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VOLATILIZATION LOSS FROM UREA AND MODIFIED FORMS OF UREA

Urea is the most commonly used nitrogenous fertilizer because of its high nitrogen content, hydrolysable nature, lower cost and easy availability. Urea when applied to soil is hydrolysed by the enzyme urease to ammonium carbonate and carbon dioxide. As ammonium carbonate is unstable, it dissociates to ammonium ion and carbon dioxide. The free ammonia formed in this process is usually lost to the atmosphere by volatilization. Volatilization loss of ammonia from applied urea is reported for both acid and calcareous soils (Fenn and Miyamotto, 1981; Fenn and Hossner, 1985; Rao and Batra, 1983), the loss being more in the latter. The nitrogen loss through ammonia volatilization is higher when the rate of application of urea is more (Sharma and Gupta, 1989). Many reports are available about the use of coating materials like neem cake on delaying nitrification and ammonia volatilization loss from urea (Bains *et al.*, 1971; Duraiswamy and Palaniappan, 1990). Coating of urea with indigenous materials like neem cake and tar are reported to improve the efficiency of applied urea in rubber growing soil mainly through delaying the nitrification process (Karthikakuttyamma *et al.*, 1994; George *et al.*, 2000). The present study was undertaken to study the nitrogen loss from surface applied urea at different rates of application and the effect of modified forms of urea on reducing the loss of ammonia.

The incubation study was conducted according to the standard method of Sharma and Gupta (1989). The soil used for the study was collected from the experimental area of the Rubber Research Institute of India (RRII) farm at Kottayam in Kerala state. The soil used for the study belonged to the taxonomic classification of ustic khandihumults. It was acidic (pH 4.39), high in organic carbon status (2.59%), sandy clay loam in texture with a cation exchange capacity of 8.2 cmol (p+)/kg. Soil samples were collected from the top 0-30 cm layer, air-dried and sieved through 2mm mesh and 250g was placed in a 500ml conical flask. Two test tubes, one containing 5ml of 4 percent boric acid and the other containing 2.5ml of 20 per cent barium peroxide were suspended in the flask using a thread. Boric acid was used to absorb the ammonia evolved from the fertilizer applied and barium peroxide for obtaining ample supply of oxygen into the system. Moisture of the soil was maintained at field capacity. Urea at different rates *viz.*, 100, 250 and 350 kg N/ha and three modified forms *viz.*, neem cake blended urea, neem coated urea and nimin coated urea at the rate of 250 kg N/ha were placed on the soil surface. The flasks were closed with rubber cork and incubated. Each treatment was replicated five times. A blank with no fertilizer was also run. At every 24 hour intervals, the test tube containing ammonia absorbed in boric acid was taken out and titrated against standard 0.01N hydrochloric acid using mixed indicator, methyl red and bromocresolgreen. Barium peroxide was renewed every two days. Ammonia volatilized was calculated as per cent loss of nitrogen from the applied nitrogen.

A nitrogen loss of 2.6 per cent occurred when urea equivalent to 250 kg N/ha, the nursery application dose was applied (Table 1). Whitehead and Raistrick (1990) reported a cumulative ammonia volatilization loss of 0.6 per cent in 9 days for soils having pH 3.7. Similarly, a nitrogen loss of 3.2 per cent from a soil having pH 4.8 under banana cultivation was reported by Prasertsak *et al.* (2000). The present observation is thus comparable to the earlier reports for acidic soils. The loss of ammonia was found to occur from the second to the tenth day of incubation. No ammonia evolution recorded on the first day in any treatment. Maximum loss was observed on the third day and there after the

Table 1. **Effect of different rates of N application on ammonia volatilization (% N)**

Urea (kgN/ha)	Days of incubation										
	1	2	3	4	5	6	7	8	9	10	Total
100	-	0.13	0.16	0.13	0.06	0.05	0.05	0.05	0.04	0.04	0.71
250	-	0.15	0.83	0.41	0.29	0.21	0.19	0.18	0.18	0.16	2.60
350	-	0.24	0.91	0.52	0.49	0.37	0.21	0.21	0.25	0.25	3.43

CD (P≤ 0.01) = 0.18**

loss decreased. This may be due to the fact that hydrolysis will be commenced on second day onwards and also it will complete almost within 7 days. Fenn and Miyamotto (1981) reported no significant ammonia loss within the first two days of incubation and that maximum loss occurred during the third to fifth day under laboratory conditions. The volatilization of ammonia is a common phenomenon for fertilizers that are alkaline or that produce an alkaline reaction once applied to soil. Urea is such a fertilizer. It releases nitrogen in ammonium form and at the same time creates a strong alkaline condition that favors the loss of the nitrogen as volatile ammonia.

It was observed that in all the treatments, the maximum loss of ammonia was observed on the third day and was 0.16, 0.83 and 0.91 per cent respectively for doses of 100, 250 and 350 kg N/ha. The loss steadily declined from the fourth day and reached a low value by the 10th day (Table 1). The loss of ammonia was found to increase with increase in the rate of application. When quantity increased, the concentration of ammonia in the reaction zone also increased and thus resulted in higher loss when rate was increased. Sharma and Gupta (1989) working with sandy soils observed similar results when the rate of application of urea was increased. This is expected, as ammonia loss is a first order reaction, being directly related to the solution nitrogen concentration.

Table 2 shows the effect of modified forms of urea on volatilization loss. When urea was applied at the rate of 250 kg N/ha, the cumulative loss for 10 days was 2.6 per cent. When modified forms of urea were applied, the loss of nitrogen significantly reduced to 1.71,1.19 and 1.46 per cent for neem cake blended urea, neem coated urea and nimin coated urea, respectively. All the modified forms of urea were found to be effective in reducing the ammonia volatilization loss. The maximum efficiency being noticed for neem coated urea. The other two modified forms were comparable. While no loss was observed on the first day after the application in any of the treatments, it was detected from the second day onwards for all modified forms. Coating materials form a layer over urea granules and thereby slow down the hydrolysis which result in reduction in loss of ammonia. Sharma and Gupta (1989) reported significant reduction in ammonia loss when urea was blended with neem cake or coated with shellac and neem

Table 2. **Effect of modified forms of urea on ammonia volatilization (%N)**

Modified forms of urea	Days of incubation										
	1	2	3	4	5	6	7	8	9	10	Total
Urea	-	0.15	0.83	0.41	0.29	0.21	0.19	0.18	0.18	0.16	2.60
NCBU§	-	0.04	0.41	0.43	0.32	0.20	0.08	0.10	0.07	0.06	1.71
NCU‡	-	0.02	0.27	0.26	0.18	0.12	0.11	0.10	0.06	0.07	1.19
NiCU+	-	0.02	0.31	0.32	0.28	0.18	0.13	0.10	0.06	0.06	1.46

§Neem cake blended urea; ‡Neem coated urea; +Nimin coated urea CD (P≤ 0.01) = 0.38**

cake. Bains *et al.* (1971) found that for the production of effective tillers in rice, application of IBDU (isobutylidene diurea) and neem seed crush extract treated urea at the rate of 100 kg N/ha, was on par with 200 kg N/ha applied as untreated urea. A significant increase in number of filled grains per panicle and thousand grain weight in the case of neem seed extract treated urea was also recorded.

Application of 120 kg N/ha as neem cake blended urea given in two splits registered an yield increase of 22 per cent over the usually recommended dose of 160 kg N/ha as urea alone in 4 splits for coffee (George *et al.*, 2000). Karthikakuttyamma *et al.* (1994) reported on the basis of a pot culture experiment that urea form was the best source of nitrogen with respect to the growth and apparent recovery of applied nitrogen for rubber seedlings.

This study has revealed that ammonia volatilization take place in the acidic rubber growing soils too, and that such losses are greater at higher application rates. It supports the recommended practice of split application of urea fertilizers for rubber. Modified forms of urea can also be used for increasing the efficiency of urea fertilizers though it has not yet been recommended for rubber. From this study it is clear that modified forms can easily be used for reducing the nitrogen loss through ammonia volatilization. Blending of urea with neem cake was found to be effective and economical in reducing nitrogen loss and can be recommended to farmers as coating is a time consuming and tedious process. Use of nimin coated urea is easier as it is a readymade product though its availability is limited.

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REFERENCES

Bains, S.S., Prasad, R. and Bhatia, P.C. (1971). Use of indigenous material to enhance the efficiency of fertilizer for rice. *Fertilizer News*, **16(3)** : 30-32.

Duraiswamy, V.K and Palaniappan, S.P. (1990). Studies on modified urea materials. *Madras Agricultural Journal*, **77**(5&6) : 241-243.

Fenn, L.B. and Miyamotto (1981). Ammonia loss and associated reactions of urea in calcareous soils. *Soil Science Society of America Journal*, **45** : 537-540.

Fenn, L.B. and Hossner, L.R. (1985). Ammonia volatilization from ammonia or ammonium forming nitrogen fertilizers. *Advances in Soil Science*, **1** : 537-540.

George, S., Syamala, V.K. and Punnose, K.I. (2000). Efficiency of slow release fertilizers for young rubber. In: *Plantation Crops Research and Development in the New Millenium*. (Eds. P. Rethinam, H.H. Khan, V.M. Reddy, P.K. Mandal and K. Suresh), Coconut Development Board, Cochin, pp. 373-377.

Karthikakuttyamma, M., Suresh, P.R., Mathew, M., Varghese, A. and Syamala, V.K. (1994). Relative efficiency of modified urea fertilizers for young rubber plants. *Indian Journal of Natural Rubber Research*, **7**(2) : 120-125.

Prasertsak, P., Freney, J.R., Saffigna, P.G., Denmead, O.T and Prove, B.G. (2001). Fate of urea nitrogen applied to banana crop in the wet tropics of Queensland. *Nutrient Cycling in Agroecosystem*, **59**(1) : 65-73.

Rao, D.L.N. and Batra, L. (1983). Ammonia volatilization from applied nitrogen in alkali soils. *Plant and Soil*, **70** : 219-228.

Sharma, B.D. and Gupta, I.C. (1989). Effect of rate and source of nitrogen and moisture content of soil on ammonia volatilization from sandy soils. *Journal of the Indian Society of Soil Science*, **37** : 665-669

Whitehead, D.C., and Raistrick, N. (1990). Ammonia volatilization from nitrogen compounds used as fertilizers following surface application to soils. *Journal of Soil Science*, **41** : 387-394.

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