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Research Article

Nitrogen Mineralization Potential of Soil Amended with FYM under Different Temperature

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Abstract

Mineralization of nitrogen is the release of organically bound N from organic matter to the plant available mineral form ($NH+_4$-N, NO^-_3). This important investigation was assessed in laboratory incubation experiment to quantify the release of mineral N from FYM and urea amended soil either alone and in combination to provide a pool N of 120 $kgNha^{-1}$. A control treatment having only soil was also included. All these four treatments were assessed at two different temperatures i.e. 15^0C and 25^0C for a period of Five weeks. During the course of the experiment, 60% relative water holding capacity was maintained. Experiment was laid out in CR Design. Sampling was made after each week, to study the total N, organic C, mineral N, soil pH, salinity, and electrical conductivity. The result showed that maximum nitrogen mineralization was observed in soil amended with FYM+Urea treatment during 5 weeks. The lowest mineral nitrogen was observed in control during 5th weeks of incubation. However, mineral nitrogen increased gradually with time in all treatments. FYM and urea amended soil had significantly increased total nitrogen, and soil organic carbon, soil EC with incubation period, whereas soil pH decreased linearly. From the results it was concluded that combined application of FYM and urea had higher potential for increased mineralization, and thus is recommended for getting high mineral nitrogen and soil fertility, which may have the ability to increase productivity and yield.

Keywords: Nitrogen; Urea; Mineralization

Introduction

Mineralization of nitrogen is the release of organically bound N from organic matter to the plant available mineral form ($NH+_4$-N, $NO-_3$-N). It is an important process where the unavailable N becomes available for the plant and microbes use. The NO_3-N is usually the dominant form of plant available N in most arid and semiarid region [1]. Addition of dairy manure often increase yield mainly because of increased plant nutrient availability through mineralization and improved soil structure [2]. Ismaily., *et al.* [3] reported that the N and C states of arid and semi arid agriculture soil increased with the application of manure. Changes in N mineralization are directly related to microbial activity and biomass inputs, which are affected by abiotic factors including temperature and soil moisture [4], soil wetting and drying cycles [5], soil texture [6], and soil characteristics [7,8].

Nitrogen mineralization has been shown to accelerate with increasing soil temperature under conditions found in agricultural systems [9,10]. It has been reported that decomposition is 3.7times faster at 25°C than at 15°C and 13 times faster at 15°C than at 5°C [11]. The effect of temperature on the rate of N mineralization can also change with latitude. Campbell., *et al.* [12] reported that soils in the northern region of the USA were affected more by incubation temperatures than Southern soils. Similarly, Campbell., *et al.* [12] concluded that the decomposition rate as a function of temperature, which is related to the amount of readily decomposable organic matter in the soil. Soils in northern climates, where the summer is shorter, have less decomposition occurring in a given year compared to soils in southern climates, which experience long summers.

Mineralization is also greatest when soil moisture is near field capacity and declines with soil drying [9]. Linn and Doran [13] showed that in moist soils microbial activity is optimum when soil water-filled pore space (WFPS) is near 60%, resulting in maximum organic matter decomposition. Anaerobic conditions tend to occur at a WFPS greater than 60%, thereby slowing the decomposition process. Knoepp and Swank [14] found that there was a significant interaction between moisture content and soil temperature in N mineralization. Wetting and drying cycles have an influence on microbial activity, there by affecting decomposition of SOM [15-17]. Drying followed by rapid rewetting cycles generally causes an increase in organic substrate available for microbial attack [15]. The labile substrates that become available (i.e., C and N compounds in the form of organic material) are rapidly mineralized by the remaining soil microbes, which causes a pulse in mineralization of N and C [18]. Wetting and drying cycles have also been shown to cause soil aggregates to break apart, exposing physically protected organic matter to further degradation [19,20].

Keeping in view the importance of this studies, and limited work done on this aspect in the study area, the current experiment was hypothesis to find out that both urea and FYM amended soil whether used alone or in combination had no effects on the soil organic matter mineralization and other physico-chemical properties over a period of five weeks.

Material and Methods

The study was conducted to asses the release of mineral N and other soil physico-chemical properties from farmyard manure (FYM) and urea alone and in combinations amended soil during laboratory incubation experiment. The details of laboratory incubation experimental treatments are;

Treatments		Urea (%N)	FYM (%N)	Pool N (kg ha^{-1})
T_1	Control	0	0	0
T_2	FYM	0	100	120
T_3	Urea	100	0	120
T_4	FYM +UREA	50	50	120

Table 1

These four treatments were based on the chemical composition of the FYM. All these four treatments were incubated for 42 days, at two different temperature i.e. 15^{0}C and 25°C, and the experiment was arranged in a CR design with three repeats.

Sample preparation

Soil simple at 0-30 cm depth was collected from NDF The University of Agriculture, Peshawar. Known amount of soil sample (70g) was taken in an incubation petri dish and amended with required amount of fertilizers as per above treatments and 60% moisture content was added according to weight of samples and maintained moisture content by adding after two days again weighting the samples.

Laboratory analysis

Samples were taken out at 0, 7, 14, 21, 28,35,and 42 days of incubation and analyzed for soil physico-chemical properties including soil mineral N (NH_4-N and NO_3-N), total N, soil organic C, soil EC, pH and salinity.

Soil mineral N

Mineral N was determined by the methods as described by Mulvaney [21]. In this methods, 20 g of soil samples was shaken with 100 ml of 1M KC1 for 1hr and filtered. An aliquot of 20 ml was distilled with 0.2gMgO to recover NH_4-N and NO_3-N. The distillate was collected in 5ml boric acid mixed indicator solution and titrated against 0.005 M HCL. Nitrogen was calculated as 1 ml of 0.005 HCL equals 70µg N. NO3_N was determined by difference.

Soil total nitrogen

Total nitrogen in soil sample was determined by Kjeldahl procedure [22]. In this method, 0.2g of soil sample was digested with 3ml of concentrated H_2SO_4 in the presence of digestion mixture containing K_2SO_4, $CuSO_4$ and Se on block digested for about 4-5hours. The digestion mixture started at 50^{0}C and then gradually raised to 100, 150, 200, 250, 300, and finally to 350^{o}C which was maintained at least for 1hour. After cooling the digest was transfer to 100ml flask, out of which 20ml was distilled in the presence of 5ml of 40% NaOH solution into a 5ml boric acid mixed indicator solution. The distillate was titrated against standard 0.005N HCl. Nitrogen was calculated as 1ml of 0.005M HCL Equal 70µg N.

Soil organic matter

Organic matter in sample was determined by the walkaly-Black procedure as described in Nelson and Sommers (1996). In this method 1.0g of soil sample was treated with 10ml of 1 N $K_2Cr_2O_7$ and 20ml of concentrated H_2SO_4. After cooling, 200ml of distilled water were added filtered and titrated against 0.5N $FeSO_4$ solution using ortrophenolphthalein as indicator with the appearance of maroon colour as end point. A blank titration was also run. Organic matter was calculated from the amount of ferrous sulphat used in titration which determined the amount of unused dichromate and in turn calculated the amount of chromate used in the oxidation of organic C in soil. Organic C was converted to soil organic matter.

Electrical conductivity

Ten gram of soil was taken from soil sample from Petri dish of each treatment in a 100mL bottle and shaken for 60 minutes with 50ml of water (1:5). After shaking the suspension was left over night to allow the soil to settle down. A pipette type conductivity cell was filled with the supernatant and electrical conductivity was measured in dSm^{-1} (Richard, 1954) using the EC meter.

Soil PH.

Soil pH was determined in 1:5 soil water suspensions [23] using the soil pH meter.

Statistical analysis

The data was analyzed by procedure described in Steel and Torrie [24] using computer software Statistic 8.1 relevant to repeated measurement analysis, basically trialed in CR design. The treatments mean were separated by on the basis of standard errors of mean.

Results and Discussion

Soil mineral Nitrogen (mg kg^{-1})

Soil mineral nitrogen is an imporatnt parameter contributing to soil fertility (available nutrient) and is directly or indirectly affected by addition of organic manurs to soil. Soil nitrogen as affected by FYM and urea alone and in combination at various temprature (15^0Cand 25^0C) are presented in Figure 1. It revealed that at 15^0C soil mineral nitrogen increased as incubation intervals increased from 0 to 42 days for all all treatments. Similar trend was found at 25^0C. Lower soil mineral nitrogen at 15^0C and 25^0C was found in soil samples collected from experimental units treated with FYM at first interval while higher soil mineral nitrogen was recorded in soil treated with FYM and combination with urea after 5th in both 15^0C and 25^0C. Fertilizer application in combination with FYM resulted in a greater increase in mineral nitrogen pool than with FYM application alone. Crop availability of nitrogen from FYM is generally lower than the availability of nitrogen from inorganic fertilizer, possibly due to slow release of organically bonded nitrogen immobilization of nitrogen and volatilization of NH_3 from surface applied manure. These results are supported by the finding of Jokela [25], who reported that fertilizer application with FYM greater increase in mineral nitrogen.

Soil total nitrogen (%)

Soil total nitrogen is an imporatnt parameter contributing to soil fertility, and shows the capibility of soil to affect the mineralization. The total N content is directly or indirectly affected by addition of organic manurs and fertilizer to soil. Soil nitrogen as affected by FYM and urea alone and in combination at various temprature (15^0C and 25^0C) are presented in Figure 2. It revealed that at 150C soil nitrogen increased as incubation intervals increased from 0 to 42 days for the all treatments. Similar trend was found at 25^0C. Low soil nitrogen at 15^0C and 25^0C was found in soil samples collected from experimental units at zero interval while higher soil N was recorded in soil treated with FYM alone, compare to control. Our hypothesis that FYM decomposed was rapidly due to low C:N ratio resulted lower aggregate stability and soil nitrogen accumulation. In support of our observations, high N and low C/N ratio organic inputs have been shown to decompose rapidly [26,27].

Figure 1: Graphical representation of soil mineral N amended with manure at different temperature over a period of time.

Figure 2: Graphical representation of soil total N amended with manure at different temperature over a period of time.

Soil organic carbon (%)

Soil organic carbon is an imporatnt parameter contributing to soil fertility which are directly or indirectly affected by addition of organic manurs and fertilizer to soil. Soil organic carbon as affected by FYM and urea alone and in combination at various temprature (15^0C and 25^0C) are presented in Figure 3. It revealed that at15^0C soil organic C increased as incubation intervals increased from 0 to last sampling for all treatments. Similar trend was found at 25^0C. Low soil C at 15^0C and 25^0C was found in soil samples collected from experimental units treated at first interval while higher soil C was recorded in soil treated with FYM alone compared to low content in control for the same interval. The hypothesis that FYM decompose rapidly due to low C:N ratio resulted lower aggregate stability and Soil organic carbon accomulation. In support of our observations, high N and low C/N ratio OR inputs have been shown to decompose rapidly [26,27].

Soil pH

Soil pH as an important parameter it ranges from 1 to 14. At the range of pH 6.6 To 7.5 most of the nutrient are available and it affect the availability of nutrients at high and low pH. PH of the amended soil as affected by FYM and urea alone and in combination are presented in Figure 4. It revealed that in first intervals the pH is same in all treatment but the pH of manure amended (FYM) soil decreased and in urea alone increased at 15^0C the similar trend was also found in 25^0C.

The reduction in soil pH with FYM could be associated with release of H+ as result of various organic acids production during decomposition process or ionization of various functional groups associated with organic sources. Our result of reduction in soil pH with application of FYM was in line with the results reported by Sharif., *et al.* [28] who found that addition of organic manure or compost caused reduction in soil pH. Addition of urea to the soil decline CO_2 evaluation and increase the soil pH our results was supported by Sarah J., *et al.* [29] Addition of urea showed a significant decline in CO_2 evolution with increasing soil acidity.

Figure 3: Graphical representation of soil Organic carbon (%) of soil amended with manure at different temperature over a period of time.

Figure 4: Graphical representation of pH in soil amended with manure at different temperature over a period of time.

SOIL EC (μscm^{-1})

Figure 5 showed the data of soil EC. It revealed that initialy the soil EC was decreasd in period of of time at 4th intervals and in last intervals the EC increased and high increased ocured in a soil amended with FYM in both temperature (15^0Cand 25^0C) which is essential for plant growth. The electrical conductivity (EC) of soil-water mixtures indicates the amount of salts present in the soil. All soils contain some salts, which are essential for plant growth. However, excess salts hinder plant growth by affecting the soil-water balance. The high EC values determined in this experiment may be explained by the decomposition of the larger organic fragments and their intermediates or end product of FYM during incubation periods. EC values of the soils treated with the FYM were lower than 4dS m^{-1}, the traditional value above which soils present a salinization hazard [23]. The result is in agreement with those of Erdem Yilmaz. And Zeki Alagöz [30] who reported that Soil EC affected with the incorporation of FYM [31-39].

Figure 5: Graphical representation of EC in soil amended with manure at different temperature over a period of time.

Conclusion and Recommendation

- Soil mineral, total N was higher in FYM + urea amended soil, and increased linearly with the incubation period,
- Organic C was higher in FYM either used sole or combined with N and was increased with the incubation time.
- Higher increase rate for Total N was observed in FYM + urea treatment.
- There was a slight change in pH for different treatments; however soil pH was higher for urea treatment than others.

Based on the results, it is recommended that mixed application of FYM and urea release higher mineral N and hence would be better if applied to soil for improved productivity.

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