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EFFECT OF UREA FORMS ON AMMONIA VOLATILIZATION, N RECOVERY AND YIELD OF LOWLAND RICE IN SANDY AND LATERITE SOILS

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Abstract An experiment was conducted to identify the best urea form which allows minimum N loss through ammonia volatilization but simultaneously ensuring good yield in the sandy and laterite soils of Kerala. The sulphur coated urea and urea mudball deep placement recorded minimum N loss through ammonia volatilization (2.85% and 5.29% respectively, of the applied N). However, application of urea supergranule in the reduced zone recorded the maximum grain yield and N recovery. Though the rate of ammonia volatilization was comparable between the two soils, yield was higher in laterite soil, irrespective of the treatments.

INTRODUCTION

Nitrogen is the major limiting nutrient in wetland rice. Response to N application is noticed in almost all types of rice soils. However, 20-30% of the applied N is only utilised by the rice crop under wetland situations. It has been attributed to various types of losses such as the gaseous losses through ammonia voltalization and denitrification, aqueous losses through leaching and run off or chemical and biological fixation. One means of increasing the N supply in soils without applying additional quantities of fertilizer is to improve the N use efficeincy. Deep placement of N fertilizer and use of slow release fertilizers have been suggested to decrease volatilization loss of applied N. With this background an investigation was undertaken to identify suitable slow release N sources which minimises the loss of N through ammonia volatilization, the major mechanism of N loss but simultaneously ensuring good yield of lowland rice in sandy and laterite soils.

MATERIALS AND METHODS

A study was conducted at the Regional Agricultural Research Station, Pattambi during September to December, 1988 using sandy soil collected from Onattukara (pH 5.04, OC 0.82%, CEC 4.28 me/100 g soil) and laterite soil collected from Pattambi (pH 5.17, OC 1.13%, CEC 6.34 me/100 g soil). The crop was raised in plastic pots of 18 litre capacity with a tap fitted at the bottom. The bottom layer of the pot was packed up with acid washed gravel and sand to a thickness of 5 cm. Afterwards, soil weighing 10 kg was filled in the pots. The soil was kept under 5 cm submergence for two weeks. The different N carries viz., prilled urea (PU) complete basal, urea supergranule (USG), gypsum coated urea (GCU), sulphur coated urea (SCU), coaltar coated urea (CCU), urea mudball (UM), prilled urea (PU) split (50% basal, 25% 20 days after transplanting, 25% 40 DAT), urea:coconut pith:soil in the ratio 1:3:2 (UCS) and rock phosphate coated urea (RPCU) at 90 kg N/ha were tested along with a no N control. The experiment was laid out in CRD with two replications. All the N carriers were basally applied except the urea split treatment. The N carriers were surface applied. However, USG and UM were deep placed at 10 cm depth in between two hills. P and K each at the rate of 45 kg P_2O_5 and K_2O/ha were uniformly applied in all pots. The entire quantity of P as superphosphate and half the quantity of K in the form of muriate of potash were applied as basal and the remaining quantity of K at 40 DAT. The test variety Jaya was transplanted with 28 days old seedlings in two hills pef pot at the rate of two plants per hill. Continuous submergence of 5 cm was maintained throughout the crop growth period.

Volatilized ammonia from each pot was trapped by employing the static closed system and acid trap device. The device consisted of a polythene cage covering the entire pot and a petridish containing 50 ml of 0.1 N H_2SO_4 was placed at 10cm above the flood water. The acid trap was withdrawn at 3,6,9,12 and 15 DAT and the trapped ammonia was estimated by microkjeldahl distillation method (Jackson, 1958). In the case of urea split treatment alone, these estimations were carried out at 11 intervals. The polythene cages were removed at 15 DAT except for urea split treatment where the cages replaced at 20 and 40 DAT following the top dressing of N and retained 9 more days for every top dressing. The content of N in grain and straw was estimated by sulphuric acid digestion followed by microkjeldahl distillation (Jackson, 1958) and the uptake of N was computed. Percentage N recovery, grain and straw yield were also recorded.

RESULTS AND DISCUSSION

Ammonia volatilization: The scrutiny of data given in Table 1 indicated that the soil types did not significantly influence the rate of ammonia volatilization whereas the effect of N carriers was highly significant in both soils. PU complete basal and SCU recorded maximum and minimum ammonia volatilization losses, respectively. Sudhakara and Prasad (1986) and Saravanan *et al* (1988) also found that volatilization loss of ammonia from PU was greater than that of other N sources. Prasad (1976) had demonstrated that substantially less ammonia was volatilized from SCU than from conventional ammoniacal fertilizers regardless of method of application. This was attributed to the slower dissolution of N coupled with oxidation of its sulphur component resulting in the lowering of pH, a condition favouring ammonia retention.

The mean values of N loss through ammonia volatilization increased from 5.84 mg N at 3 DAT and reached the peak values of 9.55 mg N at 9 DAT, then decreased to lowest value of 4.52 mg N at 15 DAT. However, in urea full basal and UCS treatments, the peak value of ammonia loss was recorded at 6 DAT. At 15 DAT, CCU and urea split treatments recorded the highest and lowest N loss respectively through ammonia volatilization among the different N carriers tested. In general 67% and 87% of the total ammonia volatilization has occurred within 9 and 12 DAT respectively. In the case of urea full basal and SCU treatments 76% and 65% respectively of the total N loss occurred within 9 DAT.

The cumulative N loss from soil through ammonia volatilization is given in Table 2. The magnitude of the loss was in the following orders: Urea full basal = UCS = CCU = GCU > RPCU = urea split = USG > UM > SCU. In urea split treatment the basal application recorded 27.59 mg N and the top dressing at 20 and 40 DAT recorded 7.91 and 3.58 mg N ammonia volatilization respectively. The decreased N loss in the second top dressing at 40 DAT can be attributed to the increased plant canopy. Fillery *et al* (1984) reported that shading of flood water by rice canopy in the later

Table 4. Effect of different urea forms on N uptake and recovery in sandy and laterite soils

[illegible] (S)	Urea forms (T)										Mean	CD (0.05)	
	No N	P[illegible] basal	[illegible]	[illegible]	[illegible]	[illegible]CU	[illegible]M	[illegible] split	UCS	RPCU			
Grain N uptake (g/pot)													
Sandy	0.25	0.29	0.42	0.27	0.32	0.31	0.41	0.36	0.[illegible]9	0.37	0.3[illegible]	S	0.047
Laterite	0.58	0.71	0.92	0.63	0.73	0.78	0.83	0.91	0.68	0.66	0.74	T	0.105
Mean	0.42	0.50	0.64	0.45	0.52	0.55	0.62	0.64	0.48	0.52		S x T	NS
Straw N uptake (g/pot)													
Sandy	0.11	0.17	0.25	0.15	0.16	0.15	0.23	0.16	0.15	0.17	0.17	S	NS
Laterite	0.22	0.27	0.34	0.40	0.27	0.37	0.34	0.48	0.37	0.25	0.33	T	NS
Mean	0.17	0.[illegible]2	0.29	0.28	0.22	0.26	0.28	0.32	0.26	0.21		SxT	NS
N recovery (%)													
Sandy		21.7	46.3	14.3	25.0	21.7	43.8	30.8	1[illegible]2	33.3	28.3		
Laterite		18.4	38.9	22.3	20.0	3[illegible]4	31.6	42.5	23.[illegible]	12.1	26.7		
Mean		20.1	42.6	18.3	22.5	26.1	37.7	36.7	21.0	22.7			

Table 3. Effect of differenturea terms on the total and productive tiller number and yeld of rice in sandy and laterite soils

Soil (S)	Urea forms (T)										Mean	CD (0.05)	
	No N	PU basal	USG	GCU	SCU	CCU	UM	PU split	UCS	RPCU			
Total tiller number													
Sandy	8.8	13.0	19.8	14.3	12.0	14.3	19.0	11.3	12.3	13.3	13.8	S	1.46
Laterite	20.8	20.0	25.3	28.8	18.0	23.0	23.0	27.5	22.0	19.8	22.8	T	3.26
Mean	14.8	16.5	22.5	21.5	15.0	18.6	21.0	19.4	17.1	16.5		Sx T	4.61
Productive tiller number													
Sandy	7.3	9.3	10.5	9.0	9.0	8.8	11.0	8.8	8.3	9.0	9.1	S	1.05
Laterite	14.5	13.3	16.8	17.8	13.0	15.5	16.0	16.5	16.0	14.5	15.4	T	NS
Mean	10.9	11.3	13.6	13.4	11.0	12.1	13.5	12.6	12.1	11.8	SxT	NS	
Grain weight (g/pot)													
Sandy	21.00	27.79	37.58	27.96	29.11	29.55	38.96	31.29	26.33	31.37	30.90	S	2.947
Laterite	50.25	58.36	80.84	56.56	54.86	59.42	60.61	68.59	54.87	53.53	59.79	T	6.591
Mean	35.62	43.07	59.21	42.26	41.99	44.49	49.78	49.94	40.60	42.45		SxT	NS
Straw weight (g/pot)													
Sandy	17.76	25.98	38,99	26.50	26.15	26.88	35.63	27.36	24.46	28.69	27.84	S	3.712
Laterite	36.21	41.15	50.29	59.49	40.11	43.25	44.34	56.41	53.95	48.50	47.37	T	8.300
Mean	26.99	33.57	44.64	42.99	33.13	35.07	39.98	•41.88	39.20	38.60			

NS Not significant

Table 2. Different urea forms on the cumulative N loss through ammonia volatilization in sandy and laterite soils

Urea forms (I)	Cumulative N loss (S) mg N		Mean	Loss of added N, %
	Sandy	Laterile		
No N	2.37	1.72	2.05	
PU basal	56.19	56.65	56.42	13.52
USG	38.40	33.80	36.10	8.47
GCU	45.82	46.24	46.03	10.94
SCU	17.11	9.87	13.49	2.85
CCU	50.19	53.83	52.02	12.43
UM	28.54	18.13	23.33	5.29
PU split	40.12	38.76	39.44	9.30
UCS	56.17	56.64	55.40	13.27
RPCU	39.70	50.62	45.16	10.72
Mean	37.46	36.43		
	S	T	SxT	N added 402 mg
C D (0.05)	NS	0.789	NS	

NS Not significant

stages of crop growth reduced ammonia volatilization from top dressed N fertilizer.

Grain and straw yield

From the data presented in Table 3, it can be seen that the mean grain and straw yields were significntly higher in the laterite soil than the sandy soil due to better soil productivity of laterite soil. Among the different N carriers tested USG placed in the reduced layer produced the maximum grain and straw yield and the grain yield was significantly superior to other treatments. Increased number of total and productive tillers in the USG treatment reflected in the increased yield. The results were in close agreement with the findings of Vijayachandran and Premadevi (1982) and Saravanan *et al.* (1988).

N uptake and N recovery

The uptake of N by grain produced from laterite soil was more than double the quantity of that from sandy soil (Table 4). Deep placement of USG and urea split application recorded maximum N uptake by grain, followed by UM and CCU treatment. However, N uptake by straw did not significantly vary between soil types and N sources.

The percentage N recovery was also maximum for USG treatments (42.6%), followed by UM and urea split treatments. In laterite soil, split aplication of urea recovered more N than other sources applied as basal.

Eventhough SCU and UM deep placement treatments recorded the lowest

Table 1. Different urea forms on the ammonia volatilization (mg N) in sandy and laterite soil at different periods

Urea forms (T)	Soil (S)		Mean	Days after transplanting (P)					Mean
	Sandy	Laterite		3	6	9	12	15	
NoN	0.47	0.34	0.41	0.32	0.51	0.39	0.48	0.36	0.41
PU basal	11.24	11.33	11.28	11.94	17.29	13.48	9.61	4.11	11.28
USG	7.68	6.76	7.22	4.00	6.74	10.54	8.61	6.22	7.22
GCU	9.16	9.25	9.21	5.22	10.89	13.95	9.27	6.71	9.21
SCU	3.42	1.98	2.70	1.33	2.47	4.94	2.69	2.07	2.70
CCU	10.04	10.77	10.40	5.34	8.71	14.80	13.76	9.42	10.40
UM	5.71	3.61	4.67	1.14	3.04	4.90	7.58	6.68	4.67
PU split	6.02	5.15	5.59	7.62	9.52	6.10	3.68	1.02	5.59
UCS	11.23	10.93	11.08	15.70	17.25	12.46	7.50	2.50	11.08
RPCU	7.94	10.12	9.03	5.96	8.01	13.93	11.11	6.16	9.03
Mean	7.29	7.03		5.85	8.44	9.55	7.43	4.52	
Soil (S)									
Sandy				5.32	8.73	9.43	8.29	4.69	7.29
Laterite				6.39	8.15	9.67	6.56	4.35	7.03
Mean				5.85	8.44	9.55	7.43	4.52	

	S	T	P	S x T	S x P	P x T
CD (0.05)	NS	0.992	0.702	1.403	0.992	2.219

NS - Not significant

N added 403 mg

rate of ammonia volatilization loss it has not reflected in improving the yield and N recovery either in the sandy or laterite soils. It is attributed to other types of N losses occurring in the wetland conditions. Between the soils, the rate of ammonia volatilization was uniform whereas the yield varied significantly. This clearly indicated that apart from ammonia volatalization, other types of N losses and physico-chemical properties of the soils have greater significance in deciding the yield of rice.

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