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MOBILITY AND LEACHING OF NITROGEN FORMS THROUGH SANDY AND CALCAREOUS SOILS AS AFFECTED BY THE APPLICATION OF SOME SOIL AMENDMENTS

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ABSTRACT: **A laboratory experiment was conducted to study the effect of some soil amendments i.e. biogas manure (BM),chicken manure (CM), taffla material (T), sulfur (S) and two water capture fertilizers (acidic and neutral WCF) on nitrogen behaviour through intermittent leaching using sandy and calcareous soils. The soil amendments were used individualy and in different combinations.**

The obtained results can be summarized as follows:

1. **Application of CM, BM, T and WCF increased the available nitrogen forms (NH_4^+ and NO_3^-) due to their effect on CEC and pH of the media.**
2. **The highest values of leached (NH_4^++NO_3^-)–N were found under the application of CM+T+acidic WCF in the first leachate of calcareous soil, but in the sandy soil the highest values were observed under the application of CM+T+S and acidic WCF in the 5th soil leachate**
3. **Application of chicken manure individual or combined with other soil amendments increased the values of residual (NH_4^++NO_3)-N in the soil compared to the biogas manure treatments.**
4. **The greatest value residual available (NH_4^++NO_3^-)-N was recorded at the third layer (20-30 cm) of soil columns of both sandy and calcareous soils, while the lowest value was recorded at the first layer (0-10 cm).**

5. **Nitrification rate was clearly affected by the different soil amendments and their combinations, The greatest value of nitrification rate was observed under the addition of BM+T+S+acidic WCF in the second layer (10-20cm) of sandy soil, while in the calcareous soil, the highest value was observed under the addition of CM+T+S in the same layer.**
6. **The highest mean value of nitrate : ammonium ratio for different treatments were 0.67 using biogas manure and 0.24 with chicken manure in the sandy soil, but in the calcareous soil, the greatest one were 0.48 using BM and 0.36 with CM.**
7. **The highest accumulated leached (NH_4^++NO_3^-)-N were observed under treatment of CM+T+S+neutral WCF in bouth sandy and calcareous soils.**

Key words: Soil amendments, leaching of nitrogen forms, sandy and calcareous soils, Nitrification rate.

INTRODUTION

Recently reclaimed sandy and calcareous soils are generally poor in organic materials, colloids and nutrients content. Therefore, cultivation of these soils became necessary to overcome the fast growing population .In these soils, added nutrients are subjected to loss via leaching or volatilization. One of the possibilities to increase the efficiency of added fertilizers is using soil amendments.

Reduction of nutrient loss via leaching and run off; reduction of chemical and biological immobilization reactions in soils which cause plant unavailable form of nitrogen ,reduction of rapid nitrification and nitrogen loss through ammonia volatization and denitrification, Fox *et al.* (1996). Belkacem and Nys (1997) investigated the effects of liming and gypsum addition on the chemical characteristics of soil and leachates through soil column and NH_4-N at monthly invtervals through out the 20-months peiod. Nitrogen was leached mostly as NO_3^- N in the lime treatments and in the control, whereas nitrification was inhibited in gysum treatment and nitrogen was predominately NH_4-N form. Awad (1990) reported that urea fertilizer combined with soil conditioner (veterra hydrogel) gave the greatest value of nitrogen efficiency ratio. Dahdouh *et al.* (2004) found that the addition of nitrification inhibitor slightly affected the transformation of ammonium to nitrate due to the adsorption of the inhibitor on adsorptive sites of organic manure. Farid *et al.* (2006) concluded that organic waste materials can be used as sources of nutritive nutrients. On the other hand, they stated heavy application of organic wastes lead to accumulation of heavy metals in dangerous level. High pH value and $CaCO_3$ content of the calcareous soils may be considered as an advantagy prevents toxic hazard of such heavy elements.

The present study amied to investigate the effect of soil amendments on mobility and leaching of N through intermittent leaching in sandy and calcareous soils.

MATERIALS AND METHODS

Soil columns experiment was conducted using loamy sand and clay loam calcareous soils to study the effect of some soil amendemtns on the distribution of NH_4-N and NO_3-N ions in soil and leachates. Nine hundred grams of air dried soil samples were placed in plastic columns of 50 cm in hight and 12 cm in diameter. The soil in each column was packed to 30 cm by tapping. At the end of the experiment, the soil columns were divided into three sections i.e. (0-10),(10-20) and (20-30 cm).

The following soil amendments treatments were applied to different soil columns. (1) Control (2) Biogas manure (BM). (3) Biogas manure + Taffla (BM+T). (4) Biogas manure + Taffla +acidic water capture fertilizer (BM+T+ acidic WCF). (5) Biogas manure + Taffla + neutral water capture fertilizer (BM+T+ neutral WCF). (6) Biogas manure + Taffla + sulphur (BM+M+S). (7) Biogas manure + Taffla + sulphur + acidic water capture fertilizer (BM+T+S+ acidic WCF). (8) Biogas manure + Taffla material + sulphur + neutral water capture fertilizer (BM+T+S+ neutral WCF). (9) Chicken manure (CM). (10) Chicken manure + Taffla (CM+T). (11) Chicken manure + Taffla + acidic water capture fertilizer (CM+T+ acidicWCF). (12) Chicken manure + Taffla + neutral water capture fertilizer (CM+T+ neutral WCF). (13) Chicken manure + Taffla + sulphur (CM+T+S). (14) Chicken manure + Taffla + sulphur + acidic water capture fertilizer (CM+T+S+

acidicWCF). (15) Chicken manure + Taffla + sulphur+ neutral water capture fertilizer (CM+T+S+ neutral WCF).

Physical and chemical analyses of investigated soils, Taffla material, water capture fertilizer and organic materials are presented in Tables (1, 2, 3and 4).

Table 1. Some physical and chemical properties of the investigated soils

Characteristic	Sandy soil	calcareous soil
Soil particles distribution		
Sand ,%	81.91	36.17
Silt,%	12.06	29.79
Clay,%	6.03	34.04
Textural class	loamy sand	clay loam
Field capacity (FC),%	11.85	26.25
$CaCO_3$,%	0.48	35.5
Organic matter,%	0.48	0.64
pH*	8.01	7.74
EC dS/m**	0.34	0.88
Soluble cations and anions, (mmole/L)**		
Ca^{++}	1.3	3.2
Mg^{++}	0.6	1.9
Na^{+}	1.25	3.0
K^{+}	0.30	1.35
CO_3^{--}	-	-
HCO_3^{-}	1.12	1.28
Cl^{-}	0.99	3.78
SO_4^{--}	1.34	4.39
Total N,%	0.36	0.34
Total P,%	0.16	0.24
Total K,%	0.08	0.10

* Soil-water suspension 1: 2.5 ** Soil water extract 1:5

Table 2. Some Physical and chemical properties of the taffla material

Characteristic	Value
Taffla particles distribution	
Sand, %	44.60
Silt,%	4.26
Clay,%	51.14
Textural class	clay
Field capacity (FC),%	33.04
$CaCO_3$,%	4.88
Organic matter,%	0.48
pH*	7.25
EC, dS/m**	1.88
Soluble cations and anions,(mmole/L)**	
Ca^{++}	3.5
Mg^{++}	3.2
Na^{+}	9.43
K^{+}	0.39
CO_3^{--}	-
HCO_3^{-}	1.6
Cl^{-}	8.19
SO_4--	6.73
Total N,%	0.37
Total P,%	0.21
Total K,%	0.15

* Soil-water suspension 1: 2.5 ** Soil water extract 1: 5

Table 3. Some chemical composition of the water capture fertilizer (WCF) used

Nutrient	Value%
N	13.0
P	5.0
K	11.0
Zn	0.13
Fe	0.085
Mn	0.07
Mg	0.06
Cu	0.15
Mo	0.015

Table 4. Some chemical composition of biogas and chicken manure used

Characteristic	Chicken manure	Biogas manure
EC**, dS/m	4.8	3.1
pH*	7.58	7.84
organic matter,(%)	23.49	40.30
Total N,(%)	3.15	2.48
Total P,(%)	5.53	1.82
Total K,(%)	0.39	0.2
C/N ratio	4.32	9.42

*Soil-water suspension 1: 2.5

**Soil water extract 1: 5

Biogas, chicken manures as well as taffla material were added to the soils at the rate of 20 tons /fed. The treatments of acidic and neutral water capture fertilizers were added to the same soils at the rate of 40 kg /fed. The elemental sulphur was applied at a rate of 500 kgs/fed. Different soil amendements were firstly mixed with the soil of each column, Then moisture content of all columns was maintained to reach water holding capacity. Ammonium nitrate fertilizer was added at the rate of 200 ppmN.

Treated soils were subjected to eight times intermittent leaching by tap water every seven days. Leaching was observed by adding sufficient amounts of water (108 ml and 234 ml for sandy and calcareous soil, respectively) to displace the soil solution at field capacity.

The leachates were collected at the beginning of the experiment (zero time) then each seven days until the end of the experiment and directly analysed for NH_4-N and NO_3-N after carrying out each of the different leaching treatment. The soil columns were divided into three sections according to depth (0 – 10, 10 – 20 and 20 – 30 cm). The soil samples of the three sections were directly analyzed for NH_4^+–N and NO_3^-–N, once at the end of experiment.

Methods of Analysis

The particles size distribution of the soil samples was measured using the international pipette methods as described by Piper (1950).

- The electrical conductivity (EC) of soil water extract was determined by using the bridge, Jackson (1958).
- Calcium carbonate content of the soil was determined volumetrically using collions calcimeter described by Piper (1950).
- Soil pH was measured using glass electrode pH meter in a 1:2.5 soil water suspension (Cottenie, 1982).
- Soluble cations and anions were determined in (1: 5) soil water extract (Black, 1965).
- Sodium and potassium were determined by using flame photometer as described by Cottenie (1982).
- Organic matter was determined following walkelly and Black method, as described by Jackson (1958).

- Calcium and magnesium were determined following the versenate method (Jackson, 1958).
- Total nitrogen in soil was determined using the microkjeldahl method according to Jackson (1958).
- Total potassium in soil was determined by flame photometer according to Jackson, (1958).
- Total phosphorus in soil was determined colourmetrically using ascorbic acid method (Watanabe and Olsen, 1965).

RESULTS AND DISCUSSION

The effect of tested soil amendments and their interactions on nitrogen mobility and leaching through sandy and calcareous soils under intermittent leaching through soil columns are discussed in the following sub headings:

Soluble Nitrogen Fractions

Sandy soil

Regarding the effect of biogas manure (BM) combined with different soil amendments, values of soluble nitrogen fractions ($NH_4 - N$ and $NO_3 - N$) leached under the investigated treatments are recorded in Table 5 and Fig. 1. Results show that the addition of biogas manure combined with taffla material (T), Sulphur (S) and water capture fertilizer (WCF) clearly affected the transformation of ammonium to nitrate. The highest value of leached NH_4-N at the first week was observed under the addition of biogas manure individual. On the other hand, the greatest value of leached NO_3-N was found under the treatment of biogas manure combined with taffla material, sulfur and neutral WCF. This result may be attributed to the effect of WCF as indicated by Osman Fatma and El-Mogy (2005) who mentioned that the combination between organic biogas manure and WCF led to increase the fertilizer N efficiency.

In the second leachate, the highest value of $NH_4 - N$ was observed under the addition of BM + T + S or BM + T + S + WCF; that may be due to the effect of taffla material as well as organic manure for increasing CEC as confirmed by Mahmoud (1996).While the highest value of NO_3-N was observed under no addition of soil amendments.

In the third leachate, similar trend to that recorded at the second leachate was observed for leached NH_4-N; while the greatest value of NO_3 –N was found under the treatment of biogas manure individual.

From the fourth leachate to the end of experiment, data showed that the highest values of leached NH_4-N were recorded under no addition of soil amendments; except of the fifith leachate hence the highest value was observed under no addition of soil amendments or under the treatment of (BM+T), while the highest values of leached NO_3-N were observed under the application of (BM+T) or (BM +T +S + neutralWCF); (BM+ T+ neutral WCF); and (BM+T+S), respectively. Gouda (1979), Abdel –Aziz *et al.* (1990) and El-Shanawany *et al.* (1994) mentioned that using taflla material in coarse textured soils caused an increase in CEC.

Regarding the effect of chicken manure (CM) combined with different soil amendments, data in Table 5 and illustrated in Fig. 1 show that generally the highest value of leached NH_4-N was observed under the treatments of (CM+T+S+WCF) except for the first and final leachates; hence the highest values were observed under the treatment of (CM +T + acidic WCF). These results may be attributed to the effect of CM which increased available N as reported by Dahdouh *et al.* (2004).

In recpect to leached NO_3-N; data reveal that generally the highest value was observed under the treatments of (CM+T) and (CM+T+S), respectively. These results may be due to the addition of CM and taffla material which increase the available nitrogen as reported by Mahmoud (2001) and Khater *et al.* (2002).

From the abovementioned results, data showed that application of soil amendments i.e. CM, S, taffla material and WCF increased the availability of nitrogen forms due to their effect on CEC and pH of the media as mentioned by Basyony (2002), Negm *et al.* (2003) and Wahdan *et al.* (2005).

Calcareous soil

Regarding the effect of biogas manure combined with different soil amendments, values of soluble nitrogen fractions (NH_4 – N and NO_3 – N) leached from the investigated treatments are recorded in Table 6 and illustrated in Fig. 2. Results show that the addition of biogas manure combined with taffla material, sulfur and water capture fertilizer affected the transformation of ammonium to nitrate. Data reveal that the highest value of $NH_4 - N$ in second and third weeks were observed under the application treatment of (BM + T + WCF). While, the highest values from the fourth to the seventh weeks were recorded under the application treatment of (BM individually). However, in the final leachate the highest value was observed due to the application of (BM+T+S).

Concerning the highest values of leached NO_3-N, data showed that the highest values were observed due to the addition of (BM+T+S+WCF) at the first and sixth leachates, In the second and fifith leachates, the highest values were obtained under the addition of (BM+T+S); while in the third and fourth leachates the highest values were found under the addition of (BM individually). However, the highest values at the seventh and eighth leachates were recorded under the treatment of (BM+T+WCF). From the results, mentioned before, it could be reprted that addition of organic manure, S, taffla material and WCF acidic affected the availability of nitrogen forms due to their effect on reducing the soil pH and increasing the availability of nitrogen forms as stated by Wahdan *et al.* (2005) and Abdel-All *et al.* (2007).

Investigating the effect of chicken manure combined with different soil amendments, data in Table 6 and Fig. 2 Show that the highest values of leached $NH_4 - N$ in the first, seventh and final leachates were observed under the treatment of (CM + T+ WCF). In the second and sixth leachates the addition of (CM+T) gave the highest values of leached NH_4-N, while in the third and fifith leachates the highest values were obtained due to the addition of (CM + T + S + neutralWCF). However, in the fourth leachat, the addition of (CM+T+S) gave the highest values of leached NH_4-N.

Concerning the leachated NO_3-N, data reveal that the application of (CM+T) gave the highest value in the fifith leachate ,while in the third and sixth leachates the highest values were recorded under the treatment of (CM+T+S). In the first and second leachates, the addition of (CM + T + S + neutral WCF) gave the highest values. However, the addition of (CM + T + acidicWCF) gave the highest value in the fourth leachate. Moreover, the highest values of

Table 5. Effect of some soil amendments and their combination on leaching nitrogen forms through sandy soil columns

Treatments	N-form (ppm)	Number of leachates							
		1	2	3	4	5	6	7	8
Control	NH_4-N	1.33	1.26	1.12	1.82	1.54	1.54	1.12	0.56
	NO_3-N	0.38	2.80	1.26	0.28	0.00	0.00	0.14	0.00
BM	NH_4-N	1.86	1.12	1.12	0.98	1.40	1.54	0.70	0.56
	NO_3-N	0.35	1.54	1.68	1.40	0.70	0.14	0.14	0.00
BM + T	NH_4-N	1.35	1.26	0.98	0.70	1.54	1.26	0.56	0.56
	NO_3-N	0.23	0.84	0.56	2.80	0.84	0.28	0.14	0.00
BM + T + acidic WCF	NH_4-N	1.47	1.26	0.98	0.70	1.26	1.26	0.98	0.56
	NO_3-N	0.28	0.84	0.42	1.96	0.84	0.00	0.14	0.14
BM + T + neutral WCF	NH_4-N	1.31	1.26	0.84	0.84	1.26	1.26	0.70	0.42
	NO_3-N	0.39	0.70	0.84	1.82	0.98	0.14	0.14	0.14
BM + T + S	NH_4-N	1.44	1.40	0.98	0.84	1.26	1.12	0.84	0.28
	NO_3-N	0.25	0.84	1.40	1.26	1.12	0.14	0.00	0.42
BM + T + S + acidic WCF	NH_4-N	1.75	1.40	1.26	0.84	1.40	0.98	0.70	0.84
	NO_3-N	0.35	0.70	0.56	1.40	0.70	0.28	0.00	0.00
BM + T + S + neutral WCF	NH_4-N	1.24	1.40	0.98	0.84	0.98	1.12	0.70	0.56
	NO_3-N	0.72	0.98	0.42	1.40	1.12	0.28	0.00	0.14
CM	NH_4-N	2.61	5.46	5.04	3.78	3.22	3.50	3.36	2.66
	NO_3-N	0.24	0.70	0.14	1.26	0.98	0.28	0.00	0.56
CM + T	NH_4-N	2.22	4.90	3.92	2.94	2.66	2.10	0.56	0.70
	NO_3-N	0.36	0.42	0.70	1.26	0.98	0.14	0.70	0.98
CM + T + acidic WCF	NH_4-N	2.75	4.48	1.96	2.94	3.92	4.62	3.36	3.36
	NO_3-N	0.22	1.26	0.70	0.42	0.28	0.14	0.56	1.26
CM + T + neutral WCF	NH_4-N	1.57	5.32	4.76	4.62	3.78	3.92	2.66	1.54
	NO_3-N	0.24	0.14	0.42	0.14	0.42	0.42	0.28	1.40
CM + T + S	NH_4-N	1.94	4.34	4.76	4.62	4.90	3.22	0.84	0.28
	NO_3-N	0.41	0.28	0.42	0.28	0.70	1.12	0.84	0.28
CM + T + S + acidic WCF	NH_4-N	2.48	4.20	5.04	5.88	6.72	5.32	2.80	1.26
	NO_3-N	0.45	0.42	0.98	0.56	0.70	0.14	1.26	1.54
CM + T + S + neutral WCF	NH_4-N	1.71	4.34	5.32	5.18	4.20	5.74	6.58	1.40
	NO_3-N	0.39	1.26	0.28	0.14	0.56	0.56	0.28	0.42

BM: Biogas manure, T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer, S: Sulfur, CM: Chicken manure.

Table 6. Effect of some soil amendments and their combination on leaching nitrogen forms through calcareous soil columns

Treatments	N-form (ppm)	Number of leachates							
		1	2	3	4	5	6	7	8
Control	NH_4-N	3.47	1.68	2.24	2.24	1.68	1.82	0.98	0.84
	NO_3-N	0.24	1.26	1.82	1.26	0.70	0.14	0.70	0.56
BM	NH_4-N	3.23	1.68	2.24	1.96	2.52	1.96	1.68	0.84
	NO_3-N	0.69	1.54	2.24	2.38	0.28	0.14	0.42	0.42
BM + T	NH_4-N	2.99	1.40	1.68	1.82	1.96	1.82	1.12	0.70
	NO_3-N	0.75	1.26	1.68	0.42	0.28	0.56	0.28	0.00
BM + T + acidic WCF	NH_4-N	3.44	2.10	1.96	2.10	2.24	0.98	1.40	0.84
	NO_3-N	0.16	0.70	0.28	1.54	0.28	0.14	0.84	0.14
BM + T + neutral WCF	NH_4-N	3.61	1.82	3.08	1.68	1.82	0.84	0.98	0.98
	NO_3-N	2.19	0.70	1.12	0.98	0.28	0.42	0.56	0.56
BM + T + S	NH_4-N	2.79	1.26	1.82	1.68	2.10	1.12	1.40	1.12
	NO_3-N	0.40	2.10	0.42	0.14	0.70	0.14	0.00	0.14
BM + T + S + acidic WCF	NH_4-N	3.12	1.26	2.10	1.40	1.82	0.84	1.40	0.98
	NO_3-N	3.90	1.54	0.28	0.84	0.28	0.42	0.00	0.28
BM + T + S + neutral WCF	NH_4-N	3.52	1.68	1.68	1.68	1.96	0.70	1.26	0.98
	NO_3-N	3.13	2.38	1.40	2.38	0.28	0.84	0.28	0.42
CM	NH_4-N	4.04	1.82	1.96	3.50	1.54	1.26	1.26	1.26
	NO_3-N	0.38	0.70	1.82	0.42	0.14	0.14	0.28	0.00
CM + T	NH_4-N	3.65	2.66	2.52	3.08	2.24	1.26	1.68	1.26
	NO_3-N	2.71	0.56	0.42	1.82	0.84	0.14	0.14	0.28
CM + T + acidic WCF	NH_4-N	7.01	1.96	2.10	2.24	2.38	0.98	1.26	1.33
	NO_3-N	2.17	0.42	0.28	1.68	0.14	0.14	0.00	0.24
CM + T + neutral WCF	NH_4-N	2.89	1.82	2.52	3.92	1.82	1.54	1.54	0.84
	NO_3-N	0.70	0.56	1.54	0.28	0.42	0.42	0.00	0.00
CM + T + S	NH_4-N	4.01	1.82	1.12	5.04	3.50	1.12	2.24	0.84
	NO_3-N	0.58	0.42	1.82	0.56	0.14	0.70	0.14	0.00
CM + T + S + acidic WCF	NH_4-N	3.37	1.68	1.82	4.90	2.1	0.84	1.54	0.00
	NO_3-N	0.77	0.70	1.26	0.56	0.28	0.56	0.42	0.00
CM + T + S + neutral WCF	NH_4-N	4.56	1.68	3.08	4.34	2.80	0.84	1.26	1.12
	NO_3-N	3.24	0.84	0.56	0.56	0.14	0.42	0.28	0.00

BM: Biogas manure, T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer, S: Sulfur, CM: Chicken manure.

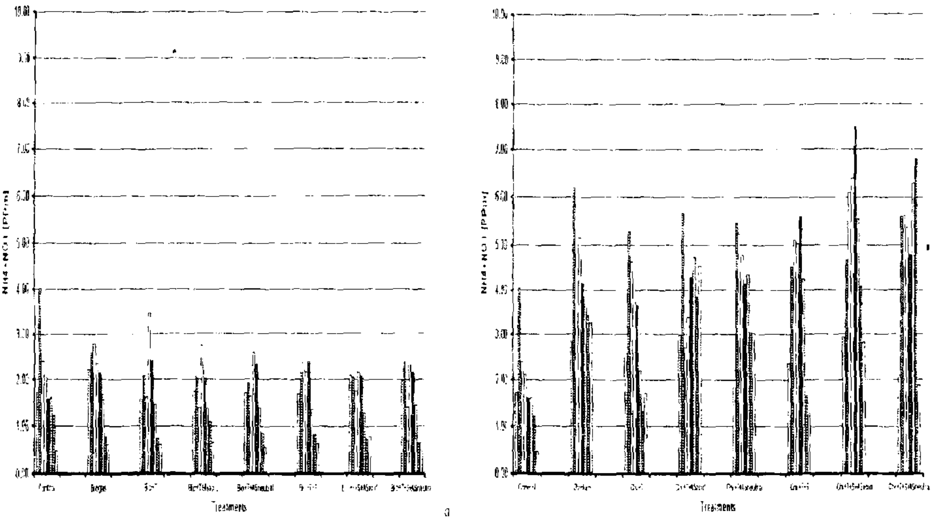


Fig. 1. Leaching of $(NH_4^{+}+NO_3^{-})$-N through sandy soil columns as affected by the application of some soil amendments

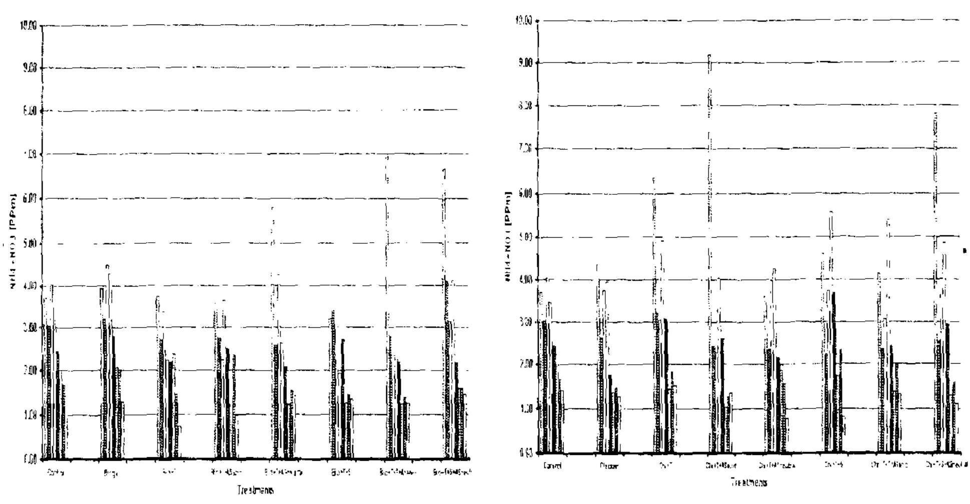


Fig. 2. Leaching of $(NH_4^{+}+NO_3^{-})$-N through calcareous soil columns as affected by the application of some soil amendments

leached NO_3-N in the seventh and eighth were observed with no addition of soil amendments. In this respect, using taffla material, elemental sulphur, and chicken manure affected the CEC, pH and consequently the availability of nitrogen forms as reported by Salem (2004), Wahdan *et al.* (2005) and Abdel-All *et al.* (2007).

Nitrate - Ammonium (NO_3^- – N / NH_4^+ – N) Ratio

Sandy soil

Nitrate-ammonium ratio for the different treatments was calculated according to the amounts of ammonium and nitrate in the leachates.

The results in Table 7 indicate that the highest mean values of the ratio were 0.67 using biogas manure and 0.24 with chicken manure. In the first leachate, the greatest ratio was found under the treatment of biogas manure combined with taffla material or combined with taffla and acidic WCF.

In the second and third leachates, the highest ratio were found under the treatments of control or BM, respectiviely. While the addition of chicken manure, the highest ratio was observed with CM + T + acidic WCF, and CM+ T+ acidic WCF, respectively.

In the fourth and fifth leachates, the greatest ratios were found under the addition of biogas manure combined with taffla material and under BM+ T+ S+ neutral WCF treatments, respectively.

In the sixth and seventh leachates, the greatest ratio was found with the treatment of (BM + T + S + acidic WCF) and (BM+T), respectively. On the other hand, addition of chicken manure gave the highest ratio under the addition of chicken manure combined with taffla material or with CM +T, respectively.

In the final leachate (8 weeks), the greatest ratio was found under the treatment of (BM T + S). On the other hand, addition of chicken manure,the highest ratio under the treatment of (CM + T).

El-Sherbieny *et al.* (1986) studied the activity index and leacheability of some controlled – release nitrogen fertilizers and their availability in sandy soil and they stated the mean values of the nitrate ammonium ratio ranged from 0.38 to 0.88.

Calcareous soil

Data presented in Table 8 show the highest mean values of the ratio

Table 7. Nitrification efficiency of leacheable nitrogen in the intermittent leaching through sandy soil columns as affected by testd soil amendments

Treatments	Number of leachates							
	1	2	3	4	5	6	7	8
Control	0.17	2.22	1.13	0.15	0.00	0.00	0.13	0.00
BM	0.15	1.37	1.5	1.43	0.50	0.09	0.20	0.00
BM + T	0.66	0.66	0.57	4.0	0.54	0.22	0.25	0.00
BM + T + acidic WCF	0.66	0.66	0.43	2.80	0.66	0.00	0.14	0.25
BM + T + neutral WCF	0.33	0.56	1.0	2.16	0.78	0.11	0.20	0.33
BM + T + S	0.20	0.60	1.43	1.50	0.89	0.13	0.00	1.50
BM + T + S + acidic WCF	0.15	0.50	0.44	1.67	0.50	0.28	0.00	0.00
BM + T + S + neutral WCF	0.56	0.70	0.43	1.67	1.14	0.25	0.00	0.25
CM	0.11	0.13	0.03	0.33	0.30	0.08	0.00	0.21
CM + T	0.19	0.09	0.18	0.43	0.37	0.07	1.25	1.40
CM + T + acidic WCF	0.1	0.28	0.36	0.14	0.07	0.03	0.17	0.38
CM + T + neutral WCF	0.18	0.03	0.09	0.03	0.11	0.11	0.11	0.91
CM + T + S	0.21	0.06	0.09	0.06	0.14	0.35	1.0	0.25
CM + T + S + acidic WCF	0.17	0.1	0.19	0.10	0.10	0.03	0.45	1.22
CM + T + S + neutral WCF	0.25	0.29	0.05	0.03	0.13	0.10	0.04	0.30

BM: Biogas manure, T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral 0.08capture fertilizer, S: Sulfur, CM: Chicken manure. N.E: Nitrification efficiency (N.E=NO_3-N/ NH_4-N ratio).

Table 8. Nitrification efficiency of leacheable nitrogen in the intermittent leaching through calcareous soil columns as affected by some soil amendments

Treatments	Number of leachates							
	1	2	3	4	5	6	7	8
Control	0.08	0.75	0.81	0.56	0.42	0.06	0.71	0.67
BM	0.22	0.92	1.0	1.21	0.05	0.07	0.25	0.50
BM + T	0.24	0.90	1.0	0.23	0.14	0.31	0.25	0.00
BM + T + acidic WCF	0.04	0.33	0.14	0.73	0.13	0.14	0.60	0.17
BM + T + neutral WCF	0.77	0.38	0.36	0.58	0.15	0.50	0.57	0.57
BM + T + S	0.15	1.70	0.33	0.08	0.33	0.13	0.00	0.13
BM + T + S + acidic WCF	1.27	1.22	0.13	0.60	0.15	0.50	0.00	0.29
BM + T + S + neutral WCF	0.88	1.42	0.83	1.42	0.14	1.20	0.22	0.43
CM	0.10	0.38	0.93	0.12	0.09	0.11	0.22	0.00
CM + T	0.73	0.21	0.17	0.59	0.38	0.11	0.08	4.50
CM + T + acidic WCF	0.32	0.21	0.13	0.75	0.06	0.14	0.00	0.33
CM + T + neutral WCF	0.24	0.31	0.61	0.07	0.23	0.27	0.00	0.00
CM + T + S	0.14	0.23	1.63	0.11	0.04	0.63	0.06	0.00
CM + T + S + acidic WCF	0.25	0.42	0.69	0.11	0.13	0.67	0.27	0.00
CM + T + S + neutral WCF	0.70	0.50	0.18	0.13	0.05	0.50	0.22	0.00

BM: Biogas manure, T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer, S: Sulfur, CM: Chicken manure, N.E: Nitrification efficiency (N.E=NO_3-N/ NH_4-N ratio) were 0.48 under the addition of biogas manure and 0.36 with chicken manure. In the first leachate, the greatest ratio was observed under the treatment of biogas manure combined with taffla material, sulfur and acidic WCF. On the other hand, addition of chicken manure gave the highest ratio under the addition of chicken manure combined with taffla material.

In the second leachate, the highest ratio was observed due to the addition of (BM + T+ S). Regarding to the addition of chicken manure, the greatest ratio was found with the treatment of chicken manure combined with taffla material and sulphur.

In the fourth leachate, the greatest ratio was found under the treatment of (BM + T+ S + neutral WCF). Concerning to the addition of chicken manure the highest ratios was observed with (CM + T + acidic WCF). In the sixth and seventh leachates, the greatest ratio were found under the treatments of (BM + TM + S + neutral WCF) and control treatments, respectively. While the addition of using chicken manure gave the greatest ratio under (CM + TM+ S + acid WCF).These results may be due to the effects of chicken manure and taffla material in improving the soil properties and increasing the rate of nitrification process as recorded by Abdel-Samad, *and* Eid (1995), Negm *et al.* (2003) and Dahdouh *et al.* (2004).

Residual Available Nitrogen in Soil

Sandy soil

Regarding to the residual available-N, (NH_4 + NO_3) – N in the soil after the intermittent leaching, data in Table 9 showed that in the case of biogas manure, the highest value of residual available – N was observed under the addition of (BM + T) in the layer of (20 – 30 cm) while the lowest value was found under the addition of (BM + T+ S + neutral WCF) in first soil layer of (0 – 10 cm). Concerning the effect of chicken manure the greatest value of residual available – N was observed under the addition of (CM + T + acidic WCF) in the layer (20 – 30 cm), while the lowest value was found under the treatment of (CM + T) in the layer (10 – 20 cm) or (CM + TM + S + acidic WCF) in the first layer, (0–10cm). These results may be attributed to the effect of organic manure on the exchange capacity and soil reaction as reported by Basyony, (2002) and Negm *et al.* (2003).

It is obvious from the obtained data in Table 9 that in the case of biogas manure, the greatest value of residual NH_4 – N was found under the addition of (BM + T) in the third layer (20 – 30 cm) while the lowest value was found with (BM + T + S) in the first layer (0 – 10 cm) or BM + T + S + acidic WCF in the second layer (10 – 20 cm). On the other hand, under chicken manure addition, the highest value was observed with (CM + T + acidic WCF) in the third layer (20 – 30 cm), while CM individually gave the lowest value of NH_4-N in the the layer of (0-10cm).

Taking the residual NO_3 – N in the soil after the intermittent leaching, into consideration, data in Table 9 show that in the case of biogas manure the highest value of residual NO_3 – N was noticed with the control treatment in the layer (20 – 30 cm) or with (BM + T + S)in the first layer (0 – 10 cm), while the lowest value was found with control in the layer of (0 -10 cm) or BM treatment in layers (0 – 10 cm).On the other hand, using chicken manure, the highest value was found with the addition of (CM + T + S + neutral WCF) in the layer (20 – 30 cm) while the lowest was found with CM individual in layer of (10 – 20 cm) and (20 – 30 cm) or (CM + T) in layer of (10 – 20 cm) and (20 – 30 cm) or under the addition of (CM + T + S + acidic WCF) in first layer of (0 – 10 cm). Dahdouh *et al.* (2004) reported that chicken manure application increased the values of available nitrogen remained in the soil after leaching through soil columns.

Calcareous soil

According to the results in the present study, data in Table 9 show that in the case of biogas manure, the treatment of BM+T+S in the layer of (20-30cm) gave the highest value of (NH_4+NO_3)-N ,while the lowest value was found with (BM + T + neutral WCF) treatment in the layer of (10 – 20 cm). On the other hand, using chicken manure, the highest value was attained with CM individual in the soil layer of (20 – 30 cm), while treating soil with (CM + T + S + acidic WCF) gave the lowest available –N in the layer of (10 – 20 cm). That may be due to the effect of organic manure and taffla material on increasing the available N as confirmed by Dahdouh *et al.* (2004).

Table 9. Residual available N-forms (ppm) in the different layers of sandy and calcareous soil columns at the end of interimittent leaching as influenced by some soil amendments

Treatments	Soil depth (cm)	Sandy soil			Calcareous soil		
		NH_4-N	(NH_4+NO_3)-N	NO_3-N	NH_4-N	(NH_4+NO_3)-N	NO_3-N
Control	0 - 10	52.50	52.50	0.00	56.70	60.90	4.20
	10 - 20	37.80	50.40	12.60	52.50	52.50	0.00
	20 - 30	25.20	42.00	16.80	60.90	60.90	0.00
BM	0 - 10	63.00	63.00	0.00	44.10	60.90	16.80
	10 - 20	42.00	42.00	0.00	42.00	50.40	8.40
	20 - 30	67.20	67.20	0.00	54.60	54.60	0.00
BM+T	0 - 10	37.80	48.30	10.50	54.60	58.80	4.20
	10 - 20	37.80	48.30	10.50	56.70	56.70	0.00
	20 - 30	81.90	81.90	0.00	56.70	56.70	0.00
BM+T+ acidic WCF	0 - 10	39.90	44.10	4.20	52.50	60.90	8.40
	10 - 20	44.10	50.40	6.30	52.50	63.00	10.50
	20 - 30	56.70	56.70	0.00	52.50	52.50	0.00
BM+T+ neutral WCF	0 - 10	39.90	44.10	4.20	50.40	50.40	0.00
	10 - 20	42.00	48.30	6.30	46.20	46.20	0.00
	20 - 30	63.00	63.00	0.00	56.70	56.70	0.00
BM+T+S	0 - 10	25.20	39.90	14.70	42.00	60.90	18.90
	10 - 20	29.40	42.00	12.60	50.40	50.40	0.00
	20 - 30	44.10	44.10	0.00	84.00	84.00	0.00
BM+T+S+ acidic WCF	0 - 10	33.60	42.00	8.40	60.90	60.90	0.00
	10 - 20	25.20	39.90	14.70	60.90	67.20	6.30
	20 - 30	37.80	44.10	6.30	65.10	65.10	0.00
BM+T+S+ neutral WCF	0 - 10	31.50	35.70	4.20	42.00	56.70	14.70
	10 - 20	39.90	39.90	0.00	42.00	56.70	14.70
	20 - 30	42.00	42.00	0.00	65.10	79.80	14.70
CM	0 - 10	27.30	42.00	14.70	60.90	60.90	0.00
	10 - 20	42.00	42.00	0.00	147.00	153.30	6.30
	20 - 30	52.50	52.50	0.00	134.40	182.70	48.30
CM+T	0 - 10	37.80	48.30	10.50	67.20	67.20	0.00
	10 - 20	39.90	39.90	0.00	86.10	100.80	14.70
	20 - 30	46.20	46.20	0.00	69.30	69.30	0.00
CM+T+ acidic WCF	0 - 10	42.00	56.70	14.70	52.50	52.50	0.00
	10 - 20	42.00	60.90	18.90	149.10	149.10	0.00
	20 - 30	65.10	94.50	29.40	92.40	92.40	0.00
CM+T+ neutral WCF	0 - 10	44.10	44.10	0.00	54.60	86.10	31.50
	10 - 20	44.10	54.60	10.50	79.80	84.00	4.20
	20 - 30	42.00	60.90	18.90	142.80	142.80	0.00
CM+T+S	0 - 10	44.10	63.00	18.90	60.90	60.90	0.00
	10 - 20	42.00	56.70	14.70	60.90	98.70	37.80
	20 - 30	50.40	65.10	14.70	102.90	102.90	0.00
CM+T+S+ acidic WCF	0 - 10	39.90	39.90	0.00	42.00	50.40	8.40
	10 - 20	58.80	65.10	6.30	44.10	44.10	0.00
	20 - 30	39.90	50.40	10.50	65.10	65.10	0.00
CM+T+S+ neutral WCF	0 - 10	42.00	52.50	10.50	60.90	60.90	0.00
	10 - 20	42.00	60.90	18.90	46.20	46.20	0.00
	20 - 30	58.80	90.30	31.50	134.40	134.40	0.00

BM: Biogas manure, T: Taffla, Acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer, S: Sulfur, CM: Chicken manure

In addition, the present results in Table 9 show that in the case of biogas manure, the greatest value was observed with the addition of (BM + T + S) in the layer of (20 – 30 cm), and with the addition of BM individual in layer of (10 – 20 cm), while the addition of BM combined with taffla material and sulfur in layer of (0 – 10 cm) gave the lowest ammonium nitrogen value. On the other hand, using chicken manure the value was the highest with the addition of (CM + T + acidic WCF) in layer of (10 – 20 cm), while the lowest value was found with the addition of (CM + T + S + acidic WCF) in the upper the layer of (0 – 10 cm). Khater *et al.* (2002) and Negm *et al.* (2003) reported that application of some organic amendments increased the available – N and led to an improvements in soil properties.

In the present study, it was noticed that in the case of biogas, the highest value of residual NO3 – N was found with the addition of (BM + T + S) in layer of (0 – 10 cm), while the lowest value was found with BM individual in layer of (20 – 30 cm) or with the addition (BM + T) in the layer of (10 - 20 cm) and (20 – 30 cm).On the other hand, under using chicken manure the greatest value was observed with CM individual in the layer of (20 – 30 cm) while the lowest value was found with CM in the layer of (0 – 10 cm) or (CM+ T) in the layer (0 – 10 cm). These results may be due to the effect of taffla materials and WCF which increased CEC and available N as a result of lowering pH values as reported by El-Shanawany *et al.* (1994) and Osman Fatma *et al.* (2004).

Nitrification Rate (%)

Sandy soil

Nitrification efficiency as percentage was calculated according to the following equation $NO_3 - N / (NH_4 + NO_3) - N . 100$. Data presented in Table 10 showed that the highest value of nitrification rate was found with the addition of (BM + TM + S) in the layer of (0 – 10 cm). On the other hand, the values were declined in the third layer (20 – 30 cm), with the same treatment.

Using chicken manure, data show that the highest value was found with the addition of chicken manure individual in the layer of, (0 – 10 cm), while in the layers of (10 – 20 cm) and (20 – 30 cm) the greatest value of nitrification rate was found with the addition (CM + T + acidic WCF).

Calcareous soil

According to the obtained results of Table 10, the greatest value of nitrification rate was found under the addition of (BM + T + S) in the upper layer of (0 – 10cm), while in the second layer of (20 – 30 cm), the highest rate was shown with the addition of (BM + T + S+ neutral WCF). On the other hand, the values were declined in the layer of (20 – 30 cm). Using chicken manure the greatest value was found with the addition of (CM + T + neutral WCF) in layer of (0 – 10 cm), in the layer of (10 – 20 cm) the highest value was recorded under the addition of CM + T + S. On the other hand, the values were declined in the third layer (20 – 30 cm).

Accumulated Leached N–forms

Sandy soil

It is obvious from the obtained results in Figs. 3 and 4. That in the case of biogas manure after two weeks, the accumulated NH_4-N in the leachate was the highest in the treatment of (BM+T+S+acidic WCF), while the lowest value was found under the treatment of (BM + T + neutral WCF). In the case of chicken manure, the greatest values were found under the treatment of chicken manure individual, while the lowest value was found in the treatment of (CM + T+ S + neutral WCF).

In the case of biogas manure, the accumulated NH_4-N in the leachate after four weeks was the highest under the treatment of BM + T+ S + acidic WCF, while the lowest value was found in the treatment of (BM + T+ neutral WCF).

These results may be due to the effect of chicken manure, taffla material, and water capture fertilizer which affected the properties of soil and then nitrification process as indicated by Khater *et al.* (2002) and Osman Fatma *et al.* (2005).

As regard to chicken manure application,the accumulated NH_4-N in the leachate was the highest under the treatment of (CM + T + acidic WCF), while the lowest value was found with the addition of (CM + T + acidic WCF) .

As regard to of biogas manure, after sixth weeks, the accumulated ammonium in the leachate was the greatest in the treatment of control, while the lowest value was found with BM + T + S + neutral WCF. On the other hand, in the case of chicken manure, the highest value was found in the treatment of CM + T +S + acidic WCF, while the lowest one was found with CM+T treatment.

After eight weeks of intermittent leaching, the accumulated leached ammonium was the greatest in the treatment of control or biogas manure individual while the lowest was found with (BM + T+ S + neutral WCF). Using chicken manure the greatest value was attained with (CM + T+ S + neutral WCF), while the lowest value was found in the treatment of (CM + T). In the case of biogas manure, after two weeks, the accumulated nitrate – N in the leachate was the highest in the treatment of control while the lowest value was found with (BM + T or BM + T + S + neutral WCF). On the other hand, using chicken manure, the greates value was found with (CM + T + S + neutral WCF), while the lowest value was found with (CM + T + neutral WCF) treatment.

After sixth weeks, in the case of biogas manure, the greatest value of NO_3-N was found under the biogas manure individual treatment, while the lowest value was observed under the treatment of (BM + T+ S + acidic WCF). On the other hand, using chicken manure, the accumulated NO_3– N in the leachate was the greatest under the treatment of chicken manure + taffla material, while the lowest value was found under the addition of (CM + T + neutral WCF).

As regard to biogas manure, after eight weeks, the accumulated NO_3-N in the leachate was the greatest under the treatment of biogas manure, individual while the lowest value observed under the treatment of (BM + T + S + acidic WCF). On the other hand, in the case of chicken manure addition the greatest was found under the treatment of (CM + T+ S + acidic WCF), while the lowest value was found with the addition of (CM + T + neutral WCF).

After eight weeks, in the case of biogas manure the accumulated (NH_4+NO_3) – N was the highest under the treatment of biogas manure individual, while the lowest value was found with the addition of (BM + T + S + acidic WCF). On the other hand, using chicken manure the accumulate available – N under the leachate was the greatest in the treatment of CM + T + S + acidic WCF, while the lowest was found under the addition of (CM + T).

Basyony (2002), Negm *et al.* (2003) and Wahdan *et al.* (2005) mentioned that organic material, sulfur and taffla application increased the available nitrogen forms and affected CEC and pH values.

Calcareous soil

Results of accumulated N forms leached through calcareous soil columns are illustrated in Figs. 5and 6. In the case of biogas manure, after two weeks, the accumulated NH_4-N in the leachate was the highest under the treatment of (BM + T+ neutral WCF), while the lowest was found under the treatment of (BM + T + S). On the other hand, using chicken manure, the accumulated NH_4-N under the leachate was the greatest in the treatment of (CM + T + acidic WCF), while the lowest was found under the addition of (BM + T + neutral WCF).

After sixth weeks, in the case of biogas manure, the accumulated NH_4-N in the leachate was the greatest under treatment of biogas manure individual while the lowest was observed due to the treatment of (BM + T+ S + neutral WCF). On the other hand, using chicken manure the highest value was found with the addition of (CM + T + S), while the lowest value was observed with the addition of chicken manure individual.

After eight weeks, in the case of biogas manure, the accumulated NH_4-N in the leachate was the highest under the treatment of biogas manure individual, while the lowest value was found with the addition of (BM + T + S + acidic WCF). On the other hand, using chicken manure, the greatest value was found with the addition of (BM + T + S), while the lowest value was found with the addition of chicken manure individual.

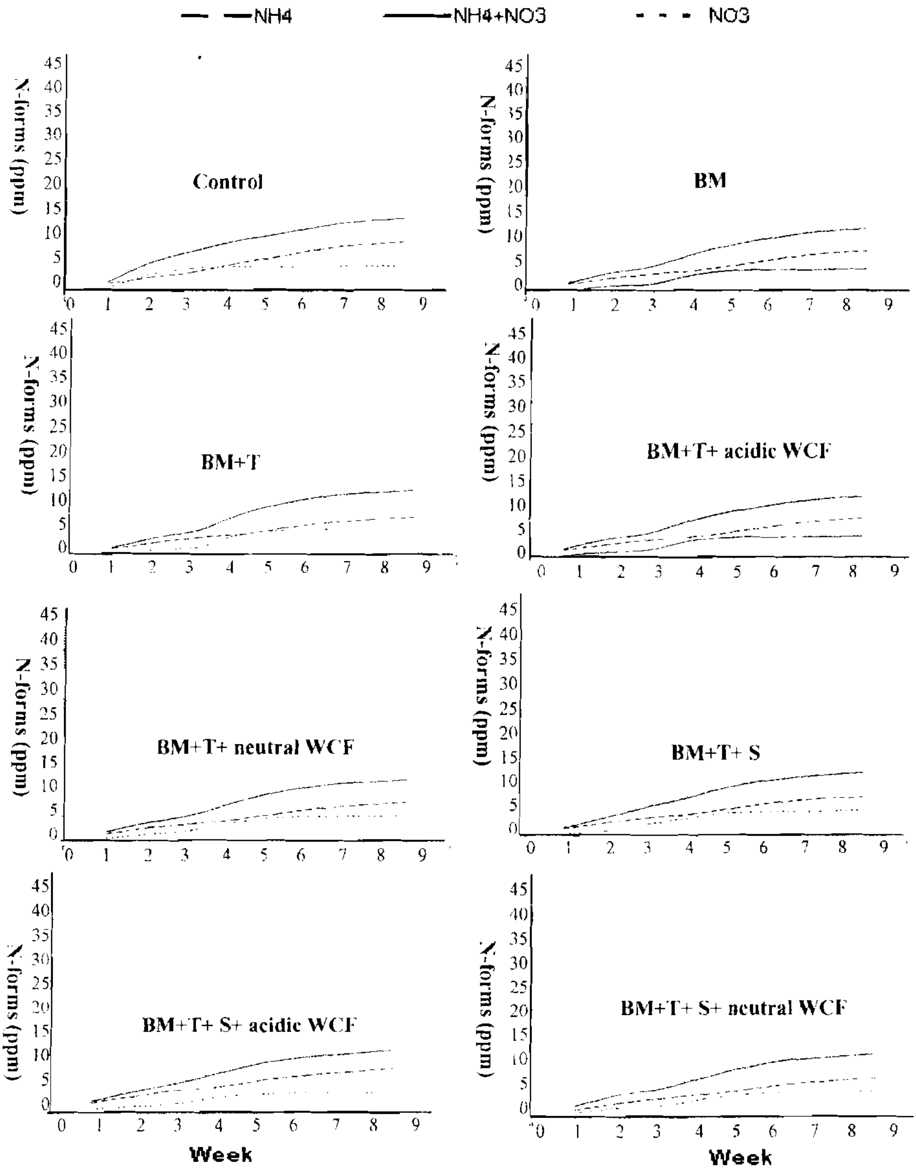
In the case of chicken manure, the values were the highest with chicken manure combined with TM+ S + neutral WCF, while the lowest value was found with the addition of chicken manure individual. These results were confirmed with those stated by Abdel- All *et al.*, (2007).

In general, treating soil with (BM + T + S + neutral WCF) gave the greatest values of accumulated leached nitrogen forms from second to eighth.

Table 10. Nitrification rate (%) in the different layers of sandy and calcareous soil Columns at the end of intermittent leaching as affected by investigated Soil amendments

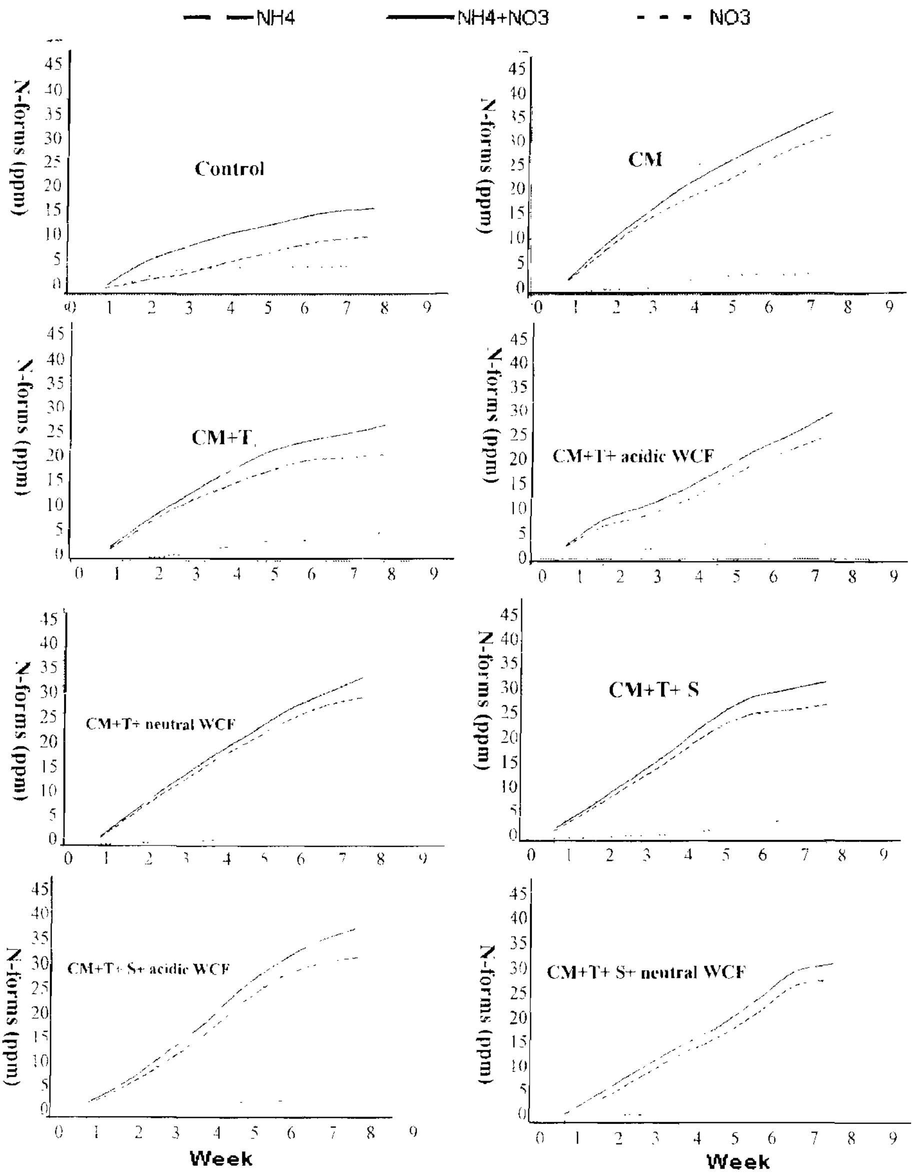
Treatments	Sandy soil			Calcareous soil		
	Soil depth(cm)					
	0-10	10-20	20-30	0-10	10-20	20-30
Control	0.00	25	40.00	6.89	0.00	0.00
BM	0.00	0.00	0.00	27.5	16.66	0.00
BM + T	21.7	21.7	0.00	7.14	0.00	0.00
BM + T + acidic WCF	9.5	12.5	0.00	13.79	16.66	0.00
BM + T + neutral WCF	9.5	13.04	0.00	0.00	0.00	0.00
BM + T + S	36.8	30	0.00	31.03	0.00	0.00
BM + T + S + acidic WCF	20	36.84	14.28	0.00	9.37	0.00
BM + T + S + neutral WCF	11.76	0.00	0.00	25.9	25.9	18.42
CM	35	0.00	0.00	0.00	4.10	26.43
CM + T	21.73	0.00	0.00	0.00	14.58	0.00
CM + T + acidic WCF	26	31.03	31.11	0.00	0.00	0.00
CM + T + neutral WCF	0.00	19.23	31.03	37.45	5.00	0.00
CM + T + S	30	26	22.6	0.00	38.29	0.00
CM + T + S + acidic WCF	0.00	9.67	20.8	16.66	0.00	0.00
CM + T + S + neutral WCF	20	31	31.9	0.00	0.00	0.00

BM: Biogas manure. T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer, S: Sulfur, CM: Chicken manure



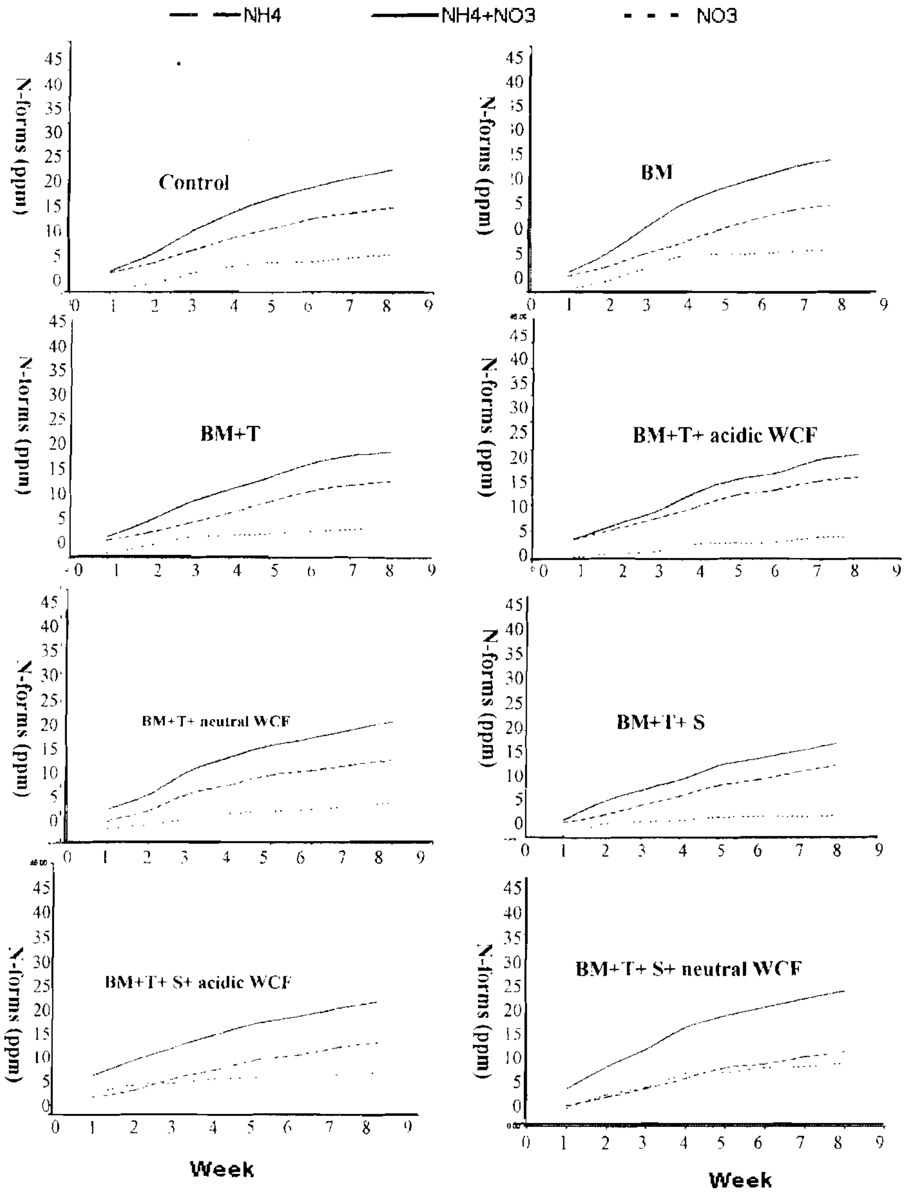
BM: Biogas manure, T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer, S: Sulfur

Fig. 3. Accumulated leacheable N-forms as a result to intermittent leaching through sandy soil coulombs treated with different soil amendments



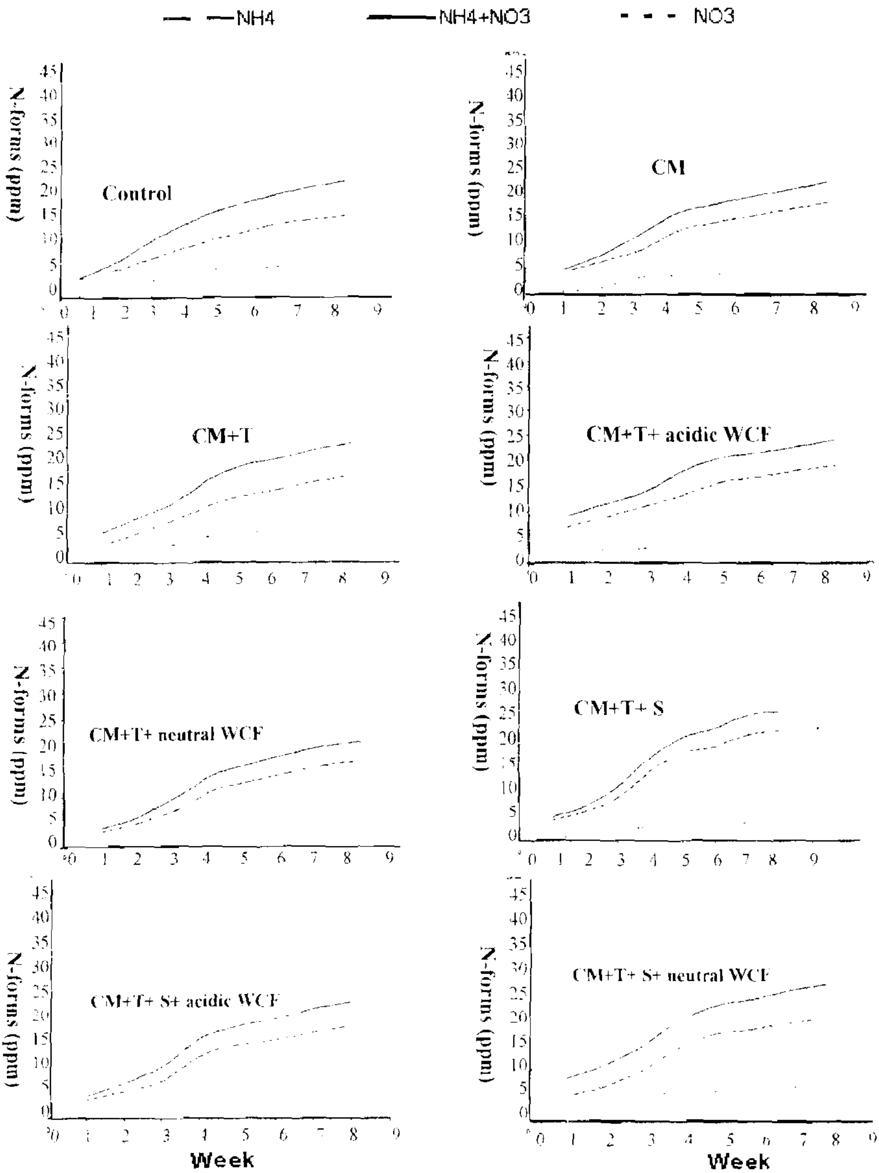
T: Taflla. acidic WCF: Acidic water capture fertilizer. neutral WCF: Neutral capture fertilizer. S: Sulfur. CM: Chicken manure

Fig. 4. Accumulated leacheable N-forms as a result to intermittent leaching through sandy soil coulombs treated with different soil amendments



BM: Biogas manure, T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer, S: Sulfur

Fig. 5. Accumulated leacheable N-forms as a result to intermittent leaching through calcareous soil coulombs treated with different soil amendments



T: Taflla, acidic WCF: Acidic water capture fertilizer, neutral WCF: Neutral capture fertilizer. S: Sulfur, CM: Chicken manure

Fig. 6. Accumulated leacheable N-forms as a result to intermittent leaching through calcareous soil coulombs treated with different soil amendments

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حركه وغسيل صور النيتروجين خلال الأراضى الرملية والجيرية تحت تأثير إضافة بعض مصلحات التربة

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أجريت تجربة معملية لدراسة تأثير بعض مصلحات التربة مثل سماد البيوجاز وسماد الدواجن والطفلة والكبريت والسماد الماسك للماء الحامضي والمتعادل علي سلوك النيتروجين خلال عمليات الغسيل المتقطع في الأرض الرملية والجيرية وهذه المواد تحت الدراسة أضيفت منفردة أو مختلطة.

ويمكن تلخيص النتائج المتحصل عليها كما يلي:

١- ازدادت الكمية الميسرة من النيتروجين الأمونيومي والنتراتي وذلك عند معاملة التربة بكل من سماد الدواجن وسماد البيوجاز والطفلة والسماد الماسك للماء الحامضي والمتعادل كنتيجة لتأثيرها علي السعة التبادلية الكاتيونية وكذلك درجة حموضة الوسط.

٢- وصلت الكمية المغسولة من النيتروجين الأمونيومي والنتراتي إلي أقصاها في الغسلة الأولي للأرض الجيرية عند معاملتها بسماد الدواجن المخلوط مع الطفلة والسماد الماسك للماء الحامضي، بينما وصلت أقصاها في الغسلة الخامسة للأرض الرملية المعاملة بسماد الدواجن المخلوط مع الطفلة والكبريت.

٣- إضافة سماد الدواجن منفرداً أو مختلطاً مع مصلحات التربة الأخري أدي إلي زيادة الكمية المتبقية من النيتروجين الأمونيومي والنتراتي بالتربة مقارنة بالمعاملة بسماد البيوجاز.

٤- كانت الكمية العظمى من النيتروجين الأمونيومي والنتراتي والميسر والمتبقى موجودة في الطبقة الثالثة (٢٠-٣٠سم) من أعمدة التربة لكلا من الأرضين الرملية والجيرية بينما كان أقلها في الطبقة الأولي (صفر- ١٠سم).

٥- تأثر معدل التأزت بوضوح بإضافة مصلحات التربة المختلفة و هذا المعدل وصل إلي أقصي قيمة له في الطبقة الثانية (١٠-٢٠ سم) من الأرض الرملية المعاملة بسماد البيوجاز، مختلطة مع الطفلة والكبريت والسماد الماسك للماء الحامضي بينما وصل هذا المعدل أقصاه في نفس الطبقة (١٠-٢٠سم) للأرض الجيرية المعاملة بسماد الدواجن مع الطفلة والكبريت.

٦- أقصي متوسط لقيمة نسبة النترات إلي الأمونيوم في مختلف المعاملات كان ٠,٦٧ عند المعاملة بسماد البيوجاز و ٠,٢٤ عند المعاملة بسماد الدواجن في الأرض الرملية ولكن في الأرض الجيرية كانت القيمة العظمي هي ٠,٤٨ باستخدام سماد البيوجاز و ٠,٣٦ عند استخدام سماد الدواجن.

٧- أقصي كمية من النيتروجين الأمونيومي والنتراتي المغسولة كانت عند المعاملة بسماد الدواجن مختلطة مع الطفلة والكبريت والسماد الماسك للماء المتعادل في الأرض الرملية والجيرية.