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Stages of organic matter addition vs. N transformation in soil

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Abstract

FYM and mustard cake, the two variable source of organic matter, were used as amendments and N sources in a typic ustifluvent soil. Organic matters were added at two modes i.e 21 days' before and on the day of actual start of the experiment. Inorganic N as urea was added as treatment material. Results of the experiment reveal that comparatively higher amount of inorganic N was accumulated in soil incubated at 21 days compared to soils amended with organic matter upto 90 days period. Compared to the sources of organic matters, it was observed that the amount of inorganic N was recorded much higher in mustard cake amended soil than that of the soil amended with FYM. However, the amount of organic N content did not vary much and also did not show any definite trend of changes. The overall result showed that mustard cake proved superior results over that of FYM with regard to accumulation of inorganic N in soil. Addition of organic matters 21 days before the start of the experiment showed better results with regards to availability of N in soils.

Keywords: Nitrogen transformation; FYM, Mustard cake; inorganic N.

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Introduction

Nitrogen plays an important role for growth and metabolic activities of plant. Nitrogen present in soil, mostly comes from natural sources and applied fertilizer. Natural source of nitrogen is the organic matter, which controls the release and dynamics of nitrogen in soils during the cropping season (Nourbakhsh and Dick, 2005). Addition of organic matter in the form of farm yard manure (FYM) enhances hydrolysable and non-hydrolysable N contents in soil (Kamat *et. al.,* 1982). Singh *et al.,* (2001) established that total hydrolysable N status declined with application of fertilizer N alone and increased with conjunctive use of fertilizer N and organic manures.

Application of organic matter of different decomposability not only affects its pattern of N chantey but also influences the distribution of different forms of nitrogen in soils (Beraud *et. al.,* 2005). The main difference in organic matter resulted from their total C, N and inorganic N content. Devi (2009) reported that oil cake contains high amount of nitrogen (8.34%). The proportion of N mineralized from different organic materials ranged from 28% in wheat to 95% in gliricidra (Reddy and Mohanty, 2008).

Transformation of organic and inorganic nitrogen in soil is of prime importance, which is governed by physico-chemical and biological properties of soil. Application of inorganic N influences the transformation of N in soil as well as added organic matters of different decomposability.

Time of application of organic matter influences the transformation of different forms of N in soils. The timing of nutrient application in the field is governed by several basic considerations: (i) making the nutrient available when the plant need it, (ii) avoiding excess availability, especially of nitrogen, before and after the principal period of plant uptake, (iii) making nutrients available when they will strengthen, not weaken, long season and perennial plants, and (iv) conducting field operation when conditions make them practical and feasible. For efficient management of nitrogen deficient crop residues, incorporation of organic matter well in advance of the crop sowing is essential so that the added organic matter gets through the time for decomposition and mineralization of the microbial immobilized nitrogen. Three to four weeks are usually required for adequate transformation of crop residues before next crop can be successfully grown. In a specific study carried out by Velthof *et. al.,* (1999) it was found for autumn applied poultry manures the estimated N effectiveness is much lower. Gondek and Filipek (2004) reported that the organic carbon content of the soil depend more on the kind of fertilizers than on time of application. The present investigation was, therefore, conducted to study the transformation of different forms of inorganic and organic nitrogen in soil amended with two sources of organic matter with varying decomposability at different stages of the experiment.

Materials and methods

Soil used in the investigation was collected from Instructional farm, Jaguli of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. Soil is dried and passed through 0.5 mm sieve. The physical and chemical properties of the soil is as follows: pH – 6.2; EC – 0.26; texture - Clay; WHC – 60%; Oxidisable org. C – 0.67%; Exchangeable NH_4^+ - 116.6 mgkg^{-1}; Soluble NO_3^- - 112.0 mgkg^{-1}; Available N – 228.6 mgkg^{-1} (Stevenson, 1996). Each of 10 gm soil (0 – 15 cm depth) was taken in 100 ml beaker. There were two sets of same treatments for two different times of application of organic matters. In the first set FYM or Mustard cake was added 21 days before the start of the experiment. In the 2nd set FYM or Mustard cake was added on the day of start of the experiment. N in the form of urea at 75 mg kg^{-1} was added to all N treated systems. Separate sets were maintained for identical collection of soil samples on 0th , 15th , 30th , 60th , 90th day of the experiment to analyze different forms of inorganic N. All the treatments were replicated thrice. Soils were maintained at 60% of water holding capacity and kept at room temperature (26 ± 2^{0}C) throughout the experimentation period. The loss of moisture due to evaporation was replenished by periodic addition of sterile distilled water on every alternate day by difference in weight. 2 M KCL solution was employed for extraction of available N and was estimated by the method of Bremner and Keeney (1966).

Results and discussion

Results reveal that irrespective of treatments, exchangeable ammoniacal N decreased upto 60th day amd then shown an increasing trend upto 90th day of incubation (Table 1). Irrespective of stages of sampling comparatively higher amount of exchangeable NH_4^+ was accumulated in soils incubated with either of the organic matters at 0th day. This result clearly indicated that faster rate of N mineralization was taken place in soil incubated with added inorganic N. The initial decrease of exchangeable NH_4^+ might be due to utilization of that N by the microbial biomass for their livelihood (Saha and Mukhopadhyay, 1984) and or loss of N through the processes of denitrification (Dutta *et al,* 1991) as well as volatilization (Cantarella *et al,* 2009). The increase in the level of exchangeable NH_4^+ might be due to mineralization of organic sources by microbial biomass. Furthermore, comparatively higher amount of exchangeable NH_4^+ was recorded with mustard cake than FYM treated system. This was due to higher content of total N in mustard cake than that of FYM (Saha, 1987).

The changes in the content of soluble NO_3^- during the incubation period was placed in Table 2 representing the same trend as exchangeable NH_4^+ . 21 days prior application of both organic matter, irrespective of added inorganic N showed better release of soluble NO_3^- at the early stages of incubation as compared with 0th day addition resulting better accumulation of soluble NO_3^- by microbial community in soil (Saha and Pal, 1990). Further at later stage of incubation irrespective of treatments, the increase in soluble NO_3^- disclosed microbial mineralization of organic N. 0th days application of organic matter showed better accumulation of soluble NO_3^- than 21 day prior application of organic matter in soil.

The overall results suggested that significant effect of treatments were particularly observed on treatment, incubation period and added inorganic N in soil over the whole experimentation period. However, their interaction effect did not always show a consistent trend of results.

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Table 1. Periodic changes in the amount (mg kg^{-1}) of exchangeable NH_4^+ in soil treated with organic matters of different decomposability and added at different time intervals

Treatment		Incubation period (days)				
		0	15	30	60	90
Soil	A	93.3	79.3	70.0	50.4	121.0
	B	116.6	100.3	84.0	61.6	181.0
Soil + FYM	A	147.0	93.3	79.3	57.7	275.0
	B	147.0	112.0	91.0	65.3	287.4
Soil + FYM + N	A	142.0	98.0	88.6	67.2	281.8
	B	136.0	72.3	72.3	63.4	293.0
Soil + MC	A	120.3	79.3	60.6	56.0	302.0
	B	117.3	99.0	60.6	59.7	328.4
Soil + MC + N	A	139.0	88.6	81.6	70.9	324.3
	B	124.3	88.6	74.6	67.2	388.0
CD at 5%	Incubation	8.7464	5.7542	8.9841	7.4228	8.2523
	Nitrogen	10.7121	7.0474	11.0033	9.0911	10.107
	Type	8.7464	5.7542	8.9841	7.4228	8.2523
	In X N	15.1492	9.9665	NS	NS	14.2934
	In X Type	NS	NS	NS	NS	11.6705
	N X Type	NS	9.9665	15.561	12.8567	14.2934
	In X N X Type	NS	NS	NS	NS	NS

A = Organic matter added 21 days before the start (o days) of the experiment,

B = Organic matter added on the day (0 day) of start of the experiment,

FYM = Farm Yard Manure, MC = Mustard cake, In = Incubation, OM = Organic matter

N = Inorganic nitrogen addition, NS = Not significant, Type = type of organic matter

Table 2. Periodic changes in the amount (mg kg^{-1}) of Soluble NO_3^- in soil treated with organic matters of different decomposability and added at different time intervals

Treatment		Incubation period (days)				
		0	15	30	60	90
Soil	A	109.6	98.0	93.3	88.6	228.1
	B	112.0	102.0	81.6	70.9	234.4
Soil + FYM	A	154.0	137.6	105.0	98.9	249.7
	B	119.0	119.0	92.3	85.8	310.4
Soil + FYM + N	A	139.3	142.3	123.6	98.9	236.5
	B	131.0	128.3	116.6	74.6	319.6
Soil + MC	A	172.6	170.3	143.6	142.3	328.0
	B	154.0	149.3	138.1	107.3	370.9
Soil + MC + N	A	154.0	147.0	138.0	119.0	338.9
	B	147.0	142.6	133.0	93.3	381.0
CD at 5%	Incubation	NS	7.3216	NS	NS	8.4654
	Nitrogen	12.0636	NS	NS	7.8547	10.368
	Type	9.8499	NS	4.8826	NS	8.4654
	In X N	17.0605	12.6814	8.4568	NS	14.6625
	In XType	NS	NS	NS	NS	11.9719
	N X Type	NS	NS	8.4568	NS	14.6625
	In X N X Type	NS	NS	NS	NS	20.736

A = Organic matter added 21 days before the start (o days) of the experiment,

B = Organic matter added on the day (0 day) of start of the experiment,

FYM = Farm Yard Manure, MC = Mustard cake, In = Incubation, OM = Organic matter

N = Inorganic nitrogen addition, NS = Not significant, Type = type of organic matter