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Decomposition Pattern of Bio-Slurry in two Contrasting Soils of Bangladesh

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Abstract: Bio-slurry has potential value as good quality organic fertilizer and an agent of soil carbon sequestration through build up of soil organic matter level. Cow-dung and poultry manure had the higher organic carbon content as well as higher nutrient concentration compared to Cow-dung and poultry bio-slurry. Nutrient concentration particularly N, P and S in CD and CB was found lower than the PM and PB. The highest carbon mineralization in Balina soil was found in poultry manure amended soil followed by cow dung, poultry bio-slurry and the lowest in cow dung bio-slurry. Carbon mineralization of manures in Noadda soil also followed the similar trend like Balina soil. However, Carbon mineralization of poultry manure and poultry bio-slurry was lower and cow dung and cow dung bio-slurry was higher in Noadda compared to Balina soil. Thus, decomposition of manure does not depend only on the quality of soil rather both the quality of manure and soil. Decomposition of manure was found slightly higher (around 5%) in Balina soil compared to Noadda soil when averaged over four manures. Among the manure, around three to four times less amount of CO_2 was evolved during the decomposition of cow-dung and poultry bio-slurry as compared to cow-dung and poultry manure. Thus, this study indicate that soil application of bio-slurry had high potential in the mitigation of the greenhouse effect as well as short-term benefits in terms of improving soil organic matter stock, as compared to manure.
Keywords: Bio-slurry, organic fertilizer, Nutrient, Balina soil.

INTRODUCTION

The crop yield is low in Bangladesh compared to other countries due to a number of constraints of which soil is one of the most dominant factors. Soil functions in relation to crop production are mainly controlled by soil organic matter content. However, the organic matter content of Bangladesh soil is generally low. Organic matter content of about 60% of cultivable lands in Bangladesh is below 1% in compared to an ideal minimum value of 3% [1]. Intensive crop cultivation, higher rate of soil organic matter decomposition under the prevailing subtropical hot and humid climate, low or no use of organic manure, little or no use of green manure and exportation of crop residues from crop fields make the situation more alarming. Therefore, now this is the high concern to maintain the organic matter content of Bangladesh soil to a satisfactory level for food security of the rapidly growing population. The increase of soil organic carbon (SOC) as a result of biochar application is well documented in the literature [2-4]. The effect of biochar additions on soil carbon and nutrient cycling is still under investigation and the experimental findings are inconclusive, as both increased and decreased greenhouse gas (GHG) emissions and N mineralization rates have been reported [5-13]. Direct effects of biochar on soil cation exchange capacity (CEC), pH, PAWC, BD, and nutrient adsorption may have cascading influences on carbon and nutrient cycling. Furthermore, there is evidence that biochar amendments induce neutral, positive and negative priming effects on the turnover of SOC and the mineralization of crop residues [14-18]. To address this, biochar experimental findings must be integrated and re-analyzed under a common framework. Meta-analysis studies [19- 21, 10, 22, 18] are the first steps in the integration of biochar information, but they lack the power of prediction that a mechanistic approach can offer.

Soil organic matter (SOM) is the organic component of soil, consisting of three primary parts including small (fresh) plant residues and small living soil organisms, decomposing (active) organic matter, and stable organic matter (humus). It includes all living soil organisms together with the remains of dead organisms in their various degrees of decomposition. It is essential for maintaining soil health and considered as the life of soil as well as the storehouse of plant nutrients [23]. It is important in relation to soil fertility, sustainable agricultural systems, and crop productivity. Organic matter (OM) is a reservoir of nutrients that can be released to the soil. Each percent of organic matter in the soil releases 20 to 30 pounds of nitrogen, 4.5 to 6.6 pounds of P2O5, and 2 to 3 pounds of sulfur per year and also prevents leaching of nutrients. It behaves somewhat like a sponge, with the ability to absorb and hold up to 90 percent of its weight in water. It causes soils to clump and form soil aggregates, which improves soil structure and also reduce soil erosion by 20 to 33 percent. It improves cation exchange capacity of soil [24, 25]. Hence, proper management of OM is the key for sustainable agriculture. The microbial carbon-use-efficiency (CUE; the proportion of C uptake allocated to growth vs. the microbial CO2 production by respiration) has been shown to decrease with increasing soil temperature [26-28] or to be invariant with temperature [29].Surprisingly, gross N mineralization showed no temperature sensitivity in our incubation study which concurs with results found for managed temperate soils [30] but contrasts with findings from others where gross N mineralization increased with incubation temperature [31-35].

Soil organic matter content is affected mostly by climate, texture, hydrology, land use and vegetation. Organic matter content of cultivated soils in the tropics declines more rapidly than that of soils in the temperate regions; consequently, cultivated soils in the tropics generally show lower organic matter content. During the decomposition of plant material, respiration of soil microbes converts organic carbon to CO_2 (in aerobic condition) and CH_4 (in anaerobic condition).

Maintenance of soil fertility is a prerequisite for long term sustainable crop production and it is certain that organic manure (cow-dung, poultry manure and their slurry) can play a vital role in the sustainability of soil fertility and crop production. So, the maintenance of soil organic matter is a burning issue both for the farmers and agricultural scientists. Application of bi-product of the recently popularized biogas technology named 'bio-slurry' in soil could be one of the options to maintain declining soil fertility of Bangladesh. More than 25,000 biogas plants of varying gas-producing capacities (2-6 m^3) are generating more than 200,000 tons of slurry on dry weight basis. Proper application of these huge amounts of bio-slurry to crop land may help improve soil Organic matter status. Incorporation of crop residues increases the supply of carbonaceous materials as an energy source for microorganisms. These lead to a series of biological transformations e.g. mineralization, nitrification and denitrification. Upon mineralization, crop residue supplies essential plant nutrients [36, 37].

The amount of organic matter in soil depends on the input of organic material, its rate of decomposition, the rate at which existing soil organic matter is mineralized, soil texture, and climate. All four factors interact so that the amount of soil organic matter changes, Organic matter buildup in soils directly depends on the rate of decomposition- slower the rate, higher the buildup. Such mineralization will vary from source to source and soil to soil.

Since use of bio-slurry as manure in cropland is a new technology in Bangladesh, their mineralization pattern in different soil over time should be studied. With this view, the present study was undertaken to estimate and analyze the carbon mineralization pattern of bio-slurry along with different manures (cowdung, cowdung bio-slurry, and poultry manure and poultry manure bio-slurry) in two contrasting soils (Balina and Noadda) with respect to time. Balina represents young floodplain soil that cover 80% of our land area while Noadda represents highly weathered terrace soil that cover 8% of our land area. The study had the following objectives: to determine the nutrient concentration in different manure and bio-slurry and to determine the rate and pattern of decomposition of different manures such as cowdung, cowdung bio-slurry, poultry manure and poultry manure bio-slurry in two contrasting soils (Balina and Noadda)

MATERIALS AND METHODS

Two contrasting soils namely very young floodplain soil 'Balina' and highly weathered terrace soil 'Noadda' were used in this experiment. Balina and Noadda soil samples were collected from the surface (0-15 cm) of a selected area of Batipar, Sadar Upazilla, Mymensingh and Bhaluka, Bhaluka Upazilla, Mymensingh. The lands were fallow during the collection of soil samples. The collected soils were air dried for several days and ground. Plant residues and other extraneous materials were removed and were sieved through 10-mesh sieve and mixed thoroughly. This whole process was done several times until adequate amount of soil was prepared for the experiment. Sufficient amount of sieved soil was kept in a polyethylene bag for chemical analysis. The morphological, physical and chemical properties of the initial soil have been presented in Table-1.

Table-1: Morphological, physical and chemical characteristics of the initial soil Morphological characteristics

	Balina soil	Noadda soil
Locality	Batipar, Mymensingh	Bhaluka, Mymensingh
AEZ	Old Brahmaputra Flood Plain	Madhupur tract
Soil tract	Old Brahmaputra Alluvium	Madhupur clay
Soil series	Balina series	Noadda series
Soil type	MollicHaplaquepts	UlticUstochrepts
Drainage	Low	Moderate
Flood level	Bellow flood level	Above flood level
Cropping pattern	Rice-Fallow-Fallow	Fallow-Fallow-Rice
Topography	Very low land	High land

B. Physical characteristics

Particle size distribution	Balina soil	Noadda soil
Sand(%)	17.0	10.0
Silt(%)	48.0	46.0
Clay(%)	35.0	44.0
Textural class	Silty loam	Silty loam

C. Chemical composition

Constituent	Balina soil	Noadda soil
pH	4.9	3.7
Organic carbon (%)	1.53	0.92
Organic matter (%)	2.59	1.60
Total N (g/kg)	1.9	1.0
NH_4-N (mg/kg soil)	3.35	3.35
$N0_3$-N (mg/kgsoil)	18.4	6.0
Available P(mg/ kg soil)	8.4	33.9
Available S(mg/kgsoil)	19.37	12.9

Chemical analysis of manure

Determination of total carbon from Manure

For the determination of carbon, 2g of oven dried manure sample was taken in each crucible. Then crucibles were placed in a combustion chamber and combusted the samples at 450°C for 8 hours. After completion of combustion the samples were weighted and recorded the data. The weight losses from the samples indicate amount of organic matter in the samples. These obtained organic matter contents were divided by 1.73 to determine the total organic carbon in the sample.

Determination of total Nitrogen from manure

For the determination of nitrogen, 0.1 g of oven dried Manure sample was taken in a micro-kjeldahl flask. Then 1.1 g of catalyst mixture (K_2SO_2: $CuSO_4$. $5H_20$: Se powder = 100:10:1), 3 ml of 30% H_20_2 and 5ml of conc. H_2SO_4 were added into the flask. The flask was swirled and allowed to stand for about 10 minutes. Then the flask was heated until the digest become colorless. After cooling, the digest was transferred into a 100 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar way. The digests were then taken in distillation chamber after adding 15 ml NaOH with 25 ml of sample. The distilled samples were collected into a conical flask containing boric acid and bromochrysol green indicator at pH 5. Then the distilled samples were titrated with 0.1 N H_2SO_4. The titrated values calculated for determination of nitrogen.

Calculation

$$\%N=14(A-B) X M X100/ (1000 X W)$$

Where,

M= concentration of H_2SO_4 used in titration.
A = ml HCl used in sample titration
B = ml HCl used in blank titration
14 = atomic weight of nitrogen
W = wt. of soil sample in gram

Digestion of manure samples for the determination of P, K and S content

Exactly 0.5g oven dried ground manure sample was transferred into 100 ml digestion vessel. Ten ml of diacid mixture (HNO_3: $HClO_4$= 2:1) were added into the vessel. After leaving for a while the flasks were heated at a temperature slowly raised to 200^0C. Heating was stopped when the dense white fume of $HClO_4$ occurred. After cooling, the contents were taken into a 50 ml volumetric flask and the volume was made with distilled water. The digests were used for the determination of P, K and S.

Phosphorus

The phosphorus content of manure samples were determined by developing blue color with stannous chloride ($SnCl_2$ reduction of phosphomolybdate complex and measuring the color with the help of spectrophotometer (Model- LT-31). The phosphorus content in the extract was determined by developing blue color by $SnCl_2.2H_2O$ reluctant and phosphomolybdate complex. The intensity of color was measured calorimetrically at 660 nm wavelength and the phosphorus content in the extract was determined by plotting the spectrophotometer readings on the P standard curve.

Potassium

K content in the digest was determined by flame photometer at 420 nm wave length and calibrated with a standard K curve [38].

Sulphur

Sulphur content in the digest was analyzed turbid metrically with the help of spectrophotometer (Model-LT-31) at 425 nm wavelength. The sulpher content in the digest was determined by plotting the spectrophotometer readings on the S standard curve.

Experimental details

Complete randomized design (CRD) with two replications was followed for this experiment. The locations of the plastic incubation boxes receiving different treatments were exchanged among the treatments throughout the incubation at one month interval for homogenization. The experiment comprised of five treatments including a control. The treatments were as follows:

To =Control (No organic matter)
T_1=Poultry manure
T_2= Poultry bio-slurry
T_3= Cow dung
T_4=Cow dung bio-slurry

All the amendments which are they were applied @ 2 g/ 100 g soil.

Statistical analysis

The recorded data were subjected to statistical analysis. All the data were analyzed for ANOVA with the help of a computer package program of MSTATC (Mathematical and Statistical calculation). A one way ANOVA was made by F variance test. The pair comparisons were performed by Least Significant Difference (LSD) test at 1% level of probability [39].

RESULTS

Nutrient composition of manure & bio-slurry

Chemical analysis among four treatments viz. cowdung, cowdung bio-slurry, poultry manure and poultry bio-slurry was done in the laboratory of the Department of Soil Science, Bangladesh Agricultural University, Mymensingh.

Organic Carbon

The organic carbon content of different manures and bio-slurry was significantly different at 1% level of probability. Organic carbon content of the manures was varied from 10.11% to 35.11% among the treatments (Table-2). The highest organic carbon content of 35.11% was observed in poultry manure and the lowest organic carbon content of 10.11% was found in cowdung bio-slurry. The organic carbon content of cow-dung and poultry bio-slurry was 29.79% and 16.32% respectively. Organic carbon content of cow-dung was statistically superior to cow-dung slurry, and organic carbon content of poultry manure was statistically superior to poultry manure slurry. The results were relevant with the findings of ATC [40] who found 41.46% organic carbon content in sun-dried bio-slurry.

Table-2: Nutrient content of cow-dung, cow-dung slurry, poultry manure, poultry manure slurry and soil.

Manure	%OC	%N	%P	%K	%S	C:N	C:P	C:S
Cow-dung	29.79b	1.120c	0.307b	1.113b	0.233c	26.06a	97.03a	125.28a
Cow-dung Slurry	10.11d	0.700d	0.180c	0.860c	0.137d	14.44b	56.17b	73.80b
Poultry manure	35.11a	2.520a	1.280a	3.807a	0.503b	13.93b	27.43c	69.80c
Poultry manure Slurry	16.32c	1.400b	1.260a	0.883c	0.613a	11.66c	12.95d	26.62d
SE±	3.078	0.206	0.156	0.374	0.059	4.03	4.19	4.25
LSD	5.089	0.189	0.090	0.090	0.020	5.10	4.08	5.12
Level of sig.	**	**	**	**	**	**	**	**

** means significant at 5% level

Nitrogen

The nitrogen content of different manures and bio-slurry was significantly different at 1% level of probability. Nitrogen content was varied from 0.70% to 2.52% among the treatments (Table-2). The highest nitrogen content 2.52% was observed in poultry manure and the lowest 0.70% in cowdung bio-slurry. The nitrogen content of poultry bio-slurry and cow-dung was 1.40 and 1.12%, respectively.

This result was in the range of previously reported N content of 1.5-2.0% in fresh cow-dung slurry by Tripati [41] and Acharya [42]. In all cases N content of cow-dung and poultry bio-slurry was always found lower than the cow-dung and poultry manure.

Phosphorus

The phosphorus content of different manures and bio-slurry was significantly different at 1% level of significance. Phosphorus content was varied from 0.180% to 1.28% among the treatments (Table22). The highest 1.28% was observed in poultry manure while the lowest 0.180% was found in cowdung bio-slurry the phosphorus content between poultry manure and poultry bio-slurry was statistically similar. Phosphorus content in cow dung was 0.307. This finding is in line with the Phosphorus content of different slurry and manure reported by Demont *et al*., [43].

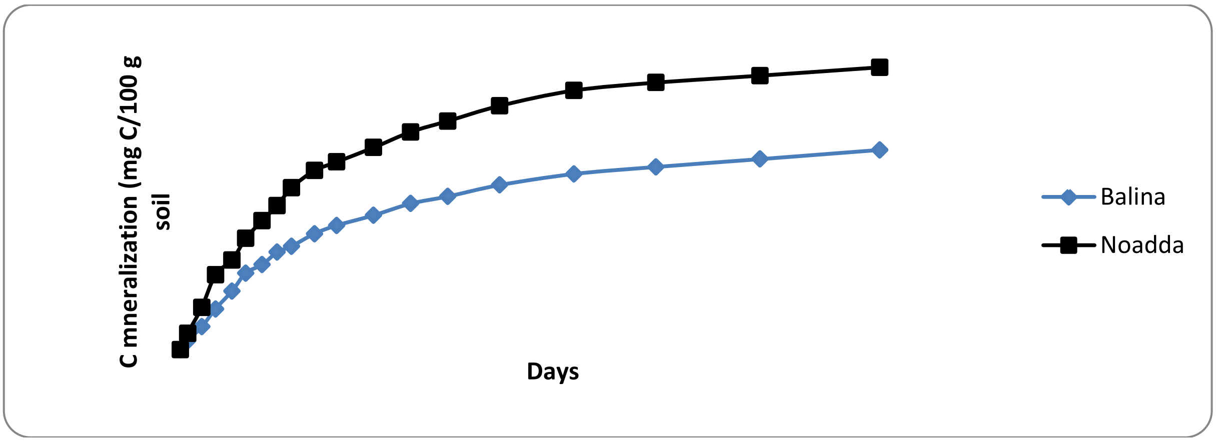

Fig-1: Absolute carbon mineralization pattern of inherent soil organic matter of two different soil series

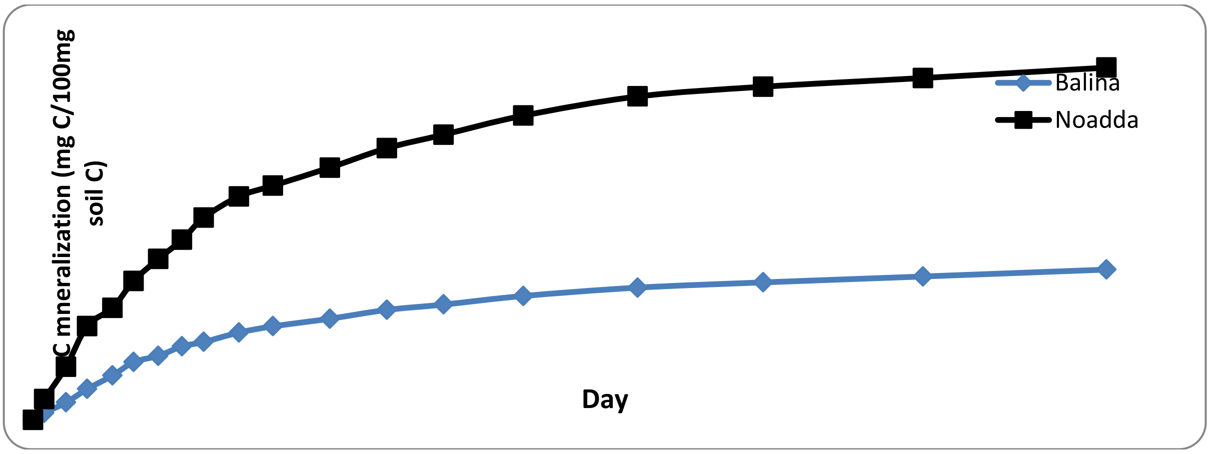

Fig-2: Relative carbon mineralization pattern of inherent soil organic matter of two different soil series

Potassium

The potassium content of different manures and bio-slurry was significantly different at 1% level of significance. Potassium content was varied from 0.860% to 3.81% among the slurry and manure treatments (Table-2). The highest potassium content of 3.81% was observed in poultry manure and the lowest potassium content of 0.860% was found in cowdung bio-slurry. The potassium content in manures followed the following trends: poultry manure> cow-dung > poultry bio-slurry> cowdung bio-slurry. In all cases, K content of cow-dung and poultry bio-slurry was always found lower than the cow-dung and poultry manure.

Sulphur

The sulphur content of different manures and bio-slurry was significantly different at 1% level of significance. Sulphur content was varied from 0.137 to 0.613% among the treatments (Table-2). The highest sulphur content of 0.613% was found in poultry bio-slurry while the lowest sulphur content of 0.137% was found in cowdung bio-slurry. The sulphur content of poultry manure and cow-dung was 0.503 and 0.233, respectively.

Estimation of Carbon Mineralization from Cowdung, Cowdung bio-slurry, Poultry manure and Poultry manure bio-slurry

Carbon mineralization patterns of inherent soil organic matter

The cumulative carbon mineralization of inherent soil organic matter of two different soils is shown in the figure 1. On an absolute basis, carbon mineralization from inherent soil organic matter of these two soils were 29.72 and 42.00 mg C 100 g soil^{-1} 94 days^{-1} in Balina and Noadda series, however, on a relative basis it account 1.95 and 4.56% of soil OC (Figure-2). The carbon mineralization rate for both soil were high upto 20 days after that it's increasing but slowly.

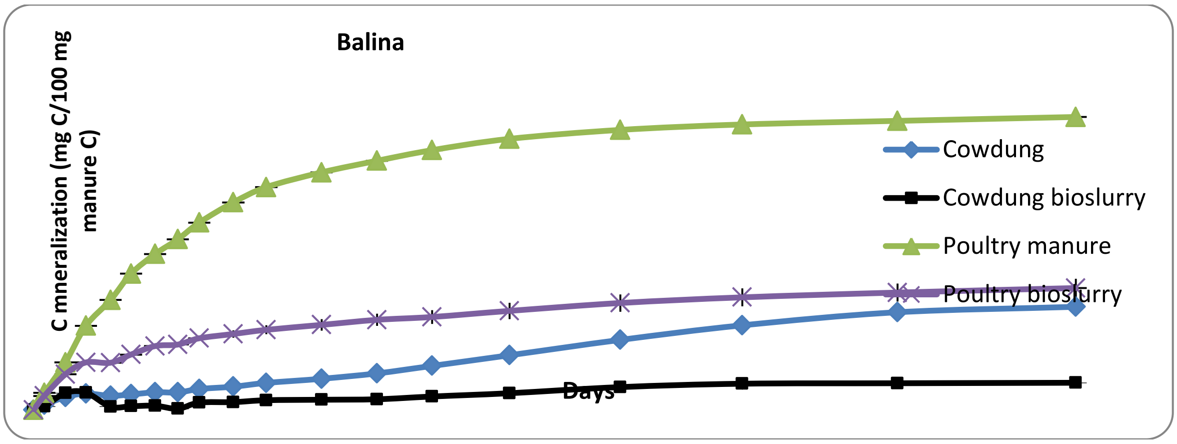

Fig-3: Cumulative carbon mineralization patterns of manures in Balina soil.

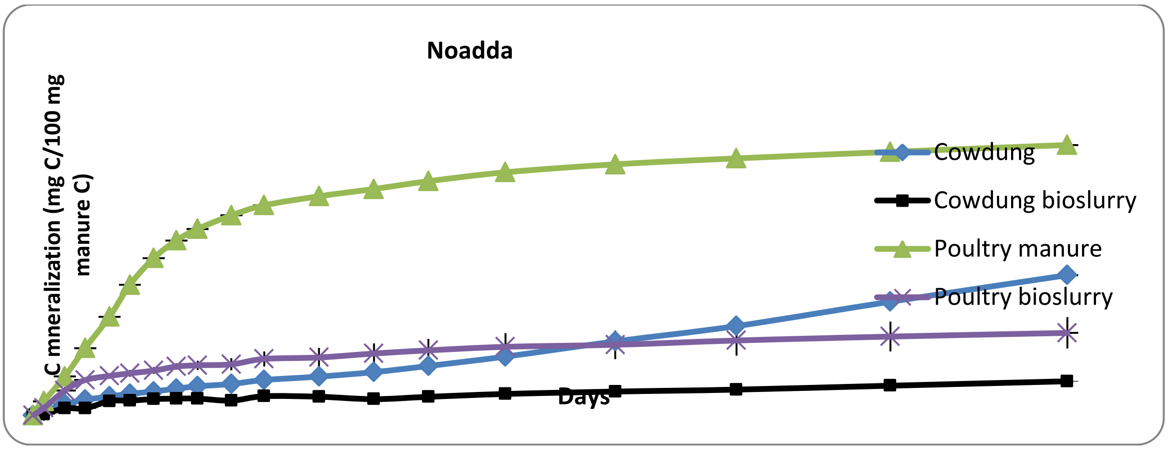

Fig-4: Cumulative carbon mineralization patterns of manures in Noadda soil

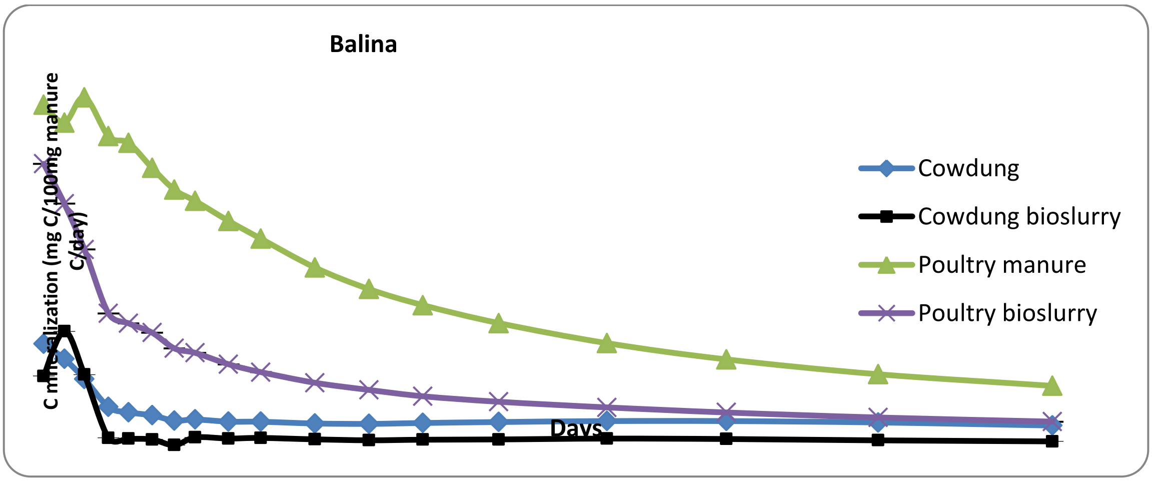

Fig-5: Daily mineralization patterns of different manures in Balina soil

Carbon mineralization patterns of manures and slurry in two soils

Figure 3 and 4 show the cumulative carbon mineralization patterns of different manures in Balina and Noadda soil. It is seen that carbon mineralization of different manure started exponentially and continued up to 20 days of incubation and then progressed linearly during the rest period of incubation. Carbon mineralization of poultry manure was the highest (19.49% of added manure OC 94 $days^{-1}$) and Cowdung bio-slurry was the lowest (1.81% of added manure OC 94 $days^{-1}$) among all of the manures in Balina soil (Figure-4, 5). Carbon mineralization of cowdung and poultry bioslurry in the same soil was 8.11 and 6.86% of added manure OC 94 $days^{-1}$, respectively. Carbon mineralization of different manures follow this trend (Poultry manure > Cowdung > poultry bioslurry > Cowdung bio-slurry) in Balina soil series. Carbon mineralization of manures in Noadda soil also followed the similar trend like Balina soil. The highest carbon mineralization (17.73% of added manure OC 94 $days^{-1}$) in Noadda soil was found in poultry manure amended soil followed by cowdung (9.19% of added manure OC 94 $days^{-1}$), poultry bioslurry (5.41% of added manure OC 94 $days^{-1}$) and the lowest in cowdung bioslurry (2.24 % of added manure OC 94 $days^{-1}$) amended soil (Figure 5). Around three to four times less carbon mineralization was observed in cow-dung and poultry bio-slurry amended soil as compared to cow-dung and poultry manure amended soil.

Carbon mineralization rate of different manures in two different soils

Figure-5 and 6 show the mineralization rate of different manures per day in two soils. The carbon dioxide evolution rate was high up to 15 days in the cowdung and cowdung bio-slurry where as in the poultry manure and poultry bio-slurry it was up to 30 days. The mineralization rate became steady after 20 days in cowdung and cowdung bio-slurry and 60-70 days in poultry manure and poultry bio-slurry in both the soils.

Decomposition rate of carbon in different manure varied between 0.04 and 8.33 mg C g^{-1} manure day^{-1} accounting 0.02 and 1.19% of added OC. All the manure's were decomposed very quickly at the beginning of incubation and the decomposition rate decreased gradually day by day. Decomposition rate of poultry manure was the highest and cowdung bio-slurry was the lowest in both the soils. Decomposition rate of different manure followed this trend: Poultry manure > Poultry bio-slurry > cowdung > cowdung bio-slurry in both the soils. Decomposition rates of different manure were high in Balina soil than Noadda soil.

Carbon mineralization of manures in two soils

Decomposition of studied four manure did not follow a definite pattern of mineralization in two contrasting soil (Figure-7). Carbon mineralization of poultry manure and poultry bio-slurry was higher in Balina soil compared to Noadda soil. On the other hand, carbon mineralization of cowdung and cowdung bio-slurry in Noadda soil was higher than Balina soil. However, decomposition of manure was found slightly higher (around 5%) in Balina soil compared to Noadda soil when averaged for four manures. On an average, 9.07% of the added manure carbon was mineralized in Balina soil at the first 94 days of incubation while this was 8.64% in Noadda soil (Figure-8).

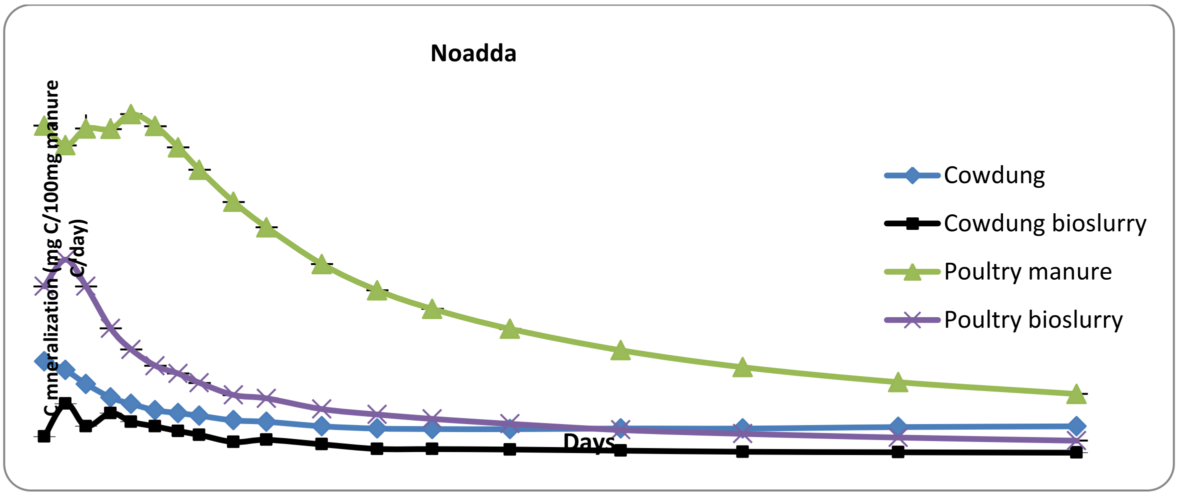

Fig-6: Daily mineralization patterns of different manures in Noadda soil

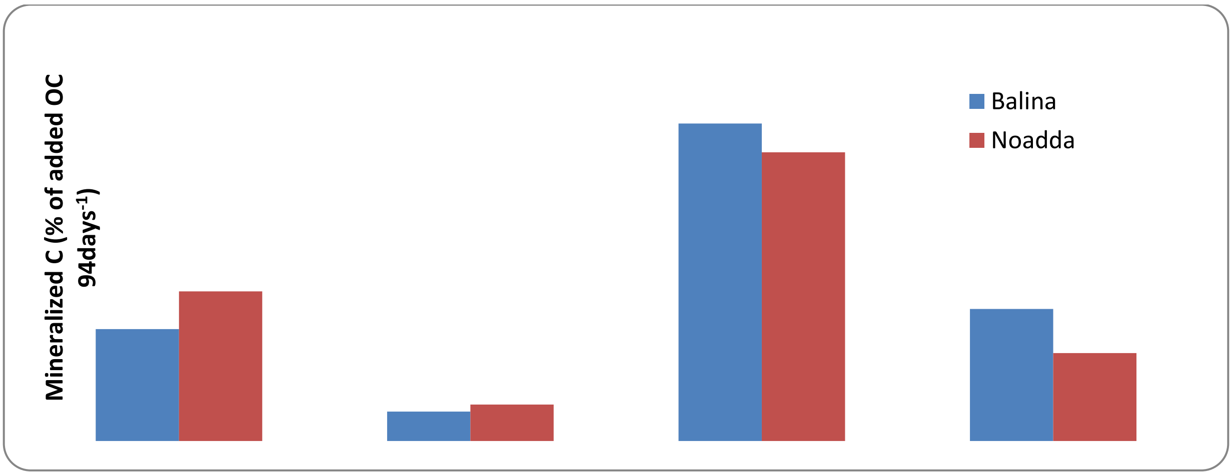

Fig-7: Amount of mineralized carbon (at the end of 94 days incubation) in different manure incorporated in two contrasting soil

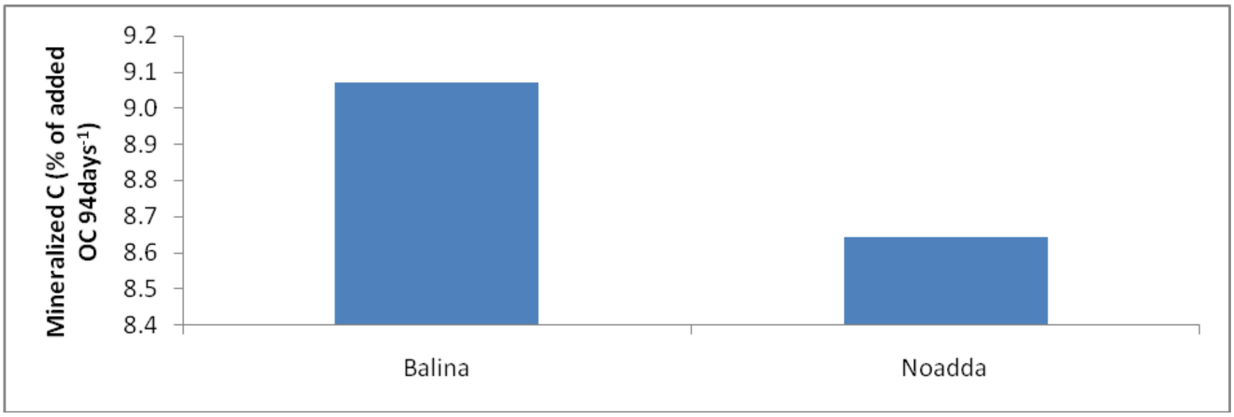

Fig-8: Average amount of mineralized carbon (at the end of 94 days incubation) from different manure in Balina and Noadda soil

DISCUSSION

Chemical composition of manure and their mineralization in soil is important in regulating the function of soil for agricultural productivity. Thus, chemical composition of two commonly applied manure in Bangladesh along with two byproduct of very recently popularized biogas technology and their mineralization were studied in two major soils of Bangladesh. Balina and Noadda soils were selected as a representative of very young floodplain soil and terrace soil that account 80 and 8%of Bangladesh soils.

OC content of cow-dung and poultry bio-slurry was always found lower than the cow-dung and poultry manure. This result is logical as about 25 to 30 percent of the organic matter from the faecal matter (cow-dung and poultry manure) is converted into biogas during the anaerobic fermentation process while the rest becomes available as a residual manure [44, 45] which is generally considered to be rich in major plant nutrients (NPK) as well as in micro nutrients [41]. However, a large amount of nutrients particularly N and K is lost from slurry during the drying of slurry through volatilization and leaching loss. This is evident from the lowerN and K content of cow-dung and poultry bio-slurry as compared to cow-dung and poultry manure (Table-1). Lower N content of cow-dung and poultry bio-slurrycould be due to the fact that the water soluble N in bio-slurry remains as ammoniacal form accounting 12-18% of total N [42] was lost through volatilization (around 96 percent of the dissolved ammonia escaped into the air) during the evaporation and drying of the digested paste like slurry due to alkaline pH of the slurry (Acharya, 1961; Chawla, 1984). Indeed, an anaerobic fermentation in the biogas digester does not result in any absolute increase in the nitrogen content of the slurry; the relative increase is noticed due to the loss of 25 to 30 percent of the loss of organic matter of the dung during biogas generation (Gupta, 1991). However, volatilization losses of the ammoniacal-N during drying of the slurry decreased the total N content of the slurry compared to manure. Similar to N, K content of cow-dung and poultry bio-slurry was always found lower than the cow-dung and poultry manure. It could be due to the fact that the water soluble K in bio-slurry was lost through leaching during the drying of the digested paste like slurry in soil pit.

The cumulative amount of C mineralized in 94 days of incubation in soils treated with cow-dung, cow-dung bio-slurry, poultry manure and poultry bio-slurry ranged between 1.81 and 19.49% of added manure C. This result is in the range of C mineralization of 1.84 to 50.1% of added OC reported from a 39 day laboratory incubation at 21°C of six food industry waste, a mixture of food industry waste and pig slurry and three compost, one-third of added pig slurry C mineralized within three months [46] and 20% of added pig slurry C mineralized within 15 days. Around three to four times less amount of CO_2 evolved during the decomposition of cow-dung and poultry bio-slurry as compared to cow-dung and poultry manure in our experiment indicates high resistance of cow-dung and poultry bio-slurry to microbial degradation. This is in the similar trend of Chen *et al*., [47] who reported nearly five times lower C mineralization of maize plant bioslurry compared to maize residues (6.4 versus 30% of added OC) in a 21 days incubation at 19°C with 75% water holding capacity. This lower mineralization of bio-slurry compared to manure might be due to conversion (20-30%) of labile organic matter into biogas during anaerobic fermentation of the slurry. Indeed, after anaerobic fermentation more recalcitrant compounds remains in slurry that are quite resistant to microbial decay. Therefore, land application of bio-slurry had short-term benefits in terms of improving soil organic matter stock, as compared to manure. Lower emission of CO_2 and longer persistent time in soil indicate high potential of bio-slurry in the mitigation of the greenhouse effect when being used as organic fertilizers.

CONCLUSIONS

Cow-dung and poultry manure had the higher organic carbon content as well as higher nutrient concentration compared to Cow-dung and poultry bio-slurry. Carbon mineralization of manures in Noadda soil also followed the similar trend like Balina soil. Carbon mineralization of poultry manure and poultry bio-slurry was lower and cowdung and cowdung bio-slurry was higher in Noadda compared to Balina soil. . Among the manure, around three to four times less amount of CO_2 was evolved during the decomposition of cow-dung and poultry bio-slurry as compared to cow-dung and poultry manure. Data obtained in the present study clearly indicated distinct variations in the rate of carbon mineralization from different manures added to soils of two different series. Therefore, estimation of carbon mineralization from various organic sources in all different soils appear imperative in the context of soil organic matter management for increasing soil fertility and crop productivity.

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