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Ammonia Volatilization from Different Soils Amended with Organic Materials

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A series of experiments were conducted on different soils (Alfisol, Vertisol and Entisol) under laboratory conditions to measure ammonia voltalization losses as affected by rate of organic matter (City Compost, FYM < glyricidia and pongamia litter) application. It has been observed that irrespective of type of organic matter applied, the maximum voltalization loss occured during first 2 weeks and gradually the rate of loss was lower and the loss was negligible after 18 d. Highest cumulative loss occurred with City Compost and glyricidia litter applied. Entisol treatments recorded lower ammonia volatilization compared with Vertisol and Alfisol in all the treatments. Greater volatilization loss of nitrogen in City Compost treatment weas attributable to alkaline pH of the materials itself (pH = 7.6). In the present study, the losses were negligible after 2 weeks. This has led to the inference that decreases in NH_4-N level and most probably simultaneous nitrification and denitrificxation reaction.

Key Words: Ammonia, Volatilization, Organic matter.

INTRODUCTION

Ammonia volatilization is an imzportant nitrogen loss mechanism for the fertilizer nitrogen applied to farm field and incorporation of green manures in soil[1]. Losses of NH_4–N by volatilization should be low, since incorporation of green manure in soil affected NH_3 volatilization through its influence on pH and partial pressure of CO_2. It has been reported by fenn and Kissel[2] that ammonia volatilization is temperature dependent and the magnitude of thermal effect is highly variable among soils and experimental conditions especially in presence of $CaCO_3$ in the soil and certain type of ammonium compounds. The present experiment was conducted to study the amount of ammonia volatilization loss from different organic manures incorporated with different soils.

EXPERIMENTAL

Surface soil samples (0-20 cm depth) were collected from fields at three locations to obtain different soils (Alfisol, Vertisol and Entisol). Surface samples collected were transported to laboratory for further processing and subsequent conducting of experiments. Transported soil samples were air dried, ground to pass through 2 mm sieve and used for laboratory incubation studies.

Organic materials (FYM, City Compost) were finely ground and glyricidia litter and pongamia litter were chopped into small pieces. Organic materials were analyzed for total organic carbon content by following procedure given by Ciavatta *et al.*[3]. Total N content was estimated using H_2SO_4 and digestion mixture (K_2SO_4; $CuSO_4{\cdot}5H_2O$; Se) by macro Kjeldahl procedure.

Ammonia volatilization was studied following a method devised by Feigin and Waisel[4] in laboratory with slight modification. Weighed quantities of oven dried organic materials chopped into small pieces were thoroughly mixed with 200 g of soil. The mixture was placed at the bottom of 1000 mL capacity conical flasks. Appropriate controls were maintained which did not receive any organic materials. Afterward, the soil moisture content was maintained and 3 mL of 4 % boric acid was taken in test tube for trapping the evolved ammonia gas and it was hung up to the hook in the flask. The flask was made air tight with rubber stopper and each treatment was repeated twice. At period intervals, the boric acid was against 0.25 N H_2SO_4 using mixed indicator. The losses of ammonia through volatilization were measured.

RESULTS AND DISCUSSION

Cumulative ammonia volatilization

Results on the ammonia volatilization pattern (cumulative) as a consequence of different organic materials incorporated into three soils are presented in Figs. 1-3 and Tables 1-3. in the organic material unamended VER and ALF soils (control) about 10 per cent of the applied N was lost due to NH_3 volatilization in 60 d. These loses were, however, 12.5, 18.7, 8.8 and 15.3 % in VER soils and 12.75, 18.5, 16.1 and 13.4 % with the addition of FYM, city compost, pongamia litter and glyricidia litter in the soils, respectively.

In case of entisoil in the organic material unamended soil (control), about 5 % of the applied N was lost due to NH_3 volatilization in 60 d. These losses were 10.3, 8.5, 5.9 and 6.0 per cent with the addition of FYM, city compost, pongamia litter and glyricidia litter in the soil respectively.

Maximum cumulative NH_3 volatilization was record in city compost treatment. This treatment retained higher NH_3 volatilization capacity during all intervals of ammonia volatilization estimation.

Rate of NH_3 volatilization

Rate of ammonia volatilization loss were highest for first 2 weeks among various treatments (Figs. 1-3).

The ammonia volatilization loss rates peaked at the 13th day under control (2.4 %), FYM (3.2 %), City Compost (2.7 %), pongamia (4.7 %) and glyricidia (2.5 % d^{-1}) treatment in alfisol. After 20th day of application the ammonia volatilization rate remained more or less constant.

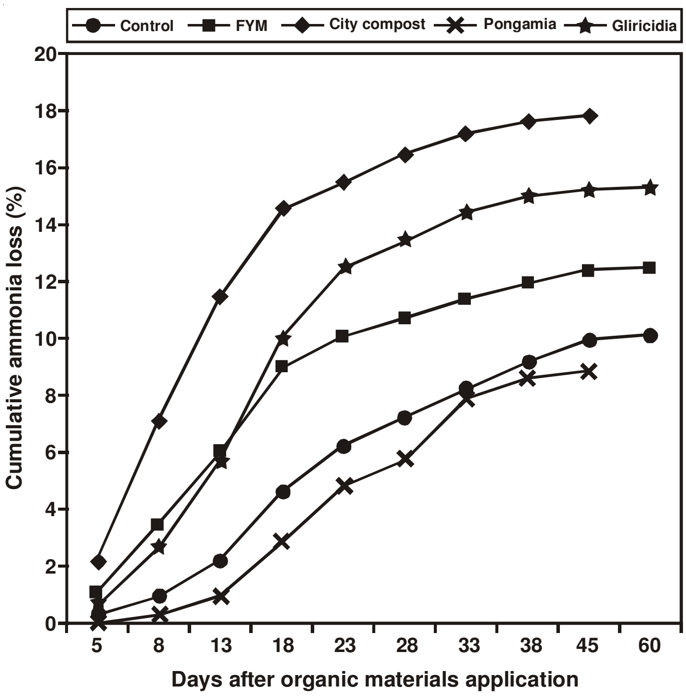

Fig. 1. Effect of different organic materials of NH_3 volatilization losses in Vertisol

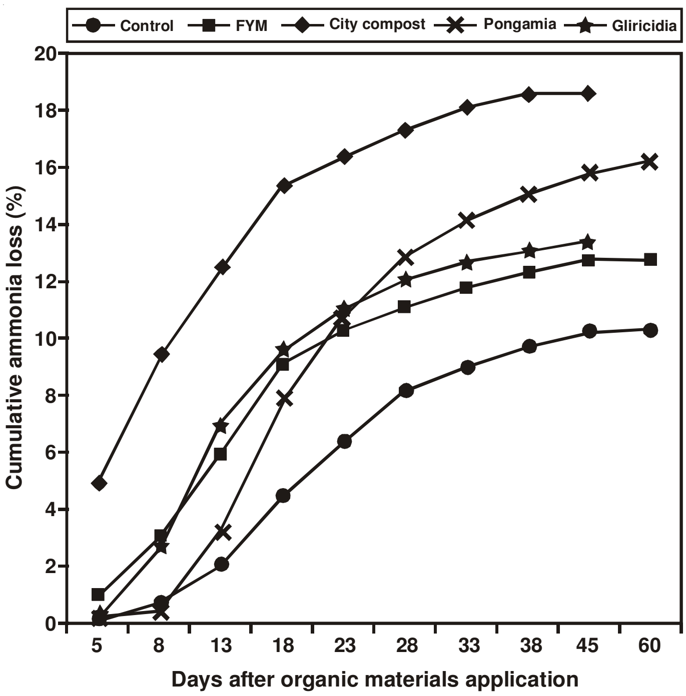

Fig. 2. Effect of different organic materials of NH_3 volatilization losses in Alfisol

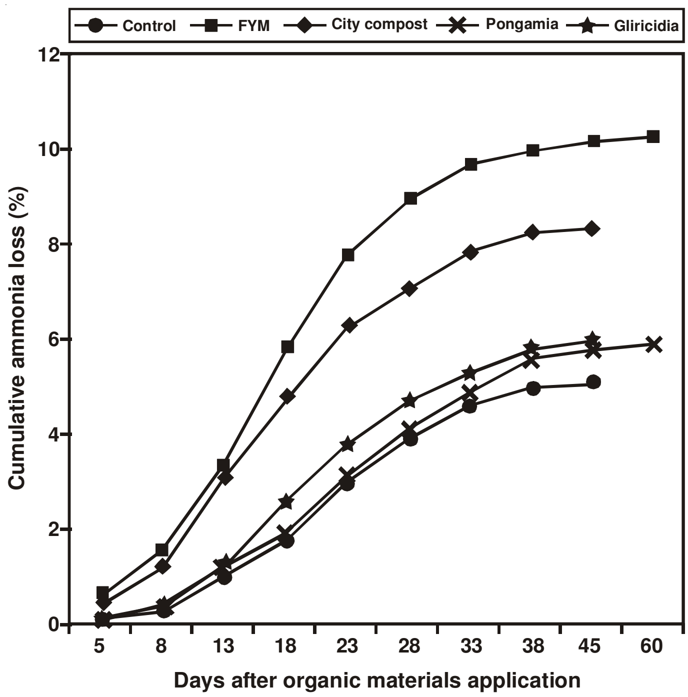

Fig. 3 Effect of different organic materials of NH_3 volatilization losses in Entisol

TABLE-1
EFFECT OF ORGANIC MATERIALS ON AMMONIA VOLATILIZATION LOSSES (%) FROM VERTISOL

Incubation period (d)	Organic residues									
	Control		FYM		City compost		Pongamia		Glyricidia	
0-5	0.2	Cum.	1.0	Cum.	2.2	Cum.	–	Cum.	0.6	Cum.
5-8	0.7	0.9	2.5	3.5	4.9	7.1	0.2	0.2	2.0	2.6
8-13	1.3	2.2	2.5	6.0	4.4	11.5	0.7	0.9	3.1	5.7
13-18	2.4	4.6	3.0	9.0	3.1	14.6	2.0	2.9	4.3	10.0
18-23	1.6	6.2	1.0	10.0	0.9	15.5	1.9	4.8	2.5	12.5
23-28	1.0	7.2	0.7	10.7	0.9	16.4	0.9	5.7	1.0	13.5
28-33	1.0	8.2	0.7	10.4	0.8	17.2	2.2	7.9	0.9	14.4
33-38	0.9	9.1	0.5	11.9	0.4	17.6	0.7	8.6	0.6	15.0
38-45	0.8	9.9	0.5	12.4	0.2	17.8	0.2	8.8	0.2	15.2
45-60	0.2	10.1	0.1	12.5	–	–	–	–	0.1	15.3

In entisol the ammonia volatilization loss rate decreased after 13th day under FYM, city compost and glyricidia treatment and after 18th days under pognamia (1.2 %) treatment (Table-3).

TABLE-2
EFFECT OF ORGANIC MATERIALS ON AMMONIA VOLATILIZATION LOSSES (%) FROM ALFISOL

Incubation period (d)	Organic residues									
	Control		FYM		City compost		Pongamia		Glyricidia	
0-5	0.1	Cum.	0.9	Cum.	4.9	Cum.	0.1	Cum.	0.2	Cum.
5-8	0.6	0.7	2.1	3.0	4.5	9.4	0.3	0.4	2.7	2.9
8-13	1.4	2.1	2.9	5.9	3.1	12.5	2.8	3.2	4.1	7.0
13-18	2.4	4.5	3.2	9.1	2.7	15.2	4.7	7.9	2.5	9.5
18-23	1.9	6.4	1.2	10.3	1.2	16.4	3.0	10.9	1.6	11.1
23-28	1.7	8.1	0.8	11.1	0.9	17.3	1.9	12.8	0.9	12.0
28-33	0.9	9.0	0.7	11.8	0.8	18.1	1.3	14.1	0.6	12.6
33-38	0.7	9.7	0.5	12.3	0.4	18.5	1.0	15.1	0.4	13.0
38-45	0.5	10.2	0.4	12.7	0.1	18.6	0.7	15.8	0.4	13.4
45-60	0.1	10.3	0.05	12.75	–	–	0.4	16.2	–	–

TABLE-3
EFFECT OF ORGANIC MATERIALS ON AMMONIA VOLATILIZATION LOSSES (%) FROM ENTISOL

Incubation period (d)	Organic residues									
	Control		FYM		City compost		Pongamia		Glyricidia	
0-5	0.1	Cum.	0.6	Cum.	0.4	Cum.	0.1	Cum.	0.1	Cum.
5-8	0.2	0.3	0.9	1.5	0.8	1.2	0.3	0.4	0.3	0.4
8-13	0.7	1.0	1.8	3.3	1.9	3.1	0.8	1.2	0.9	1.3
13-18	0.8	1.8	2.5	5.8	1.7	4.8	0.7	1.9	1.3	2.6
18-23	1.2	3.0	2.0	7.8	1.5	6.3	1.2	3.1	1.2	3.8
23-28	0.9	3.9	1.2	9.0	0.8	7.1	1.0	4.1	0.9	4.7
28-33	0.7	4.6	0.7	9.7	0.8	7.9	0.8	4.9	0.6	5.3
33-38	0.4	5.0	0.3	10.0	0.4	8.3	0.7	5.6	0.5	5.8
38-45	0.1	5.1	0.2	10.2	0.1	8.4	0.2	5.8	0.2	6.0
45-60	–	–	0.1	10.3	–	–	0.1	5.9	–	–

In Vertisol, the ammonia volatilization loss rates peaked at the 13th day under FYM (3.0 %), City Compost (3.1 %), pongamia (2.0 %) and glyricidia (4.3%) treatment (Table-1).

During subsequent weeks, the losses decreased gradually and the loss was negligible after 30 d.

The cumulative amounts of ammonia volatilization during decomposition as a consequence of different organic materials incorporation into three soils are presented in Figs. 1-3. Irrespective of type of organic matters applied, the maximum volatilization loss occurred during first two weeks and gradually the rate of loss was lower, and the loss was negligible after 18th day. The highest cumulative loss occurred with city compost and glyricidia litter applied. The cumulative ammonia volatilization losses were greater from city compost and glyricidia than from FYM. ENT treatments recorded lower ammonia volatilization compared with VER and ALF in all the treatments. Greater volatilization loss of N in city compost treatment was attributable to alkaline pH of material itself (pH 7.6).

The magnitude of volatilization losses would be higher in arid soils because of their texture being sandy to loamy sand, low in cation exchange capacity and high soil surface temperature prevailing in summer (45-50ºC) and because of calcareous nature of the soils[5]. It seems, therefore, the materials which decrease the urease activity, reduce pH surrounding the fertilizer granules, increase the cation exchange capacity and minimize or buffer the soil temperature, will reduce such losses.

Pongamia litter treatment showed a lower ammonia volatilization. This may be due to lower urease activity due to lesser energy availability for microorganisms. In case of FYM, Reddy and Mishra[6] reported that application of FYM @ 20 t ha^{-1} enhanced the urease activity.

Decrease in ammonia losses at lower pH has also been reported by Fenn and Kissel[1]. It shows that a lower rate of application, urease activity is enhanced due to energy availability of microorganisms, but higher concentration of FYM lower the pH resulting in retardation of the volatilization losses.

The losses were highest during the first week in control, FYM, City Compost, pongamia and glyricidia treatments. These losses under various treatments represented about 60 % of their total loss during this period. During subsequent weeks, the losses decreased gradually. In the present study, the losses were negligible after 2 weeks. This has led to the inference that decreases in NH_4–N levels and most probably through simultaneous nitrification and denitrification reactions.

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