relatively higher N content combined with lower H content of humic acid derived from biogas manure as compared with the other types of tested humic acids .

Generally, the obtained data are in accordance with those of ***Abou-Seeda (1988) and Badran (1994)*** who found that the N/H ratios of some humic acid types range from 0.31 to 1.20 .

4.2.1.5.2 Fulvic acids

The variations among N/H ratios of fulvic acids derived from the different residues are relatively small, ranging from 0.61 to 0.94 . The N/H ratios of fulvic acids isolated from chicken litter manure exceeded those of biogas, town refuse and poudratte manures . Generally, the obtained data are in accordance with the findings of ***Abd El-Latif (1973) , Header (1987) and Abo- El-Fadl (1993)*** who found that the N/H ratio of some fulvic acid types ranges from 0.18 to 0.94 .

4.2.2. Infrared analysis of humic acid samples

Infrared spectroscopy is considered now as one of the more suitable methods for characterizing the chemical structure of the different humic acid substances . It can provide informations concerning the presence of specific functional groups or other structural entities within the molecule .

This is due to vibration of atomic groups in the substances caused by infrared passing through them . In this investigation the optical density of some functional groups of the prepared humic and fulvic acids samples are calculated and presented in Tables (6 &7) and illustrated in Figs.(1 & 2).

4.2.2.1 <u>Absorption at 3400 cm^{-1}</u>

The infrared absorption of humic acid samples at 3400 cm-^{1} is due to frequency of H-bending of OH ***(Boyd et al. , 1980 ; Taha, 1985 and Abou seeda, 1988)*** .

<u>a) Humic acids</u>

Data presented in Table (7) and Fig. (1) show that the values of humic acids absorption at 3400 cm-^{1} ranging between 0.17 and 0.64 . The greatest intensity of infrared also at 3400 cm-^{1} was observed in the case of the humic acid derived from chicken litter manure, whereas the lowest one was obtained from humic acid obtained from poudratte manure. Such results agree well with those reported by ***Gomah et al. (1978) and Badran (1994)*** who reported that the intensities of the band at 3400 cm-^{1} variy with the source of the humic acid .

This finding is supported by the presence of higher O/H ratio in humic acid derived from chicken litter compared with other humic acid types .

<u>b) Fulvic acids</u>

Rusults show that the values of fulvic acids absorption at 3400 cm-^{1} soil ranges between 0.34 and 1.0 . The absorption of fulvic acids groups could be arranged in the following order :

town refuse F.A > biogas manure F.A > chicken manure F.A > poudratte manure F.A . These results indicate to some extent that as the C/H ratio

Table(6) Optical density of some Functional group of humic acids as obtained by infrared analysis

Organic manure	Optical density							
	3400 cm^{-1} H-bending of OH	2920-2860 cm^{-1} C-H Stretching	1725-1700 cm^{-1} C=O	1570-1515cm^{-1} C=C Stretching	1400-1390cm^{-1} O-H bending	1300 cm^{-1} C ≡ N Stretch	1230 cm^{-1} OH phenolic	1128 cm^{-1} C-H stretching or O-H
Chicken manure	0.64	0.22	1.03	0.56	0.8	0.72	0.95	0.89
Town refuse	0.41	0.49	1.02	0.91	0.76	0.81	0.85	*
Biogas manure	0.44	0.66	0.35	0.24	0.22	0.30	0.31	0.28
poudratte	0.17	0.31	0.90.	0.84	0.34	0.68	0.89	0.80

*No bands were observe

Table (7) Optical density of some functional groups of Fulvic acids as obtained by infrared analysis

Organic manure	Optical density							
	3400 cm^{-1} H-bending of OH	2920-2860 cm^{-1} C-H Stretching	1725-1700 cm^{-1} C=O	1570-1515 cm^{-1} C=C Stretching	1400-1390 cm^{-1} O-H bending	1300 cm^{-1} C=N Stretch	1230 cm^{-1} OH phenolic	1128 cm^{-1} C-H stretching or O-H
Chicken manure	0.41	0.29	0.66	0.30	1.22	0.29	0.62	0.8
Town refuse	1.00	0.33	0.53	0.40	0.33	0.33	0.67	0.95
Biogas manure	0.89	0.60	0.76	0.56	0.38	0.42	0.59	1.05
poudratte	0.34	0.31	0.70	0.31	0.54	0.32	0.4	0.83

of fulvic acid samples increased the absorption of infrared by fulvic acid at 3400 cm-[1] also increase .

4.2.2.2 Absorption at 2920 - 2860 cm^{-1}

The band at 2920 - 2860 cm^{-1} is related to allocation of aliphatic C-H stretch ***(Taha, 1985 and Badran, 1994)*** .

a) Humic acids

Data reflect higher aliphatic C-H content in humic acid prepared from biogas manure as compared with those obtained from the other residues . It is interesting to mention that the C/H ratios of humic acids prepared from organic materials are in the following order :

biogas manure > poudratte manure > town refuse > chicken litter manure .

Results of infrared analysis indicate that the absorption of the former humic acids at 2920 - 2860 cm^{-1} showed the same trend of C/H ratios except that poudratte which substituted town refuse humic acids and vice verse i.e poudratte H.A was ranked after town refuse H.A which indicate that as the C/H ratios of humic acid samples increase the absorption of humic acid by infrared at 2920 - 2860 cm^{-1} also increase . These results are in accordance with the findings of ***Taha (1985) and Badran (1994)*** .

b) Fulvic acids

Data also reflect higher aliphatic C-H content in fulvic acid prepared from biogas manure as compared with those obtained from other manurres. It is worthy to mention that the C/H ratios of fulvic acids prepared from the tested organic residues are in the following descending order :

town refuse > chicken litter manure > biogas manure > poudratte manure .

Rusults of infrared analysis show that the absorption of the former fulvic acids at 2920 - 2860 cm^{-1} are in the following order :

biogas manure F.A > town refuse F.A > poudratte manure F.A > chicken manure F.A . It is hard to draw any conclusion concerning the agreement of fulvic acid absorption at 2920 - 2860 cm^{-1} and C/H ratio. This may explain no relation between the contents of fulvic acid for C, H and their absorption at 2920 - 2860 cm^{-1}

4.2.2.3 Absorption at 1725 - 1700 cm^{-1}

The band at 1725 - 1700 cm^{-1} is mainly due to C = O stretching of COOH and ketonic C = O (Sposito et al. , 1976 and Stevenson , 1982) .

a) Humic acids

Data show that the values of humic acids absorption at 1725 - 1700 cm^{-1} range between 0.35 and 1.03, where chicken litter manure H.A showed the highest values . However,the variations between the values of humic acids absorption obtained from ckicken litter manure and town refuse are relatively small.

In general, it may be concluded that, as the humic acid content of oxygen increased, the absorption of humic acid at 1725 - 1700 cm^{-1} also, increased . This may explain the relation between the humic acids content of O , C and their absorption at 1725 - 1700 cm^{-1} . These results are in accordance with the findings of ***Abd El-Latif (1973)*** who observed that the decrease in C/O ratio of humic acid samples caused a decrease in the optical density of humic acids at 1725 - 1700 cm^{-1} .

b) Fulvic acids

Data also show that the values of fulvic acids absorption range between 0.53 and 0.76 . These results are in accordance with the finding of ***Abd El - Latif (1973)*** who found that the values of the tested fulvic acids absorption range between 0.49 and 0.73 . It is worthy to mention that the C/O ratio of fulvic acids derived from the tested organic residues are in the following order :

biogas manure F.A > poudratte manure F.A > town refuse F.A > chicken litter manure F.A .

Results of infrared absorption at 1725 - 1700 cm^{-1} show the same previous arrangement, which may suggest that as the C/O ratio of fulvic acids increased, absorption of infrared at 1725 - 1700 cm^{-1} also increase.

4.2.2.4 Absorption at 1570 - 1515 cm^{-1}

The optical density at 1570 - 1515 cm^{-1} is due to carboxylic ion , C=C stretching vibration of benzene , pyridine, etc, benzene ring substitution, secondary amine (N-H) and C = N stretching (***Stevenson, 1982 and Badran, 1994***) .

a) Humic acids

The values of humic acids absorption at 1570 - 1515 cm^{-1} range between 0.24 and 0.91 . These results agree with those of Taha (1985) and Badran (1994) who found that the corresponding values range between 0.36 and 0.82 .

Data also show that humic acid derived from town refuse contains higher values of C= N stretch as compared with other types of humic acids. This could be mainly due to the variations in C/N ratios of such substances. In general, as the C/N ratio of humic acid increase, its absorption at 1570 - 1515 cm^{-1},also increase .

b) Fulvic acids

Infrared analysis show that the absorption of fulvic acids at 1570 - 1515 cm^{-1} ranges between 0.30 and 0.56 and being in the following order :

F.A of biogas manure > F.A of town refuse > F.A of poudratte manure > F.A of chicken litter manure .

The fulvic acid derived from biogas manure contains higher values of C = N stretch as compared with the other types of fulvic acids . This could be mainly due to variations in their C/N ratios . However, the variations in the absorption of F.A obtained from poudratte and chicken litter manures are relatively small .

4.2.2.5. Absorption at 1400 - 1390 cm^{-1}

The band at 1400 - 1390 cm^{-1} indicates O - H bending vibration of alcohol or carboxylic (***Sposito et al. ,1976 and Stevenson, 1982***) . Results are shown in Tables (6 & 7) and Figs (1&2) .

a) Humic acids

Data reveal that the values of humic acids absorption at 1400 - 1390 cm^{-1} range between 0.22 and 0.80 which are in accordance with those obtained by ***El-Ghozoli (1994) and Badran (1994)*** who obtained corresponding values in the range of 0.23 to 0.73 .

The greatest intensity of infrared absorption at 1400 - 1390 cm^{-1} was observed in the case of humic acid derived from chicken manure whereas the lowest one was obtained from humic acid prepared from biogas manure . The different humic acids could be arranged according to their absorption at 1400 - 1390 cm^{-1} in the following order : H.A of chicken manure > H.A of town refuse > H.A of poudratte manure > H.A of biogas manure . This mainly due to their different O/H ratios . In general, as the humic acid of O/H ratio increase, the absorption of humic acid at 1400 - 1390 cm^{-1} also increase .

b) Fulvic acids

Data show that the values of fulvic acids absorption at 1400 - 1390 cm^{-1} range between 0.33 and 1.22 . These results are in accordance with the findings of ***Abd El-Latif (1973)*** who found that the absorption at 1400 - 1390 cm^{-1} of the fulvic acids ranges between 0.59 and 0.96 .

The greatest intensity of infrared absorption at 1400 - 1390 cm^{-1} was observed in the case of fulvic acid derived from chicken manure, whereas the lowest one was obtained from fulvic acid isolated from town refuse . The absorption of various fulvic acids could be arranged in the following order : F.A of chicken manure > F.A of poudratte manure > F.A of biogas manure > F.A of town refuse . The previous results agree to some extent with the O/H ratios of the previous fulvic acid content . The previous results could be related to the involving of O in other groups such as C = O which is absorbed at 1720 cm^{-1}, C = O or COO absorbed at 1650-1600 cm^{-1} and C=O stretching vibration and OH bending deformation at 1220 cm^{-1} .

4.2.2.6 Absorption at 1300 cm^{-1}

The band at 1300 cm^{-1} is attributed to $C \equiv N$ stretch (***Stevenson, 1982 and Badran, 1994)*** .

a) Humic acids

Data reveal that the absorption values of humic acids range between 0.30 and 0.81 . The absorption of humic acid of town refuse exceeded those of other types of humic acids . These results are in accordance with the findings of ***Badran (1994)*** who found that the absorption values of the tested humic acids fluctuating between 0.32 and 0.48 and also, show that the values of humic acids at 1300 cm^{-1} agree with their C/N ratios .

To some extent, as the ratio of C/N of humic acids increased, the absorption at 1300 cm^{-1} also, increased . Also, the previous results indicate that the lower N content humic acid is the higher intensity of infrared at the previously mentioned frequency .

b) Fulvic acids

Data show that the absorption values of fulvic acids range between 0.29 and 0.42 . The greatest intensity of infrared absorption was observed in the case of fulvic acid derived from biogas manure , whereas the lowest one was shown by that prepared from chicken manure . These results agree with the findings of ***Amer (1986)*** . The values of various fulvic acids absorption could be arranged in the following order :

F.A of biogas manure > F.A of town refuse > F.A of poudratte manure > F.A of chicken manure . However, the variations between the values of fulvic acids absorption obtained from other type of organic manures were relatively small . To some extent, the values of fulvic acid samples at 1300 cm^{-1} agree with their content of C/N ratios .

4.2.2.7 Absorption at 1230 cm^{-1}

The absorption of humic acid samples at 1230 cm^{-1} corresponding to phenolic OH groups (***Stevenson, 1982***) .

a) Humic acids

Data show that the absorption values of the derived humic acids ranged between 0.31 and 0.95 . The values are in agree with the findings of ***Abd El- Latif (1973) and Taha (1985)*** . However , the variations between the values of humic acids absorption, for those obtained from town refuse and poudratte manures were relativelly small , while that of chicken manure was higher than the other humic acids . The previous results indicate higher phenolic - OH content of humic acid derived from chicken manure compared with those obtained from the other tested. These results agree to some extent with the O/H ratios of the different humic acids .

b) Fulvic acids

Data show that the absorption values of fulvic acids ranged between 0.40 and 0.67 . These values are in agree with the finding of ***Abd El- Latif (1973)*** . On the other hand , the absorption of fulvic acid town refuse was higher than other fulvic acids . The previous results indicate higher phenolic OH content of fulvic acid prepared from town refuse compared with the other types of tested fulvic acids . These results agree to some extent with the O/H ratios of different fulvic acids, where the O/H ratio of fulvic acid prepared from soil enriched with town refuse exceeded those of other fulvic acids .

4.2.2.8 Absorption at 1128 cm^{-1}

The optical density of humic acid samples at 1128 cm^{-1} is attributed to C - H stretch or O - H (***Stevenson, 1982, Taha, 1985***) .

a) Humic acids

Data show that the values of humic acids absorption at 1128 cm^{1} range between 0.28 and 0.89 . The absorption of humic acid obtained from the chicken litter exceeded those derived from the other sources tested. These results as previously mentioned, agree with the O/H and C/H ratios of humic acids . The greatest humic acid absorption is the highest O/H ratio .

These results are in accordance with those obtained by ***Abd El-Latif (1973) and Badran (1994)*** who found that the absorption at 1128 $cm\text{-}^{1}$ of the tested humic acids ranges between 0.43 and 0.82 .

b) Fulvic acids

Data show that the values of fulvic acids absorption at 1128 cm^{-1} range between 0.80 and 1.05 . These results are in accordance with ***Abd El - Latif (1973)*** . The absorption of fulvic acid isolated from biogas manure exceeded those other types of fulvic acids . These results, as it was previously mentioned agree with the C/H ratio of fulvic acids content . The greatest fulvic acid absorption is the highest C/H ratio .

In general, the previous results indicate that the total functional groups of fulvic acids exceeded those of humic acid samples obtained from the same origin . These results agree with the finding of Abd ***El - Latif (1973) ; Taha (1985) and Abou-seeda (1988)*** .

On the other hand, the total functional groups of both humic acids and / or fulvic acids agree to same extent with their elementary analyses . The previous speculation could be related to the coordination of the functional groups at the different absorption regions .

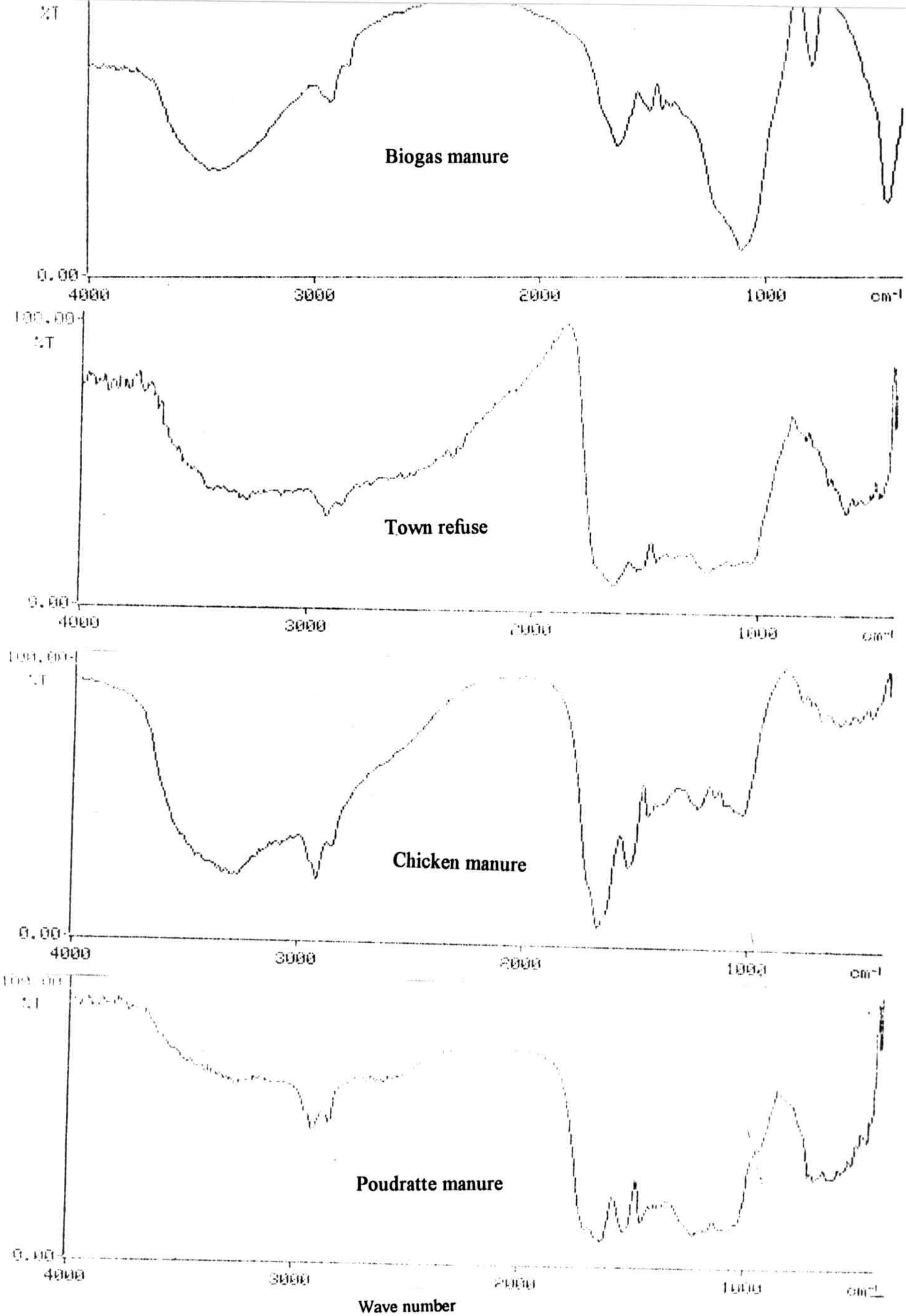


Fig (1) :Infrared spectra of humic acids derived from different organic residues .

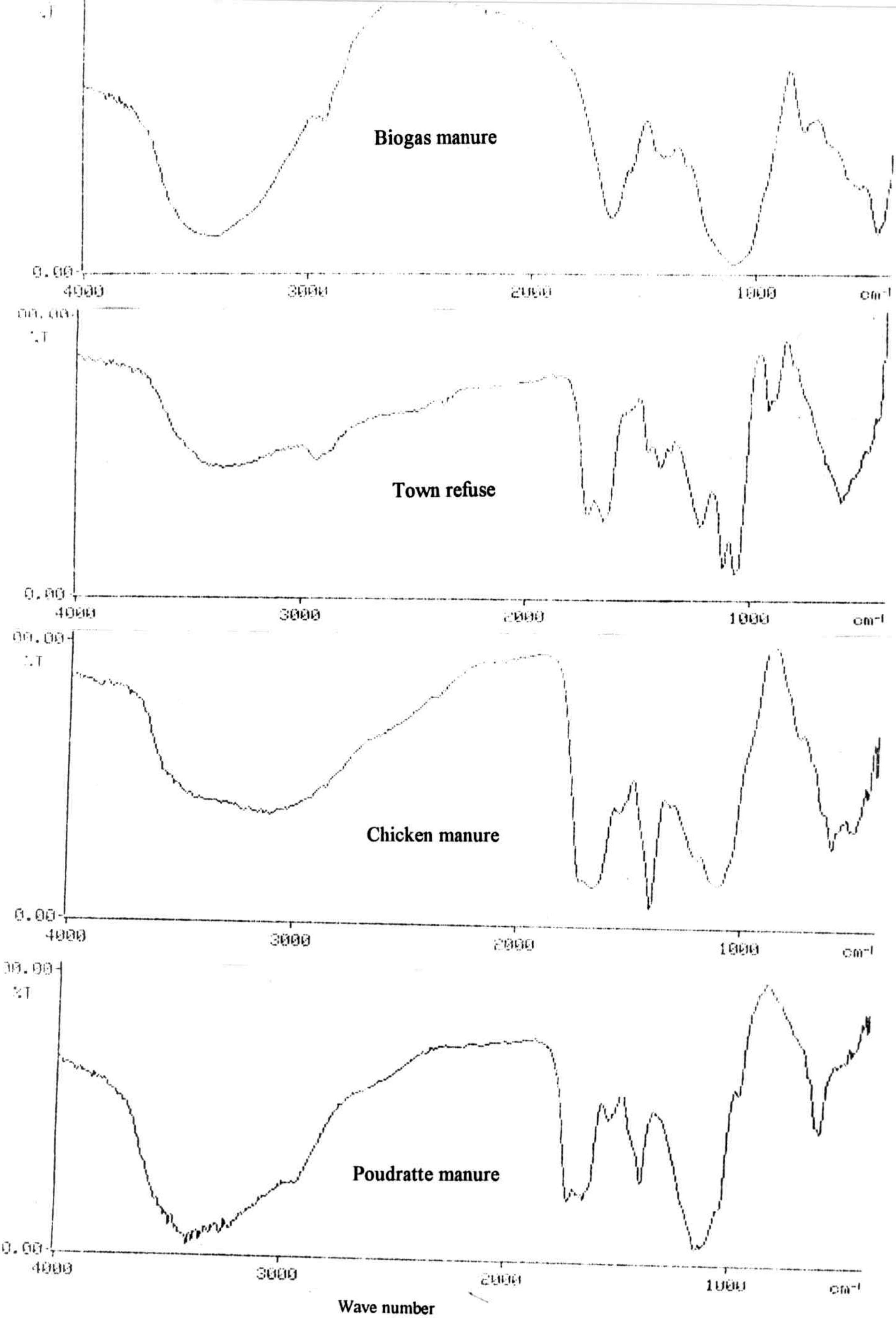


Fig (2) :Infrared spectra of fulvic acids derived from different organic residues .

4.2.3. Total acidity and acidic groups of humic substances

The sum of the dissociable hydrogen of the COOH and the phenolic-OH groups in humic or fulvic acid samples of both aromatic and aliphatic origin is defined by ***Schnitzer and Gupta (1965)*** as total acidity .

4-2-3-1- Total acidity of humic acids :

Data presented in Table (8) show that the total acidity of the tested humic acid samples ranges between 908 to 1103 me/100g acid . The total acidity values of humic acid samples derived from chicken manure exceeded those of town refuse, biogas and poudratte manures . The variations in the total acidity were mainly due to the variations in the phenolic - OH groups in the humic acids . These results are in accordance with the findings of ***Abd El-Latif (1973)*** who found that the total acidity of humic acids derived from different organic residues ranged from 934 to 1090 me/100 g acid .

4.2.3.2. Carboxyl groups in humic acids :

Data in Table (8) show that the COOH groups of humic acid samples range from 243 to 320 me/100 g acid . These result agree well with the findings of ***Abd El-Latif (1973)*** who found that the COOH groups of humic acids isolated from organic residues ranged from 203 to 312 me/100 g acid .

The results also show that the amounts of COOH groups of humic acid samples derived from chicken manure were higher than those derived from biogas, town refuse and poudratte manures .

The lower values of COOH groups of humic acids derived from poudratte manure may indicate more oxidation, compared with other

Table (8) Carboxyl and phenolic - OH groups ; CEC and total acidity in the humic acids derived from different organic residues (me 100 g $^{-1}$ acid)

Organic residue	Total acidity	Functional groups			C.E.C	%of total acidity
		COOH	Phenolic-OH	COOH/phenolic-OH ratio		
Biogas manure	1005	315	690	0.45	518.3	52
Town refuse	947	285	662	0.43	502.0	53
Chicken manure	1103	320	783	0.41	534.5	48
Poudratte manure	908	243	665	0.36	486.1	54

residues . Consequently, it contains lower amounts of COOH groups than those of humic acids derived from other organic residues .

4.2.3.3. Phenolic-OH groups of humic acids :

The phenolic-OH groups of humic acid samples ranged from 662 to 783 me /100 g acid . The greatest value was observed in humic acid originated from the chicken litter manure . The lowest one was obtained from humic acid originated from town refuse . These results are in accordanc with the findings of ***Inbar et al. (1990)*** who found that the phenolic-OH groups of humic acids ranged from 676 to 800 me/100 g acid.

Comparing the amounts of COOH and phenolic-OH groups in the humic acid samples, it appears that the phenolic-OH groups predominate . These results agree with the findings of ***Schnitzer and Khan (1978)*** .

Data in Table (8) also show that the COOH/phenolic OH ratios range between 0.36 and 0.45 . The difference between the different values of COOH/phenolic-OH ratios was relatively small . This may be due to the lower diffrences between the values of COOH groups of different origins . These results are in accordance with the findings of ***Abd El-Latif (1973)*** who found that the COOH/phenolic-OH ratio ranged between 0.26 and 0.46 .

4.2.4. Cation exchange capacity of humic acids :

Data presented in Table (8)and Figs.(3&4) represent values of the cation exchange capacity of humic acid samples evaluated at pH 7.6 . Data show that the cation exchange capacity of humic acids range between 486.1 and 534.5 me/100 acid . These results are in accordance with the findings of ***Abd El-Latif (1973) and Maes et al. (1992)*** .

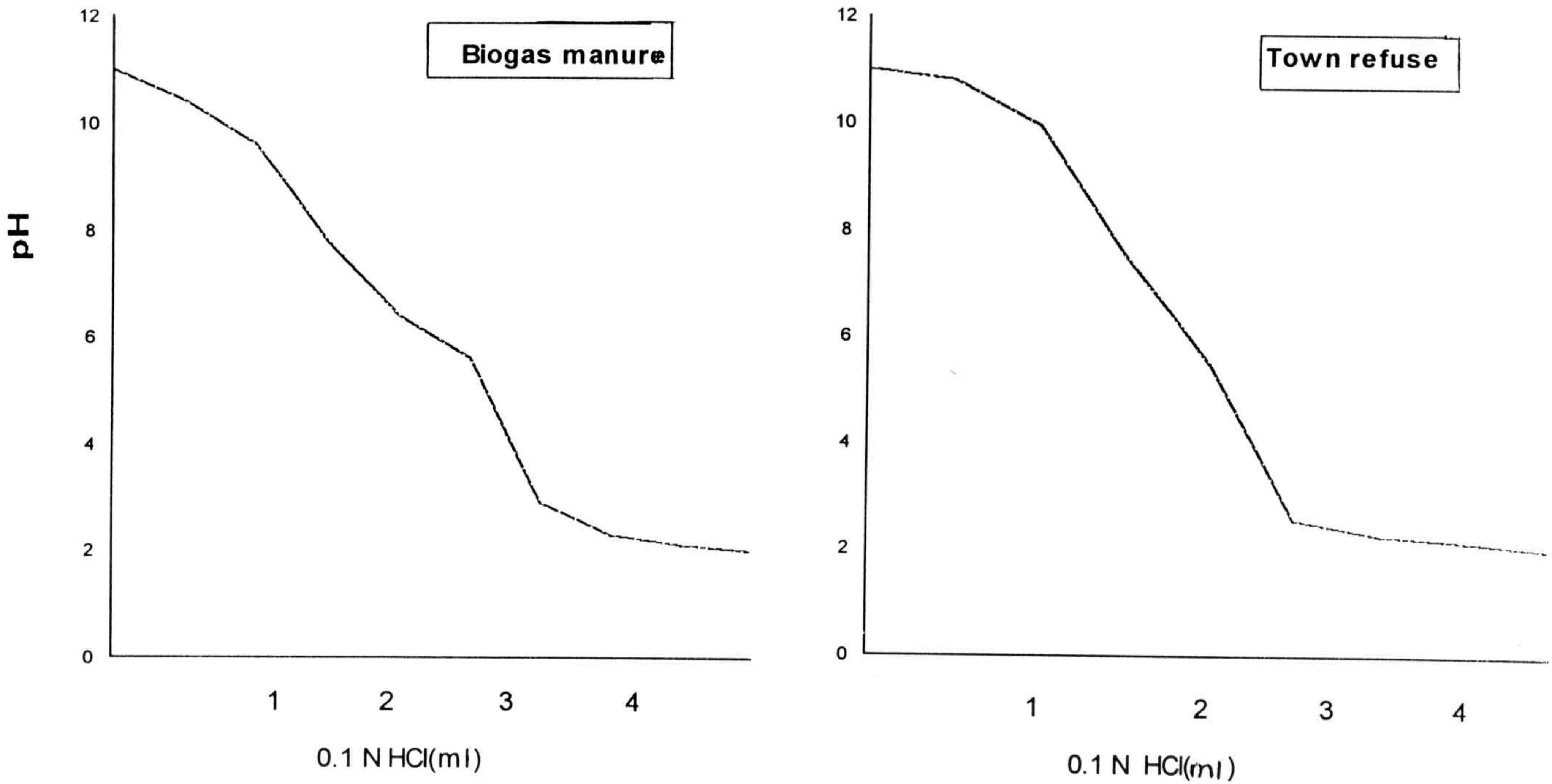


Fig.(3)Titration curves of humic acids derived from diffirent organic residues .

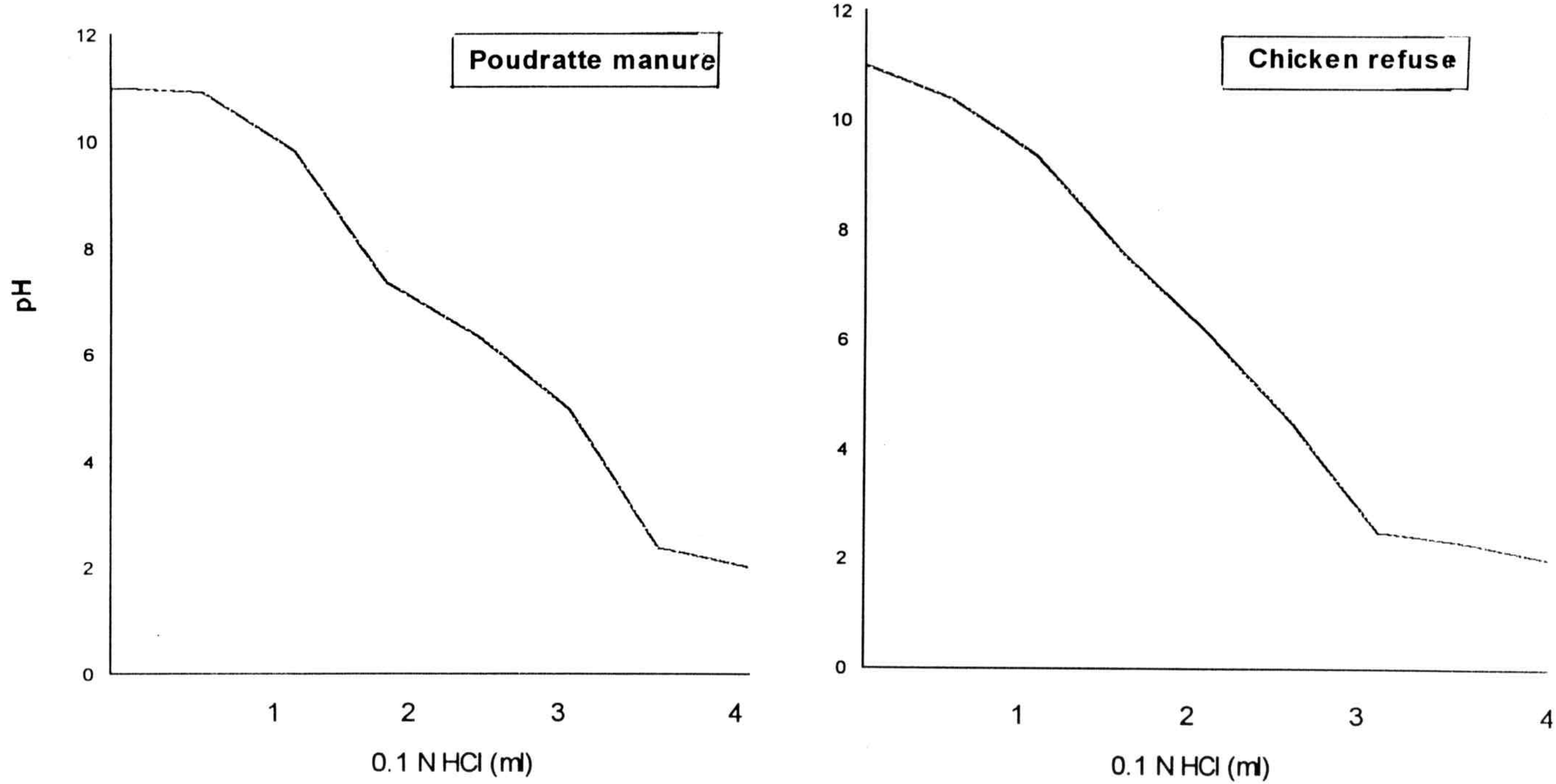


Fig.(4)Titration curves of humic acids derived from diffirent organic residues .

The cation exchange capacity of humic acid derived from chicken manure exceeded those of humic acids prepared from biogas, town refuse and poudratte manures .However, the differences between the different values of CEC were relatively small . As the COOH groups of different humic acid increase, the values of CEC of humic acids increased .

Data also show the values of the cation exchange capacity of humic acid as percentage of the total acidity . These values range between 48 and 54% . This result indicates that only about half or less of the total acidity of humic acid samples are responsible for exchange reactions of the humic acid samples determined at pH 7.3 and 7.6 .

4.3 Laboratory experiment :

This experiment was conducted under laboratory conditions to investigate the effects due to treating soils with raw or composted organic residues , enriched or not with minral fertilizers, on the availability of different soil nutrients i.e P,Fe,Mn,Zn and Cu .Data obtained are recorded in Tables (9-18) and graphically illustrated in Figs.(5-14) .

The different effects are discussed for each studied nutrient under the following subheadings :

1) The effects due to the incubation period.
2) The effects due to the different organic residues .
3) The effects due to mineral fertilization .
4) The effects due to separate application of raw residues combined with mineral fertilizer sources .
5) The effects of composting the raw residues with mineral sources before application to the soil .
6) The effects due to the interaction between the different treatments .

4.3.1 Effect on soil available P :

The effects due to the added organic residues from different sources , on the available P in both sandy and clayey soils, during the different incubation periods are presented in Tables (9&10) and illustrated in Figs. (5&6) .

4.3.1.1 The effects due to the incubation period :

a) The sandy soil :

Results in Table(9) show, in general, significant effects on soil available P due to prolonging the incubation period. Such effects were too slight during the first 15 days, thereafter they gradually increased with prolonging the incubation period to reach a maximum value after 120 days of incubation.These effects could be attributed to the microbial activity and the magnitude of microbial products particularly the organic acids or the compounds of acidic effects that may induce P availability in such soils .

Such results are confirmed by those of ***Dalton et al. (1952),Kardos (1964)*** and ***Larsen (1967)*** who reported that the organic and carbonic acids resulting from the decomposition of the organic matter would tend to decrease phosphorus sorption in noncalcareous soils .

Olsen et al. (1970) found that the soil content of available P under aerobic conditions increased by about 0.1 to 0.3 ppm/ton of applied manure . This effect was attributed to the acidifying process which could be stimulated under the aerobic conditions .

Also, ***Gill and Meelu (1983)*** demonstrated that increasing the P availability in a loamy sand soil treated with FYM may be due to the mineralization of organic P and solubility action of certain organic acid produced during manure decomposition as well as displacement of phosphate by organic anions formed from the breakdown of these acids .

b) The clayey soil :

In spite of the generally increased effect due to extending the incubation period of the clayey soil treated with manures (under the different treatments) on soil P availability, this effect showed a periodcally changing pattern rather than a steady consistent trend .The general features of this pattern are , a slight increase through the first 15 days of incubation followed by a sudden increase after 30 days, then a decreasing trend at 60 days of incubation, followed again with a sharp increase till the end of the incubation period where maximum levels of soil availabile P were attained. It is interesting to observe that the above mentioned pattern of availabile P

Table (9) Effect of organic residues and mineral fertilizers on available P(mg kg^{-1}) of Meet Kenana sandy soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	30.7	32.4	32.4	34.6	34.9	33.0	30.7	32.4	32.4	34.6	34.9	33.0	30.7	32.4	32.4	34.6	34.9	33.0	30.7	32.4	32.4	34.6	34.9	33.0
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	44.4	44.5	81.4	106.8	133.4	82.1	32.9	35.1	59.8	134.4	136.4	79.7	31.5	32.1	88.6	122.1	150.8	85.0	24.6	24.8	87.0	101.3	135.6	74.7
L2	52.6	53.9	96.40	127.5	168.4	99.8	45.1	46.8	100.4	138.4	142.7	94.7	37.8	38.6	90.8	152.0	158.9	95.6	47.9	50.1	120.0	123.8	145.6	97.5
L3	110.8	112.2	114.9	146.8	150.7	127.1	55.1	55.2	117.0	157.1	159.6	108.8	66.0	66.2	116.4	173.9	179.0	120.3	60.3	61.8	148.8	157.2	161.2	117.9
mean	69.3	70.2	97.6	127.0	150.9	103	44.4	45.7	92.4	143.3	146.2	94.4	45.1	45.6	98.6	149.3	162.9	100.3	44.3	45.6	118.6	127.4	147.5	96.7
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	77.2	77.7	112.2	131.6	166.3	113	35.2	37.9	59.6	67.3	86.4	57.3	64.2	67.5	106	124.4	150.6	102.5	32.1	34	46.8	62.5	121.6	59.4
Manure + L1	51.8	52.1	131.4	159.3	206	120.1	47.5	47.6	90	132.2	166.8	96.8	82.3	84.1	100.4	121.6	138.6	103.4	61.1	61.2	82.8	128.4	176.2	101.9
Manure + L2	62.4	62.9	135.9	176.4	220	131.5	85.5	87	123.4	125.4	187.2	121.7	107.9	108.7	116.9	143.6	179.4	131.3	76.1	80.0	126.0	139.4	178	121.9
Manure + L3	90.2	90.4	155.4	241	245.4	164.7	88.9	90.5	142.5	162	194	135.6	134.1	134.8	159.1	179.4	240.6	169.6	100.9	102.5	168.6	173.2	237.3	156.5
mean	68.1	68.5	140.9	192.2	224.1	138.8	74	75	118.6	139.9	182.6	118	108.1	109.2	125.5	148.2	182.9	134.7	79.4	81.2	125.8	143.7	117.2	126.2
M.incubated with L1	47.2	47.6	98	119.2	143.6	91.1	40.9	41.7	47.1	58.3	59.4	49.5	76.6	78.9	93.5	98.6	141.4	97.8	51.6	53.1	52.0	107.8	112.0	75.3
M.incubated with L2	55	56.8	124.8	133.6	187	111.4	53.0	53.2	62.0	66.5	72.8	61.4	89.3	89.4	95.7	123.2	142	107.9	63.7	65.9	95.6	103.4	104.4	86.6
M.incubated with L3	82.4	86.9	137.2	159.6	188.6	133.9	45.8	47.9	70.6	140.1	175.1	95.9	83.7	85.7	113.3	129.4	142.4	110.9	84.1	84.8	99.4	114.4	132.4	103.0
mean	61.5	63.8	120	137.5	173.1	111.1	46.6	47.6	59.9	88.3	102.4	69	83.2	84.7	100.8	121.4	141.9	105.5	66.5	67.9	82.3	108.5	116.3	88.3
Grand mean	67.4	68.5	118.8	150.2	181.1	117.2	53	54.3	87.2	118.2	138	90.2	77.3	78.6	108.1	138.1	161.4	112.4	60.3	61.8	102.7	120.1	126.5	993

M= manure

LSD 0.05 : *S = 6.4* *T = 10.4* *p =7.14* *SXT=21.2* *SXP=14.3* *Txp = 23.69* *SXTXP =5.53*

A: Biogas mineral equivalent B: Town refuse mineral equivalent C: Chicken litter mineral equivalent D: Poudratte mineral equivalent

Table (10) Effect of organic residues and fertilizers on available P(mg kg^{-1}) of Moshtohor clayey soil during different incubation periods.

Incub. periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	52.6	52.8	53.1	50.9	54.6	52.8	52.6	52.8	53.1	50.9	54.6	52.8	52.6	52.8	53.1	50.9	54.6	52.8	52.6	52.8	53.1	50.9	54.6	52.8
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	70.6	72.6	145.0	118	202.5	118.1	56.1	57.0	117	70.4	156.5	91.4	62.8	63.1	143.6	80.7	165.4	103.1	66.0	66.8	109.4	45.8	170	97.0
L2	86	86.7	151.0	120.4	250	138.8	63.2	65.8	136.2	96	164.2	105.1	70.3	70.8	163.1	115.8	192	122.4	73.5	74.8	122.6	95.2	201.1	113.4
L3	112.1	120.7	167	123.2	[illegible]	[illegible]	84.4	86	145.4	113.6	192.3	124.3	92.1	93.3	185.5	171.3	203	149	92.7	96.9	1766	127	240	1466
Mean	89.6	93.3	154.3	120.5	[illegible]	[illegible]	67.9	69.6	132.9	93.3	171	106.9	75.1	75.7	159.3	127.3	186.8	124.8	77.4	79.5	136.2	99.3	203.7	119
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	72.1	73.2	169.6	126.6	227	133.3	55.3	56.5	99.3	72.6	97.8	76.3	85.3	90	119.6	89.9	212	119.4	58.7	69.8	179	98.5	183	117.8
Manure + L1	133.1	144	182.8	122.0	216.6	159	113.6	115.0	131.6	75.8	70.2	121.2	145.2	149.2	173	106.8	221	159	70.4	70.5	170	118	207.5	127.3
Manure + L2	170.2	176.8	202.0	133.0	234.1	183.2	121	136.6	141.4	83.2	180.7	132.6	152.3	157	165.8	118.8	239	166.6	92.1	92.1	182.7	128	255	150
Manure + L3	175.6	184.2	219.5	147.4	257	196.7	132.8	141.6	161.2	112.4	206	150.8	160.5	167.8	230	122	256	187.3	106.5	108.6	199.5	142	256	162.5
mean	159.6	168.3	201.4	134.1	235.9	179.9	122.5	131.1	144.7	90.5	185.6	134.9	152.7	158	189.6	115.9	238.7	171.0	89.7	90.4	184.1	129.3	239.5	146.6
M.Incubated with L1	130.5	139.6	172.4	117.6	204	152.8	90.2	90.5	90.6	71	117.4	91.9	130.6	131.4	136.8	9+9.4	181.3	135.9	64.7	65.2	162.3	90.7	172.6	111.1
M.Incubated with L2	143.4	150.5	179.6	127	191.9	158.5	130.1	134.4	140	75.7	150.5	126.3	130.1	135.6	142.4	105.2	194	141.5	75.2	76	131.6	97.6	253	126.7
M.Incubated with L3	136.2	142.9	207.5	129.8	225.9	168.5	131	131.5	145	95.9	188.5	188.4	143.2	144.5	203	110.2	236.5	167.5	96.2	98	183.6	106.8	246	146
Mean	136.7	144.3	186.5	124.8	207.3	159.9	117.1	118.8	125.1	80.9	152.1	118.9	134.6	137.2	154.1	104.9	203.9	147	78.7	79.7	159.2	98.4	223.9	128
Grand mean	123	129.1	179.6	126.5	229.8	157.5	97.8	101.5	130.7	86.7	162.4	115.8	117.3	120.3	162.9	113.4	210.0	144.8	79.6	81.9	161.8	107.9	218.4	130

M= manure

LSD 0.05 : S= 6.03 T= 10.0. P=6.75 SxT =2 20.02 SxP =1 13.5 TxP = 22.4 SxTXP =5.2 change in the clay soil was consistent with different manure sources under the investigation . Such results are in accordance with those of ***Ali (1980)*** who found that the addition of organic residues progressively increased the level of water soluble P in soils to reach its maximum after 30 days of contact between soil and the organic residues .

El-Ghozoli (1994) found that the soil content of available P was increased with increasing the contact period from 7 to 30 days , decreased after 60 days and increased again with time to reach maximum values after 180 days of contact between soil and the organic residues .

4-3-1-2 The effects due to the different organic residues :

Results obtained show significant differences among the values of available P contained in the tested soils as a result of the added organic sources . The available P fraction in the clayey and sandy soils increased as a result of manuring according the following order : biogas manure > chicken litter manure > poudratte manure > town refuse .

It is clear that the biogas manure was the most efficient residue in inducing soil P availability , while town refuse was the least in both the investigated soils, the chicken litter and poudratte manures showed intermediate effect . The highest amounts of available P were extracted from biogas treatment, where values of 113 and 133.3 mg P kg^{-1} soil were obtained for sandy and clayey soils , respectively .

Considering the obtained results in view of the initial analysis of the raw residues investigated, may give reasonable explanations for these results as follows :

Although poudratte manure showed the highest P content, it failed to yield the highest effect on soil available P neither in the sandy nor in the clayey soil . Such trend may be attributed to the relatively high Fe content of poudratte as compared with the other manure sources (Table 2). Accordingly, P in poudratte manure could be mainly found as iron phosphate . Moreover, the P released from poudratte due its decomposition may react again with the released Fe . Because iron phosphates are more stable and thus less soluble than calcium phosphates, the effect of such material on soil P availability as compared with the other manures is very much questionable . Such results are confirmed by ***Poonia et al. (1986)*** who concluded that the effect of organic manure on the availability of macro and micronutrients is dependent on the nutrient concentration, type of applied manure and the soil type .

4.3.1.3 <u>The effects due to mineral fertilization :</u>

Inorganic fertilization which included ordinary superphosphate, significantly increased soil content of chemicaly extractable (available) P . This effect was consistently induced as the level of mineral fertilization increased in both the investigated soils .

Extractable P in the clayey soil was relatively higher than the corresponding one of the sandy soil . The values of extractable P in the sandy soil averaged overall treatments and incubation periods about 98.6 mg P kg^{-1} and increased to reach 122.9 mg P kg^{-1} soil in clayey one. These results could be ascribed to initially relative higher content of the clayey soil of available P .Results indicate that the application of different mineral sources , related to those contained in biogas manure (A) , town refuse manure (B) , chicken litter manure (C) and poudratte manure (D) increased the amounts of extractable P from both soils under investigation . The following order was observed for both soils A> C > D > B . Mean values of P extracted from the sandy soil were 103 , 100.3 , 96.7 and 94.4 mg P kg^{-1} soil. while the corresponding values from the clayey soile were 140.9 , 124.8 , 119 and 106.9 mg P kg^{-1}soil. respectively . These results may indicate that the application of mineral nutrients at levels related to those contained in biogas manure (A) gave the highest values of available P as compared with those equivalent to the other sources . This could be explained due to the highr mineral contentes of biogas manure as compared with other sources of organic manures . The data also , indicate that the amount of extractable P was increased when mineral fertilizers were applied to both investigated soils at the highest level (L_3)compared with the control or the lower levels (L_1 and L_2). Mean values of the extracted P averaged overall incubation periods of the sandy soil increased from 33 mg P kg^{-1} soil for control treatment to reach highest values 127.1 , 108.8 , 120.3 and 117.9 mg P kg^{-1} soil at the highest level of application (L_3) for A , B , C and D treatments, respectively . These values in the clayey soil increased from 52.8 mg P kg^{-1} soil for control to reach 162.4 ,124.3 ,149 and 146.6 mg P kg^{-1} soil for the above mentioned treatments, respectively . ***El-Fahham (1997)*** found that the inducing effect due to applied P on soil P availability was increased with increasing the level of its application .

4.3.1.4 The effects due to separate application of raw residues and mineral fertilizer sources :

Results show that soil available P was significantly increased upon treating the tested soils with the studied sources of organic residues enriched with the different levels of mineral fertilization . The application of raw residues mixed with different levels of inorganic fertilizers.increased sharply the available P fraction contained in the tested soils, as compared with adding each of these sources or fertilizers singly. This effect was consistently induced as the level of mineral fertilization increased.

It is clear that the biogas manure enriched with the mineral fertilizers was the most efficient treatment in inducing soil P availability, where mean values averaged overall incubation periods were 138.8 and 179.9 mg P kg^{-1} soil for sandy and clayey soils, respectively. On the other hand the enriched town refuse was the least affective in both the investigated soils, the corresponding values were 118 and 134.9 mg P kg^{-1} soil, respectively. It is worthy mentioning that the general trend obtained due to adding mineral fertilizers together with organic manures on soil P availability is coincided with the effect due to the organic manure sources. In other words the most effective organic source (biogas manure) in case of organic manuring treatments was also in the same order in case of manures enriched with mineral sources in separated manner.

Such results indicate that enriching the organic manures with mineral fertilizer sources increased the soil P availability as compared with the solely application of each of them. These results could be attributed to mineralization process of organic matter supplied to soil through manuring which should be expected to release several nutrients. Such results agree with those obtained by ***Montasser (1987) and Sakr et al. (1992)***.

Abd El-Latif and Abd El-Fattah (1983) found that the addition of superphosphate mixed with organic residues was more effective on soil available P.

In conclusion, it may be stated that such results may give further support and throw more lights on the vital role of organic residues on increasing both soil and mineral fertilizer P availability, whatever was the nature of such compounds and the soil itself .

4.3.1.5 The effects of composting the raw residues with mineral sources before application to the soil

The results obtained show clearly that composting the organic residues with the mineral fertilizers before application significantly increased extractable soil available P as compared with either control or applying manure without mineral fertilizers . The obtained effect was always less than that due to the separate application of these materials without incubation . This result indicate the superiority of enriched organic residues with mineral sources without incubation . The highest values of available P extracted from sandy soil were obtained with incubating the mineral sources with biogas manure (111.1 mg P kg^{-1} soil) followed by chicken litter manure (105.5 mg P kg^{-1}soil), poudratte manure (99.3 mg P kg^{-1} soil) and finally with town refuse manure (90.2 mg P kg^{-1}soil). Similar trend was observed when the clayey soil was treated with the above mentioned material, where the corresponding values were 159.9 , 147 , 128 and 118.9 mg P kg^{-1} soil for composted biogas manure , chicken litter manure , poudratte manure and town refuse manure , respectively . Data reveal also , that values of extractable P increased with increasing level of mineral sources from L_1 to L_3 .

The adverse effect on soil P availability with incubated materials as compared with the corresponding one obtained from separate application of organic manure and mineral sources could be explained on a basis that some compounds of the humified matter at the terminal stages of the decomposition of organic manures may form stable organo-mineral-colloidal complexes and thus decrease the availability of several nutrients .

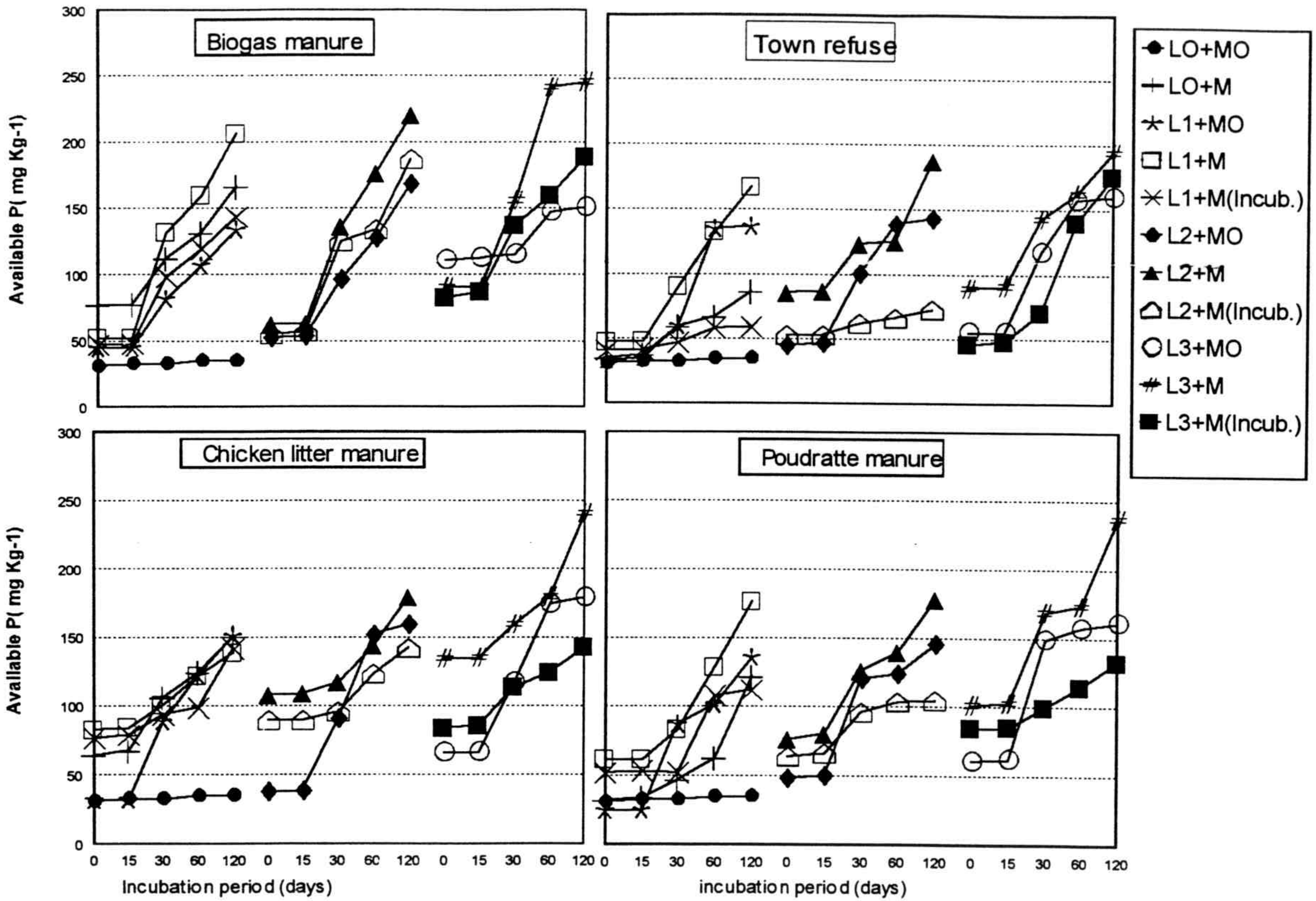


Fig. (5) Effect of organic manures in presence and absence of mineral fertilization on available P in the sandy soil .

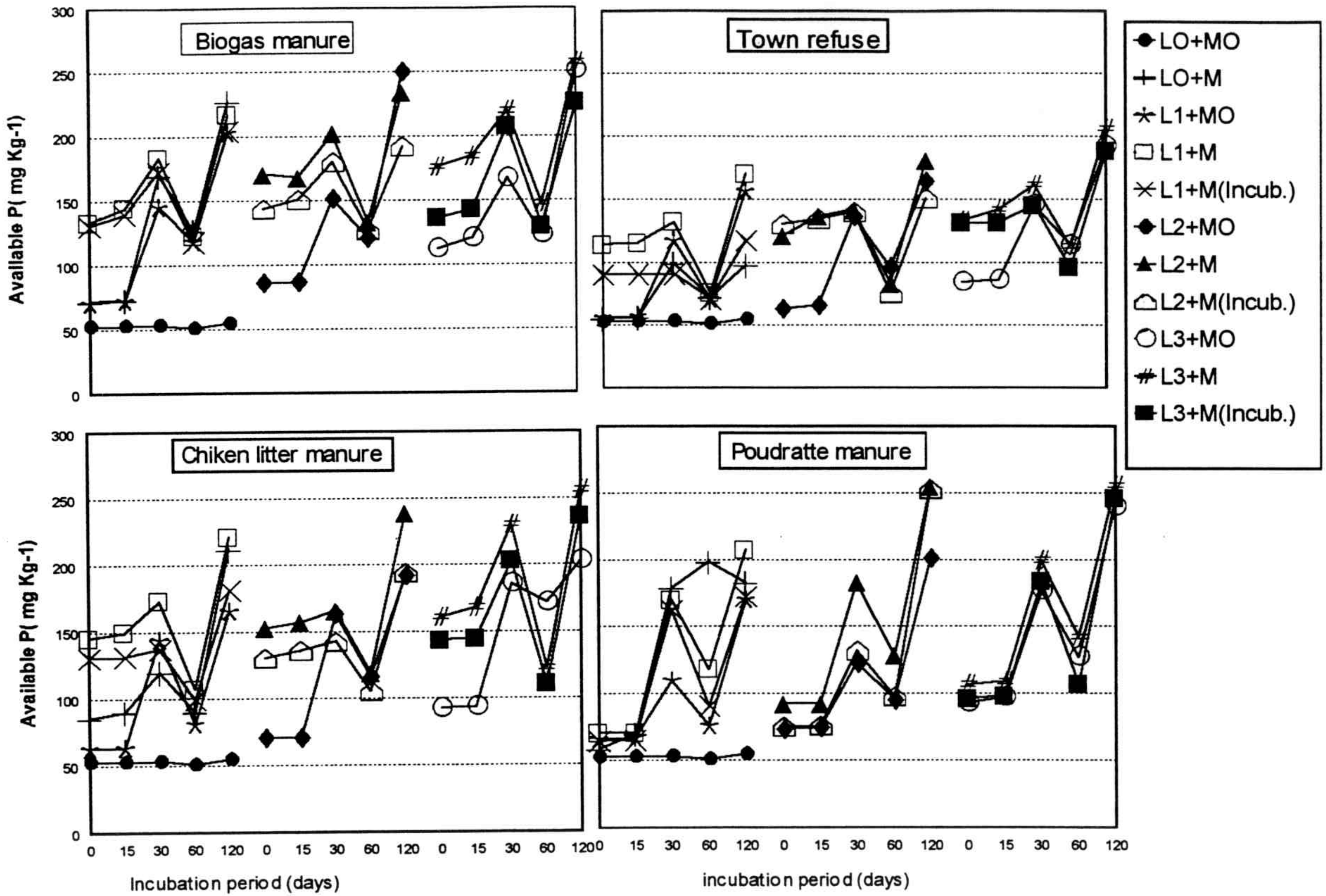


Fig. (6) Effect of organic manures in presence and absence of mineral fertilization on available P in the clayey soil .

4.3.1.6 The effect due to interaction between the different treatments :

Results show significant positive interactions through all the tested combinations in both soils on soil P availability . The most effective composting treatments could be arranged according to their effect on soil P availability in these descending orders :

In the sandy soil :

Manure + L_3 at (120 days) > Manure + L_2 at (120days) > Manure + L_1 at (120days) > L_3 at (120 days) whereas values of available soil P corresponding to these treatments were 229.6 , 191.1 , 171.9 and 162.6 mg P kg^{-1} soil ,respectively

In the clayey soil :

Manure+L_3 at (120 days) > L_3 at (120 days) > Manure +L_2 at (120 days)> Manure incubated with L_3 at (120 days) where the corresponding values of available P were 243.7 , 231.1 , 227.2 and 224.2 mg P kg^{-1}soil, respectively . Such results may lead to a general conclusion that the most efficient treatment with respect to inducing P availability in both the tested sandy and clayey siols was that of biogas manure combined with mineral fertilizer at the third level applied without incubation . On the other side, this effect was maximized after 120 days of incubation .

Results, also give further support to manuring as an essential source in combination with the other mineral fertilizer treatments, particularly in the sandy soil .

4.3.2 Effect on soil available Fe :

The effects due to the different sources of organic residues and mineral sources on the available Fe i.e. DTPA extractable Fe in both sandy and clayey soils at the different incubation periods are presented in Tables (11&12) and illustrated by Figs (7&8).

4.3.2.1 The effect due to the incubation period :

Results obtained show significant differences in the values of available Fe in the tested soils due to the different incubation periods. as indicated below.

a) The sandy soil

The obtained results show slight effects during the first 15 days of incubation . Average values overall treatments were 36.4 , 47.9 , 36.5 and 40.7 mg Fe kg^{-1} soil for BM, TR, CLM and PM, respectively . With prolonging the incubation period , these values increased to reach maximum values after 120 days of incubation .The corresponding values were 45.5 , 59.3 , 47.8 and 50.5 mg Fe kg^{-1} soil for the same treatments , respectively . Such effects could be attributed to organic and inorganic acids resulted from the decomposition of the organic matter .

b) The clayey soil

Concerning the effect of the incubation period on clayay soil treated with different organic manures , the data indicated that values of available Fe were increased as the incubation period increased and the maximum values were extracted after 120 days of incubation . Mean values of Fe extracted averaged over all treatments at 0 time of incubation were 51.2 , 58.7 , 53.7 and 53.4 mg Fe kg^{-1} soil for BM , TR , CLM and BM , respectively . The corresponding values at the end of incubation periods (120 days) were 63.5 , 75.6 , 69.1 and 72.7 mg Fe kg^{-1}soil , respectively . The increase in DTPA extractable Fe may be due to the microbial activity

Table (11) Effect of organic residues and mineral fertilizers on available Fe (mg kg^{-1}) of Meet Kenana sandy soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	17.3	17.6	18.8	19.1	19.2	18.4	17.3	17.6	18.8	19.1	19.2	18.4	17.3	17.6	18.8	19.1	19.2	18.4	17.3	17.6	18.8	19.1	19.2	18.4
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	20.0	20.1	24.5	26.1	27.1	23.9	21.7	21.8	29.8	30.0	30.2	26.7	18.2	18.7	25.0	25.5	25.9	22.7	20.1	20.5	27.2	30.0	31.1	25.8
L2	26.2	26.7	29.5	32.1	33.0	29.5	31.5	32.8	33.1	33.5	34.2	33.0	25.3	26.3	39.6	40.1	40.6	34.4	30.9	31.1	32.4	34.5	36.1	33.0
L3	42.0	42.3	43.4	45.2	46.1	43.8	55.2	57.3	57.8	58.1	60.5	57.8	40.1	40.3	41.6	42.1	42.8	41.4	43.0	43.5	46.2	49.3	49.7	46.3
Mean	29.4	29.7	32.5	34.5	35.4	32.4	36.1	37.3	40.2	40.5	41.6	39.2	27.9	28.4	35.4	35.9	36.4	32.8	31.3	31.7	35.3	37.9	38.0	34.8
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						poudratte manure					
Manure only	20.9	21.0	21.9	23.4	26.7	22.8	26.7	26.8	30.4	33.2	37.9	31.7	19.8	20.0	23.1	25.6	31.0	23.9	21.0	21.3	23.8	25.9	32.6	24.9
Manure + L1	34.8	35.0	46.6	48.7	50.1	43.0	47.8	48.2	58.7	60.0	64.5	55.8	32.7	35.2	47.2	50.0	51.6	43.3	44.8	46.3	48.4	49.1	50.9	47.9
Manure + L2	48.2	48.5	49.0	51.3	61.9	51.8	56.3	57.6	66.6	70.1	75.7	65.3	49.5	49.6	54.8	63.9	64.7	56.5	51.4	52.2	63.4	65.3	68.7	60.2
Manure + L3	63.9	64.5	68.1	70.5	75.8	68.6	77.3	77.6	89.2	90.2	99.8	86.8	69.6	69.8	73.1	76.4	78.6	73.5	64.3	65.6	66.9	70.2	79.3	69.3
Mean	49.0	49.3	54.6	56.8	62.6	54.5	60.5	61.1	71.5	73.4	80.0	69.3	50.6	51.5	58.4	63.4	65.0	57.8	53.5	54.7	59.6	61.5	66.3	59.1
M.incubated with L1	23.8	27.4	40.5	41.3	41.4	34.9	37.8	38.1	47.6	48.2	50.1	44.4	20.2	25.3	36.8	38.7	40.7	32.3	32.2	32.7	42.8	43.4	44.6	39.1
M.incubated with L2	32.2	32.4	41.1	43.6	43.9	38.6	54.0	55.0	61.7	62.1	63.1	59.2	31.6	31.8	40.9	41.2	43.6	37.8	43.0	43.9	50.9	51.0	52.1	48.2
M.incubated with L3	45.7	46.0	47.1	49.0	49.1	47.4	62.5	63.4	75.7	75.8	76.8	70.8	48.3	48.4	56.6	56.9	58.7	53.7	50.1	50.2	57.6	58.2	62.6	55.7
Mean	33.9	35.3	42.9	44.7	44.8	40.3	51.4	52.2	61.7	62.0	63.3	58.1	33.4	35.2	44.8	45.4	47.7	41.2	41.8	42.3	50.4	50.9	53.1	47.7
Grand mean	35.8	36.4	41.2	43.1	45.5	40.4	47.1	47.9	55.1	56.1	59.3	53.2	35.6	36.5	43.9	46.0	47.8	41.9	40.1	40.7	46.0	47.7	50.5	45.0
M=manure																								

LSD 0.05 : S=1.32 T=2.19 P=1.47 SxT=4.38 TxP=4.90. SxTxP=1.14

Table (12) Effect of organic residues and mineral fertilizers on available Fe (mg kg^{-1}) of Moshtohor clayey soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	27.2	27.3	28.1	28.5	28.6	27.9	27.2	27.3	28.1	28.5	28.6	27.9	27.2	27.3	28.1	28.5	28.6	27.9	27.2	27.3	28.1	28.5	28.6	27.9
Mineral levels equivalent to organic sources																								
	A						B						C						D					
L1	29.3	29.7	31.6	31.8	32.0	30.9	35.1	35.2	56.4	59.2	63.1	51.0.	31.8	32.0.	50.2	52.6	53.9	44.1	35.0.	35.2	45.5	46.2	48.0	42.8
L2	40.5	40.6	40.7	42.8	46.1	42.1	50.2	50.4	51.5	69.3	71.2	58.5	44.0.	45.2	62.5	65.2	67.0.	56.8	46.7	46.8	53.5	58.5	61.5	53.4
L3	52.0	52.1	52.5	55.2	57.2	53.8	63.8	64.0.	82.7	84.0	86.2	76.1	60.3	60.6	77.3	79.1	80.1	71.5	60.5	60.8	63.8	69.8	76.0.	66.2
Mean	40.6	40.8	41.6	43.3	45.1	42.3	49.7	49.9	63.5	70.8	73.5	61.5	45.4	45.9	63.3	65.6	67.0.	47.5	47.4	47.6	54.3	58.2	61.9	54.1
Organic manure sources (S)																								
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	43.5	44.0.	45.1	47.7	48.0.	45.7	40.1	40.6	70.2	73.8	75.5	60.0.	37.1	37.2	48.2	50.3	61.9	46.9	38.2	38.4	70.4	71.5	72.3	58.1
Manure + L1	49.7	49.8	62.3	63.8	65.4	58.2	60.2	60.7	62.8	64.7	67.4	63.2	48.2	48.7	60.3	65.3	66.1	57.7	53.2	53.6	60.4	63.1	68.9	59.8
Manure + L2	56.7	56.9	67.1	68.1	71.1	64.0.	75.8	75.9	76.2	78.7	80.5	76.9	64.7	64.9	76.9	80.2	82.1	73.8	65.1	65.5	75.0	75.5	79.5	72.1
Manure + L3	75.5	76.4	83.1	89.2	91.7	83.2	86.1	86.2	86.9	91.7	92.2	88.4	78.5	79.0.	81.1	83.2	89.9	82.3	84.8	85.3	93.5	96.7	101.2	90.9
Mean	60.5	61.0	70.8	73.7	76.1	68.5	74.0.	74.3	75.3	78.4	80.0.	76.1	63.8	64.2	72.8	76.2	79.4	71.3	67.7	68.1	76.3	78.4	83.2	74.3
M.incubated with L1	43.0	43.2	43.9	50.8	51.3	46.4	49.7	50.1	52.3	55.4	60.1	55.5	44.0.	44.2	53.1	56.3	60.6	51.7	40.5	40.6	60.6	64.4	65.7	54.4
M.incubated with L2	57.5	57.6	65.3	67.4	68.3	63.2	55.4	55.6	62.0.	62.3	69.7	60.9	52.1	52.3	63.3	66.3	67.2	62.2	50.1	50.8	69.2	71.3	72.3	62.7
M.incubated with L3	70.8	71.2	71.3	78.8	79.5	74.3	70.3	71.3	83.6	85.7	90.4	78.9	69.8	70.1	72.6	75.4	76.1	72.8	60.3	60.5	75.7	77.1	81.2	71.0
Mean	57.1	57.3	60.2	65.7	66.4	61.3	58.5	59.0.	66.0.	67.8	73.4	65.1	55.3	55.5	63.0.	66.0.	68.0.	62.2	50.3	50.6	68.5	70.9	73.1	62.7
Grand mean	51.2	51.5	58.6	61.8	63.5	57.3	58.7	59.0.	68.5	72.5	75.6	66.8	53.7	54.1	64.2	67.1	69.1	58.7	53.4	53.7	66.8	69.4	72.7	63.1

M= manure

LSD 0.05 : S=7.80. T=12.90. P =8.72

that encourages the formation of newly product of humic substances which play a major role in soil fertility . Such results were confirmed by ***Hegazy et al. (1989)*** who ascribed the increases in extractable Fe from sandy soil to mineralization process of organic matter supplied to soil through manuring which should be expected to release these micronutrients i.e Fe , Mn , Zn and Cu .

4.3.2.2 The effects due to the different organic residues :

Results obtained show significant increases in the values of available Fe from both the tested soils as a result of added organic residues. The data indicate that application of the different organic manures increased the amount of available Fe extracted from sandy soil according to the descending order : TR > PM > CLM > BM , whereas values of extractable Fe averaged over all incubation periodes were 31.7 , 24.9 , 23.9 and 22.8 mg Fe kg^{-1} soil, respectively . In the clayey soil , similar trend was obvious : TR > PM > CLM > BM . The corresponding values were 60 , 58.1 , 46.9 and 45.7 mg Fe kg^{-1} soil for the above mentioned treatments , respectively . Town refuse manure being the most efficient residue in inducing soil Fe availability in both the sandy and the clayey soils .

The increase in available Fe due to treating the studied soils with the different manures may be attributed to the microbial activity that encourages the formation of product of humic substances which play a major role in soil fertility , also could be attributed to mineralization process of organic matter supplied to soil through manuring which should be expected to release macronutrients . These results are in accordance with the findings of ***El-Sayed (1971) , Abd El-Latif and Abd El-Fattah (1985)*** who attributed this increase to the higher content of micronutrients and the lower pH values of the organic manures during the decomposition which play an important role on the extracted micronutrients .Also , ***Hegazy et al. (1989)*** found that available Fe was significantly increased as a result of application of organic residues to the sandy soils .

Considering the obtained results in view of the initial analysis of the raw residues investigated, may give a reasonable explanation for the obtained results on a basis that poudratte manure which contains the highest Fe content showed the lowest effect on soil available Fe compared with the town refuse . This may be due to precipitation of Fe by its higher content of P in the form of iron phosphate .

4.3.2.3 <u>The effects due to mineral fertilization</u>

Mineral fertilization which included ferrous sulphate significantly increased the soil content of available Fe . The greatest values of available Fe in both the sandy and the clayey soils were obtained due to the addition of mineral sources equivalent to those contained in TR followed by those contained in PM , CM and BM . Mean values of DTPA extractable Fe, averaged over all incubation periods , from sandy soil were 39.2 , 34.8 , 32.8 and 32.4 mg Fe kg^{-1} soil for the above mentioned treatments , respectively . The corresponding values of the clayey soil were 61.5 , 54.1, 47.5 and 42.3 mg Fe kg^{-1} soil , respectively . Similar results were obtained by ***Nofal (1984)*** who found that addition of 5 ppm iron sulphate to the sandy and clayey soils led to increase in extractable iron through the different intervals of incubation . This inducing effect was significantly increased as the level of mineral fertilizer increased in both soils . The clayey soil contained initialy relative higher values of soil available Fe , therefore its extractable available Fe reached values relatively higher than the corresponding ones in the sandy soil .

4.3.2.4 The effects due to separate application of raw residues and mineral fertilizer sources

Results show that the soil available Fe was significantly increased upon treating the tested soil with the studied sources of organic residues and the different levels of mineral fertilizers . This inducing effect was consistently increased as the level of mineral fertilizers increased .

It is clear that the TR added with the mineral fertilizers was the most efficient treatment for inducing soil Fe availablility in the sandy soil followed by PM , CLM and BM where the mean values were 69.3 , 59.1 , 57.8 and 54.5 mg Fe kg^{-1}soil , respectively.Similar trend was obtained in the clayey soil where the corresponding mean values were 76.1 , 74.3 , 71.3 and 68.5 mg Fe kg^{-1} soil , respectively . Sush results were confirmed with those obtained by ***Abd El-Latif and Abd El-Fattah (1985)*** who attributed the increase in micronutrients availability to the higher content of Fe, as well as, the lower pH values of organic manures during their decomposition .

4.3.2.5 The effects of composting the raw residues with mineral sources before application to the soil

Results obtained show that the organic residues mixed and incubated with the mineral fertilizers outside the soil, significantly increased available Fe in both the investigated soils . Mean values of extractable Fe from sandy soil averaged over all incubation periods were 40.3 , 58.1 , 41.2 and 47.7 mg Fe kg^{-1} soil for composting BM , TR , CLM and PM , respectively . The corresponding values of Fe extracted from the clayey soil were 61.3 , 65.1 , 62.2 and 62.7 mg Fe kg^{-1} soil for the above mentioned treatments , respectively . This effect was less than that observed due to the residues enriched with mineral fertilizers . Such trend could be attributed to the ability of humic substances to react and form stable compounds with iron . Furthermore, some compounds of the humified matter may form stable organo-mineral complexes and thus decrease the availability of metals such as iron ***(Greenland, 1970)*** .

Parfitt et al (1995) concluded that soil organic matter contains humic substances, which are extremely complicated linear polymers carrying negative charges due to the dissociation of many different carboxyl groups .When Fe, Mn, Zn and Cu are present, the formation of stable organo - mineral complexes could be induced , signifecantly . Taking into consideration effects of different manure treatments , it is of a relative importance to indicate that TR gave the highest values of available Fe followed by PM , CLM and BM whether it was applied solely or composted with different mineral sources .

4.3.2.6 The effects due to interaction between the different treatments.

Results show significant positive interactions through all the tested combinations in the sandy soil , and an insignificant increase, on Fe availability in the clayey soil .

The treatments could be arranged owing to their effect on Fe availability in the sandy soil in the following descending order : M + L_3 at (120 days) > M + L_2 at (120 days) > M. incubated with L_2 at (120 days) > M + L_1 at (120 days). Values of available soil Fe corresponding to these treatments were , 83.4 , 67.7 , 61.8 and 54.3 mg Fe kg^{-1} soil , respectively.

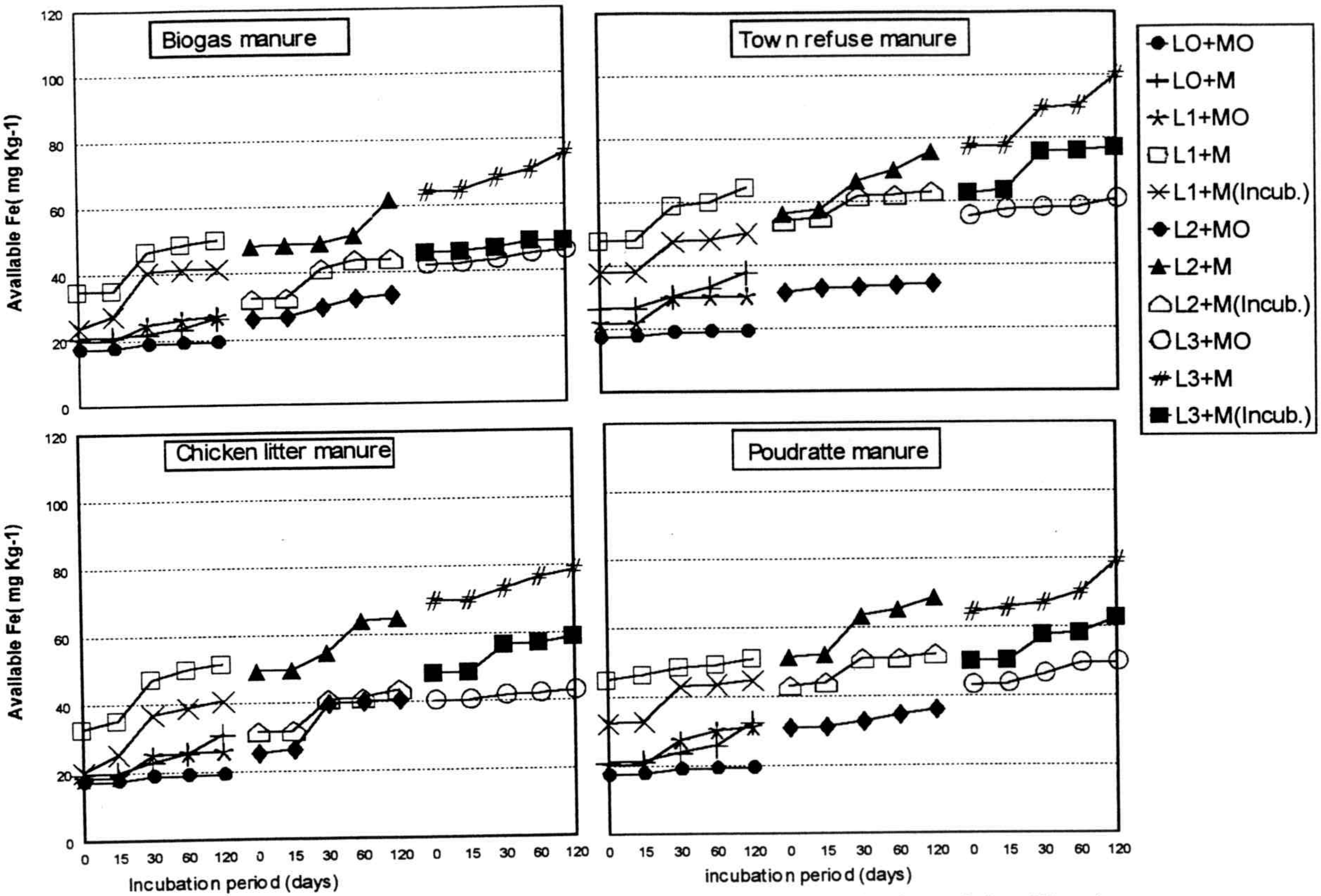


Fig. (7) Effect of organic manures in presence and absence of mineral fertilization on available Fe in the sandy soil .

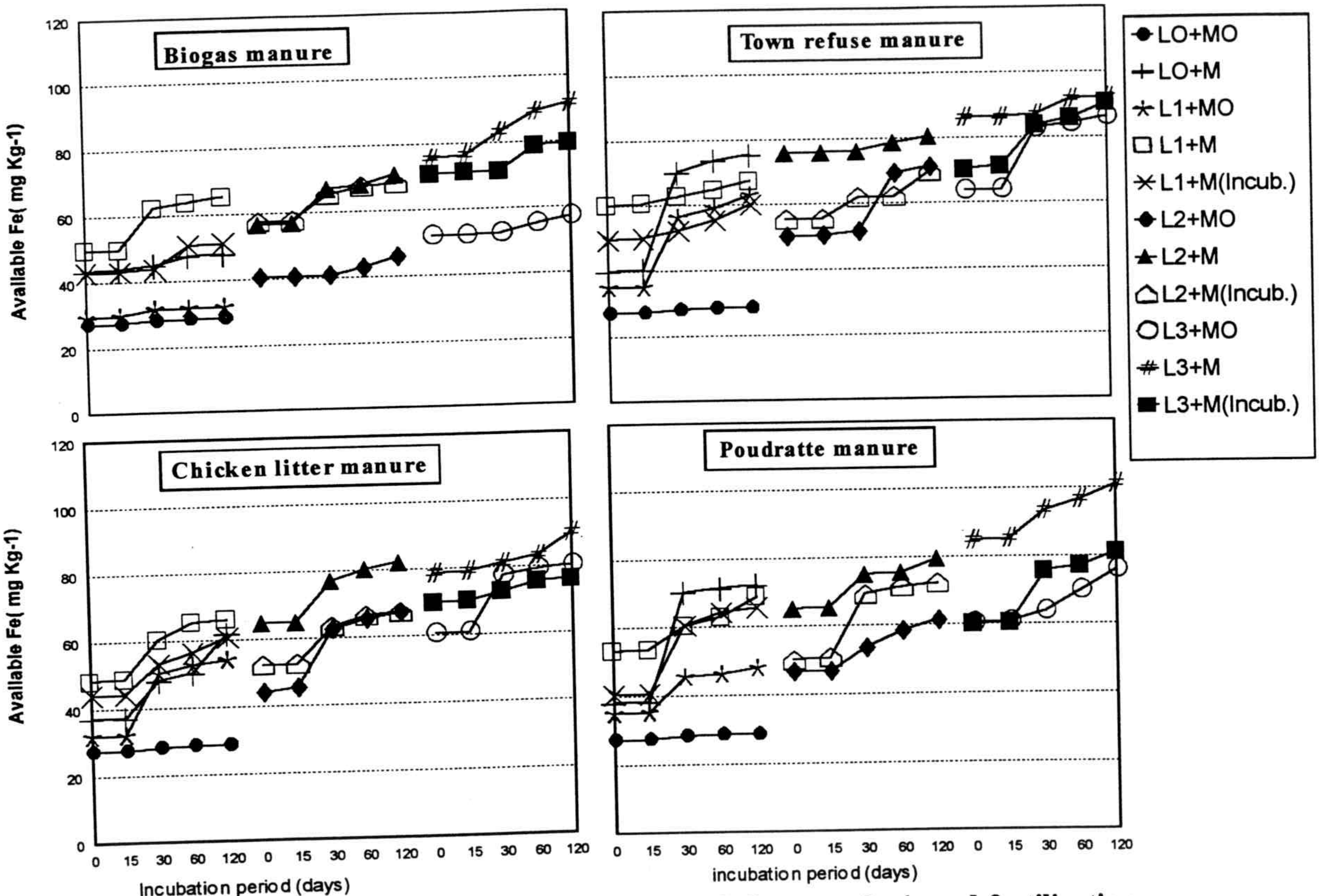


Fig. (8) Effect of organic manures in presence and absence of mineral fertilization on available Fe in the clayey soil .

As a general conclusion , results obtained indicate that the most efficient treatment with respect to inducing Fe availability in sandy soil was TR manure combined with mineral fertilizers at the third level of application and applied to the soil without composting . In the clayey soil, the following descending order was observed : M + L_3 at (120 days) > M. incubated with L_3 at (120 days) > M + L_2 at (120 days) > L_3 at (120 days). The corresponding values were 93.8 , 81.8 , 78.3 and 74.9 mg Fe kg^{-1} soil, respectively .

4.3.3 Effect on soil available Mn

The effects due to added residues from different sources on available Mn (DTPA-extractable Mn) in both the sandy and clayey soils , during the different incubation periods are presented in Tables(13&14) and illustrated in Figs.(9&10) .

4.3.3.1 The effect due to the incubation period :

Results obtained show significant differences in values of the available Mn in the tested soils due to the different incubation periods .

a) The sandy soil

Results show that the effects were too slight during the first 15 days thereafter increased sharply up to 30 days, then decreased gradually till the end of the incubation period (120 days from incubation) . The most effective period was 30 days of incubation where the maximum available Mn was extracted . Mean values of available Mn extracted from the sandy soil over all treatments were 54.7 , 66.9 , 58 and 53.3 mg Mn kg^{-1} soil for BM , TR , CLM and PM , respectively . Such variations depend mainly on which of the two processes prevails , Mn mineralization or immobilization ,due to the differential effects of the involved treatments as well as the microbial activity associated with such treatments .

b) The clayey soil

Results show an increasing effect due to extending the incubation period of residues applied to the tested clayey soil . The general trend observed with respect to Mn availability through the course of the incubation experiment, included a slight increase through the first 15 days , followed by a sudden increase after the next 30 days , follwed by a decreasing till end of the incubation process (120 days) . The most effective period was 30 days of incubation , mean values of available Mn over all treatments were 112.8 , 126.4 , 93.4 and 92.4 mg Mn kg^{-1} soil for BM , TR , CLM and PM , respectively . The increase in extractable Mn in both the soils under investigation up to 30 days could be ascribed to mineralization process of organic manures supplied to soil and the lower pH values of those materials during the decomposition period which play an important role on increasing the extracted micronutrients . On the other hand, the decrease in available Mn after 30 days of incubation may be elucidated by the formation of stable-organo-mineral clay complexes at the terminal stage of the decomposition of organic manures and thus decrease the availability of Mn .Similar results were obtained by ***Greenland(1970) and Abd El-Kariem (1989)*** .

In general , data of DTPA - extractable Mn indicated that the highest values were obtained in the clayey soil , while the lowest values were reported for the sandy one . This decrease in the amount of extractable Mn from the sandy soil may be due to its relatively lower Mn content.Similar results were obtained by ***El-Sherif et al .(1970)*** who found

Table (13) Effect of organic residues and mineral fertilizers on available Mn (mg kg^{-1}) of Meet Kenana sandy soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	10.5	10.5	11.9	11.3	10.3	10.9	10.5	10.5	11.9	11.3	10.3	10.9	10.5	10.5	11.9	11.3	10.3	10.9	10.5	10.5	11.9	11.3	10.3	10.9
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	24.5	29.3	29.9	29.2	17.5	26.1	34.7	34.8	41.1	37.8	21.9	34.1	21.1	32.7	42.7	32.5	17.6	29.3	27.2	33.3	34.5	33.2	13.8	28.4
L2	40.4	47.6	52.5	47.4	37.8	45.1	50.2	50.2	63.1	50.8	41.5	51.2	42.6	43.1	68.2	49.2	46.5	47.9	30.6	44.7	66.2	44.3	33.6	43.9
L3	54.2	54.3	55.0	54.2	53.9	54.3	62.1	62.3	71.0	69.2	58.6	64.7	51.6	58.9	74.4	58.7	55.4	59.8	46.8	58.2	73.3	58.1	41.5	55.6
Mean	39.7	43.7	45.8	43.6	36.4	42.8	49.0	49.1	58.4	52.6	40.7	50.0	38.4	44.9	58.4	46.8	39.8	45.7	34.9	45.8	57.6	45.2	29.6	42.6
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	18.0	26.0	47.6	26.0	55.7	28.6	19.9	55.1	55.3	24.2	19.9	34.8	34.7	36.0	36.1	35.3	17.5	31.9	17.9	34.1	38.4	32.4	18.0	28.2
Manure + L1	43.8	43.9	52.3	48.6	17.8	41.3	38.5	52.1	64.4	52.1	27.6	45.9	44.5	55.2	56.1	48.8	20.4	45.0	31.9	32.9	41.1	35.6	18.8	32.1
Manure + L2	50.2	56.0	72.5	51.6	26.8	51.5	43.4	62.0	76.2	62.0	29.6	54.2	48.5	61.3	76.9	60.8	22.0	53.9	47.6	47.8	70.0	57.6	22.7	49.2
Manure + L3	55.1	57.6	86.1	56.2	47.9	60.6	73.1	76.2	115.9	76.1	55.0	79.3	55.6	75.2	91.5	73.9	45.1	68.3	58.9	59.6	82.1	63.1	33.7	59.5
Mean	49.8	52.5	70.3	52.1	30.8	51.1	51.7	63.4	85.5	63.4	37.4	60.1	49.5	63.9	72.4	61.2	29.2	55.6	46.1	46.8	64.4	52.1	25.1	46.9
M.incubated with L1	34.8	37.8	38.4	35.1	14.9	32.2	30.0	31.2	51.9	30.9	22.2	33.2	23.3	41.6	41.8	27.3	19.1	30.6	24.1	24.5	29.6	31.1	16.2	25.1
M.incubated with L2	37.7	37.8	44.2	40.1	25.1	37.0	39.9	50.3	60.7	50.1	23.9	45.0	35.8	48.8	49.8	43.8	20.9	39.6	36.5	37.1	45.1	37.1	21.5	35.5
M.incubated with L3	39.2	52.7	68.7	66.9	37.9	53.1	45.7	57.1	69.4	57.1	30.0	51.9	43.2	60.0	60.1	45.7	28.3	47.4	44.7	45.1	53.3	48.4	29.6	44.2
Mean	37.3	42.8	50.4	47.4	25.9	40.8	38.5	46.2	60.7	46.0	25.4	43.4	34.1	50.1	50.6	38.9	22.8	39.3	35.1	35.6	42.7	38.9	22.4	34.1
Grand mean	39.8	44.3	54.7	46.5	30.5	43.0	43.8	53.1	66.9	51.0	33.0	49.5	40.1	51.3	58.0	47.6	29.3	45.4	36.6	41.9	53.3	44.1	24.9	39.9

M=manure

LSD 0.05 : *S=0.19* *T=0.32* *P=0.22* *SxT=0.21* *SxP=0.43* *TxP=0.72* *SxTXP=0.17*

Table (14) Effect of organic residues and mineral fertilizers on available Mn (mg kg^{-1}) of Moshtohor clayey soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	18.6	18.6	19.0	18.8	18.5	18.6	18.6	18.6	19	18.8	18.5	18.6	18.6	18.6	19	18.8	18.5	18.6	18.6	18.6	19	18.8	18.5	18.6
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	47	49.8	63.2	61.3	59.9	56.2	52.1	53.5	80.1	62.4	51.9	60	29.7	29.9	67.8	37.3	36.7	39.8	26.5	27	63.1	29.9	27.9	34.9
L2	60	60.2	82.1	66	64.1	66.5	66.5	67.3	91.7	65.6	64.5	71.1	33.2	34.1	81.9	70.9	38.4	51.7	32.1	32.1	67.8	38.7	35.9	41.3
L3	87.1	89.4	118.8	81.1	71	89.6	87.1	87.2	109.2	75.6	70.1	85.6	40.9	43.3	103.0	93.3	52.8	66.7	58.7	59.8	80	57.4	57.2	64.6
Mean	64.7	66.5	88.0	69.5	65	70.8	68.6	69.3	93.7	67.9	62.2	72.2	34.6	35.8	84.2	67.2	42.6	52.7	39.1	39.6	70.3	42	40.3	46.9
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	41.9	42.1	97.2	59.4	51	58.3	41.1	41.2	110.8	81.1	55.7	66	45.7	45.9	73.2	56.4	50.8	54.4	23.8	23.9	94.2	62.6	57.2	52.3
Manure + L1	57.3	58.8	146.3	78.5	76.2	83.4	73.4	73.6	123.2	84.8	69.5	84.9	60.8	61.3	82.3	68.9	52.5	65.1	53.2	54.8	102.1	78.3	61.2	70
Manure + L2	71	70.1	153.5	93.4	78.4	91.3	90.8	92.2	136.4	95.7	72.7	97.6	78.8	79.8	139.9	77.3	70.7	89.3	71.3	71.6	103.2	83.2	70	79.8
Manure + L3	100.4	101.2	172.8	92.1	90.1	111.3	142.6	147.2	173.4	101.0	88.8	130.5	105	106	149.3	79.8	73.6	102.4	97.9	103.8	154.4	101.7	87.5	105.1
Mean	78	76.6	157.5	88.0	81.6	95.3	102.3	104.3	144.3	93.8	77	104.3	81.5	82.4	123.8	75.3	65.6	85.6	67.5	76.7	119.9	87.9	72.9	85
M.incubated with L1	51.6	51.8	88.1	64.6	60.7	63.4	50.1	70.2	117.9	69.1	67.2	74.9	52.8	55.9	75.3	56.6	54.8	59.7	49.1	49.8	78.2	65.8	56.2	59.6
M.incubated with L2	70.3	70.6	95.3	82.8	65.4	74.5	60.8	61.9	150.5	81.6	77.5	86.5	65	76	78.8	68.2	56.6	70.7	61.3	61.4	87.3	67.7	53.4	66.3
M.incubated with L3	75.9	99.6	111.2	86.5	70.6	88.8	85.1	87.3	191.2	85.3	83.4	102.5	70.4	71	89.7	79	72.1	76.4	70.3	31.2	93.7	68.1	64.1	73.4
Mean	65.9	73.9	98.2	78.2	65.6	75.5	65.3	73.1	146.5	78.7	76.0	88	62.7	67.6	79	68.5	62.8	68.9	60.2	60.8	86.4	67.2	57.9	66.4
Grand mean	66.8	69.3	112.8	76.7	68.7	78.3	75	78.1	126.4	80.2	70.1	86	58.2	60.3	93.4	68.9	56.4	67.6	52.4	55.5	92.4	65.4	57.1	64.7

M=manure

LSD 0.05 : *S=0.47* *T=0.78* *P =0.52* *SxT =1.56* *SxP =1.05* *TxP = 1.75* *SxTxP =0.41* a positive correlation between extractable Mn and the soil content of fine fractions .

4.3.3.2 The effects due to the different organic residues .

Results show significant differences among the values of available Mn contained in the tested soils as a result of the added organic residues . Application of different sources of organic manures increased the amount of Mn extracted from both soils under inevstigation . The amount of available Mn in the sandy soil increased according to the descending order: TR > CLM > BM > PM . Mean values averaged over all incubation periods were 34.8 , 31.9 , 28.6 and 28.2 mg Mn kg^{-1}soil , respectively . The effect in the clayey soil, followed the descending order : TR > BM > CLM > PM . The corresponding values of extractable Mn were 66, 58.3, 54.4 and 52.3 mg Mn kg^{-1}soil , respectively . It is clear that the TR was the most efficient residue in inducing soil Mn availability in both the sandy and clayey soils . Superiority of TR reflects its higher Mn contents compared with the other materials . Almost similar results were obtained by ***Abd El-Kariem (1989) and Abd El-Hamied (1996)*** who found that soil incubation with organic residues increased the soil content of DTPA - extractable Mn . The increase in soil available Mn was more obvious in the clayey soil than in the sandy one .On the other side , ***Bromfield and Sherman (1950)*** noticed an increase in the level of manganese released from organic matter due to the reduction of Mn with organic compounds such as humic and fulvic acids produced during the decomposition of soil organic matter .

4.3.3.3 <u>The effects due to mineral fertilization</u>

Mineral fetilization which included manganese sulphate significantly increased the soil content of available Mn compared wih the control at all periods of incubation . This inducing effect was significantly increased as the level of mineral fertilization increased in both soils . Average values of Mn extracted from the sandy soil increased from 26.1 , 34.1, 29.3 and 28.4 mg Mn kg^{-1} soil at L_1 to 41.8 , 50 , 45.7 and 42.6 mg Mn kg^{-1} at L_3 for mineral sources equivalent to those contained in BM , TR , CLM and PM , respectively . These values in the clayey soil increased from 56.2 , 60 , 39.8 and 34.9 mg Mn kg^{-1} soil at L_1 to 70.8 , 72.2 , 52.7 and 46.9 mg Mn kg^{-1} soil at L_3 for the above mentioned treatments , respectively .

Because the clayey soil contained initialy relative higher values of soil available Mn , its DTPA - extractable Mn reached values relatively higher than the corresponding ones of the sandy soil . Mean values of available Mn average over all treatment were 44.5 and 74.3 mg Mn kg^{-1} soil for the sandy and clayey soils , respectively . Mean values of extractable Mn at low level in the sandy soil were 41.3 , 45.9 , 45 and 32.1 mg Mn kg^{1} soil, these values increased at the highest level of application to reach 60.6 , 79.3 , 68.3 and 59.5 mg Mn kg^{-1} soil for BM , TR , CLM and PM , respectively . In the clayey soil, these values when the manure was mixed with the mineral fertilizers at the level L_1 were 83.4 , 84.9 , 65.1 and 70 mg Mn kg^{-1} soil and increased to reach 111.3 , 130.5 , 102.4 and 105.1 mg Mn kg^{-1} soil when the different manures were mixed with the highest level of the mineral sources (L_3) for BM , TR , CLM and PM, respectively .

4.3.3.4 The effects due to mixing application of raw residues and mineral fertilizer sources .

Results show that soil available Mn was significantly increased upon treating the tested soils with the studied sources of organic residues mixed with the different levels of mineral fertilizers . Average values over all treatments were 44.5 and 74.3 mg Mn kg^{-1} soil for the sandy and clayey soils , respectively . This inducing effect was steadily increased as the level of mineral fertilizers increased .

It is clear that TR mixed with the mineral fertilizers and applied to the soils were the most effective residues in inducing soil available Mn in the sandy and clayey soils . The highest values of available Mn in the sandy soil (60.1mg Mn kg^{-1}soil) and the clayey soil (104.3 mg Mn kg^{-1} soil) were obtained when TR was mixed with mineral fertilizer . These results may confirm those obtained by ***Abd El-Kariem (1989)*** .

4.3.3.5 The effect due to composting the raw residues with mineral sources before application to the soils :

Results obtained indicate that application of the organic residues composted with the mineral fertilizers outside the soil increased significantly the DTPA-extractable Mn in both the investigated soils and the increase was more obvious with the highest level of applied mineral sources (L_3) . However, this effect was less than that observed upon adding the organic residues and mineral fertilizers separately to the soil without incubation . Average values over all treatment were 39.4 and 99.6 mg Mn kg^{-1} soil for the sandy and clayey soils , respectively . These values corresponded to 44.5 and 74.3 mg Mn kg^{-1} soil when the organic residues were applied with the mineral fertilizer without composting . Such effect could be attributed to the ability of humic substances released or synthesized through the decomposition of the raw residues to react with mineral soil components and formation of more stable organic mineral complexes which reduce the soil Mn availability . These results are in accordance with the findings of ***Greenland(1970) , Khalil et al. (1986) and Parfitt et al. (1995) .***

It is of a relative importance to indicate that TR was also the most efficient treatment in inducing Mn availability when it was composted with the mineral fertilizers and applied to both the soils . Average values were 43.4 and 88.0 mg Mn kg^{-1} soil for the sandy and clayey soils, respectively.

4.3.3.6 <u>The effect due to the interaction between the different treatments :</u>

Results showed significant positive interactions among all the tested combinations on soil Mn availability in both the soils . The most effective treatments could be arranged according to their effect on soil Mn availability in these descending order .

<u>In the sandy soil :</u>

Manure + L_3 at (30 days) > Manure + L_2 at (30 days) > L_3 at (30 days) > days) > M. incubated with L_3 at (30 days). Values of available soil Mn corresponding to these treatments were , 93.9 , 73.9 , 73.6 and 62.9 mg Mn kg^{-1}soil , respectively .

<u>In the clayey soil :</u>

The descending orderd was Manure + L_3 at (30 days) > Manure + L_2 at (30 days) > M. incubated with L_3 at (30 days) > Manure + L_1 at (30 days). Values of available soil Mn corresponding to these treatments were , 162.5 ,133.2 , 166.5 and 113.5 mg Mn kg^{-1}soil , respectively .

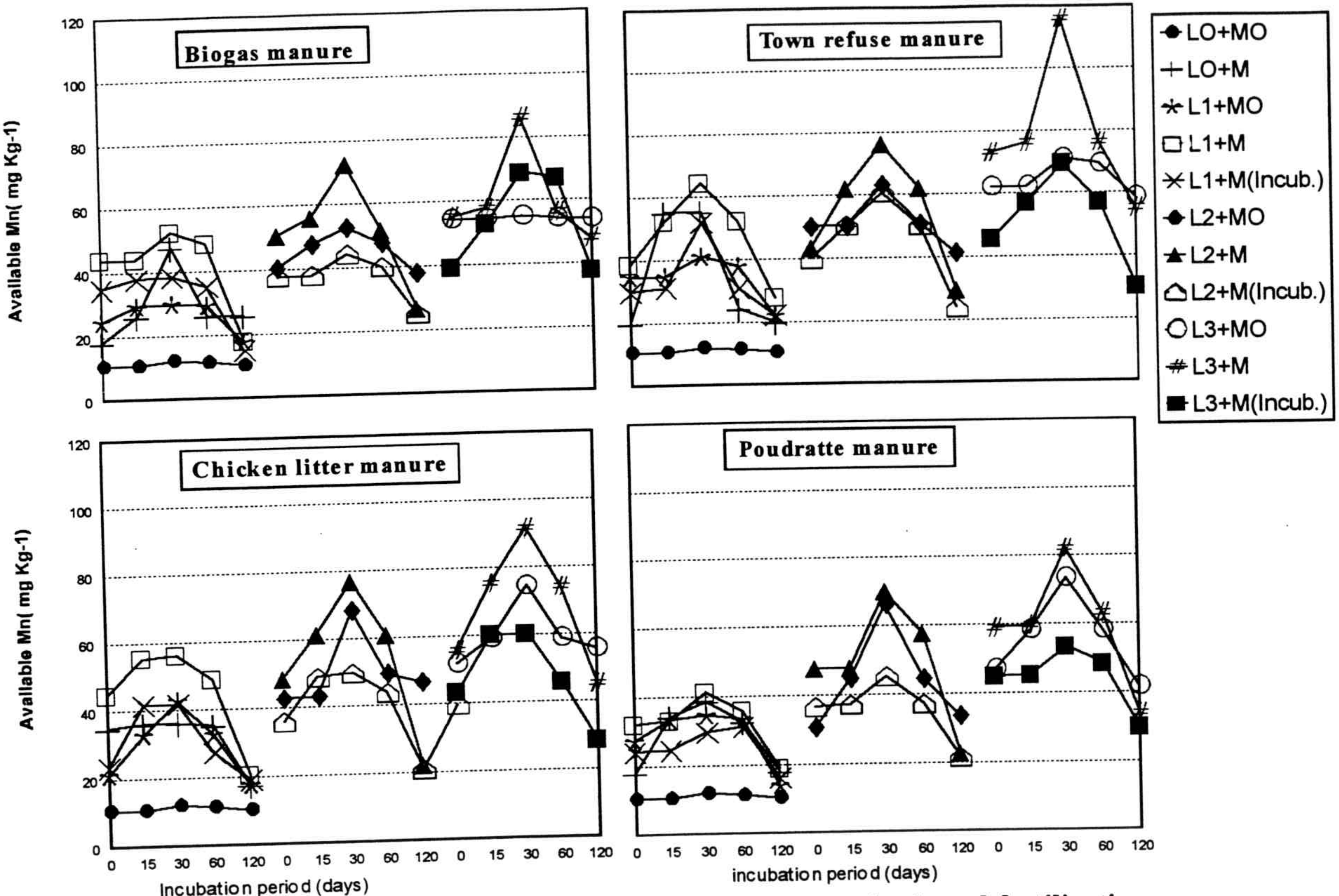


Fig. (9 Effect of organic manures in presence and absence of mineral fertilization on available Mn in the sandy soil .

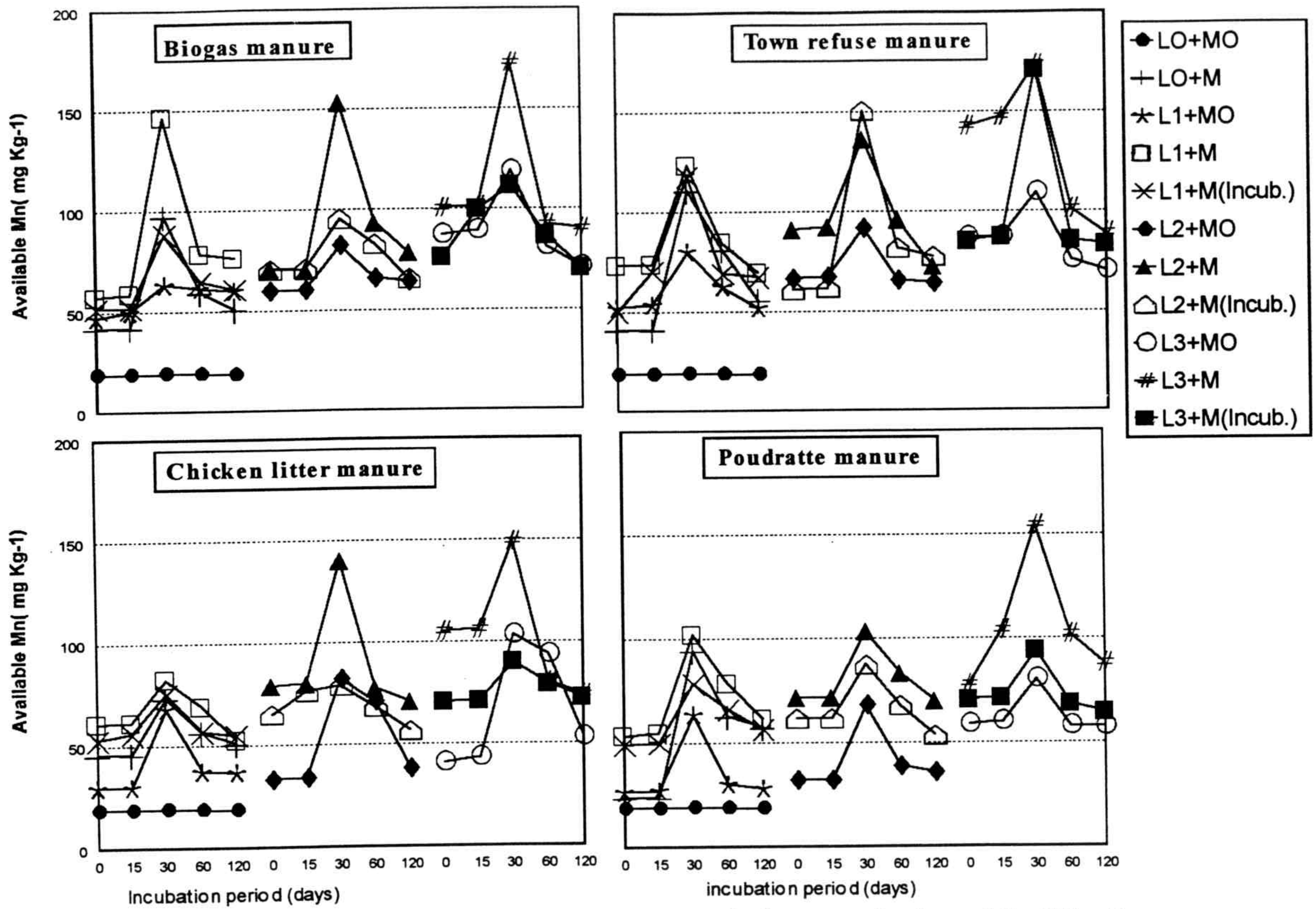


Fig. (10) Effect of organic manures in presence and absence of mineral fertilization on available Mn in the clayey soil .

Such results may lead to a general conclusion that the most efficient treatment with respect to inducing Mn availability in both the tested sandy and clayey soils at 30 days of incubation was that of TR manuring combined with mineral fertilizers at the third level and was appilied to the soil without incubation. Values of available Mn were 115.9 and 173.4 mg Mn kg^{-1} soil for the sandy and clayey soils, respectively.

4.3.4 Effect on soil available Zn

Effects due to the addition of different organic residues on the available Zn in both the sandy and clayey soils during the different incubation periods are presented in Tables (15 & 16)and illustrated in Figs (11& 12).

4.3.4.1 The effect due to the incubation period

Results obtained show significant differences in values of available Zn in both the sandy and clayey soils due to the different incubation periods. Available Zn extracted from the soils treated with the different organic manures was increased as the incubation periods increased. The maximum values were obtained from the samples extracted after 120 days of incubation.

In the sandy soil, mean values of DTPA extractable Zn increased from 4.27, 5.03, 7.29 and 6.1 mg Zn kg^{-1} soil at zero time of incubation to reach 7.0, 7.18, 9.61 and 7.37 mg Zn kg^{-1} soil at the 120 days of incubation for BM, TR, CLM and PM, respectively.

In the clayey soil, the corresponding values at zero time were 5.86, 8.95, 12.2 and 10.0 mg Zn kg^{-1} soil. These values significantly increased to reach 10.0, 14.6, 19.0 and 12.6 mg Zn kg^{-1} soil at end of the incubation period (120 days). Such trend may be due to microbial activity that encourages the formation of new products of humic substances during decomposition which play a major role in soil fertility . Similar results were obtained by ***Abd El-Kariem (1989)*** and ***Hegazy et al.(1989).***

4.3.4.2 The effects due to the different organic residues

Results obtained show significant differences in the values of available Zn extracted from both the clayey soil and sandy one as a result of added organic residues in all cases . This positive effect in the sandy and clayey soils showed in the following order :CLM > PM > TR > BM . It is clear that the chicken litter manure was the most efficient residue in inducing soil Zn availability in such soils . The least effect was due to boigas manure . Mean values of DTPA extractable Zn from the sandy soil were 7.2 , 4.57 , 4.39 and 3.67 mg Zn kg^{-1} soil for CLM , PM , TR and BM , respectively . The corresponding values in the clayey soil were 13.9 , 8.96 , 8.2 and 5.99 mg Zn kg^{-1} soil for the above mentioned treatments , respectively . Similar results were obtained by ***Abd El-Kariem (1989) and Abd El-Hamied (1996)*** who stated that soil content of DTPA - extractable Zn was increased as a result of adding town refuse , chicken manure and biogas manure . Considering the obtained data in view of the initial analysis of the raw residues, it is clear that the chicken litter manure was of the highest Zn content , consequently it was expected to be of the highest effect on soil available Zn . Almost similar results were obtained by ***Abd El-Latif and Abd El-Fatlah (1985)*** who showed that the addition of organic materials such as gawafa seeds and the crust of both orange and peanut to a sandy loam soil and a sandy clay loam soil , markedly increased the available Zn .

4.3.4.3 The effect due to mineral fertilization

Mineral fetilization which included zinc sulphate significantly increased soil content of available Zn . This inducing effect was significantly increased as the level of mineral fertilizers increased .

Because the clayey soil contained initialy relative higher values of soil available Zn , its available Zn reached values relatively higher than the corresponding ones of the sandy soil .

In the sandy soil , mean values of DTPA extractable Zn were 3.28 , 3.29 , 4.63 and 3.15 mg Zn kg^1 soil at the lowest level (L_1) of the applied mineral fertizilers . At the highest level (L_3) , the values significantly increased to reach 5.4 , 6.58 , 9.84 and 7.79 mg Zn kg^1 soil for the applied mineral fertilizers equivalent to elements contained in BM , TR , CLM and PM , respectively .

In the clayey soil , data indicate that DTPA extractable Zn was increased when the mineral fertilizers were applied as compared with the control (without application) . Mean values at the lowest level (L_1) were 3.38 , 5.17 , 7.52 and 7.56 mg Zn kg^1 soil and reached the maximum at the highest level (L_3) where values of 6.18 , 13.5 , 16.4 and 15.8 mg Zn kg^1 soil were obtained for the applied fertilizers equivalent to elements contained in BM , TR , CLM and PM , respectively . Similar results were obtained by ***Abd El- Kariem (1989)*** who stated that the DTPA extractable Zn was increased when Zn was applied to calcareous and sandy soils as compared with the control at all periods of incubation .

Table (15) Effect of organic residues and mineral fertilizers on available Zn ($mgkg^{-1}$) of Meet Kenana sandy soil during differnt incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	1.88	1.98	2.05	2.50.	2.88	2.25	1.88	1.98	2.05	2.50.	2.88	2.25	1.88	1.98	2.05	2.50.	2.88	2.25	1.88	1.98	2.05	2.50	2.88	2.25
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	2.25	2.65	3.19	3.9	4.42	3.28	2.4	2.9	3.03	3.32	4.8	3.29	4.37	4.57	4.62	4.72	4.87	4.63	2.17	2.28	3.66	3.71	4.64	3.15
L2	2.7	2.78	4.4	5.8	5.84	4.3	3.52	3.72	3.84	4.08	5.86	4.2	5.25	5.34	7.48	7.61	8.28	6.79	4.36	4.54	4.63	5.3	5.58	4.88
L3	3.63	3.76	5.06	5.44	9.12	5.4	6.31	6.42	6.6	6.72	6.88	6.58	9.6	9.73	9.78	9.84	10.7	9.84	7.10	7.23	7.56	8.5	8.58	7.79
Mean	2.86	3.06	4.21	5.04	6.46	4.36	4.13	4.38	4.38	4.7	5.84	4.69	6.4	6.54	7.29	7.39	7.92	7.8	4.54	4.68	5.28	5.83	6.26	5.27
	Organic manure sources (S)																							
	Biogas manure						**Town refuse manure**						**Chicken litter manure**						**Poudratte manure**					
Manure only	2.20.	2.26	2.32	5.75	5.8	3.67	2.23	4.24	4.48	5.4	5.6	4.39	4.10.	4.48	8.16	9.7	9.9	7.2	3.9	4.02	4.75	4.9	5.3	4.57
Manure + L1	5.11	5.18	5.25	6.46	6.5	5.7	4.0.	4.12	6.5	6.74	6.78	5.62	6.58	6.76	7.13	7.68	8.24	7.27	4.5	4.61	5.01	7.52	8.58	6.04
Manure + L2	6.38	6.65	6.72	7.46	7.5	6.94	5.44	5.6	8.14	8.28	8.6	7.21	8.75	8.84	8.92	9.63	10.9	9.4	8.03	8.05	8.14	10.9	14.3	9.88
Manure + L3	7.51	7.62	7.93	10.7	10.7	8.90.	9.8	9.93	10.0.	10.2	10.3	10.0.	11.3	11.5	12.0.	12.9	14.0.	12.3	10.3	10.5	10.7	12.4	14.9	11.6
Mean	6.33	6.48	6.63	8.20.	8.22	7.18	6.41	6.55	8.21	8.4	8.56	7.61	8.87	9.03	9.68	10.1	10.7	9.65	7.61	7.75	7.92	10.3	12.6	9.23
M.Incubated with L1	2.83	2.9	4.18	4.63	4.81	3.86	3.42	3.52	4.25	5.1	5.98	4.45	4.7	4.82	6.52	7.6	8.02	6.33	4.0.	4.14	4.5	7.25	8.30	5.97
M.Incubated with L2	4.11	4.16	6.95	7.38	7.4	6.00.	4.92	5.01	6.12	7.0.	7.1	6.03	7.79	7.98	8.15	8.9	9.54	8.87	7.53	7.72	7.81	10.1	13.7	9.37
M.Incubated with L3	5.81	5.92	8.28	8.36	8.38	7.35	8.1	8.16	9.92	10.0.	10.1	9.26	10.5	10.7	10.8	11.3	12.8	11.2	9.15	9.23	9.43	11.6	13.8	10.6
Mean	4.25	4.32	6.61	6.71	6.79	5.73	5.48	5.56	6.76	7.4	7.69	6.58	7.66	7.83	8.49	9.26	10.1	8.67	6.87	7.03	7.18	9.71	11.90	8.54
Grand mean	4.27	4.45	5.43	6.59	7.0.	5.54	5.03	5.37	6.25	6.69	7.18	6.10.	7.29	7.47	8.45	9.0.	9.61	8.34	6.10	6.24	6.59	8.24	9.76	7.37

M=manure

LSD 0.05 : *S=0.36* *T=0.67* *P=0.42* *SxT=0.59* *SxP=0.22* *TxP=0.94* *SxTxP=0.05*

Table (16) Effect of organic residues and mineral fertilizers on available Zn (mg kg^{-1}) of Moshtohor clayey soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	2.81	2.88	3.16	3.27	3.42	3.38	2.81	2.88	3.16	3.27	3.42	3.38	2.81	2.88	3.16	3.27	3.42	3.38	2.81	2.88	3.16	3.27	3.42	3.38
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	2.48	3.9	3.99	4.03	5.52	3.38	3.76	4.32	5.8	5.85	6.12	5.17	6.51	6.57	6.74	6.78	11.0	7.52	5.34	5.78	8.0	8.07	10.6	7.56
L2	3.6	3.74	4.42	4.53	4.54	4.16	7.08	7.52	11.0	11.7	13.8	10.3	9.48	10.3	11.1	11.2	16.0	11.6	7.34	8.25	10.7	10.9	15.9	10.5
L3	4.35	4.56	4.58	6.12	6.36	6.18	9.23	9.4	15.7	15.8	17.6	13.5	11.7	11.7	16.3	16.5	25.7	16.4	10.3	13.2	16.1	16.3	23.1	15.8
Mean	3.47	4.06	4.32	4.89	5.47	4.57	6.69	7.08	10.8	11.1	12.5	9.65	9.23	9.52	11.4	11.5	17.6	11.8	7.66	9.07	11.6	11.8	16.5	11.3
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	5.14	5.2	5.6	5.68	8.36	5.99	7.0	7.9	8.63	8.69	8.77	8.2	10.7	10.9	11.1	18.2	18.4	13.9	8.01	8.12	8.3	8.46	11.9	8.96
Manure + L1	7.73	8.25	8.31	9.5	10.7	8.9	10.3	10.4	11.6	11.8	13.4	11.5	11.2	11.3	14.0	14.1	14.7	13.1	8.42	8.5	11.6	12.9	13.2	10.9
Manure + L2	9.93	10.8	11.6	11.9	16.1	12.1	12.2	12.5	14.4	14.5	16.1	13.9	14.4	14.6	17.1	21.0	21.9	17.8	12.1	12.2	12.8	13.0	21.8	14.4
Manure + L3	12.3	12.6	13.9	14.0	20.5	14.7	15.2	16.0	19.3	29.2	29.4	21.8	19.3	24.3	26.5	26.6	28.6	25.1	19.8	22.2	26.6	26.7	29.1	24.9
Mean	9.98	10.6	11.3	11.8	15.8	11.9	12.6	13.0	15.1	18.5	19.6	15.8	15.0	16.7	19.2	20.6	21.7	18.7	13.3	14.2	15.9	16.0	20.9	16.1
M.Incubated with L1	3.83	3.92	6.88	7.22	7.6	5.89	5.16	5.22	7.5	7.76	8.15	6.75	9.60	9.79	11.0	11.1	12.3	10.8	7.35	7.42	8.75	9.1	11.2	8.76
M.Incubated with L2	4.00	4.08	7.46	7.62	8.2	6.27	8.01	8.82	9.62	9.7	10.1	9.25	12.0	12.2	16.0	16.3	18.1	14.9	10.6	11.0	11.1	11.1	15.9	11.9
M.Incubated with L3	5.29	5.38	9.55	9.78	12.3	8.46	11.5	15.3	17.4	18.1	22.8	17.0	17.5	18.3	18.5	21.0	23.5	19.7	11.9	12.1	14.3	14.4	17.8	14.0
Mean	4.37	4.46	7.96	8.20	9.36	6.87	8.22	9.78	11.5	11.8	13.7	11.0	13.0	13.4	15.2	16.1	18.0	15.1	9.95	10.2	11.4	11.5	15.0	11.6
Grand mean	5.86	6.25	7.63	8.03	10.0	7.60	8.95	9.75	12.3	13.3	14.6	11.8	12.2	13.0	14.9	16.3	19.0	15.1	10.0	10.9	12.5	12.6	16.9	12.6

M=manure

LSD 0.05 : *S=0.5* *T=0.08* *P=0.06* *SxT=0.17* *SxP=0.12* *TxP=0.19* *SxTxP=0.04*

4.3.4.4. The effects due to the separate application of organic and mineral fertilizer sources :

Results show that the soil available Zn was significantly increased upon treating both the sandy and clayey soils with the studied sources of organic residues applied separately along with the different levels of mineral fertilizers . This inducing effect was significantly increased as the level of mineral fertilizers increased by application of the organic manures. At the lowwst level of the applied mineral fertilizers (L_1) values of DTPA extractable Zn increased as compared with the control treatment to reach 5.7 , 5.62 , 7.27 and 6.04 mg Zn kg^1 soil in the sandy soil for BM, TR , CLM and PM , respectively . When the highest level of the mineral fertilizers (L_3) was applied with the organic manures , the values of the available Zn increased to reach 8.9 , 10.0 , 12.3 and 11.6 mg Zn kg^1 soil for the above mentioned treatment , respectively .

In the clayey soil , values of the DTPA extractable Zn upon application of the different manures with the lowest level of the mineral fertilizers (L_1) were 8.9 , 11.5 , 13.1 and 10.9 mg Zn kg^1 soil for BM , TR , CLM and PM , respectively . These values reached to the maximum when the different manures were applied with the highest levels of the mineral fertilizers (L_3) where values of 14.7 , 21.8 , 25.1 and 24.9 mg Zn kg^1 soil were extracted for the samples treated with BM , TR , CLM and PM , respectively . It is clear that the chicken litter manure associated with the mineral fertilizers at the highest level was the most effective treatment in inducing soil available Zn in both soils under investigation . These results may confirm that obtained by ***Baunghman (1956)*** and ***Abd El-Kariem (1989)*** who found that DTPA extractable Zn was increased due to addition of organic manures plus $ZnSO_4.7\ H_2O$ to the tested soils .

4.3.4.5 The effects due to composting the raw residues with mineral sources before application to the soils .

Results show that the organic residues incubated with the mineral fertilizers before application to soil increased the DTPA -extractable fraction of Zn in both investigated soils . Such an effect was more pronounced with increasing level of the mineral fertilizers application however, this effect was less pronounced as compared with applying organic residues and the mineral fertilizers in separate manner .

In the sandy soil , values of DTPA extractable Zn at the lowest level of mineral fertilizers (L_1) were 3.86 , 4.45 , 6.33 and 5.97 mg Zn kg^1 soil for samples of treated with BM , TR , CLM and PM , respectively . These values increased by increasing level of the applied mineral fertilizers where the values 7.35 , 9.26 , 11.2 and 10.6 mg Zn kg^1 soil were obtained when the highest level (L_3) of the mineral fertilizers was composted with the above mentioned of organic manures , respectively .

In the clayey soil , values of extracted Zn when manures were composted with the lowest level (L_1) of the mineral fertilizers were 5.89 , 6.75 , 10.8 and 8.76 mg Zn kg^1 soil . These values significantly increased when manures were incubated with the highest level (L_3) of the mineral fertilizers where 8.46 , 17.0 , 19.7 and 14.0 mg Zn kg^1 were extracted from the clayey samples treated with BM , TR , CLM and PM , respectively . Such an effect could be attributed to the ability of humic substances to react and form stable organic mineral complexes , and thus the availability of soil zinc could be reduced . Almost similar results were obtained by ***Greenland (1970)*** who stated that some compounds of the humified matter at the terminal decomposition stage of the organic

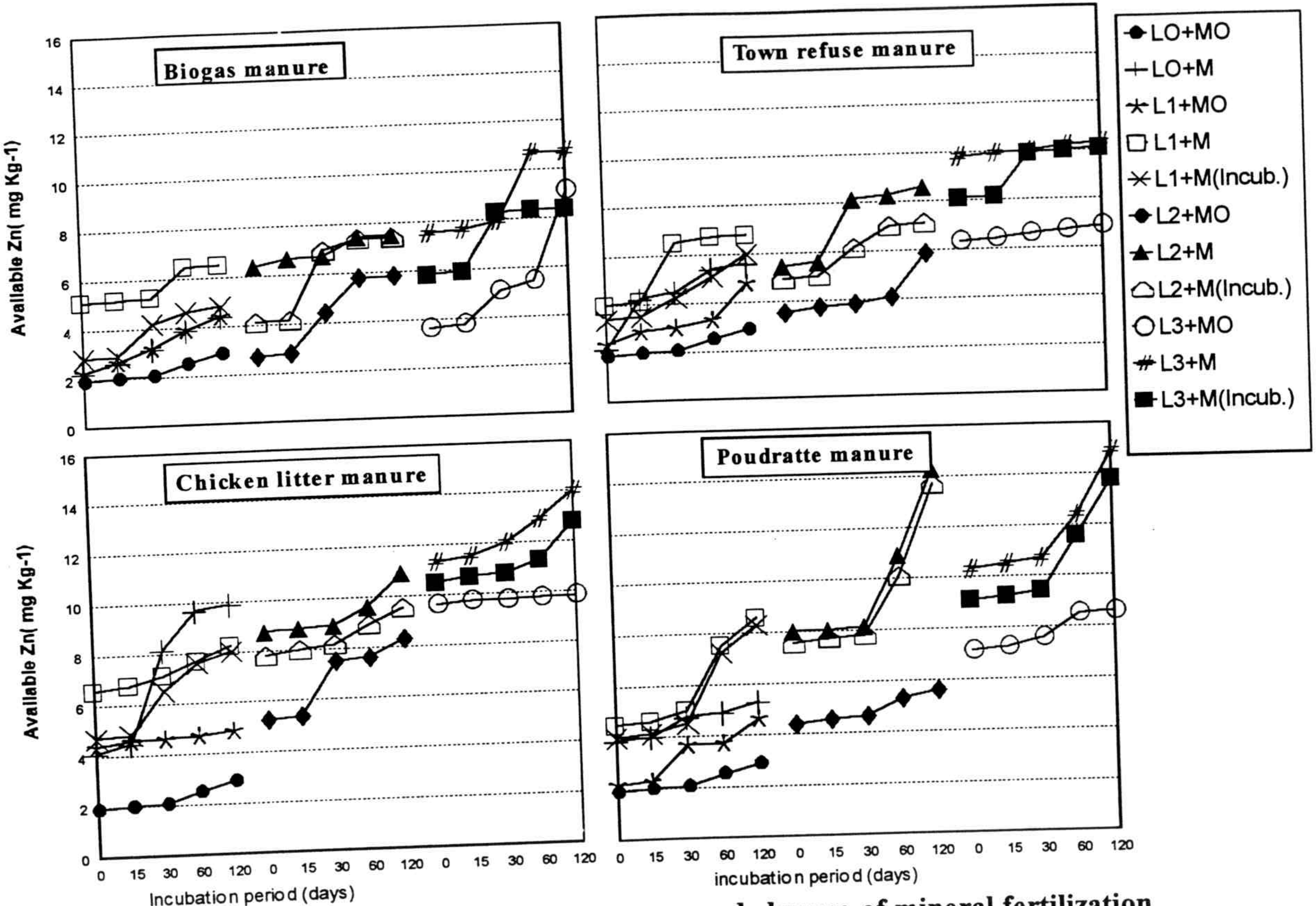


Fig. (11) Effect of organic manures in presence and absence of mineral fertilization on available Zn in the sandy soil .

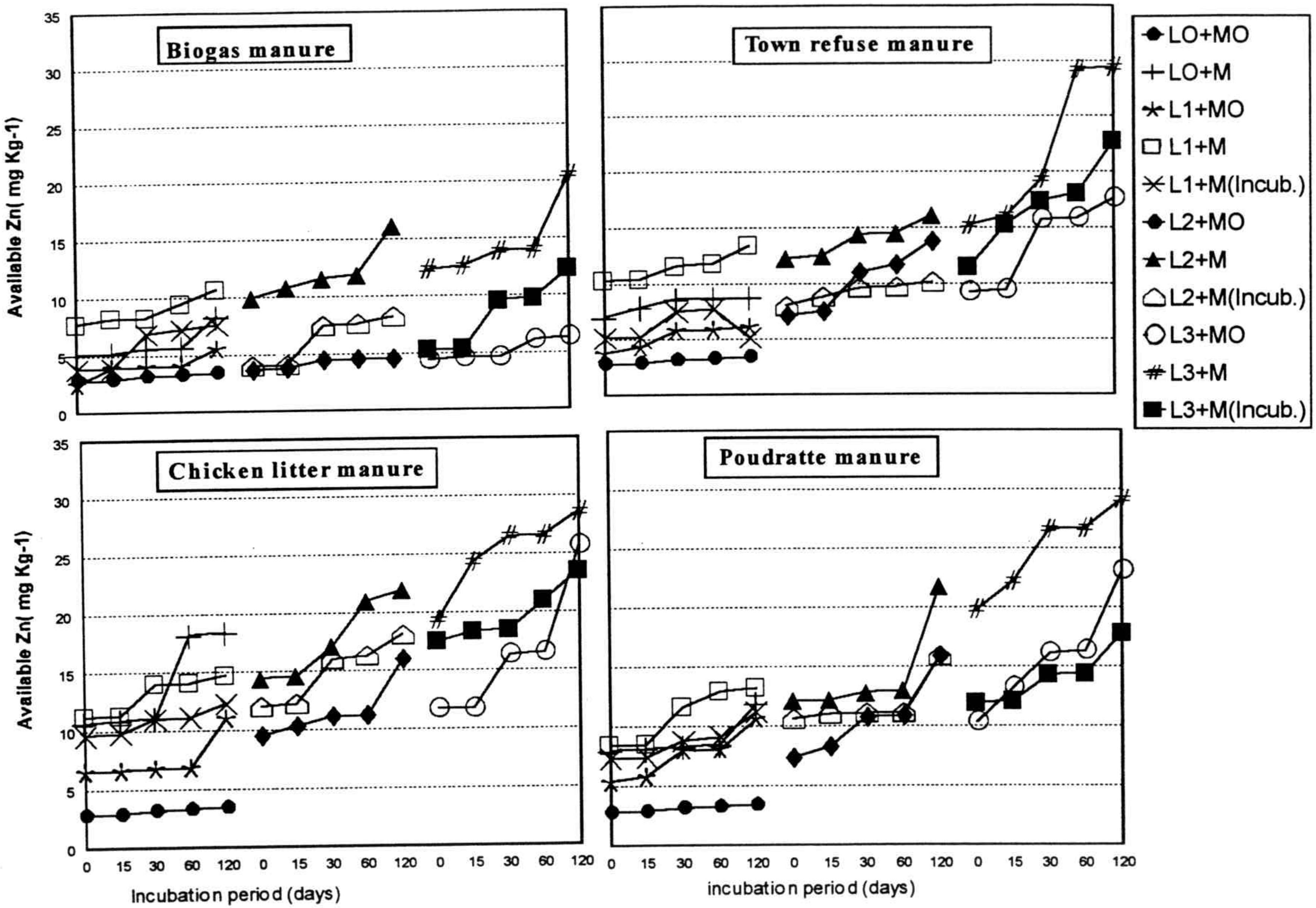


Fig. (12) Effect of organic manures in presence and absence of mineral fertilization on available Znin the clayey soil .

manures may form stable organo - mineral - clay colloidal complexes . and thus decrease the availability of such metals as iron and zinc .

4.3.3.6 The effect due to the interaction among the different treatments :

The obtained results showed significant positive interactions through all the tested combinations on soil Zn availability in the sandy and clayey soils . The composted treatments could be arranged according to their effect on the available Zn in the sandy soil content of in the following descending order : Manure + L_3 at (120 days) > M. incubated with L_3 at (120 days) > Manure + L_2 at (120 days) > L_3 at (120 days) where values of the available soil Zn corresponding to these treatments were 12.5 , 10.9, 10.3 , and 8.82 mg Zn Kg^{-1} soil respectively .

In the clayey soil , the following trend was recorded : Manure + L_3 at (120 days) > M. incubated with L_3 at (120 days) > Manure + L_2 at (120 days) > L_3 at (120 days) , the corresponding values were 26.9 , 19.1 , 19.0 and 18.2 mg Zn Kg^{-1} soil , respectively . Such results may lead to a general conclusion that the most efficient treatment with respect to inducing Zn availabitily in the sandy and clayey soils was the chicken litter manure combined with mineral fertilizers at the third level and applied to the soil without incubation . This effect was maximized after 120 days from its application.

4.3.5 Effect on soil available Cu

The effects due to different organic residues either alone or mixed with different mineral fertilizers on the available Cu in both the sandy and clayey soils. during the different incubation periods are presented in Tables (17 & 18) and illustrated in Figs (13 & 14) .

4.3.5.1 The effect due to the incubation period

Results obtained show significant differences in values of the available Cu in the tested soils due to the different incubation periods .

a) The sandy soil

Results reveal that the effects were too slight during the first 15 days, mean values average over all treatments were 5.81 , 3.0 , 4.3 and 5.28 mg Cu kg^{-1} soil for BM , TR , CLM and PM, respectively . These values increased gradually to reach maximum at end of incubation (120 days) . The corresponding values were 7.13 , 3.72 , 6.1 and 6.53 mg Cu kg^{-1} soil for the above mentioned treatments , respectively .

b) The clayey soil

Results indicate, generally that the most effective period in inducing available soil Cu was 30 days for the different organic manures . Slight increase was observed during the initial 15 days ,mean values average over all treatments were 9.63 , 8.06 , 6.86 and 6.71 mg Cu kg^{-1} soil for BM , TR , CLM and PM, respectively . Thereafter the values increased progressively up to 30 days where the values reached the maximum for BM (12.2), TR (10.6), CLM (8.86) and PM (10.3) mg Cu kg^{-1} soil at the 30 th day from incubation, followed by a decreasing trend after 60 days but were still higher than those values obtained after 15 days , followed again by increase till end of the incubation (120 days) .

4.3.5.2. The effect due to the different organic residues

Data obtained show significant differenes in values the of available Cu extracted from the tested soils as a result of the added organic residues. The amount of available Cu in the sandy soil increased in the following order : BM > PM > CLM > TR . Average values were 3.56 , 2.47 , 2.19 and 1.41 mg Cu kg^{-1} soil , respectively . This effect in the clayey soil, Table (17) Effect of organic residues and mineral fertilizers on available Cu (mg kg^{-1}) of Meet Kenana sandy soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	1.06	1.06	1.19	1.02	1.16	1.10.	1.06	1.06	1.19	1.02	1.16	1.10.	1.06	1.06	1.19	1.02	1.16	1.10.	1.06	1.06	1.19	1.02	1.16	1.10.
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	3.37	3.48	3.73	4.06	4.18	3.76	1.20.	1.28	2.06	2.40.	2.46	1.88	2.40.	2.54	3.14	3.60.	3.97	3.13	2.60	2.61	2.95	3.31	3.46	2.98
L2	5.11	5.20.	6.07	6.14	7.14	5.93	1.98	2.04	2.90.	2.95	2.98	2.57	3.28	3.84	4.46	4.80.	5.35	4.34	4.40.	4.44	4.68	5.48	6.10.	5.01
L3	8.73	8.90.	9.29	9.58	9.62	9.22	4.13	4.14	4.48	5.02	5.16	4.58	6.95	7.10.	9.72	10.90.	11.2	9.17	8.61	8.76	9.03	9.17	9.42	9.00.
Mean	5.73	5.86	6.36	6.59	6.98	6.30.	2.43	2.48	3.14	3.45	3.53	3.01	4.21	4.49	5.77	6.43	6.84	5.54	5.20	5.27	5.55	5.98	6.32	5.66
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	2.81	2.90.	3.51	4.08	4.52	3.56	1.18	1.02	1.21	1.54	1.93	1.41	1.93	2.04	2.14	2.37	2.47	2.19	2.07	2.12	2.30.	2.65	3.21	2.47
Manure + L1	4.07	4.60.	5.26	6.0.	6.13	5.21	2.49	2.65	2.86	2.92	3.02	2.70.	3.01	3.04	4.96	5.28	6.06	4.47	2.14	2.87	3.42	3.90	4.54	3.37
Manure + L2	6.45	6.58	7.42	8.20.	8.57	7.42	3.45	3.52	3.71	4.26	4.37	3.86	4.03	4.26	4.97	5.13	5.66	4.81	5.82	5.96	6.48	6.89	7.71	6.57
Manure + L3	8.95	9.28	9.5	9.55	10.0.	9.45	5.01	5.05	5.20.	5.64	5.80.	5.34	7.51	7.62	9.87	11.1	11.8	9.58	9.15	9.33	9.72	10.0	10.2	9.68
Mean	6.49	6.82	7.56	7.90.	8.07	7.36	3.65	3.72	3.92	4.27	4.39	3.99	4.85	4.97	6.60.	7.17	7.84	6.28	5.70	6.05	6.54	6.93	7.48	6.54
M.incubated with L1	3.52	3.61	3.96	4.41	5.12	4.07	2.50.	2.51	2.58	2.63	2.73	2.59	2.33	2.64	3.18	3.72	3.84	3.14	2.30.	2.65	3.13	3.58	3.85	3.10
M.incubated with L2	6.08	6.28	7.32	7.48	7.70.	6.97	2.83	2.96	3.13	3.28	3.54	3.15	3.92	4.0.	4.24	4.31	4.32	4.16	5.02	5.25	5.36	6.05	6.91	5.72
M.incubated with L3	7.15	7.32	8.32	8.34	8.86	8.0.	4.62	4.74	4.90.	5.10.	5.22	4.91	4.81	5.92	6.30.	6.34	6.36	5.94	8.70.	8.81	8.99	9.83	9.91	9.26
Mean	5.58	5.73	6.53	6.74	7.22	6.34	3.31	3.40.	3.53	3.67	3.83	3.55	3.68	4.18	4.57	4.79	4.84	4.41	5.34	5.57	5.82	6.48	6.89	6.02
Grand mean	5.62	5.81	6.48	6.77	7.13	3.35	2.93	3.0.	3.30.	3.57	3.72	3.30.	4.0.	4.30.	5.29	5.75	6.10.	5.09	5.08	5.28	5.60	6.08	6.53	5.71

M=manure

LSD 0.05 : ***S=0.5*** ***T=0.08*** ***P =.05*** ***SxT =0.16*** ***SxP =0.10*** ***TxP = 0.17*** ***SxTxP =0.04***

Table (18) Effect of organic residues and mineral fertilizers on available Cu (mg kg^{-1}) of Moshtohor clayey soil during different incubation periods.

Incub.periods(days)(P)	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean	0	15	30	60	120	mean
Treatments(T)																								
Control	2.80.	2.81	3.46	3.42	4.26	3.35	2.80.	2.81	3.46	3.42	4.26	3.35	2.80.	2.81	3.46	3.42	4.26	3.35	2.80.	2.81	3.46	3.42	4.26	3.35
	Mineral levels equivalent to organic sources																							
	A						B						C						D					
L1	6.51	6.68	7.65	6.72	8.90.	7.29	4.78	4.95	8.96	5.66	8.30.	6.53	4.35	4.44	5.38	4.52	4.76	4.69	3.44	3.45	8.73	4.24	7.29	5.43
L2	7.31	8.90.	9.81	8.81	10.9	9.15	6.59	6.70.	12.8	8.34	9.20.	8.72	6.15	6.70.	8.06	6.86	7.18	6.57	6.15	6.26	10.0	7.48	8.06	7.59
L3	10.7	14.8	15.1	10.9	16.9	13.7	12.1	12.8	14.6	12.2	12.5	13.0.	6.62	9.70.	12.6	6.74	7.89	9.31	10.8	10.9	13.8	11.1	11.7	11.7
Mean	8.17	10.1	10.9	8.81	12.2	10.0.	7.82	8.15	12.1	8.73	10.0.	9.40.	5.70.	6.94	8.68	6.04	6.24	6.85	6.80.	6.86	10.8	7.60	9.01	8.24
	Organic manure sources (S)																							
	Biogas manure						Town refuse manure						Chicken litter manure						Poudratte manure					
Manure only	3.01	3.04	9.30.	9.10.	9.20.	6.73	4.11	4.14	9.3	6.85	9.20.	6.72	2.87	2.93	5.80.	4.99	5.54	4.42	2.70.	2.72	7.90.	4.40.	4.64	4.67
Manure + L1	6.82	7.08	9.88	7.72	8.58	7.81	6.10.	6.14	7.82	6.36	6.52	6.59	5.63	5.94	7.04	6.02	6.66	6.26	6.60.	6.65	9.94	7.96	9.84	8.20.
Manure + L2	10.1	10.3	15.5	10.7	13.0.	11.9	8.30.	8.32	12.8	10.7	11.1	10.4	7.11	7.30.	9.16	7.16	8.96	7.94	7.05	7.24	11.2	8.66	9.58	8.75
Manure + L3	11.4	15.5	17.9	15.0.	16.3	15.2	13.1	13.3	15.4	14.0.	14.8	14.1	11.7	11.9	17.3	12.5	15.6	13.8	11.7	11.9	17.2	12.6	13.3	13.3
Mean	9.40.	11.0.	14.4	11.1	12.6	11.7	9.20.	9.30.	11.7	10.4	10.8	10.3	8.15	8.38	11.2	8.56	10.4	9.33	8.45	8.59	12.8	9.74	10.9	10.1
M.incubated with L1	6.10.	6.20	6.98	6.20.	6.36	6.37	5.12	5.33	5.48	5.14	5.40.	5.29	5.12	5.34	6.20.	5.38	5.68	5.55	5.13	5.25	7.20.	5.60	6.78	5.99
M.incubated with L2	9.05	9.41	11.3	9.13	9.63	9.70.	6.60.	7.70.	7.76	6.70.	7.18	7.18	5.15	5.54	6.92	5.42	5.78	5.76	5.55	5.64	7.96	70.0	7.85	6.80.
M.incubated with L3	10.2	14.5	15.0.	10.8	11.0.	12.3	10.8	11.1	11.6	11.9	11.5	11.2	8.70.	8.88	10.1	9.20.	9.81	9.34	7.10.	7.20.	8.66	7.20	7.60.	7.55
Mean	8.45	10.0.	11.1	8.71	8.99	9.50.	7.50.	8.04	8.28	7.60.	8.03	7.90.	6.32	6.58	7.74	6.66	7.10	6.88	5.92	6.03	7.94	6.60.	7.41	6.78
Grand mean	8.10.	9.63	12.2	9.50.	11.1	10.1	7.76	8.06	10.6	8.70.	9.56	8.95	6.33	6.86	8.86	6.87	7.67	7.31	6.62	6.71	10.3	7.62	8.66	8.0.

M=manure

LSD 0.05 : S=0.06 T=0.10. P =0.07 SxT =0.21 SxP =0.14 TxP = 0.23 SxTxP =0.05 showed the following order : BM > TR > PM > CLM . The corresponding values of DTPA extractable Cu were 6.73 ,6.72 ,4.67 and 4.42 mg Cu kg^{1} soil , respectively . It is clear that the biogas manure was the most effective residue in inducing soil Cu availability in both the sandy and clayey soils as compared with the other sources of the organic manures .

Data indicate, in general, that DTPA - extractable Cu of the clayey soil was soundly higher than that of the sandy one . This may be due to the relatively lower Cu content of the sandy soil as compared with the clayey one . Similar results were obtained by ***Abd El-Latif and Abd El-Fattah (1985)*** who found that increasing Cu availability was related to the higher content of Cu and the lower pH values of the organic manures during decomposition process which plays an important role in extractablity of Cu. ***Hegazy et al. (1989)*** stated that available Cu was significantly increased as a result of organic manures application .

4.3.5.3 <u>The effect due to mineral fertilization</u> :

Inorganic fertilizers which included copper sulphate significantly increased soil content of available Cu . Average values over all periods of incubation and treatments were 5.13 and 8.64 mg Cu kg^{-1} soil for the sandy and clayey soils, respectively . This inducing effect was consistently increased as the level of minral fertilization increased in both the soils . Mean values of available Cu in the sandy soil at the lowest level (L_1) were 3.76 , 1.88 , 3.13 and 2.98 mg Cu kg^{-1} soil for the mineral fertilizers equivalent to elements contained in BM , TR , CLM and PM , respectively . The corresponding values at highest level (L_3) were 6.3 , 3.01 , 5.54 and 5.66 mg Cu kg^{-1} soil, respectively .

Because the clayey soil contained initialy relative higher values of the available Cu , its available Cu reached relatively higher values than the corresponding ones of the sandy soil . In the clayey soil mean values averaged over all periods of incubation at the lowest level of mineral fertilizers L_1 were 7.29 , 6.53 , 4.49 and 5.43 mg Cu kg^{-1} soil, while at L_3 , these values increased to reach 10.0 , 9.4 , 6.85 and 8.24 mg Cu kg^{-1}soil for BM , TR , CLM and PM , respectively . Similar results were obtained by ***Zhu and Alva (1993)*** who found that available Cu was significantly increased when Cu was applied to a sandy soil as compared with the control at all periods of incubation .

4.3.5.4 The effect due to separate application of raw residues and mineral fertilizer sources .

Results show that soil available Cu was significantly increased upon treating the tested soils with the studied sources of organic residues mixed with the different levels of mineral fertilizers . This inducing effect was significantly increased as level of the mineral fertilizers increased . It is clear that application of biogas manure with the mineral fertilizers to the soils was the most efficient residues in inducing soil Cu availability in both soils . In the sandy soil, average values of DTPA extractable Cu when organic manures were applied with the lowest level of mineral fertilizers (L_1) were 5.21 , 2.7 , 4.47 and 3.37 mg Cu kg^{-1}soil for L_1 + BM , L_1 + TR , L_1 + CLM and L_1 + PM , respectively . The corresponding values at the highest levels of mineral fertilizers L_3 were 9.45 , 5.34 , 9.58 and 9.68 mg Cu kg^{-1} soil for the above mentioned treatments respectively .

In the clayey soil , application of the mineral fertilizers with organic residues significantly increased values of DTPA extractable Cu . This effect was more obvious with increasing level of the mineral fertilizers . Mean values of available Cu at the lowest level of mineral fertilizers were 7.81 , 6.59 , 6.26 and 8.2 mg Cu kg^{-1}soil for BM , TR , CLM and PM , respectively . These values increased to reach 15.2 , 14.1 , 13.8 and 13.3 mg Cu kg^{-1}soil for the above mentioned treatments , respectively . The results showed that mixing mineral fertilizers with BM , in particular , has an improving effect on the available Cu as compared with the other sources of organic manures. Superiority of BM + mineral fertilizers reflcts its higher Cu contents compounds with the other materials . Similar results were obtained by ***Hegazy et al. (1989)** . **and Abd El- Salam et al. (1996)*** .

4.3.5.5 <u>The effect due to composting the raw residues with mineral sources before application to the soils.</u>

Results obtained show that the organic residues mixed and incubated with the mineral fertilizers outside the soil increased significantly the DTPA-extractable Cu in both the investigated soils . However this effect was less than the corresponding one observed due to adding the organic residues together with the mineral fertilizers to the soils without incubation . Mean values of Cu extracted from the sandy soil when the organic residues were composted with the lowest level of the mineral fertilizers (L_1) were 4.07 , 2.59 , 3.14 and 3.1 Cu kg^{-1}soil for BM , TR , CLM and PM ,respectively . At the highest levels of the mineral fertilizers, these values increased to reach 8.0 , 4.91 , 5.94 and 9.26 Cu kg^{1} soil for the above mentioned organic manures , respectively .

In the clayey soil , the corresponding values when manures were composted with the lowest level of the mineral fertilizers were 6.37 , 5.29, 5.5 and 5.99 Cu kg^{-1} soil , respectively . These values increased to reach 12.3 , 11.5 , 9.34 and 7.55 Cu kg^{-1} soil when the composted manure + L_3 were applied i.e BM + L_3 , TR + L_3 , CLM + L_3 and PM + L_3 , respectively.

The values of available Cu were highest upon application of the composted BM + mineral fertilizers . The values of DTPA extractable Cu were lowest when organic residues composted with mineral fertilizers compared with the highest ones extracted from application of the same organic residues with the same levels of mineral fertilizers may be elucidated due to formation of stable organo-mineral clay colloidal complexes at the terminal stage of the decompostition of such organic material . Similar results were obtained by ***Greenland (1970)*** . Also, the ability of humic substances released through the decompostion of the raw residues to react with mineral complexes which reduce the soil Cu availability ***(Parfitt et al., 1995)*** .

4.3.5.6 The effect due to the interaction between the different treatments .

The obtained results show significant positive interactions through all the tested combinations and both soils on soil Cu availability . The composted treatments could be arranged according to their effect on soil Cu availability in the following descending orders :

In the sandy soil :

Manure + L_3 at (120 days) > L_3 at (120 days) > M. incubated with L_3 at (120 days) > Manure + L_2 at (120 days). The values of available soil Cu corresponding to these treatments were 9.28 , 8.85 , 7.58 and 6.44 mg Cu kg^{-1}soil , respectively .

In the clayey soil :

Manure + L_3 at (120 days) > L_3 at (120 days) > Manure + L_2 at (120 days) > M. incubated with L_3 at (120 days) , corresponding values were 15.0 , 12.2 , 10.7 and 9.97 mg Cu kg^{-1} soil , respectively .

Such results may lead to a general conclusion that the most effective treatment with respect to inducing Cu availability in both the tested sandy and clayey soils was that of the biogas manure combined with mineral fertilizers at the third level applied to the soil without incubation .

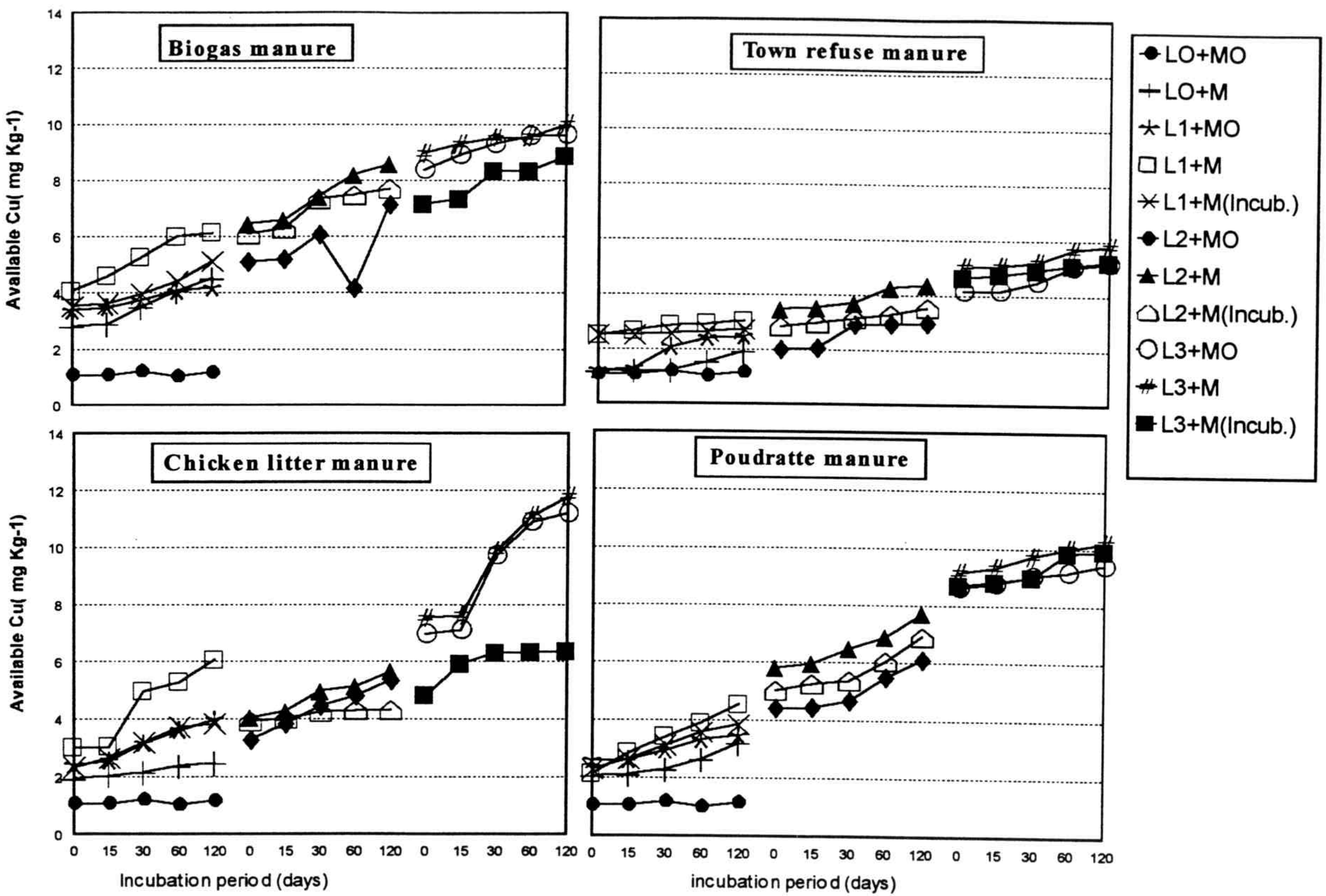


Fig. (13) Effect of organic manures in presence and absence of mineral fertilization on available Cu in the sandy soil .

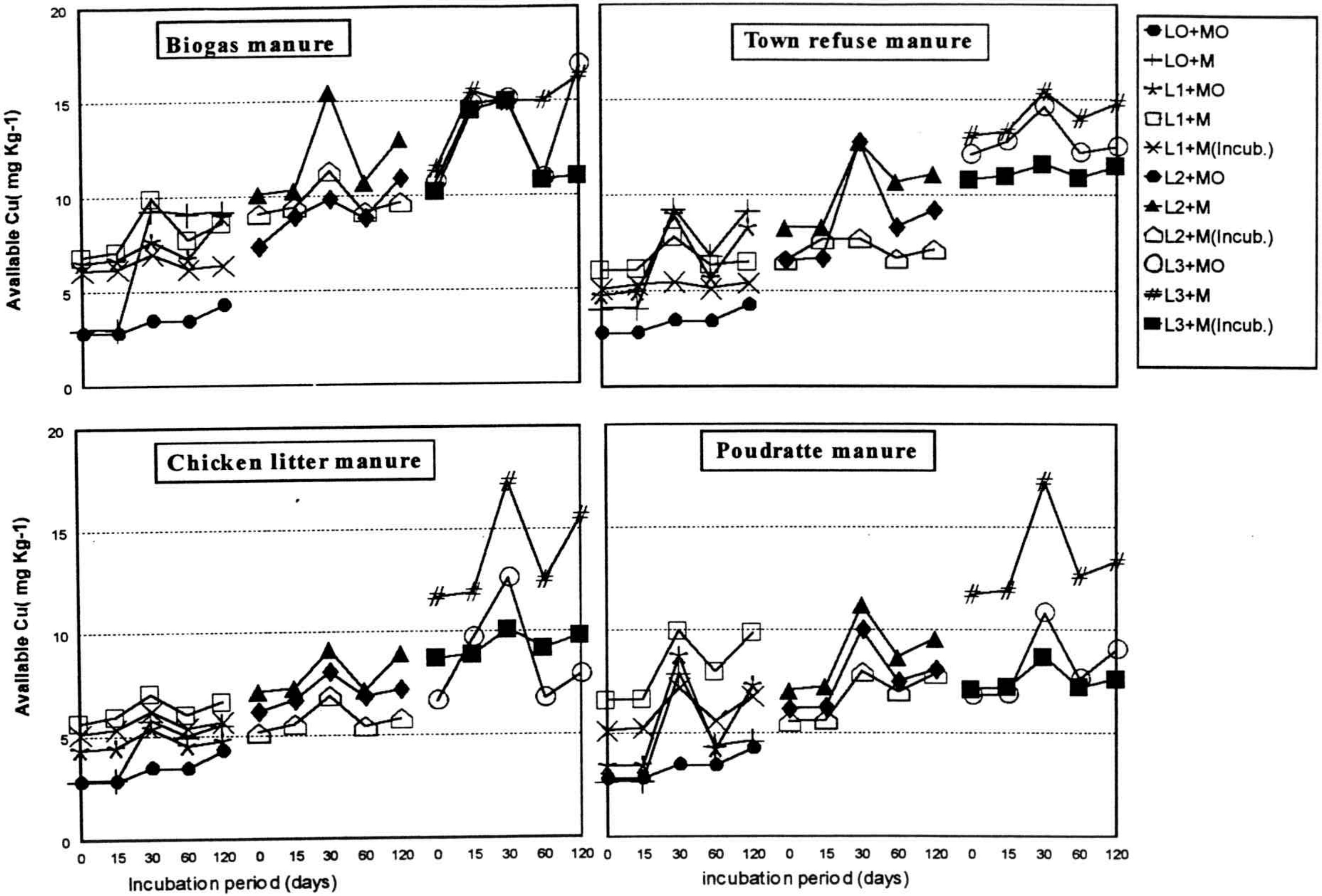


Fig. (14) Effect of organic manures in presence and absence of mineral fertilization on available Cu in the clayey soil .

4.4 Green house experiment

4.4.1 Effect of organic manures and mineral fertilizers on dry matter yield of wheat plants :

4.4.1.1 Effect of type of the applied organic manure

Data presented in Table (19) reveal that application of any of the used organic manures increased significantly the dry matter yield of the wheat plants grown on both the sandy and the clayey soils where values of this yield raised from 4.01 g pot^{-1} in case of the control treatment of the sandy soil up to 5.32 , 5.22 , 5.19 and 5.08 g pot^{-1} upon application of the biogas manure , town refuse , chicken litter manure and poudratte , respectively.The corresponding dry matter yield of wheat grown on the clayey soil raised from 4.30 g pot^{-1} in the control treatments up to 7.64 , 6.10 , 6.45 and 5.57 g pot^{-1} , respectively . These results stand in well agreement with those **of *Sak r et al. (1992) , Fahmy (1995), Abd El-Salam et al (1996) and Abd El-Hamied (1996).*** The results indicate to the superiority of the biogas manure in both the sandy and clayey soils where the values of the dry matter yield of the wheat plants grown thereon attained 5.32 and 7.64 g pot^{-1} ,respectively . On the other hand , poudratte seemed to be of the least effect on dry matter yield of the wheat plants grown on both the investigated soils since its application to these soils resulted in dry matter yield of about 5.08 and 5.57 g pot^{-1} in the sandy and the clayey soil , respectively .

4.4.1.2. Effect of the mineral fertilizers applied solely or combined with the organic manures :

It is obvious from data presented in Table (19) that application of the inorganic fertilizers in absence of the organic manures increased significantly the dry matter yield of the plants grown on both the investigated soils. The increase seemed more obvious by doubling level of the applied fertilizers and achieved maximum by raising level of application to be equivalent to four times that of organic manures . The dry matter yield of the wheat plants grown on the sandy soil increased from 4.01 to 4.58 , 4.03 and 4.03 g pot^{-1} when the mixtures of the inorganic fertilizers were applied in quantities having elemental compositions and concentrations equivalent to the biogas manure , town refuse and chicken litter manure , respectively . On the other hand, a reduction in dry matter yield occurred when a mixture of inorganic fertilizers equivalent to both the elemental camposition and concentration of the poudratte was applied . Doubling the elemental conceutrations of the inorganic fertilizers (L_2), raised the dry matter yield to 6.29 , 5.35 , 5.70 and 4.85 g pot^{-1} in case of biogas manure, town refuse , chicken litter manure and poudratte manure , respectively . The corresponding dry matter yield attained upon increasing level of the applied inorganic fertilizers to four times their concentrations present in the above mentioned organic manures (L_3) increased the dry matter yield of the wheat plants grown on the sandy soil up to 7.70 , 6.75 , 6.60 and 5.13 g pot^{-1} , respectively . The corresponding dry matter yield of the wheat plants grown on the clayey soil attained 4.95 , 4.81 , 4.90 and 4.52 g pot^{-1}, respectively in case of applying the first level (L_1)of the inorganic fertilizers , 7.41 , 6.50 , 6.32 and 4.99 ,respectively upon application of the second level (L_2) of the inorganic fertilizers and 8.47 , 7.23 , 8.29 and 5.95 g pot^{-1} , respectively when the inorganic fertilizers were applied at their highest level (L_3) . These results agree well with the finding of ***Suyamto (1990)*** who found that the dry matter of maize plants increased by 160% with increasing inorganic fertilizers compared with the control .

Table (19) Effect of organic manures and mineral nutrient sources on dry matter yield *(g pot^{-1})* of wheat plants.

Treatments (T)	Manure source (M)											
	Biogas manure			Town refuse			Chicken litter manure			Pouudratte manure		
	Soil (S)											
	sandy	clayey	mean	sandy	clayey	mean	sandy	clayey	mean	sandy	clayey	mean
Control	4.01	4.3	4.15	4.01	4.30.	4.15	4.01	4.30.	4.15	4.01	4.30.	4.15
L1	4.58	4.95	4.76	4.03	4.81	4.42	4.03	4.90.	4.46	3.79	4.52	4.15
L2	6.29	7.41	6.85	5.35	6.50.	5.92	5.70.	6.32	6.01	4.85	4.99	4.92
L3	7.70.	8.47	8.10.	6.75	7.23	6.99	6.60.	8.29	7.44	5.13	5.95	5.54
Manure	5.32	7.64	6.48	5.22	6.10.	5.66	5.19	6.45	5.82	5.08	5.57	5.33
Manure + L1	7.07	7.70.	7.38	5.61	7.53	6.57	6.19	7.20.	6.70.	6.46	6.58	6.52
Manure + L2	10.4	10.9	10.7	7.56	9.48	8.52	9.26	9.97	9.61	7.72	8.01	7.87
Manure + L3	13.9	14.7	14.3	9.42	13.0.	11.2	9.61	13.1	11.4	8.45	9.25	8.85
M.incubated with L1	6.02	6.65	6.33	5.0.	6.90.	5.95	5.17	6.84	6.0.	5.80.	5.86	5.83
M.incubated with L2	8.12	8.86	8.49	6.65	8.20.	7.43	8.32	8.50.	8.41	7.05	7.74	7.40.
M.incubated with L3	8.35	9.14	8.74	6.79	9.30.	8.04	8.50.	8.85	8.67	7.89	8.11	8.00.
Mean	7.78	8.64	8.21	6.24	7.90.	7.07	6.85	8.08	7.46	6.22	6.65	6.44

L1,L2 and L3 = Mineral levels equivalent to organic sources

LSD 0.05 T=0.45 M=0.27 S=0.19 TXM=0.33 TXS=0.47 MXS=0.79

Enriching the organic manures with the inorganic fertilizers seemed to cause more pronounced effect on the dry matter yield of the plants grown on both the studied soils. Moreover , the higher the level of the inorganic fertilizers that enrich the organic residue, the more the dry matter yield attained . Data in Table (19) illustrate the above mentioned effect , where, in case of the plants grown on the sandy soil , the dry matter yield attained when the boigas manure ,town refuse, chicken manure and poudratte manure applied together with the inorganic fertilizers at their first level of application (L_1) were 7.07 , 5.61 , 6.19 and 6.46 g pot^{-1} , respectively . Combination of the organic manures with the inorganic fertilizers at their second level (L_2) resulted in dry matter yield of about 10.4 , 7.56 , 9.26 and 7.72 g pot^{-1} , respectively . The application of the organic residues combined with the inorganic fertilizers at their highest level of application resulted in dry matter yield of the wheat plants grown on the sandy soil of about 13.9 , 9.24 , 9.61 and 8.45 g pot^{-1} , respectively. When the same aforementioned treatments were conducted on the clayey soil , the dry matter yields of the wheat plants attained in case of applying the studied organic manures with the first level of the inorganic fertilizers (L_1) were 7.70 , 7.53 , 7.20 and 6.58 g pot^{-1} , respectively. These values raised to 10.9 , 9.48 , 9.97 and 8.01 g pot^{-1} ,respectively then up to 14.7 , 13.0 , 13.1 and 9.25 g pot^{-1} , respectively when the organic manures were applid together with the second then the third level of the inorganic fertilizers i.e (L_2 then L_3) .

As for the soil effect, it is clear that the dry matter yield of wheat plants grown on the clayey soil treated by organic residues mixed with mineral fertilizers was higher than the corresponding one of the sandy soil.

It may be concluded that the inducing effect of organic manuring on the productivity of light textured soils is due to the humus formed in the soil , which improve the physical and chemical properties of soil and partly to extra supply of nutrients . These nutrients are likely to be released from the organic matter after its decomposition by the microorganisms and then become available to plants . The inducing effect on dry matter yield of wheat plants was increased in both tested soils with increasing the level of applied mineral fetilizers .

Data in Table (19) reveal the role played by the inorganic fertilizers applied at the aforementioned levels combined with any of the studied manures already incubated outside the soil . Compared with the control treatment, the application of the already incubated organic manures combined with the inorganic fertilizers resulted in significant increase in dry matter yield of the wheat plants grown on both the sandy and the clayey soils. Increasing the level of the applied inorganic fertilizers seemed to exert more effect on the dry matter yield whose values in Table (19) reveal that it achieved 6.02 , 5.0 , 5.17 and 5.80 g pot^{-1} , respectively in the sandy soil when the mixture of the inorganic fertilizers were applied at its first level (L_1) . These values raised to 8.12 , 6.65 , 8.32 and 7.05 when level of the applied inorganic fertilizers was increased to the second level (L_2) whereas when the inorganic fertilizers was further raised up to the highest level (L_3), values of the dry matter yield of the plants grown on the sandy soil achieved their maximum i.e. 8.35 , 6.79 , 8.50 and 7.89 g pot^{-1} , respectively .

In case of the clayey soil , the application of the incubated organic manures combined with the first level of the inorganic fertilizers (L_1) resulted in dry matter yields of about 6.65 , 6.90 , 6.84 and 5.86 g pot^{-1} , respectively .The corresponding values upon application of the associated inorganic fertilizers at the second level (L_2) were 8.86 , 8.20 , 8.50 and 7.74 g pot^{-1} , respectively . The values of the dry matter yield raised up to 9.14 , 9.30 , 8.85 and 8.11 g pot^{-1} , when the associated inorganic fertilizers were applied at the third level (L_3).

It is clear that the biogas manure applied either in presence or absence of mineral fertilizers was the most efficient residue in increasing the dry matter yield of wheat plants in both tested soils , while the poudratte manure was the least efficient residue . Town refuse and chicken manure showed intermediate effect with respect to dry matter yield in both investigated soils .

4.4.2 Effect of organic manures and mineral fertilizers on macronutrients concentration and uptake by wheat plants

4.4.2.1 Effect on nitrogen :

Data presented in Tables (20 & 21) reveal the N concentration as well as its uptake as influenced by the fertilization treatments under study.

4.4.2.1.1 Effect of type of the organic manure :

Results presented in Table (20) indicate that the control treatment resulted in N concentration in the wheat plants grown on the sandy soil of about 1.4%.Treating this soil with the organic manures affected significantly N concentration in the plants grown thereon . The effect seemed more obvious upon using the biogas manure and the chicken litter manure where they both induced N concentration in the plants to about 2.5% . The N concentration in the plants treated with the town refuse was the least compared with those attained due to the other organic manures .It was about 2% only, however this concentration exceeds that of the control treatment by about 43% .Poudratte manure induced N in the wheat plants of about 2.3% . This means that effect of poudratte on concentration of N in the wheat plants is intermediate compared with those of the other organic manures . In brief , the investigated organic manures can be arranged according to their effect on N concentration in the wheat plants in the following descending order : biogas manure = chicken litter manure > poudratte manure > town refuse . Regarding the effect of manure type on N uptake by the wheat plants , data reveal that significant increases occurred due to manuring . The uptake was highest by the plants treated with the biogas manure where it reached 133.5 mg pot^{-1} . On the other hand N uptake by the plants treated with the town refuse was lowest and of about 104.4 g pot^{-1} , however this value is still far higher than that of the control which was about 57.3 mg pot^{-1} . Chicken litter manure occupied the second order after the biogas manure in its effect on N uptake whose value was 131.8 mg pot^{-1} whereas the poudratte resulted in lower N uptake of about 119.8 mg pot^{-1} . Thus, the organic manure can be arranged according to their effect on N uptake in the following descending order: BM > CM > PM > TR . These results are supported by those obtained by ***Montasser (1987) and Abd El-Kariem (1989)*** .

Considering the effect of type of the applied organic manure on concentration and uptake of N by the plants grown on the clayey soils , data in Table (21) indicate significant increases in N concentration in the plants grown on this soil, compared with N concentration in the control treatment which was 1.63% , the biogas manure treated plants were highest in N concentration , the chicken manure treated plants came thereafter then the poudratte treated plants and finally the town refuse treated ones . The values of N concentration in these plants were 2.94 , 2.89 , 2.66 and 2.17 mg pot^{-1} , respectively . In other words, the organic manures can be arranged according to their effect on N concentration in the plants grown on the clayey soil in the following descending order : BM > CM > PM > TR . This order of the organic manures according to their effect on N concentration in the plants grown on the clayey soil coincides with that already attained in the sandy soil . Evaluation of the organic manures according to their effect on N uptake by wheat plants grown on the clayey soil reveal that they can be arranged descendingly as follows : BM > CM > TR > PM . The values of N uptake were 224.6 , 186.4 , 151.4 and 148.1 mg pot^{-1} ,respectively . These values are far higher than that characterizing the control plant which did not exceed 80 mg pot^{-1} . It is worthy to mention that the order of the organic manures according to their effect on N uptake by the plants grown on the clayey soil differed somewhat from that attained due to their effect on N concentration where TR came in the third order in the first one but in the last order in the second one . Also, this pattern of arranging the organic manures according to their effect of N uptake by the plants grown in the clayey soil is different from that achieved in the sandy soil .

4.4.2.1.2 <u>Effect of mineral fertilizers :</u>

Results presented in Tables (20&21) illustrate that the mineral fertilizers increased N concentration in the wheat plants grown on both the sandy and clayey soils . It is obvious that the increase becomes more pronounced by increasing level of the applied fertilizers . At the first level of the mineral fertilizers L_1 that varieties depending on elemental composition and rate of the used organic manures , The N concentration in the plants grown on the clayey soil followed the order : CM > BM > PM > TR where the values obtained were 2.55 , 2.40 , 2.25 and 2.20, respectively . Increasing level of the applied mineral fertilizers to

L_2 was associated with a change in order of efficiency of the organic manure equivalent of the mineral fertilizers to be BM = CM < TR < PM . The order changed again upon rising level of the applied mineral fertilizers to L_3 to be CM > BM = TR > PM . such changes are likely to occur due to continuous changes in equilibrium between nutrients on the soil solid phase and its solution phase which in turn affects quantity of the nutrient available for plant uptake and consequently its concentration in plant . The uptake by the wheat plants grown on the sandy soil varied according to level of the applied mineral fertilizers . The more the level the higher the uptake .The different levels (L_1 , L_2 and L_3) varied in their effect on N uptake on their elemental composition and concentration that are equivalent to the elemenal composition and concentrations of the organic manures . At L_1 level , the following order was attained : CM (124.9 mg pot^{-1})> BM(118.8 mg pot^{-1}) > TR (105.8 mg pot^{-1}) >PM (90.4 mg pot^{-1}). At L_1 level, the order become BM (207.5 mg pot^{-1}) > TR (180.7 mg pot^{-1}) > CM (176.9 mg pot^{-1}) > PM (105.5 mg pot^{-1}) . Increasing level of the applied mineral fertilizers was associated with another change where the order became BM (245.6 mg pot^{-1}) > CM (243.7 mg pot^{-1})> TR (209.7 mg pot^{-1}) > PM (149.9 mg pot^{-1}) . These variations seem to be related as mentioned before to corresponding changes in the nitrogen equilibrium status in soil .

The nitrogen concentration in the plants grown on the sandy soil upon application of the first level of the mineral fertilizers took the order BM (2.25%) > CM (2.1%) > PM (2.0%) > TR (1.8%) , however, upon increasing level of the applied inorganic fertilizers into L_2 , the order became BM (2.6%) = CM (2.6%) > TR (2.1%) = PM (2.1%) . The increase of level of the appiled mineral fertilizers up to L_3 was accociated with the following order : CM (3.1%) > BM(2.9%) > TR (2.5%) PM (2.4%) . The N uptake by the plants grown on the sandy soil increased by increasing level of the applied mineral fertilizers, however, the increase within each level of application varied due to the elemental composition and concentration of the mineral fertilizers that represents the studied organic manure . In this concern, at the first level of the mineral fertilizers L_1 , the uptake of N followed the order : BM (103.1 mg pot^{-1}) > CM (87.8 mg pot^{-1}) > PM (76.2 mg pot^{-1}) > TR (72.5 mg pot^{-1}) .

At the second level of the mineral fertilizers L_2 , the uptake of N could be arranged descendingly in the order : BM (163.5 mg pot^{-1}) > CM (148.2 mg pot^{-1}) > TR (112.4 mg pot^{-1}) > PM (103.3 mg pot^{-1}) , when the soil was treated by the organic manures equivalent of the mineral fertilizers at its highest level of application (L_3) , the uptake of N become order :BM (223.3 mg pot^{-1}) > CM (204.6 mg pot^{-1}) > TR (168.8 mg pot^{-1}) > PM (126.1 mg pot^{-1}) .

In case of the plants grown on the clayey soil , N uptake increased from 118.8 to 207.5 then 245.6 mg pot^{-1} when level of the mineral fertilizers equivalent to the BM were applied in the levels L_1 , L_2 and L_3 . The corresponding N uptake achieved when the mineral fertilizers equivalent to CM were used were 124.9 , 176.9 and 243.7 mg pot^{-1} , respectively . In case of TR equivalent of the mineral fertilizers rising their level from L_1 to L_2 then L_3 resulted in N uptake having the values 105.8 to 180.7 then 209.7 mg pot^{-1} , respectively . The corresponding values achieved in case of applying the poudratte equivalents of the mineral fertilizers were 90.4 , 105.5 and 149.9 mg pot^{-1} , respectively .

The results reveal that the biogas manure equivalents of the mineral fertilizers gave higher values of N uptake by wheat plants grown on both sandy and clayey soils compared with those attained due to the other manures . Also , it can be observed that increasing level of the applied mineral fertilizers resulted in , generally , increase in N uptake .

4.4.2.1.3 Effect of the organic manures applied combination with the mineral fertilizers :

Data in Tables (20&21) show the effects of the different organic manures enriched with mineral fertilizers at different levels on concentration and uptake of N by the wheat plants grown on both the sandy and clayey soils . The most effective treatment on N concentration in the plants grown on the sandy soil is the biogas manure associated with its equivalent of the mineral fertilizers at the highest level (L_3) where the N concentration attained is 3.7% . On the other hand , the least effect attained on the N concentration in this soil was due to the poudratte manure associated with its equivalent of the mineral fertilizers at its lowest level of application L_1 ,where the N concentration did not exceed 2.2% .

In the clayey soil , the N concentration was highest in plants treated with biogas manure associated with its equivalent of the mineral fertilizers at its highest level (L_3) where its value was 3.61% . The town refuse associated with its equivalent of the mineral fertilizers at its lowest level (L_1) gave the lowest N concentration which is 2.31% .

Effect of the organic manures combined with different equivalents of the mineral fertilizers on N uptake was highest due to treating both soils with biogas manure combined with its equivalent of mineral fertilizers at its highest level of application L_3 where the values obtained were 514.3 and 530.7 mg pot^{-1} in the sandy and clayey soils , respectively . On the other hand,the lowest N uptake attained in the sandy soil , 134.6 mg pot^{1},was due to treating the soil with town refuse associated with its equivalent of mineral fertilizers at the lowest level L_1. The corresponding value 169.1 mg pot^{-1} attained in the clayey soil was due to fertilizing the soil with the poudratte manure combined with its equivalent of the mineral fertilizers at the lowest level L_1.

It is worthy to indicate that the plants grown on the soils treated with organic manures enriched with mineral fertilizers showed higher N concentration and uptake than the plants treated with either organic manures only or mineral fertilizers alone . Meanwhile , the biogas manure combined with the mineral fertilizers at the level L_3 showed the highest effect on both N concentration and uptake in both the studied soils . ***Abd El-Kariem (1989)*** went almost to similar results .

4.4.2.1.4 <u>Effect of the organic manures enriched with the mineral fertilizers and incubated outside the soil:</u>

Data presented in Tables (20 & 21) reveal that incubating the organic manures enriched with the mineral fertilizers outside the soil and their application resulted in an increase in N concentration from 1.4 and 1.63% in the control plants grown on the sandy and clayey soils , respectively to 2.3 and 2.52% in the plants grown on the sandy and clayey soils treated with already incubated BM and its equivalent of the mineral fertilizers (L_1). The corresponding N concentrations upon incubation with BM + L_2 raised to 2.7 and 2.85%, respectively . Increasing level of the mineral fertilizers applied together with the incubated BM increased N concentrations to 3.0 and 2.97% ,respectively . The already incubated town refuse when TR enriched with the mineral fertilizers at L_1 level resulted in N concentrations in the plants grown on the sandy and clayey soils to be 1.9 and 2.24% , respectively . These values become 2.2 and 2.83% when level of the associated mineral fertilizers was raised up to L_2

whereas increasing this level up to L_3 caused concentration of N in the plants grown on the sandy and clayey soils to be 2.7 and 2.92 %, respectively .

Treating the sandy and clayey soils with incubated CM combined with its equivalent of the mineral fertilizers L_1 increased N concentrations in the plants grown on both the soils to 2.6 and 2.74% , respectively . The corresponding values achieved due to treating soils with incubated CM + L_2 are 2.8 and 2.83% , respectively while the values achieved due to rising level of the associated mineral fertilizers to L_3 are 3.2 and 3.1% , respectively .

Treating the sandy and clayey soils with PM already incubated outside the soil with mineral fertilizers at a level of L_1 caused concentrations of N in the plants grown on these soils to be 2.1 and 2.31% , respectively . The corresponding values upon increasing level of the associated mineral fertilizers to L_2 were 2.3 and 2.4% , respectively raised up to 2.7 and 2.55% , respectively when level of the associated mineral fertilizers was raised to L_3 . It can be noticed that increasing level of the associated mineral fertilizers caused the N concentration of plants grown on the sandy and clayey soils to increase i.e. the highest N concentrations were achieved at the highest level of the applied mineral fertilizers (L_3) in case of treating the soil with chicken litter manure .

Uptake of N increased due to treating the sandy soil with already incubated BM + mineral fertilizers at a level of L_1 to 140.8 mg pot-^{1} , raisede by increasing level of the associated mineral fertilizers to 224.1 mg pot-^{1}and achieved 252.1 mg pot^{-1} by further increase in level of associated mineral fertilizers into L_3 . The values of N uptake when the TR was incubated outside the soil and combined with the mineral fertilizers at the

Table (20) N, P and K uptake and concentration by Wheat plants grown on Sandy Soil as affected by organic residues and mineral fertilizers .

Treatments	Concentration (%)			Uptake (mg pot-1)			Treatments	Concentration (%)			Uptake (mg pot-1)		
	N	P	K	N	P	K		N	P	K	N	P	K
Control	1.40.	0.13	1.80.	57.3	5.40.	74.1							
L1	2.25	0.28	1.30.	103.10.	12.80.	59.5	L1	2.10.	0.20.	1.90.	87.80	8.30	76.90
L2	2.60.	0.34	1.60.	163.50.	21.4	105.6	L2	2.60.	0.33	2.00.	148.20	18.80.	114.00
L3	2.90.	0.44	1.70.	223.3	33.5	133.2	L3	3.10.	0.48	2.10.	204.60.	31.70.	138.60
Biogas manure	2.50.	0.31	2.50.	133.00.	16.30.	137.2	Chicken litter manure	2.50.	0.27	2.80.	131.8	14.4	148.9
B.M + L1	2.60.	0.35	2.70.	188.0.	24.7	190.8	C L M + L1	2.60.	0.45	2.40.	164.0.	28.0.	148.5
B.M + L2	2.90.	0.46	2.70.	307.2	48.0.	289.4	C L M + L2	2.90.	0.52	2.60.	274.0.	48.3	244.4
B.M +L3	3.70.	0.80.	2.80.	514.30.	111.2	389.20.	C L M +L3	3.30.	0.56	2.70.	322.9	54.0.	259.50.
B.M incubated with L1	2.30.	0.30.	2.30.	140.8	18.1	142.6	C L M incubated with L1	2.60.	0.27	2.60.	134.4	14.0.	135.9
B.M incubated withL2	2.70.	0.40.	2.40.	224.1	34.1	194.8	C L M incubated with L2	2.80.	0.40.	2.10.	238.7	34.0.	171.3
B.M incubated with L3	3.00.	0.52	2.50.	252.1	57.6	208.70.	C L M incubated with L3	3.20.	0.50.	2.20.	272.00.	42.50.	189.50
mean	2.83	0.40.	2.27	224.90.	37.80.	185.10.	mean	2.72	0.39	2.32	197.9	29.50.	162.80.
L1	1.80.	0.18	2.30.	72.50.	7.25	92.70.	L1	2.00..	0.13	1.80.	76.20.	4.70.	70.1
L2	2.10.	0.20.	2.40.	112.40.	10.70.	128.40.	L2	2.10.	0.17	1.80.	103.3	8.10.	87.3
L3	2.50.	0.28.	2.60.	168.80.	18.90.	175.50.	L3	2.40.	0.25	1.90.	126.1	13.0.	97.50.
Town refuse	2.00.	0.15	2.30.	104.4	9.00.	120.10.	Poudratte manure	2.30.	0.16	2.10.	119.8	8.40.	108.2
T.R + L1	2.40.	0.20.	2.30.	134.6	10.9	128.80.	P.M +L1	2.20.	0.19	2.00..	147.9	12.3	132.4
T.R + L2	2.50.	0.29	2.40.	194.2	21.9	185.2	P.M +L2	2.50.	0.20.	2.10.	196	16.0.	162.10
T.R + L3	2.90.	0.33	2.40.	275.1	31.2	230.7	P.M + L3	2.80.	0.30.	2.20.	240.8	25.4	186.00
T.R incubated with L1	1.90.	0.19	2.10.	95.00.	9.50.	105.00.	P.M incubated with L1	2.10.	0.17	1.90.	121.80	9.90.	110.20
T.R incubated with L2	2.20.	0.21	2.40.	146.30.	14.00.	159.60.	P.M incubated with L2	2.30.	0.18	1.95	162.10	12.70	137.50
T.R incubated with L3	2.70.	0.30.	2.40.	225.40.	25.00.	200.40.	P.M incubated with L3	2.70.	0.26	2.00.	213.00	20.50	158.5
mean	2.34	0.23	2.36	152.90.	15.80.	152.60.	mean	2.28	0.20.	1.93	154.70.	13.10	125.10

L1,L2 and L3= mineral levels equivalent to organic sources

Table (21) N, P and K concentration and uptake by Wheat plants grown on clayey soil as affected by organic residues and mineral fertilizers .

Treatments	Concentration (%)			Uptake (mg pot-1)			Treatments	Concentration (%)			Uptake (mg pot-1)		
	N	P	K	N	P	K		N	P	K	N	P	K
Control	1.63	0.14	2.70.	79.30.	9.49	131.5							
L1	2.40.	0.23	2.82	118.8	11.4	139.6	L1	2.55	0.21	2.40.	124.9	10.5	117.6
L2	2.8	0.26	2.13	207.5	18.9	157.8	L2	2.80.	0.30.	2.57	176.9	19.1	163.1
L3	2.9	0.40.	2.58	245.6	33.9	218.5	L3	2.94	0.37	2.6	243.7	30.7	215.5
Biogas manure	2.94	0.53	2.45	224.6	40.5	178.8	Chicken litter manure	2.89	0.49	2.87	186.4	32.2	185.1
B.M + L1	3.10.	0.37	2.97	238.7	28.7	228.7	C L M + L1	2.40.	0.32	2.72	173.5	23.5	195.8
B.M + L2	3.30.	0.44	3.22	359.7	48	351.0.	C L M + L2	2.97	0.37	2.81	296.1	36.9	280.1
B.M +L3	3.61	0.49	3.62	530.7	72	532.1	C L M +L3	3.15	0.40.	2.95	412.7	52.4	386.5
B.M incubated with L1	2.52	0.36	2.77	167.6	23.9	184.2	C L M incubated with L1	2.74	0.29	2.50.	187.4	19.8	171.0.
B.M incubated withL2	2.85	0.41	2.81	252.5	36.3	249	C L M incubated with L2	2.83	0.32	2.86	240.5	27.2	243.1
B.M incubated with L3	2.97	0.43	2.88	271.4	39.3	263.2	C L M incubated with L3	3.10.	0.37	2.9	274.4	32.7	256.7
mean	2.98	0.40.	2.78	261.7	35.7	250.3	mean	2.84	0.34	2.62	231.7	28.5	221.4
L1	2.20.	0.21	2.36	105.8	10.1	113.5	L1	2.25	0.18	2.30.	90.4	7.1	92.4
L2	2.78	0.24	2.40.	180.7	15.6	156	L2	2.46	0.22	2.40.	105.5	11.0.	119.8
L3	2.90.	0.30.	2.70.	209.7	21.7	195.2	L3	2.52	0.30.	2.50.	149.9	17.9	123.7
Town refuse	2.17	0.16	1.62	151.4	11.30.	113.1	poudrate manure	2.66	0.24	2.11	148.1	13.7	117.5
T.R + L1	2.31	0.25	2.40.	173.9	18.8	180.7	P.M +L1	2.57	0.26	2.61	169.1	17.2	171.7
T.R + L2	2.89	0.31	2.37	273.9	29.4	224.6	P.M +L2	2.76	0.33	2.77	221.1	26.5	221.8
T.R + L3	2.99	0.38	2.78	388.1	49.3	360.8	P.M + L3	2.80.	0.37	2.80.	259	34.2	259
T.R incubated with L1	2.24	0.22	2.45	154.6	15.2	169	P.M incubated with L1	2.31	0.20.	2.63	135.4	11.7	154.1
T.R incubated with L2	2.83	0.25	2.48	232.1	20.5	203.4	P.M incubated with L2	2.49	0.23	2.65	192.7	20.6	205.1
T.R incubated with L3	2.92	0.36	2.75	271.6	33.5	255.8	P.M incubated with L3	2.55	0.32	2.68	206.8	25.9	217.3
mean	2.62	0.27	2.43	214.2	22.5	185.9	mean	2.53	0.26	2.53	167.8	18.6	168.3

levels L_1 , L_2 and L_3 were 95.0 , 146.3 and 225.4 mg pot-^{1} , respectively. The corresponding values achieved when CM was associated with the mineral fertilizers at the levels of L_1 , L_2 and L_3 were 134.4 , 238.7 and 272.0 mg pot-^{1} , respectively . In case of the PM , the corresponding values of N uptake were 121.8 , 162.1 and 213.0 mg pot-^{1} , respectively .

Uptake of N by the plants grown on the clayey soils increased due to rising level of the mineral fertilizers equivalent to the studied organic manures from L_1 to L_2 then L_3 . In case of the BM incubated outside the soil combined with mineral fertilizers , the values achieved were 167.6 to 252.5 then 271.4 mg pot^1 . The corresponding values in case of the TR were 154.6 , 232.1 and 271.6 mg pot^1 , respectively , while those achieved in case of the CM were 187.4 , 240.5 and 274.4 mg pot^1, respectively corresponding to 135.4 , 192.7 and 206.8 mg pot^1 , respectively in case of the PM .

The results reveal that the incubated CM when associated with mineral fertilizers gave higher values for both N concentration and uptake compared with those attained due to the other incubated manures when associated with the mineral fertilizers . Also , it can be observed that increasing level of the applied mineral fertilizers resulted , generally ,in an increase in both concentration and uptake .

4.4.2.2 Effect on phosphorous :

4.4.2.2.1 Effect of organic manures :

Data presented in Tables (20 & 21) show the effect of organic manures on both concentration and uptake of P by the plants grown on both the sandy and clayey soils . Concentration of P increased from 0.13% in the plants grown on the untreated sandy soil (control treatment) to 0.31, 0.27 , 0.16 and 0.15 in the plants treated with the biogas manures chicken litter manure , poudratte manure and town refuse , respectively . In the clayey soil , P concentration in the plants grown thereon increased from 0.14% to 0.53% , 0.49% , 0.24% and 0.16% due to treating the soil with biogas manure chicken litter manure , poudratte and town refuse , respectively . These results agree with those of ***Holanda et al. (1984)*** and ***Mahmoud (1996)*** who found that P-concentration in ryegrass plants increased as a result of application of poudratte and town refuse manures. Uptake of P by the plants grown on the sandy soil increased from 5.40 mg pot^{-1} in the control treatment to 16.3 , 14.4 , 8.4 and 9.0 mg pot^{-1} in the plants manured with the biogas manure , chicken litter manure , poudratte and town refuse , respectively . In the clayey soil, P uptake increaed from 9.49 mg pot^{-1} in the untreated plants to 40.5 , 32.2 , 13.7 and 11.3 mg pot^{1} by the plants treated with the biogas manure , chicken litter manure, poudratte and town refuse , respectively . Thus taking into consideration the effect of the studied organic manures on both concentration and uptake of P , the results indicate genelally to the superiority of the biogas manure as followed by the chicken litter manure over the other studied organic manures .

4.4.2.2.2 <u>Effect of the mineral fertilizers :</u>

Data in Tables (20 & 21) reveal that application of the mineral fertilizers increased P concentration as well as its uptake by the plants grown on both the sandy and clayey soils . The increase seemed more obvious by increasing level of the applied fertilizer where the highest values attained at the higheat level of application of the mineral fertilizers (L_3) .In the plants grown on the sandy soil, P concentration raised from 0.28 to 0.34 then 0.44% when level of the mineral fertilizers equivalent to the biogas manure was increased from L_1 to L_2 then L_3. the corresponding

P concentrations in case of the mineral fertilizers equivalent to the chicken litter manure were 0.20 , 0.33 and 0.45% respectively . In case of applying mineral fertilizers equivalent to the town refuse, the correspanding P concentrations were 0.18 , 0.20 and 0.28% , respectively whereas the corresponding values in case of the applying mineral fertilizers equivalent to poudratte were 0.13 , 0.17 and 0.25% , respectively . These values indicate that the chicken litter manure equivalent mineral fertilizers seemed to be of the highest effect on P concentration whereas that of the poudratte manure seemed to be of the lowest effect on P concentration in plants grown on the sandy soil . In the clayey soil P concentrations in the plants treated with the biogas manure , chicken litter manure , town refuse or poudratte equivalent mineral fertilizers achieved the highest values at the highest level of application of the mineral fertilizers i.e. L_3 where these concentration were 0.40 , 0.37 , 0.30 and 0.30, respectively . The biogas manure equivalent of the mineral fertilizer showed the highest effect on P concentration in the wheat plants grown on the clayey soil whereas the lowest effect was shown by both the town refuse and poudratte equivalent mineral fertilizers .

Uptake of P achieved the highest values in the sandy soil 33.5 mg pot^{-1} when the soil was treated by the biogas manure equivalent of mineral fertilizers at its highest level of application (L_3) whereas the lowest value 4.7 mg pot^{-1} was attained upon treating the sandy soil with poudratte equivalent of the mineral fertilizers .

Regarding effect the organic manures equivalents of the mineral fertilizers on P concentration in the plants grown on the clayey soil data in Table (21) reveal that biogas manure equivalent of the mineral fertilizers at its highest level of application (L_3) resulted in the highest P concentration

(0.40%) whereas the lowest P concentration (0.18%) was produced due to treating the clayey soil with the lowest level (L_1) of the poudratte equivalent of the mineral fertilizers . The P uptake was also higheat 33.9 mg pot^{-1} where P concentration was highest and lowest 7.1 mg pot^{-1} where P concentration was at its lowest value . The results indicate generally that the inducing effect on P concentration and uptake was increased in both the investigated soils by increasing level of the applied mineral fertilizers . These results agree well with those of ***Ward et al. (1975)*** .

4.4.2.2.3 Effect of the organic manures applied together with the mineral fertilizers :

Tables (20 & 21) show the effects of the different organic manures enriched with mineral fertilizers at different levels on concentration and uptake of P by the wheat plants grown on both the sandy and the clayey soils . The best treatment on P concentration in the plants grown on the sandy soil is the biogas manure associated with its equivalent of the mineral fertilizers at the highest level (L_3) where the P concentration attained is 0.80% . On the other hand , the least effect attained on the P concentration in this soil was due to the poudratte associated with its equivalent of the mineral fertilizers at its lowest level of application L_1 where the P concentration did not exceed 0.30% .

In the clayey soil , the P concentration was highest in plants treated with biogas manure associated with its equivalent of the mineral fertilizers at its highest level (L_3) where its value was 0.49% . The town refuse associated with its equivalent of the mineral fertilizers at its lowest level (L_1) gave the lowest P concentration which is 0.25% .

Effect of the organic manures combined with different equivalents of the mineral fertilizers on P uptake seemed to be compatible with their effect on P concentration i.e. the P uptake was highest due to treating both the soils with biogas manure combined with its equivalent of mineral fertilizers at its highest level of application L_3 where the values obtained were 111.2 and 72.0 mg pot^{-1} in the sandy and clayey soils , respectively . On the ather hand , the lowest P uptake attained in the sandy soil 10.9 mg pot^{-1} was due to treating the soil with the town refuse associated with its equivalent of mineral fertilizers at lowest level L_1. The corresponding value 17.2 mg pot^{-1} attained in the clayey soil was due to fertilizing the soil with the poudratte combined with its equivalent of the mineral fertilizers at the lowest level L_1 .

It is worthy to indicate that the plants grown on the soils treated with organic manures enriched with mineral fertilizers showed higher P concentration and uptake than the plants treated with either organic manures only or mineral fertilizers alone . Meanwhile , the biogas manure combined with the mineral fertilizers at the level L_3 showed the highest effect on both P concentration and uptake in both the studied soils .

4.4.2.2.4 Effect of the organic manures already incubated outside the soils combined with the mineral fertilizers :

The incubation of the organic manures outside the soil and their application with the mineral fertilizers to the investigated soil although increased both P concentration and uptake by the wheat plants grown on both the soils yet the increase seemed more lower when compared with that occurred due to direct application of the mineral fertilizers together with organic manures . However, the biogas manure incubated out the soil combined with its equivalent of the mineral fertilizers at its highest level L_3 resulted in the highest P concentration and uptake in the sandy and clayey soils where the concentration values were 0.52 and 0.43% , respectively whereas the uptake values were 57.6 and 39.3 mg pot^{-1} ,respectively .

4.4.2.3 Effect on potassium

4.4.2.3.1 Effect of type of organic manure :

Data presented in Tables (20 & 21) reveal that application of the different tested organic manures , generally , resulted in increase in both concentration and uptake of K by the wheat plants in both the sandy and the clayey soils . In the sandy soil, the effect seemed higher upon utilization of the chicken manure where K concentration in the wheat plants was 2.8% . On the other hand the poudratte resulted in the lowest K concentration in the plants grown on the sandy soil since its value was 2.1% , however, this value is still higher than that of the control plants which was 1.8% only .

K uptake by the plants grown on the sandy soil was affected by organic manures in a way similar to that by which the K concentration was affected i.e. the chicken manure resulted in the highest K uptake which is 148.9 mg pot^{-1} whereas the poudratte resulted in the lowest uptake which was 108.2 mg pot^{-1} . Concentration of K in the plants grown on the clayey soil was highest upon treating the soil with chicken litter manure where its was 2.87%, however, relatively lower K concentration , 2.45 %, was shown by the plants grown on the soil treated with the biogas manure whereas the town refuse resulted in the lowest K concentration in the plants grown on the clayey soil which was only 1.62 % . Values of K uptake by the plants grown on the clayey soil were 185.1 , 178.8 , 117.5 and 113.1 mg pot^{-1} up trenting the soil with the chicken litter manure , biogas manure, poudratte and town refuse , respectively .The positive effect of the organic manures on concentration and uptake of K by plants was reported by many investigators such as ***Holanda et al. (1984)*** and ***Fawzy (1993)*** .

4.4.2.3.2 Effect of the mineral fertilizers

Data in Tables (20 & 21) reveal that except for the BM application of the mineral fertilizers at any level of their application increased concentration and uptake of K by the plants grown on the sandy soil. The increase seemed dependent on level of application i.e. the higher the level the higher concentration and uptake . Comparison among the different treatments reveals that the town refuse equivalent of the mineral fertilizers at its highest level of application (L_3) resulted in the highest K concentration in the plants grown on the sandy soil (2.6%) . On the other hand, the biogas manure equivalent of the mineral fertilizers resulted in the lowest K concentration in the plants grown on the sandy soil (1.3%) which is lower than K concentration of the control plant . The K uptake also was highest in the plants treated with the town refuse equivalent of the mineral fertilizer at its highest level L_3 (175.5 mg pot^{-1}) whereas the lowest K uptake was recorded by the plants treated with biogas manure equivalent of the mineral fertilizers at its lowest level of application (L_1), 59.5 mg pot^{1} which is lower than the K concentration in the control plant . Application of the mineral fertilizers to the clayey soil adversely affected K concentration in the plants grown on the clayey soil . This was true for all the organic manures equivalents of the mineral fertilizers except for that of the biogas manure equivalent to its lowest level i.e. L_1 . On the other hand, K uptake by the plants grown on clayey soil was affected positively due to treating soil with the mineral fertilizers . The effect seemed highest in the plants treated with the boigas manure equivalent to the mineral fertilizers at its highest level of application L_3 where K uptake was 218.5 mg pot^{-1}

whereas the lowest effect was due to the lowest level L_1 of poudratte equivalent of the mineral fertilizers where K uptake was only92.4 mg pot^{-1}. The K uptake values may explain the low K concentration values on basis of the dilution effect that is due to the increase in dry matter yield of the wheat plants .

4.4.2.3.3 Effect of organic manures applied combined with mineral fertilizers :

The combinations between the different organic manures and mineral fertilizers exerted a pronounced effect on both K concentration and uptake by the wheat plants grown on both the sandy and clayey soils . The combination between the biogas manures and its equivalent of the mineral fertilizers at its highest level (L_3) resulted in the highest K concentrations in the plants grown on both the soils which were 2.08 and 3.62% , respectively . The K uptake values corresponding the highest K concentrations were also highest i.e. The biogas manure combined with the mineral fertilizers at the level L_3 resulted in the highest K uptake whose values were 389.2 and 532.1 mg pot $^{-1}$ in the sandy and clayey soils, respectively . ***Heggi et al. (1992)*** went almost to similar results .

4.4.2.3.4 Effect of combination on between the organic manures incubated outside the soil and the mineral fertilizers :

Data presented in Tables (20 & 21) reveal that incubating the organic manures outside the soil and their application together with the mineral fertilizers resulted in increase in K concentration from 1.8% and 2.70% in the control plants grown on the sandy and clayey soils , respectively to 2.3% and 2.77% in the plants grown on the sandy and clayey soils treated with already incubated BM and its equivalent of the mineral fertilizers (L_1) . The corresponding K concentrations upon incubation with BM + L_2 raised to 2.4% and 2.81%, respectively . Increasing level of the mineral fertilizers applied together with the incubated BM increased K concentrations to 2.5 and 2.88% , respectively .

Treating the sandy and clayey soils with incubated CM combined with its equivalent of the mineral fertilizers L_1 increased K concentrations in the plants grown on both the soils to 2.60 and 2.5% , respectively . The corresponding values achieved due to treating soils with incubated CM + L_2 are 2.1 and 2.86% , respectively while the values achieved due to raising level of the associated mineral fertilizers to L_3 are 2.20 and 2.90% , respectively . The already incubated town refuse when TR enriched with the mineral fertilizers at L_1 level resulted in K concentrations in the plants grown on the sandy and clayey soils to be 2.1 and 2.45% , respectively . These values become 2.4 and 2.48% when level of the associated mineral fertilizers was raised up to L_2 whereas increasing this level up to L_3 caused concentration of K in the plants grown on the sandy and clayey soils to be 2.4 and 2.75 % , respectively .

Treating the sandy and clayey soils with PM already incubated outside the soil with mineral fertilizers at a level of L_1 caused concentrations of K in the plants grown on these soils to be 1.9 and 2.63%, respectively . The corresponding values upon increasing level of the associated mineral fertilizers to L_2 were 1.95 and 2.65% , respectively raised up to 2.0 and 2.68% , respectively when level of the associated mineral fertilizers was raised to L_3 . It can be noticed that increasing level of the associated mineral fertilizers caused the K concentration of plants grown on the sandy soil to increase i.e. the highest K concentrations were achieved at the highest level of the applied mineral fertilizers (L_3) in case of treating the soil with biogas manure (BM) , town refuse (TR) or poudratte incubated outside the soil . On the other hand increasing level of the mineral fertilizers up to L_3 was associated with decrease in K concentration in case of treating the sandy soil with chicken litter manure.

In the clayey soil , it was found, generally , that the higher the level of associated applied mineral fertilizers , the higher the concentration of K in the plants grown thereon . Worthwhile to indicate that the chicken manure incubated outside the soil associated with its equivalent of the mineral fertilizers L_1 resulted in the highest K concentration in the plants grown on the sandy soil whereas the biogas manure associated with the its equivalent of the mineral fertilizers at the level L_3 resulted in the highest K concentration in the plants grown on the clayey soils .

Uptake of K increased due to treating the sandy soil with already incubated BM + mineral fertilizers at a level of L_1 to 142.6 mg pot-^{1} , raisede by increasing level of the associated mineral fertilizers to 194.8 mg pot-^{1}and achieved 208.7 mg pot-^{1} by further increase in level of associated mineral fertilizers into L_3 . The corresponding values achieved when CM was associated with the mineral fertilizers at the levels of L_1 , L_2 and L_3 were 135.9 , 171.3 and 189.5 mg pot-^{1} , respectively . The values of K uptake when the TR was incubated outside the soil and combined with the mineral fertilizers at the levels L_1 , L_2 and L_3 were 105.0 , 159.6 and 200.4 mg pot-^{1} , respectively . In case of the PM , the corresponding values of K uptake were 110.2 , 137.5 and 158.5 mg pot-^{1} , respectively .

The results reveal that the incubated BM when associated with mineral fertilizers gave higher values for both K concentration and uptake compared with those attained due to the other incubated manures when associated with the mineral fertilizers . Also , it can be observed that increasing level of the applied mineral fertilizers resulted in , generally , increase in both concentration and uptake .

From the abovementioned results, it can be said that application of organic manures alone or combined with mineral nutrient sources increased, generally, N, P and K concentration and uptake by wheat plants grown on sandy and clayey soils . The increase in nutrient uptake may be due to one or more of the following reasons namely : (1) The high content of these nutrients in organic residues compared with untreated soils, (2) increasing CEC of the treated soils through organic manure additions and (3)the improvement of soil structure which is reflected on water movement and decreasing nutrient losses by leaching and deep percolation.

4.4.3 <u>Effect on micronutrients concentration and uptake by wheat plants :</u>

concentration and uptake of some micronutrients i.e. Fe , Mn , Zn and Cu were studied due to treating the studied sandy and clayey soils with the invesigated organic manures whether applied solely or in comibination with mineral fertilizers . The influences of the different fertilization treatments under study on concentration and uptake of the above mentioned nutrients will be clarified under the following headings :

4.4.3.1 Effect on iron

4..4.3.1.1 Effect of type of the organic manure :

Data shown in Tables (22 & 23) reveal that manuring raised concentration and uptake of the iron by the plants grown on sandy and clayey soils . Concentration of Fe increased from 205 ppm in the control plants to 931.8 , 822.0 , 696.0 and 627.5 ppm upon treating the sandy soil with the BM , CM , TR and PM, respectively . The Fe concentration in the plants grown on the clayey soils raised from 232 ppm in the control plants to 1003.7 , 615.5 , 677.5 and 725 ppm in the plants grown on the clayey soil treated with the BM , CM , TR , and PM , respectively .

Values of Fe uptake by the plants grown on the sandy soil increased from 0.82 mg pot^{-1} by the control plants to 4.96 , 2.26 , 3.63 and 3.18 mg pot^{-1} in the plants treated with BM , CM , TR , and PM , respectively . In the clayey soil the Fe uptake increased from 1.12 mg pot^{-1} by the untreated plants to 7.32 , 3.96 , 4.13 and 4.03 mg pot^{-1} by the plants treated with BM , CM , TR , and PM , respectively .

Both values of Fe concentration and uptake indicate to the superiority of the BM compared with the other organic manures. Several investigators went to similar results ***Fahmy, (1995)*** , ***Abd El-Hamied (1996) and Tadross (1997).*** Such increases in Fe concentration and consequently its uptake by the plants can be attributed to the high content of Fe in the used organic manures (Table2) .

4.4.3.1.2 <u>Effect of the mineral fertilizers :</u>

The mineral fertilization which included ferrous sulfate resulted in obviouns increase in both concentration and uptake of Fe by the wheat plants grown on both the studied soils . Increasing level of the applied mineral fertilizers from L_1 to L_2 then L_3 was associated with increases in Fe concentration in the plants grown on the sandy soil from 740 to 1030 then 1140 ppm, respectively in case of using a mixture of the mineral fertilizers equivalent to its elemental composition and concentration of Fe to BM . Using the mineral fertilizers equivalent to the CM increased Fe concentration from 560 to 637 then 920. ppm upon raising level of these mineral fertilizers from L_1 to L_2 then L_3. The corresponding Fe concentrations upon using the TR equivalent of the mineral fertilizers were

580.6 , 853.7 and 970 ppm, respectively where the values achieved due to using the PM were 540.0 , 666.2 and 1243.7 ppm, respectively .

In case of the plants grown on the clayey soil , Fe concentration increased from 851.2 to 960 then 1050 ppm when level of the mineral fertilizers equivalent to the BM were applied in the levels L_1 , L_2 and L_3. The corresponding Fe concentrations achieved when the mineral fertilizers equivalent to CM were used were 510 , 800 and 1061 ppm, respectively . In case of the TR equivalent of the mineral fertilizers , rising their level from L_1 to L_2 then L_3 resulted in Fe concentrations having the values 560 to 843.7 then 993.1 ppm, respectively . The corresponding values achieved in case of applying the poudratte equivalents of the mineral fertilizers were 532.5 , 777.5 and 982.5 ppm, respectively . Such reported increases in Fe concentration were reflected on plants uptake of Fe. In case of the BM equivalent of the mineral fertilizers , Fe uptake by the plants grown on the sandy soil increased from 3.39 to 6.48 then 8.78 mg pot-^{1} upon rising level of the appplied mineral fertilizers from L_1 to L_2 then L_3. The corresponding Fe uptake values reported in case of the CM were 2.73 , 4.51 and 7.66 mg pot-^{1} , the values reported in case of TR were 2.33 , 5.66 and 6.54 mg pot^{1} , respectively and those reported in case of PM were 2.05 , 2.23 and 6.38 mg pot^{-1} ,respectively .

Uptake of Fe by the plants grown on the clayey soils increased due to rising level of the mineral fertilizers equivalent to the studied organic manures from L_1 to L_2 then L_3 . In case of the BM , the values achieved were 3.87 to 7.11 and then 8.89 mg pot^{1} . The corresponding values in case of the CM were 2.49 , 5.06 and 8.79 mg pot^{1} , respectively , while those achieved in case of the TR were 2.69 , 5.48 and 7.18 mg pot^{1}, respectively corresponding to 2.14 , 3.33 and 4.86 mg pot^{1} , respectively in case of the PM . Thus it can be concluded that the inducing effect of the mineral fertilizers although varied according to the organic manure they represent, yet it was consistently increased by increasing level of the mineral fertilization in both soils . These findings agrees well with that reported by ***Abd El-Haleem (1991) and Farid (1995)*** who found that the Fe application increase both concentration and uptake of Fe by plants .

4.4.3.1.3 Effect of the organic manures mixed with the mineral fertilizers :

The comparison among the values of both Fe concentration and uptake obtained due to organic manuring combined with application of the mineral fertilizers and the other fertilization treatments occurred herein, reveal that the combinations between any of the organic manures and mineral fertilizers were more effective on both Fe concentration and uptake.This finding can be clarified by the data presented in Tables (22&23). The combination between the BM and the first level of the mineral fertilizers increased Fe concentration from 205 and 232 ppm in the plants grown on the sandy and clayey soils , respectively to 986.2 and 976.7 ppm , respectively . Increasing the level of the mineral fertilizers to L_2 was associated with increases in Fe concentration to 1115 and 1016 ppm, respectively while the further increase in level of the fertilizers to L_3 resulted in Fe concentration in the plants grown on the sandy and clayey soils of abont 1234 and 1205 ppm ,respectively . In case of the combination between CM and the mineral fertilizers , Fe concentration in the plants grown on the sandy soil raised from 766.2 to 840 then 1303.4 ppm while that of the plants grown on the clayey soil raised from 760 to 830 then 1192.5 ppm ,respectively upon increasing level of the mineral fertilizers from L_1 to L_2 then L_3 . In case of the TR Fe concentrations in the plants grown on the sandy soil were 733.7 , 862.5 and 1464.3 ppm , respectively whereas the Fe concentrations in those grown on the clayey soil were 643.8 , 903 and 1120 ppm , respectively . Concentrations of Fe in the plants grown on the sandy soil and fertilized with the PM combined with the mineral fertilizers at L_1 , L_2 then L_3 levels were 666.5 , 713.7 and 1302 ppm ,respectively corresponding to 846.9 , 1020 and 1217.5 ppm in the plants grown on the clayey soil .

The above mentioned results indicate that increasing level of the mineral fertilizers that associated the organic manures resulted increase in concentration of Fe in the plants grown on both the investigated soils, however, the magnitude of increase seemed to be dependent not only on level of the applied mineral fertilizers but also on type of the organic manure and also type of the soil to which the fertilizers are added .

Fe uptake which is a final product of its concentration and the dry matter yield of the plant showed values varying according to type of the organic manure ,type of soil and level of the applied mineral fertilizers . The values of Fe uptake shown by the plants grown on the sandy soil and received the biogas manure combined with mineral fertilizers at the levels L_1 , L_2 and L_3 were 6.97 , 11.6 and 17.3 mg pot^1 ,respectively . The corresponding Fe uptake values recorded by the plants grown on the clayey soil were 7.52 , 11.1 and 15.1 mg pot^1 , respectively . In case of CM combined with mineral fertilizers , values of Fe uptake by the plants grown on the sandy soil were 4.74 , 7.77 and 12.5 mg pot^1 ,respectively corresponding to 5.47 , 8.27 and 15.6 mg pot^1 by the plants grown on the clayey soil . Rising level of the mineral fertilizers combined with the TR from L_1 to L_2 then L_3 caused Fe uptake by the plants grown on the sandy soil to increase from 4.11 to 6.51 then 13.8 mg pot^1 ,respectively. The corresponding values achieved by the plants grown on the clayey soil were 4.84 , 8.56 and 14.5 mg pot^{1} , respectively . The same mineral fertilization treatments combined with the PM caused the Fe uptake by the plants grown on the sandy soil to be 4.30 , 5.51 and 11.0 mg pot^{1} ,respectively . The corresponding Fe uptake values by the plants grown on the clayey soil were 5.57 , 8.17 and 11.3 mg pot^{1} ,respectively .

4.4.3.1.4 Effect of the alreadv incubated outside the soils organic manures combined with the mineral fertilizers :

Data in Tables (22 & 23) reveal that the application of already in cubated organic manures outside the soils together with the studied level of the mineral fertilizers although increased both Fe concentration and uptake by the treated plants compared with the untreated ones, yet the values obtained are generally lower than those obtained due to the corresponding treatments without incubation of the organic manures .

Fe concentrations in the plants grown on the sandy and clayey soils and treated with the mineral fertilizers at the levels L_1 , L_2 then L_3 were :

In case of association with the BM : 748.2 , 1100 and 1230 ppm in the plants grown on the sandy soil and 855 , 970 and 980 ppm in the plants grown on the clayey soil .

In case of association with the CM : 567.5 , 639.7 and 923.7 ppm , respectively in the plants grown on the sandy soil, corresponding to 750 , 806.3 and 1147.5 ppm, in the plants grown on the clayey soil .

In case of association with the TR : 662.5 , 862.0 and 985.7 ppm, respectively in the plants grown on the sandy soil corresponding to 636 , 847.5 and 1052 ppm in the plants grown on the clayey soil .

Table (22) Fe and Mn concentration and uptake by Wheat plants grown on sandy soil as affected by organic residues and mineral fertilizers .

Treatments	Concentration		Uptake		Treatments	Concentration		Uptake	
	Fe ppm	Mn ppm	Fe mg pot-1	Mn ug pot-1		Fe ppm	Mn ppm	Fe mg pot-1	Mn ug pot-1
Control	205	22.7	0.82	91.0.					
L1	740.0.	42.6	3.39	195.1	L1	560	55.1	2.73	222.1
L2	1030	61.0.	6.48	383.6	L2	637	61.2	4.51	348
L3	1140	70	8.78	539	L3	920.0.	70.6	7.66	452
Blogas manure	931.8	33.7	4.96	179.3	Chicken litter manure	822	56.8	2.26	295.1
B.M + L1	986.2	60.7	6.97	429.1	C L M + L1	766.2	66.9	4.74	413.9
B.M + L2	1115	69.5	11.6	717.6	C L M + L2	840	70.8	7.77	655.6
B.M +L3	1243	92	17.3	1278.8	C L M +L3	1303.4	103.7	12.5	997
B.M Incubated with L1	748.2	59.4	4.50.	357.4	C L M Incubated with L1	567.5	61.9	2.93	319.8
B.M Incubated withL2	1100	69.4	8.93	563.2	C L M Incubated with L2	639.7	65.6	5.32	545.9
B.M Incubated with L3	1230	87	10.2	726.5	C L M Incubated with L3	923.7	74.4	7.85	632.1
mean	1026	70.8	8.31	537.0.	mean	798.0.	68.7	5.60.	489.2
L1	580.6	36.9	2.33	148.7	L1	540.0.	52.5	2.05	198.9
L2	853.7	60.6	5.66	401.9	L2	666.2	65.1	2.23	315.8
L3	970	106	6.54	567.1	L3	1243.7	79.3	6.38	406.6
Town refuse	696.2	72.5	3.63	378.5	Poudrate manure	627.5	48.7	3.18	247.6
T.R + L1	733.7	81.9	4.11	459.5	P.M +L1	666.5	69.1	4.3	446.5
T.R + L2	862.5	96.2	6.51	727.3	P.M +L2	713.7	78.2	5.51	604.1
T.R + L3	1464.3	132.5	13.8	1248	P.M + L3	1302	91.2	11.0.	771.1
T.R Incubated with L1	662.5	50	3.31	250	P.M Incubated with L1	490	60.6	2.84	351.5
T.R Incubated with L2	862.0	69.4	5.73	461.5	P.M Incubated with L2	700.3	74.4	4.93	524.3
T.R Incubated with L3	985.7	114.4	6.69	776.5	P.M Incubated with L3	1025.1	90	8.08	710.1
mean	890.7	82	5.83	541.5	mean	797.5	70.9	5.15	457.7

Table (23) Fe and Mn concentration and uptake by Wheat plants grown on clayey soil as affected by organic residues and mineral fertilizers .

Treatments	Concentration		Uptake		Treatments	Concentration		Uptake	
	Fe ppm	Mn ppm	Fe mg pot-1	Mn ug pot-1		Fe ppm	Mn ppm	Fe mg pot-1	Mn ug pot-1
Control	232	22.7	1.12	292.3					
L1	851.2	54.1	3.87	246.1	L1	510	61.2	2.49	300
L2	960	67.5	7.11	500.1	L2	800	70.3	5.06	444.3
L3	1050	73.8	8.89	625.3	L3	1061	79.3	8.79	657.4
Biogas manure	1003.7	65.4	7.32	477.5	Chicken litter manure	615.5	64.3	3.96	414.7
B.M + L1	976.7	73.7	7.52	567.8	C L M + L1	760	77.1	5.47	555.1
B.M + L2	1016	75.6	11.1	824	C L M + L2	830	79.4	8.27	791.6
B.M +L3	1205.0.	81.2	15.1	1193.6	C L M +L3	1192.5	85.0.	15.6	1113.5
B.M Incubated with L1	855	65.6	5.68	436.3	C L M. Incubated with L1	750	72.5	5.13	495.9
B.M Incubated withL2	970	72.5	8.59	642.4	C L M. Incubated with L2	806.3	74.5	6.85	633.3
B.M Incubated with L3	980	75.6	10.1	691.10.	C L M. Incubated with L3	1147.5	80.1	10.2	708.9
mean	997.8	70.5	8.53	620.4	mean	847.3	74.4	7.19	611.5
L1	560	70.5	2.69	339.1	L1	532.5	62.2	2.14	250
L2	843.7	72.6	5.48	472	L2	777.5	71.8	3.33	308.3
L3	993.1	90.1	7.18	651.4	L3	982.5	78.7	4.86	389.5
Town refuse	677.5	71.8	4.13	438.0.	Poudratte manure	725	60.7	4.03	338.1
T.R + L1	643.8	88.8	4.84	668.7	P.M +L1	846.9	75	5.57	493.5
T.R + L2	903	91.2	8.56	865.0.	P.M +L2	1020	87	8.17	696.8
T.R + L3	1120	98.7	14.5	1281.7	P.M + L3	1217.5	100	11.3	925
T.R Incubated with L1	636	77.5	4.38	543.8	P.M Incubated with L1	745	68.1	4.36	399
T.R Incubated with L2	847.5	88.8	6.95	728.2	P.M Incubated with L2	823.8	78.1	6.37	604.5
T.R Incubated with L3	1052	91.2	9.78	848.2	P.M Incubated with L3	1165	82.1	9.45	665.8
mean	827.7	84.1	6.44	682.7	mean	883.6	76.4	5.95	507.1

In case of association with the PM : 490 , 700.3 and 1025.1 ppm in the plants grown on the sandy soil corresponding to 745 , 823.8 and 1165 ppm, respectively in the plants grown on the clayey soil .

Values of uptake of Fe by the plants grown on the sandy soil that was treated with the organic manures incubated outside the soil and combined with the levels L_1 , L_2 then L_3 of the mineral fertilizers were :
In case of the BM : 4.5 , 8.93 and 10.2 mg pot^1 ,respectively .
In case of the CM : 2.93 , 5.32 and 7.85 mg pot^1 ,respectively .
In case of TR : 3.31 , 5.73 and 6.69 mg pot^1 ,respectively .
In case of PM : 2.84 , 4.93 and 8.08 mg pot^1 ,respectively .

The corresponding values of Fe uptake by the plants grown on the clayey soil were 5.68 , 8.59 and 10.1 in case of BM ; 5.13 , 685 and 10.2 mg pot^1 in case of CM ; 4.38 , 6.95 and 9.78 in case of the TR and 4.36 , 6.37 and 9.45 mg pot^1 in case of the PM .

It is obvious from the aforementioned results that Fe uptake by the plants grown on the clayey soil was generally higher than the ones grown on the sandy soil . Low natural fertility of the sandy soil due to its low content of organic matter and the clay fraction may account for such observation .

4.4.3.2 <u>Effect on manganese</u> :

<u>4.4.3.2.1 Effect of the organic manure type:</u>

Data presented in Tables (22 & 23) show that both concentration and uptake of Mn by the wheat plants grown on both the sandy and clayey soils seemed to be markedly affected by application of the different studied manures . Mn concentration increased from 22.7 ppm in the control plants grown on both the sandy and clayey soils to 33.7 and 65.4 ppm , respectively in the plants grown on the sandy and clayey soil and received BM as an organic manure . The corresponding values in case of treating the soils with CM were 56.8 and 64.3 ppm , respectively . Mn concentration showed higher values upon treating the soils with TR being 72.5 and 71.8 ppm , respectively . On the other hand PM case Mn concentration to be 48.7 and 60.7 ppm, respectively .

The above mentioned data reveal that TR was of the most pronounced effect on Mn concentration in the plants grown on both the soils whereas BM was of the least effect . The effect of CM was higher relatively higher than that of PM . Mn uptake by the control plants grown on the sandy and clayey soils increased from 91.0 and 292.3 ug pot^{-1} , respectively to 179.3 and 477.5 $ugpot^{-1}$,respectively upon treating the soils with BM ; 295.1 and 414.7 ug pot^{-1} , respectively upon using CM ; 378.5 and 438.0 ug pot^{-1} , respectively when the soils were treated with TR; 247.6 and 338.1 ug pot^{-1}, respectively when the soils were treated with PM . The data indicate that the tested manures can be arranged in the following descending order due to their effect on Mn uptake by the plants grown on the sandy soil : TR > CM > PM > BM . However , a somewhat different order could be observed due to the organic manures on Mn uptake by the plants grown on the clayey soil where the effect of PM was followed by the BM then CM and finally PM .

Abd El-Kariem (1989) and Abd El-Hamied (1996) reported positive effects for BM , TR and CM on concentration and uptake of Mn by plants grown on sandy and clayey soils

4.4.3.2.2 <u>Effect of the mineral fertilizers</u> :

Data in Tables (22 & 23) reveal that treating the studied soils with the mineral fertilizers caused Mn concentration in the plants grown on both the sandy and clayey soils to increase and the induced effect seemed more obvious by an increasing level of the applied fertilizers . This finding can be illustrated by values of Mn concentration which were 42.6 , 61.0 and 70.0 ppm upon treating the sandy soil with the mineral fertilizers equivalent to the BM at the levels L_1 , L_2 and L_3, respectively . The same treatments caused Mn concentration in the plants grown on the clayey soil to be 54.1 , 67.5 and 73.8 ppm . Treating the sandy soil with mineral fertilizers equivalent to the CM at the levels L_1 , L_2 and L_3 caused Mn concentrations to be 55.1 , 61.2 and 70.6 ppm , respectively . The corresponding concentrations in the plants grown on the clayey soil were 61.2, 70.3 and 79.3 ppm , respectively . TR equivalent of the mineral fertilizers at the levels L_1 , L_2 and L_3 caused the Mn concentrations to be : 36.9 , 60.6 and 106.0 ppm in the plants grown on the sandy soil corresponding to 70.5 , 72.6 and 90.1 ppm in the plants grown on the clayey soil .

Increasing level of the mineral fertilizers equivalent to the PM from L_1 , L_2 then L_3 caused the Mn concentration in the plants grown on the sandy soil to be 52.5 , 65.1 and 79.3 ppm , respectively . The corresponding values in the plants grown on the clayey soil are 62.2 , 71.8 and 78.7 ppm, respectively.

Regarding the effect of the organic manures equivalent of the mineral fertilizers (L_1 , L_2 and L_3) on Mn uptake by the wheat plants grown on the sandy soil could be arranged descendingly in the order :

At L_1 level , CM (222.1 ug pot^{-1}) > PM(198.9 ug pot^{-1}) > BM (195.1 ug pot^{-1}) > TR (148.7 ug pot^{-1}) .

At L_2 level , the order become : TR(401.9 ug pot^{-1}) > BM (383.6 ug pot^{-1}) > CM (348.0 ug pot^{-1}) > PM (315.8 ug pot^{-1}) .

Increasing level of the applied organic manures equivalent of the mineral fertilizers (L_3) the order becomes : TR (567.1 ug pot^{-1}) > BM (539.0 ug pot^{-1}) > CM (462.0 ug pot^{-1}) > PM (406.6 ug pot^{-1}) .

Mn uptake by plants grown on the clayey soil upon application of the first level of the mineral fertilizers took the order : TR (339.1 ug pot^{-1}) > CM (300 ug pot^{-1}) > PM (250 ug pot^{-1}) > BM(246.1 ug pot^{-1}) , however, upon increasing level of the applied inorganic fertilizers into L_2, the order becomes: BM (500.1 ug pot^{-1}) > TR (472 ug pot^{-1}) > CM (444.3 ug pot^{-1}) > PM (308.3 ug pot^{-1}) . The increase of level of the applied mineral fertilizers up to L_3 was associated with the following order : CM (657.4 ug pot^{-1}) > TR (651.4 ug pot^{-1}) > BM (625.3 ug pot^{-1}) > PM (389.5 ug pot^{-1}).

4.4.3.2.3 <u>Effect of organic manures mixed with the mineral fertilizers:</u>

The combinations between the different organic manures and mineral fertilizers exerted a pronounced effect on both Mn concentration and uptake by the wheat plants grown on both the sandy and clayey soils . The combination between the TR and PM and its equivalent of the mineral fertilizers at its highest level (L_3) resulted in the highest Mn concentrations in the plants grown on both the soils which were 132.5 and 100 ppm , respectively . The Mn uptake was highest due to treating both the sandy and clayey soils with biogas manure and town refuse combined with its equivalent of mineral fertilizers at its highest level of application L_3 where the values obtained 1278.8 and 1281.7 ug pot^{-1} in the sandy and clayey soils , respectively . On the other hand , the lowest Mn uptake was attained in the sandy soil (413.9 ug pot^{-1}) was due to treating the soil with CM associated with its equivalent of the mineral fertilizers at lowest level L_1 . The corresponding value 493.5 ug pot^{-1} attained in the clayey soil was due to fertilizing the soil with the PM combined with its equivalent of the mineral fertilizers at the lowest level L_1 . These results agree well with the findings by ***Abd El-Kariem (1989)*** who found that the uptake of Mn by corn plants grown on the sandy soil significantly increased as a result of applied organic manures combined with manganese sulphate .

4.4.3.2.4 <u>Effect of the organic manures enriched with the mineral fertilizers and incubated outside the soil :</u>

The incubation of the organic manures combined with the mineral fertilizers outside the soil and their application to the investigated soils although increased both Mn concentration and uptake by the wheat plants grown on both the soils yet the increase seemed more lower when compared with that occurred due to direct application of the organic manures together with the mineral fertilizers. However, the incubated town refuse conbined with its equivalent of the mineral fertilizers at its highest level L_3 resulted in the highest Mn concentration and uptake in the sandy and clayey soils where the concentration values were 114.4 and 91.2 ppm , respectively whereas the uptake values were 776.5 and 848.2 ug pot^{-1} ,respectively .

4.4.3.3 <u>Effect on zinc</u>

4.4.3.3.1 <u>Effect of organic manures :</u>

Data presented in Tables (24 & 25) show the effect of organic manures on both concentrations and uptake of Zn by plants grown on both the sandy and clayey soils . Concentration of Zn increased from 140 ppm in the plants grown on the untreated sandy soil (control treatment) to 192.5 , 180.2 , 278.7 and 207.5 ppm in the plants treated with the biogas manures, town refuse ,chicken litter manure and poudratte manure, respectively . In the clayey soil , Zn concentration in the plants grown thereon increased from 110 ppm to 171.3 , 152.5 , 228.0 and 146.9 ppm

Table (24) Zn and Cu concentration and uptake by Wheat plants grown on sandy soil as affected by organic residues and mineral fertilizers .

Treatments	Concentration		Uptake		Treatments	Concentration		Uptake	
	Zn ppm	Cu ppm	Zn ug pot-1	Cu ug pot-1		Zn ppm	Cu ppm	Zn ug pot-1	Cu ug pot-1
Control	140	12.8	561	51.3					
L1	156.8	28.6	718	131.0.	L1	183.1	28.2	737.5	146.4
L2	195	31.8	1226	200	L2	250	29.1	1425	165.9
L3	282	33.6	2171	258.7	L3	320	33.5	2112	221.1
Biogas manure	192.5	30.8	1024	163.8	Chicken litter manure	278.7	28.1	1446.4	145.9
B.M + L1	248.1	34	1754	240.4	C L M. + L1	285.6	28.7	1767.9	177.9
B.M + L2	301.2	37	3147	384.8	C L M + L2	422	34.5	3907.7	319.5
B.M +L3	316.2	45.6	4395	633.8	C L M +L3	473.5	35.7	4550.3	343.5
B.M incubated with L1	198.9	29.9	1197	180	C L M. incubated with L1	267.3	28.5	1381.9	147.4
B.M incubated withL2	228.7	32.6	1857	264.8	C L M. incubated with L2	272.2	32.5	2263	270.4
B.M incubated with L3	282.5	33.7	2358	281.8	C L M. incubated with L3	321.2	34.7	2730.2	295.0.
mean	240.2	33.8	1985	273.9	mean	307.4	31.4	2232	223.3
L1	175.2	21.2	706.1	85.4	L1	177.5	26.2	672.7	99.4
L2	208.0.	28	1112.8	149.8	L2	197.5	32.5	957.9	157.6
L3	245	41.9	2193	282.8	L3	249	33.2	1277.4	170.3
Town refuse	180.2	27.3	940	142.5	Poudrate manure	207.5	28.7	1054.1	146.0.
T.R + L1	306.3	29.5	1718.3	165.5	P.M +L1	256	32.5	1654.8	209.9
T.R + L2	373.7	35.6	2825	269.1	P.M +L2	276	39.7	2131.7	306.8
T.R + L3	440	47.5	4229	447.4	P.M + L3	373.7	40.1	3158	338.8
T.R incubated with L1	297.5	26.7	1487.5	133.5	P.M incubated with L1	190.2	26.9	1103.2	156.0.
T.R incubated with L2	308.8	28.1	2053.5	186.9	P.M incubated with L2	208.0.	38.7	1466	272.8
T.R incubated with L3	314.3	43.1	2134.1	292.8	P.M incubated with L3	318	39.0.	2509	307.7
mean	285.7	32.9	1726.5	215.6	mean	245.3	33.7	1449.5	216.4

Table (25) Zn and Cu concentration and uptake by Wheat plants grown on clayey soil as affected by organic residues and mineral fertilizers .

Treatments	Concentration		Uptake		Treatments	Concentration		Uptake	
	Zn ppp	Cu ppm	Zn ug pot-1	Cu ug pot-1		Zn ppm	Cu ppm	Zn ug pot-1	Cu ug pot-1
Control	110	20.2	535.7	98.6					
L1	141.5	31.2	648.1	142.2	L1	116.3	29.2	569.9	142.9
L2	167.5	35	1241.2	259.3	L2	197.2	33.3	1246.3	210.4
L3	206.2	37.5	1746.5	317.6	L3	268.7	34.2	2227.5	283.5
Biogas manure	171.3	32.5	1250.5	237.2	Chicken litter manure	228	31.6	1470.6	176
B.M + L1	176.3	32.5	1357.5	250.2	C L M + L1	238	32.5	1713.6	234
B.M + L2	190	36.2	2071	394.6	C L M + L2	245	38.8	2442.7	386.8
B.M +L3	250.5	51.2	3682.4	752.6	C L M +L3	282.5	40.4	3700.8	529.2
B.M incubated with L1	171.2	32.1	1138.5	213.3	C L M. incubated with L1	193.1	30	1320.8	205.2
B.M incubated withL2	195.6	35.4	1733	313.6	C L M. incubated with L2	207.5	34.9	1763.8	296.7
B.M incubated with L3	232.5	41.2	2125	376.6	C L M. incubated with L3	272.5	35.8	2411.6	316.8
mean	190.4	36.5	1699.4	325.7	mean	224.9	34.1	1886.8	278.2
L1	131.3	27	631.5	129.9	L1	120.0.	27.5	482.4	110.5
L2	157.5	28.1	1023.8	182.7	L2	146.2	30.5	627.2	130.8
L3	183.2	31.1	1324.8	224.8	L3	193.7	36.2	958.8	179.4
Town refuse	152.5	30	1064.5	209.4	Poudrate manure	146.9	31.2	818.2	174
T.R + L1	160	28.7	1204.8	216.1	P.M +L1	210	32.1	1381.8	211.2
T.R + L2	185.8	31.2	1761.4	296.2	P.M +L2	228	34.0.	1826.3	272.3
T.R + L3	200	33.7	2855.6	438.1	P.M + L3	273.7	37.0.	2531.7	342.2
T.R incubated with L1	153.7	27.8	1060.5	191.8	P.M incubated with L1	200	28.7	1172	168.2
T.R incubated with L2	175.1	29.6	1435.8	242.7	P.M incubated with L2	211.2	32.5	1634.7	251.6
T.R incubated with L3	191.3	31.7	1979.1	294.8	P.M incubated with L3	243.5	40.5	1974.8	328.5
mean	169	29.9	1434.2	241.7	mean	197.3	33.0.	1340.8	216.9

due to treating the soil with biogas manure, town refuse ,chicken litter manure and poudratte manure, respectively . These results agree with those of ***Abd El-Kariem (1989)*** and ***Abd El-Hamied (1996)*** who found that Zn-concentration in corn and sorghum plants increased as a result of application of biogas , chicken litter and town refuse manures.

Uptake of Zn by the plants grown on the sandy soil increased from 561.0 ug pot^{-1} in the control treatment to 1024 , 940 , 1446.4 and 1054.1 ug pot^{-1} in the plants manured with the biogas manure , town refuse, chicken litter manure and poudratte manure , respectively . In the clayey soil, Zn uptake increaed from 535.7 ug pot^{-1} in the untreated plants to 1250.5 , 1064.5 , 1470.6 and 818.2 ug pot^{-1} by the plants treated with the biogas manure , town refuse , chicken litter manure, and poudratte , respectively . Thus taking into consideration the effect of the studied organic manures on both concentration and uptake of Zn , the results indicate genelally to the superiority of the chicken litter manure over the other studied organic manures . The increase in Zn uptake can be due to production of acids and chelating compounds as a result of soil organic matter decomposition play a vital role in the availability of essential plant nutrient elements . This conclusion stands in well agreement with that of ***Wallingford et al. (1975)*** .

4.4.3.3.2 Effect of the mineral fertilizers :

Data in Tables (24 & 25) reveal that application of the mineral fertilizers increased Zn concentration and uptake by the plants grown on both the sandy and clayey soils . The increase seemed more obvious by increasing level of the applied fertilizer where the highest values attained at the highest level of application of the mineral fertilizers (L_3) .In the plants grown on the sandy soil , Zn concentration raised from 156.8 to

195.0 then 282.0 ppm when level of the biogas manure equivalent of the mineral fertilizers was increased from L_1 to L_2 then L_3. the corresponding Zn concentrations in case of the town refuse equivalents of the mineral fertilizers were 175.2 , 208.0 and 245.0 ppm, respectively . In case of applying chicken manure equivalent of the mineral fertilizers , the correspanding Zn concentrations were 183.1 , 250.0 and 320.0 ppm , respectively whereas the corresponding values in case of the applying poudratte equivalent of the mineral fertilizers were 177.5 , 197.5 and 249.0 ppm , respectively . These values indicate that the chicken litter manure equivalent of the mineral fertilizers seemed to be of the highest effect on Zn concentration whereas that of the poudratte manure seemed to be of the lowest effect on Zn concentration in plants grown on the sandy soil . In the clayey soil, Zn concentrations in the plants treated with the biogas manure , town refuse , chicken litter manure or poudratte manure equivalents of the mineral fertilizers achieved the highest values at the highest level of application of the mineral fertilizers i.e. L_3 where these concentrations were 206.2 , 183.2 , 268.7 and 193.7 ppm , respectively . The chicken litter manure equivalent of the mineral fertilizers showed the highest effect on the clayey soil whereas the lowest effect was shown by town refuse equivalent of the mineral fertilizers .

Uptake of Zn achieved the highest values in the sandy soil (2227.5 ug pot^{-1}) when the soil was treated by the chicken litter manure equivalent of mineral fertilizers at its highest level of application (L_3) whereas the lowest value (958.8 ug pot^{-1}) was attained upon treating the sandy soil with poudratte manure equivalent of the mineral fertilizers . The results indicate generally that the inducing effect on Zn concentration and uptake was increased in both the investigated soils by increasing level of the applied mineral fertilizers . These results agree well with those of ***Mohamed (1987)*** who showed that increasing mineral zinc addition to sandy soil resulted in an increase in Zn uptake by corn plants grown thereon .

4.4.3.3.3 <u>Effect of the organic manures applied together with the mineral fertilizers :</u>

Data in Tables (24 & 25) show the effects of the different organic manures enriched with mineral fertilizers at different levels on concentration and uptake of Zn by the wheat plants grown on both the sandy and clayey soils . The best treatment on Zn concentration in the plants grown on the sandy soil is the chicken litter manure associated with its equivalent of the mineral fertilizers at the highest level (L_3) where the Zn concentration attained is 473.5 ppm . On the other hand , the least effect attained on the Zn concentration in this soil was due to the biogas manure associated with its equivalent of the mineral fertilizers at its lowest level of application L_1 ,where the Zn concentration did not exceed 316.2 ppm . In the clayey soil , the Zn concentration was highest in plants treated with chicken litter manure associated with its equivalent of the mineral fertilizers at its highest level (L_3) where its value was 282.5 ppm . The town refuse associated with its equivalent of the mineral fertilizers at its lowest level (L_1) gave the lowest Zn concentration which is 160.0 ppm .

Effect of the organic manures combined with different equivalents of the mineral fertilizers on Zn uptake was highest due to treating both the soils with chicken litter manure combined with its equivalent of mineral fertilizers at its highest level of application L_3 where the values obtained were 4550.3 and 3700.8 ug pot^{-1} in the sandy and clayey soils , respectively . On the ather hand , the lowest Zn uptake attained in the sandy soil, 1654.8 ug pot^{-1},was due to treating the soil with poudratte manure associated with its equivalent of mineral fertilizers at the lowest level L_1 . The corresponding value 1204.8 ug pot^{-1} attained in the clayey soil was due to fertilizing the soil with the town refuse combined with its equivalent of the mineral fertilizers at the lowest level L_1 .

It is worthy to indicate that the plants grown on the soils treated with organic manures enriched with mineral fertilizers showed higher Zn concentration and uptake than the plants treated with either organic manures only or mineral fertilizers alone . Meanwhile , the chicken litter manure combined with the mineral fertilizers at the level L_3 showed the highest effect on both Zn concentration and uptake in both the studied soils . These results agree well with those of ***Abd El-Kariem (1989)*** .

4.4.3.3.4 <u>Effect of the organic manures enriched with the mineral fertilizers and incubated outside the soils :</u>

The incubation of the organic manures combined with the mineral fertilizers outside the soil and their application to the investigated soils although increased both Zn concentration and uptake by the wheat plants grown on both the soils yet the increase seemed more lower when compared with that occurred due to direct application of the organic manures together with the mineral fertilizers. However, the chicken litter manure incubated outside the soil conbined with its equivalent of the mineral fertilizers at its highest level L_3 resulted in the highest Zn concentration and uptake in the sandy and clayey soils where the concentration values were 321.2 and 272.5 ppm , respectively whereas the uptake values were 2730.2 and 2411.6 ug pot^{-1} ,respectively .

4.4.3.4 Effect on copper

4.4.3.4.1 Effect of organic manures :

Data shown in Tables (24 & 25) reveal that manuring raised concentration and uptake of the copper by the plants grown on sandy and clayey soils . Concentration of Cu increased from 12.8 ppm in the control plants to 30.8 , 27.3 , 28.1 and 28.7 ppm upon treating the sandy soil with the BM , TR , CM and PM, respectively . The Cu concentration in the plants grown on the clayey soil raised from 20.2 ppm in the control plants to 32.5 , 30.0 , 31.6 and 31.2 ppm in the plants grown on the clayey soil treated with the BM , TR , CM and PM , respectively .

The effect of the different organic manures treatments on Cu uptake by wheat plants grown on the sandy soil is being according to the following order : BM > PM > CM > TR , while in the clayey soil the following order was obtained : BM > TR > CM > PM . ***Hayes (1979)*** found that the sludge application increased the total plant content of Cu .

Values of Cu uptake by the plants grown on the sandy soil increased from 51.3 ug pot^{-1} by the control plants to 163.8 , 142.5 , 145.9 and 146.0 ug pot^{-1} in the plants treated with BM , TR , CM and PM , respectively. In the clayey soil, the Cu uptake increased from 98.6 ug pot^{-1} by the untreated plants to 237.2 , 209.4 , 176.0 and 174.0 ug pot^{-1} by the plants treated with BM , TR , CM and PM , respectively .

Both values of Cu concentration and its uptake indicate to the superiority of the BM compared with the other organic manure . Such increases in Cu concentration and consequently its uptake by the plants can be attributed to the high content of Cu in the used organic manures .

4.4.3.4.2 Effect of the mineral fertilizers :

The mineral fertilization which included copper sulfate resulted in obviouns increase in both concentration and uptake of Cu by the wheat plants grown on both the studied soils . Increasing level of the applied mineral fertilizers from L_1 to L_2 then L_3 was associated with increases in Cu concentration in the plants grown on the sandy soil from 28.6 to 31.8 then 33.6 ppm, respectively in case of using a mixture of the mineral fertilizers equivalent in its elemental composition and concentration of Cu to BM . Using the mineral fertilizers equivalent to the TR increased Cu concentration from 21.2 to 28.0 then 41.9. ppm upon raising level of these mineral fertilizers from L_1 to L_2 then L_3. The corresponding Cu concentrations upon using the CM equivalent of the mineral fertilizers were 28.2 , 29.1 and 33.5 ppm, respectively whereas the values achieved due to using the PM were 26.2 , 32.5 and 33.2 ppm, respectively .

In case of the plants grown on the clayey soil , Cu concentration increased from 31.2 to 35.0 then 37.5 ppm when level of the mineral fertilizers equivalent to the BM were applied in the levels L_1 , L_2 and L_3. The corresponding Cu concentrations achieved when the mineral fertilizers equivalent to TR were used were 27.0 , 28.1 and 31.1 ppm, respectively . In case of the CM equivalent of the mineral fertilizers , rising their level from L_1 to L_2 then L_3 resulted in Cu concentrations having the values 29.2 to 33.3 then 34.2 ppm, respectively . The corresponding values achieved in case of applying the poudratte equivalents of the mineral fertilizers were 27.5 , 30.5 and 36.2 ppm, respectively . Such reported increases in Cu concentration were reflected on plants uptake of Cu. In case of the BM equivalent of the mineral fertilizers , Cu uptake by the plants grown on the sandy soil increased from 131.0 to 200.0 then 258.7 ug pot^{-1} upon rising level of the appplied mineral fertilizers from L_1 to L_2 then L_3. The corresponding Cu uptake values reported in case of the TR were 85.4, 149.8 and 282.8 ug pot-^{1}, the values reported in case of CM were 146.4, 165.9 and 221.1 ug pot^1, respectively and those reported in case of PM were 99.4, 157.6 and 170.3 ug pot^1,respectively.

Uptake of Cu by the plants grown on the clayey soils increased due to rising level of the mineral fertilizers equivalent to the studied organic manures from L_1 to L_2 then L_3. In case of the BM, the values achieved were 142.2 to 259.3 and then 317.6 ug pot^1. The corresponding values in case of the TR were 129.9, 182.7 and 224.8 ug pot^1, respectively, while those achieved in case of the CM were 142.9, 210.4 and 283.5 ug pot^1, respectively corresponding to 110.5,130.8 and 179.4 ug pot^1,respectively in case of the PM.

Thus it can be concluded that the inducing effect of the mineral fertilizers although varied according to type of the organic manure they represent, yet it was consistently increased by increasing level of the mineral fertilization in both soils.

4.4.3.4.3 Effect of the organic manures mixed with the mineral fertilizers :

The comparison among the values of both Cu concentration and uptake obtained due to organic manuring, mineral fertilization and combined application of the mineral fertilizers together with the organic manures reveal that latter is more effective on both Cu concentration and uptake. This finding can be clarified by the data presented in Tables (24&25).

The combination between the BM and the first level of the mineral fertilizers increased Cu concentration from 12.8 and 20.2 ppm in the plants grown on the sandy and clayey soils to 34.0 and 32.5 ppm , respectively . Increasing the level of the mineral fertilizers to L_2 was associated with increases in Cu concentration to 37.0 and 36.2 ppm, respectively while the further increase in level of the fertilizers to L_3 resulted in Cu concentration in the plants grown on the sandy and clayey soils of about 45.6 and 51.2 ppm ,respectively . In case of the combination between TR and the mineral fertilizers , Cu concentration in the plants grown on the sandy soil raised from 29.5 to 35.6 then 47.5 ppm while that of the plants grown on the clayey soil raised from 28.7 to 31.2 then 33.7 ppm ,respectively upon increasing level of the mineral fertilizers from L_1 to L_2 then L_3 . In case of the CM , Cu concentrations in the plants grown on the sandy soil were 28.7 , 34.5 and 35.7 ppm , respectively whereas the Cu concentrations in those grown on the clayey soil were 32.5 , 38.8 and 40.4 ppm , respectively . Concentration of Cu in the plants grown on the sandy soil fertilized with the PM combined with the mineral fertilizers at L_1 , L_2 then L_3 levels were 32.5 , 39.7 and 40.1 ppm ,respectively corresponding to 32.1 , 34.0 and 37.0 ppm in the plants grown on the clayey soil .

Cu uptake which is a final product of its concentration and the dry matter yield of the plant showed values varying according to type of the organic manure , type of soil and level of the applied mineral fertilizers .

The values of Cu uptake shown by the plants grown on the sandy soil that received the BM combined with mineral fertilizers at the levels L_1 , L_2 and L_3 were 240.4 , 384.8 and 633.8 ug pot^1 ,respectively . The corresponding Cu uptake values recorded by the plants grown on the clayey soil were 250.2 , 394.6 and 752.6 ug pot^1 , respectively . In case of TR combined with mineral fertilizers , values of Cu uptake by the plants grown on the sandy soil were 165.5 , 269.1 and 447.4 ug pot^{1} ,respectively corresponding to 216.1 , 296.2 and 438.1 ug pot^{1} by the plants grown on the clayey soil .

Rising level of the mineral fertilizers combined with the CM from L_1 to L_2 then L_3 caused Cu uptake by the plants grown on the sandy soil to increase from 177.9 to 319.5 then 343.5 ug pot^{1} ,respectively. The corresponding values achieved by the plants grown on the clayey soil were 234.0 , 386.8 and 529.2 ug pot^{1} , respectively . The same mineral fertilization treatments combined with the PM caused the Cu uptake by the plants grown on the sandy soil to be 209.9 , 306.8 and 338.8 ug pot^{1} ,respectively . The corresponding Cu uptake values by the plants grown on the clayey soil were 211.2 , 272.3 and 342.2 ug pot^{1} ,respectively .

The above mentioned results indicate that increasing level of the mineral fertilizers that associated the organic manures resulted in increase in concentration of Cu in the plants grown on both the investigated soils, however, the magnitude of increase seemed to be dependent not only on level of the applied mineral fertilizers but also on type of the organic manure and also type of the soil to which the fertilizers are added .

4.4.3.4.4 Effect of the organic manures enriched with the mineral fertilizers and incubated outside the soils :

Data in Tables (24&25) reveal that the application of the already incubated organic manures outside the soils together with the studied level of the mineral fertilizers although increased both Cu concentration and uptake by the treated plants compared with the untreated ones, yet the values obtained are generally lower than those obtained due to the corresponding treatments without incubation of the organic manures .

Cu concentrations in the plants grown on the sandy and clayey soils and treated with the mineral fertilizers at the levels L_1 , L_2 then L_3 were :

In case of the association with the BM :29.9 , 32.6 and 33.7 ppm in the plants grown on the sandy soil and 32.1 , 35.4 and 41.2 ppm in the plants grown on the clayey soil , respectively ,

In case of association with the TR : 26.7 , 28.1 and 43.1 ppm , respectively in the plants grown on the sandy soil, corresponding to 27.8 , 29.6 and 31.7 ppm, in the plants grown on the clayey soil .

In case of association with the CM : 28.5 , 32.5 and 34.7 ppm, respectively in the plants grown on the sandy soil corresponding to 30.0 , 34.9 and 35.8 ppm in the plants grown on the clayey soil , respectively ,

In case of association with the PM : 26.9 , 38.7 and 39.0 ppm in the plants grown on the sandy soil corresponding to 28.7 , 32.5 and 40.5 ppm, respectively in the plants grown on the clayey soil .

Uptake of Cu increased due to treating the sandy soil with already incubated BM + mineral fertilizers at a level of L_1 to 180.0 ug pot^1 , raised by increasing level of the associated mineral fertilizers to 264.8 ug pot^1 and achieved 281.8 ug pot^1 by further increase in level of associated mineral fertilizers into L_3 . The corresponding values achieved when TR was associated with the mineral fertilizers at the levels L_1 , L_2 and L_3 were 133.5 , 186.9 and 292.8 ug pot^1 ,respectively .

The values of Cu uptake when the CM was incubated outside the soil with the mineral fertilizers at the levels L_1 , L_2 and L_3 were 147.4 , 270.4 and 295.0 ug pot^1 ,respectively . In case of the PM , the corresponding values of Cu uptake were 156.0 , 272.0 and 307.7 ug pot^1, respectively .

In the clayey soil , it was found , generally , that the higher the level of associated applied mineral fertilizers , the higher the uptake of Cu in the plants grown thereon . The N uptake was highest in the plants treated with biogas manure associated with its equivalent of the mineral fertilizers at its highest level (L_3) where its value was 376.6 ug pot^{1}. The poudratte manure associated with its equivalent of the mineral fertilizers at its lowest level (L_1) gave the lowest N uptake which is 168.2 ug pot^{1} .

Worthwile to indicate that the poudratte manure incubated outside the soil associated with its equivalent of the mineral fertilizers L_3 resulted in the highest Cu uptake in the plants grown on the sandy soil whereas the biogas manure associated with its equivalent of the mineral fertilizers at the level L_3 resulted in the highest Cu uptake in the plants grown on the clayey soil .