Abstract: Serious of incubation studies were conducted at Department of soil Science and Water Resources, College of Agriculture, University of Basrah to study the effect of temperature incubation and soil salinity levels (3, 6, 12 and 24) dS.m$^{-1}$ on N mineralization of cow manure and alfalfa residue under aerobic and flooded conditions. Fifteen gram of air dry soil with salinity levels of 3, 6, 12 and 24 dS.m$^{-1}$ treated with 5% of cow manure or alfalfa residue were incubated at 10, 20 or 30$^\circ$C for 28 days. Moisture level of incubated soil was kept at either field capacity or flooded condition. NH$_4^+$-N and NO$_3^-$-N concentrations of incubated samples were determined at the end of incubation period. Results showed that organic residues added to soils of all salinity levels increased NH$_4^+$-N and NO$_3^-$-N. Concentrations of both ions were higher in alfalfa residue treatment than those of cow manure at all treatments. Highest concentrations of NH$_4^+$-N and NO$_3^-$-N ions in all treatments obtained at samples incubated at 30$^\circ$C and E.C. of 3 dS.m$^{-1}$. Organic N mineralization under F.C. was higher than under logged water for all treatments.

Key words: NH$_4^+$, NO$_3^-$, Flooded, Field Capacity, Salinity, Temperature.

Introduction

Nitrogen is one of most important nutrient for plant growth. It involves in chlorophyll, proteins, enzymes, plant growth requires, among other (Leip et al., 2008). Plant absorbs N as NH$_4^+$ and NO$_3^-$ which usually supplied to plant by mineral and organic fertilizers. Organic fertilizers usually used by farmer as a supplementary for mineral N fertilizers (Ryals & Silver, 2013). Organic nitrogen fertilizers are represented by manures, plant residues and urea. The N component of manure and plant residues is mostly in protein form. The nitrogen as compounds in pretentious material undergo the following microbial decomposition:

\[
\text{Soil – organic – N} \rightarrow \text{R – NH}_2 + \text{CO}_2 + \text{other products} + \text{energy} \quad \cdots \cdots (1)
\]

\[
\text{R – NH}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{O} + \text{NH}_4\text{OH} + \text{ROH} + \text{energy} \quad \cdots \cdots (2)
\]

Microbial decomposition of organic N in soil affected by properties of organic residues such as C/N ratio, easily or non-easily decomposable organic molecules such as
lignin and other compounds among other properties. In addition soil properties such as pH, CEC and E.C. (Sahrawat, 2010), temperature (Wetterstedt, 2010) and soil moisture show significant effect on organic N mineralization in soil. In addition Abbasi et al. (2015) pointed that C/N of organic residue is a major factor affected the N mineralization process in soil. Soil moisture and salinity levels of irrigation water averages throughout the growing season, which in turn effect soil microorganism activity and biological process in soils. Hence, this study was carried to study the mineralization of cow manure and alfalfa residue under different moisture levels (F.C and logged water condition) and soil temperatures (10, 20 and 30 °C) with different salinity levels (3, 6, 12 and 24 dS.m⁻¹).

**Materials & Methods**

Surface soil sample was collected from depth of 0-30 cm from a field located at Basrah province, southern part of Iraq. Some physical and chemical properties of the soil were determined following procedures described by Page et al. (1982) and presented in table (1). Initial electrical conductivity (E.C) of collected soil was raised to 3, 6, 12 and 24 dS.m⁻¹ through leaching with mixture of NaCl, CaSO₄ and CaCl₂ or decreased to 3 dS.m⁻¹ through leaching with distilled water, then soil samples were air-dried. Some chemical properties of soil after adjusting of E.C were determined according to Page et al. (1982) and presented in table (1).

| Table (1): Some chemical and physical and biological properties to soil. |
|-------------------------------------------------|
| Property                      | Initial | EC (dS.m⁻¹) | Measure unit |
|--------------------------------|---------|-------------|--------------|
| E.C                           | 7.06    | 3           | 6            | 12          | 24          | dS.m⁻¹      |
| pH                            | 7.94    | 7.97        | 7.95         | 7.92        | 7.89        |             |
| CEC                           | 20.43   | 20.40       | 20.42        | 19.90       | 17.50       | Cmol(+) kg⁻¹|
| Organic matter                | 13.00   |             |             |             |             | gm. kg⁻¹    |
| Organic carbon                | 7.55    |             |             |             |             |             |
| Total nitrogen                | 1.50    |             |             |             |             |             |
| C:N                           | 5.03    |             |             |             |             |             |
| NH₄-N                         | 19.50   | 3.40        | 3.80         | 3.0         | 2.6         | mg. kg⁻¹    |
| NO₂-N                         | 0.00    | 0.00        | 0.00         | 0.00        | 0.00        |             |
| NO₃-N                         | 2.90    | 0.17        | 0.15         | 0.14        | 0.10        |             |
| CaCO₃                         | 293.00  | 359.00      | 362.00       | 368.00      | 371.00      | gm. kg⁻¹    |
| Ca²⁺                          | 16.00   | 8.00        | 14.00        | 24.00       | 45.00       | mmol. L⁻¹   |
| Mg²⁺                          | 9.00    | 4.00        | 10.00        | 18.00       | 41.00       |             |
| Na⁺                           | 17.00   | 5.00        | 10.00        | 22.00       | 43.00       |             |
| K⁺                            | 3.00    | 1.50        | 3.00         | 9.00        | 18.00       |             |
| CO₃⁻                          | 0.00    | 0.00        | 0.00         | 0.00        | 0.00        |             |
| HCO₃⁻                         | 7.00    | 4.00        | 7.00         | 15.00       | 30.00       |             |
| Cl⁻                           | 16.00   | 5.00        | 12.00        | 28.00       | 56.00       |             |
| SO₄²⁻                         | 22.00   | 10.00       | 20.00        | 36.00       | 72.00       |             |
| Soil texture                  | clay    |             |             |             |             | gm. kg⁻¹ soil |
Cow manure or alfalfa residue were mixed with soils at rate of 5% (organic source soil). Some chemical properties of organic source were determined according to Page et al. (1982) and presented in table (2). Fifteen grams (on dry soil bases) of the soils of different salinity levels treated with organic sources were placed in containers and incubated at three temperatures (10, 20 and 30 °C) for 28 days. The soil moisture of incubated samples was kept at either field capacity or logged water condition throughout incubation period. Desired moisture levels of incubated samples were maintained by periodic weighing of the containers.

![Table (2): Some chemical properties to organic source.](image)

Table (2): Some chemical properties to organic source.

| Property (Unite)       | Alfalfa residue | Cow manure |
|------------------------|-----------------|------------|
| pH (5:1)               | 5.90            | 6.80       |
| E.C (5:1) (dS.m⁻¹)     | 6.89            | 7.10       |
| Organic matter (gm. kg⁻¹) | 655.66        | 635.02     |
| Organic carbon (gm. kg⁻¹) | 381.20         | 369.20     |
| Total nitrogen gm. kg⁻¹ | 46.50           | 29.20      |
| Total phosphor (gm. kg⁻¹) | 1.30            | 1.90       |
| C:N Ratio              | 8.20            | 12.64      |

At the end of incubation period, samples were air-dried and mineralized N (NH₄⁺-N and NO₃⁻ + NO₂⁻) were determined by steam distillation following procedure of Bremner & Edwards (1965). The study was carried as factorial experiment with three replicates in complete randomized design. Data were analyzed using GenStat program.

**Results & Discussion**

**NH₄⁺ - N released**

Results of tables (3 and 4) showed that increasing incubation temperature from 10 to 30°C at all treatments resulted in significant increase in NH₄⁺ -N released from both source of organic residue as well as from control treatment at both moisture levels (F.C and logged water) and all salinity levels. Average of NH₄⁺ - N increased from 159.0 to 318.1 mg kg⁻¹ soil in samples incubated under F.C (table 3) and from 227.0 to 451.56 mg kg⁻¹ soil in samples incubated under logged water condition (table 4). Amount of NH₄⁺ - N produced in soil samples incubated under different soil moisture were significantly differ being higher for soils incubated under logged water then F.C (t value = 4.527).

Similar results were reported by Pérez-Batallón et al. (2001) and Cenkseven et al. (2017), who showed that increase soil temperature resulted in higher soil microorganisms activity, which in turn increase organic residue decomposition in soils. Data of tables (3 and 4) also revealed
that NH$_4^+$ -N concentration in soil treated with organic residues were higher than of control treatment at both moisture levels.

NH$_4^+$ -N values were higher in soils amended with alfalfa residue (average 254.0 mg.kg$^{-1}$) than their counterparts of soil treated with cow residue (average 250.4 mg.kg$^{-1}$). However, lowest value was recorded at control treatment (196.9 mg.kg$^{-1}$) in soil under F.C (table 3).

However, different trend for NH$_4^+$ - N concentration was recorded at soils incubated under logged water condition. Values of NH$_4^+$ -N concentration were 464.44 mg.kg$^{-1}$ as

Table (3): Effect of salinity levels and temperature on NH$_4^+$ - N mineralization in soil treated with cow manure or alfalfa residue incubated under F.C.

| Source       | Salinity levels (dS.m$^{-1}$) | Temperature $^\circ$C | Salinity level × source |
|--------------|-----------------------------|-----------------------|--------------------------|
|              | 10                          | 20                    | 30                       |
| Control      | 3                           | 168.0                 | 205.3                    | 308.0 | 227.1 |
|              | 6                           | 158.7                 | 177.3                    | 289.3 | 208.4 |
|              | 12                          | 149.3                 | 168.0                    | 226.0 | 181.1 |
|              | 24                          | 121.3                 | 140.0                    | 251.3 | 170.9 |
| Cow manure   | 3                           | 205.3                 | 345.3                    | 392.0 | 314.2 |
|              | 6                           | 196.0                 | 280.0                    | 308.0 | 261.3 |
|              | 12                          | 168.0                 | 224.0                    | 280.0 | 224.0 |
|              | 24                          | 158.7                 | 196.0                    | 252.0 | 202.2 |
| Alfalfa      | 3                           | 185.7                 | 391.3                    | 656.0 | 411.0 |
|              | 6                           | 152.3                 | 278.0                    | 477.3 | 302.6 |
|              | 12                          | 132.3                 | 172.3                    | 198.7 | 167.8 |
|              | 24                          | 112.3                 | 112.3                    | 179.0 | 134.6 |
| RLSD 0.05    | 55.71                       |                       |                          |       |
| Average effect temp. | 159.0           | 224.2                 | 318.1                    | Average type source |
| RLSD 0.05    | 16.08                       |                       |                          |       |
| Type source × temp. |                  |                       |                          |       |
| control      | 149.3                       | 172.7                 | 268.7                    | 196.9 |
| Cow manure   | 182.0                       | 261.3                 | 308.0                    | 250.4 |
| alfalfa      | 145.7                       | 238.5                 | 377.8                    | 254.0 |
| RLSD 0.05    | 27.85                       |                       |                          |       |
| Salinity × temp. |                  |                       |                          | Average of effect salinity |
| 3            | 186.3                       | 314.0                 | 452.0                    | 317.4 |
| 6            | 169.0                       | 245.1                 | 358.2                    | 257.4 |
| 12           | 149.9                       | 188.1                 | 234.9                    | 191.0 |
| 24           | 130.8                       | 149.4                 | 227.4                    | 169.2 |
| RLSD 0.05    | 32.16                       |                       |                          | 233.7 |
average in soil amended with cow manure and 304.39 mg.kg\(^{-1}\) as average in soil amended with alfalfa residue.

\(\text{NH}_4^+\) -N in control treatment recorded value of 192.11 mg.kg\(^{-1}\) soil (table 4). Result of Abbasi et al. (2015) showed that organic residue added to soil increased \(\text{NH}_4^+\) -N concentration.

Results of table (3) showed significant effect of organic sources on \(\text{NH}_4^+\) - N concentration in soil being higher for logged water level than under F.C level (t value = 4.527). Increasing salinity levels from 3 to 24 dS.m\(^{-1}\) decreased \(\text{NH}_4^+\) -N concentration from 317.4 to 169.2 mg.kg\(^{-1}\) in soils of field capacity treatment (table 3) and from 401.78 to 264.56 mg.kg\(^{-1}\) in soil incubation under logged water condition (table 4). These results are in accord with that of Inamura et al. (2009) and Walpola & Arunakumara (2010), who showed that increasing

| source            | Salinity levels (dS.m\(^{-1}\)) | Temperature °C | Salinity level × source |
|-------------------|---------------------------------|----------------|-------------------------|
| control           |                                 |                |                         |
| 3                 | 175.0                           | 182.0          | 420.0                   | 259.0                   |
| 6                 | 147.0                           | 161.0          | 294.0                   | 200.67                  |
| 12                | 126.0                           | 157.0          | 284.0                   | 160.56                  |
| 24                | 105.0                           | 140.0          | 199.67                  | 148.22                  |
| Cow manure        |                                 |                |                         |
| 3                 | 312.67                          | 336.0          | 582.0                   | 410.22                  |
| 6                 | 179.0                           | 246.0          | 552.67                  | 325.89                  |
| 12                | 157.0                           | 202.0          | 403.0                   | 254.0                   |
| 24                | 152.33                          | 149.0          | 336.0                   | 227.44                  |
| alfalfa           |                                 |                |                         |
| 3                 | 459.0                           | 515.0          | 634.33                  | 536.11                  |
| 6                 | 332.33                          | 440.67         | 616.0                   | 463.00                  |
| 12                | 298.67                          | 418.33         | 605.0                   | 440.67                  |
| 24                | 280.0                           | 406.67         | 567.33                  | 418.0                   |
| RLSD 0.05         |                                 | 16.826         | 320.31                  |
| Average effect temp. |                                 | 227.0          | 282.39                  | 451.56                  |
| RLSD 0.05         |                                 | 4.857          |                         |
| Type source × temp. | Control                        | 138.25         | 157.5                   | 280.58                  | 192.11                  |
|                    | Cow manure                     | 200.25         | 244.50                  | 468.42                  | 304.39                  |
|                    | Alfalfa                        | 342.5          | 445.17                  | 605.67                  | 464.44                  |
| RLSD 0.05         |                                 | 4.857          |                         |
| Salinity × temp.  |                                 |                |                         |
| 3                 | 315.56                          | 344.33         | 545.44                  | 401.78                  |
| 6                 | 219.44                          | 282.56         | 487.56                  | 329.85                  |
| 12                | 193.89                          | 255.78         | 405.56                  | 285.07                  |
| 24                | 179.11                          | 246.89         | 367.67                  | 264.56                  |
| RLSD 0.05         |                                 | 5.609          | 320.31                  |

Table (4): Effect of salinity levels and temperature on \(\text{NH}_4^+\) - N mineralization in soil treated with cow manure or alfalfa residue incubated under logged water.
salinity level decreased microbial activity in soil. Therefore, organic residue decomposing in soil is decreased.

On other hand, Khalil et al. (2005) indicated that increasing soil salinity level to about 6.0 dS.m\(^{-1}\) showed no significant effect on NH\(_4^+\) -N concentration in soil. Al-Jaberi (2010) indicated that effect of salinity on soil microbial activity and depends on the initial soil salinity level. Data of tables (3 and 4) showed that highest value of NH\(_4^+\) -N produced in soil was obtained at soil amended with alfalfa residue incubated at 30 °C and salinity level of 3 dS.m\(^{-1}\) and recorded values 656.0 mg.kg\(^{-1}\) and 634.33 mg.kg\(^{-1}\) for F.C and logged water conditions, respectively. Significant effect for the interaction between salinity level and source of organic residues, organic residue and temperature of incubation, temperature and salinity were recorded (tables 3 & 4). Results of tables (5 and 6) showed that increasing incubation temperature from 10 to 30 °C at all treatment increased NO\(_3^-\) -N concentration in soil.

### Table (5): Effect of salinity levels and temperature on NO\(_3^-\) - N mineralization in soil treated with cow manure or alfalfa residue incubated under F.C.

| source               | Salinity levels (dS.m\(^{-1}\)) | Temperature °C | Salinity level × source |
|----------------------|---------------------------------|----------------|-------------------------|
|                      | 10                | 20               | 30                |
| control              |                   |                  |                   |
| 3                    | 196.0             | 252.0            | 616.0              | 354.7          |
| 6                    | 196.0             | 233.3            | 373.3              | 267.6          |
| 12                   | 177.3             | 186.7            | 364.0              | 242.7          |
| 24                   | 149.3             | 158.7            | 326.7              | 211.6          |
| Cow manure           |                   |                  |                   |
| 3                    | 205.3             | 382.7            | 644.0              | 410.7          |
| 6                    | 196.0             | 308.0            | 625.3              | 376.4          |
| 12                   | 185.3             | 233.3            | 448.0              | 288.9          |
| 24                   | 168.0             | 177.3            | 420.0              | 255.1          |
| alfalfa              |                   |                  |                   |
| 3                    | 666.3             | 697.7            | 876.0              | 746.7          |
| 6                    | 564.7             | 634.7            | 787.3              | 662.2          |
| 12                   | 425.3             | 609.0            | 704.3              | 579.6          |
| 24                   | 280.0             | 469.7            | 666.0              | 471.9          |
| RLSD 0.05            |                   | 130.14           |                   |
| Average effect temp. | 284.1             | 361.9            | 570.9              |                   |
| RLSD 0.05            |                   | 37.57            |                   |
| Type source × temp. |                   |                  |                   |
| Control              | 179.7             | 207.7            | 420                | 269.1          |
| Cow manure           | 188.7             | 275.3            | 534.3              | 332.8          |
| Alfalfa              | 484.1             | 602.8            | 758.4              | 615.1          |
| RLSD 0.05            |                   | 37.57            |                   |
| Average of effect salinity |
| Salinity × temp.     |                   |                  |                   |
| 3                    | 355.9             | 444.1            | 712.0              | 504.0          |
| 6                    | 318.9             | 392.0            | 595.3              | 435.4          |
| 12                   | 262.7             | 343.0            | 505.4              | 370.4          |
| 24                   | 199.1             | 268.6            | 470.9              | 312.9          |
| RLSD 0.05            |                   | 43.38            |                   | 405.7          |
NO₃⁻ N Concentration

Average values of NO₃⁻ -N increased from 284.1 to 570.9 mg.kg⁻¹ in soil incubated under F.C moisture level and from 104.97 to 184.19 mg.kg⁻¹ for soil incubated under logged water level. Similar effect of temperature on NO₃⁻ -N concentration in soil was reported by Yeasmin et al. (2012) and Cenkseven et al. (2017). Data of treated tables (5 & 6) clearly indicated that NO₃⁻ -N concentration in soil treatment with organic residues were higher than of control treatment at both moisture levels and all temperatures of incubation. Average values of NO₃⁻ -N increased from 269.1 at control treatment to 332.8 mg.kg⁻¹ in soil amended with cow manure and 615.1 mg.kg⁻¹ in soil treated with alfalfa residue in soil incubated under F.C condition. However, values of NO₃⁻ -N in soil incubated under logged water condition were 109.5 mg.kg⁻¹, 186.25 mg.kg⁻¹, 118.92 mg.kg⁻¹ for control, cow manure and alfalfa residue, respectively.

Table (6): Effect of salinity levels and temperature on NO₃⁻ -N mineralization in soil treated with cow manure or alfalfa residue incubated under logged water.

| source     | Salinity levels (dS.m⁻¹) | Temperature ºC | Salinity level × source |
|------------|--------------------------|----------------|-------------------------|
|            |                          | 10             | 20          | 30          |                   |
| control    |                          | 3              | 99.0        | 111.0       | 209.33       | 139.78         |
|            |                          | 6              | 85.0        | 104.67      | 154.0        | 114.56         |
|            |                          | 12             | 74.0        | 92.0        | 129.0        | 98.33          |
|            |                          | 24             | 59.0        | 80.33       | 116.67       | 85.33          |
| Cow manure |                          | 3              | 168.0       | 188.0       | 336.0        | 230.67         |
|            |                          | 6              | 140.0       | 168.0       | 242.67       | 183.56         |
|            |                          | 12             | 130.0       | 185.67      | 224.0        | 170.89         |
|            |                          | 24             | 115.67      | 149.33      | 214.67       | 159.89         |
| alfalfa    |                          | 3              | 116.0       | 131.0       | 176.0        | 141.0          |
|            |                          | 6              | 106.0       | 116.0       | 146.0        | 122.67         |
|            |                          | 12             | 91.0        | 106.0       | 141.0        | 112.67         |
|            |                          | 24             | 76.0        | 101.0       | 121.0        | 99.33          |
| RLSD 0.05  |                          | 14.631        |             |             |               | 138.22         |
| Average eff temp. | 104.97 | 125.5    | 184.19     | RLSD 0.05  | 4.224     | Average type source |
| Type source × temp. | control  | 79.25    | 97.0       | 152.25      | 109.50      |
|            | Cow manure | 138.42   | 166.0      | 254.33      | 186.25      |
|            | alfalfa   | 97.25    | 113.5      | 146.0       | 118.92      |
| RLSD 0.05  |                          | 4.224        |             |             | 138.22      |
| Salinity × temp. | 3       | 127.67   | 143.33     | 240.44      | 170.48      |
|            | 6         | 110.33   | 129.56     | 180.89      | 140.26      |
|            | 12        | 98.33    | 118.89     | 164.67      | 127.30      |
|            | 24        | 83.56    | 110.22     | 150.78      | 114.85      |
| RLSD 0.05  |                          | 4.877        |             |             | 138.22      |
These results are in agreement with that of Balkcom et al. (2009) and Anggria et al. (2012) and who showed that concentration of NO₃⁻-N in soil differs according to types and amount of organic residue added to soils. Results showed a significant differences in NO₃⁻-N produce from different organic source at all moisture treatments of incubated soils, being higher in soils incubated under F.C than logged water condition (t value = 12.073).

Increasing salinity level from 3 to 24 Ds.m⁻¹ decreased NO₃⁻-N concentration from 504.0 to 312.9 mg.kg⁻¹ in soils incubated under F.C moisture level (table 5) and from 170.48 to 114.85 mg.kg⁻¹ in soil incubated under logged water condition. Sahrawat (2009) stated that rate of organic residue decomposing in soil decreased as soil salinity level increased. Highest values (876.0 mg.kg⁻¹) for NO₃⁻-N in soil incubated under F.C was obtained in soil with E.C 3 dS.m⁻¹ treated with alfalfa residue and incubated at 30 °C, while lowest value 149.3 mg.kg⁻¹ was record in control soil with E.C 24 dS.m⁻¹ incubated at 10 °C. In soils incubated under F.C condition. However, in soil amended with cow residue highest values were record in soil with E.C 3 dS.m⁻¹ and incubated at 30°C, while lowest value was obtained in control soil with E.C 24 dS.m⁻¹ incubated at 10°C, these values were 336.0 mg.kg⁻¹ and 59.0 mg.kg⁻¹, respectively. Significant interaction between soil salinity levels and organic residue source and soil salinity level and temperature of incubation and temperature and organic source were recorded (tables 5 and 6).

Conclusions

It could be concluded from the data presented that organic residue source and soil salinity level have significant effect on organic N mineralization in soils under both F.C and logged water condition. Effect of soil logged water on organic N mineralization differs according to type of organic residue source.

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