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EFFECT OF NITROGEN SOURCES ON THE EFFICIENCY AND YIELD OF RICE IN TYPIC USTROPEPT WETLAND SOIL

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ABSTRACT

Field experiments were conducted during *kharif* and *rabi* seasons of 1991-92 to study the influence of nitrogen sources on the efficiency and yield of rice in Typic Ustropept wetland soil. The results revealed that the yield, nitrogen, phosphorus and potassium uptake, response ratio, apparent nitrogen recovery, output efficiency and benefit cost ratio were higher under the use of neem cake coated urea and urea gypsum than the conventionally applied prilled urea on equal nitrogen basis of 125 kg N/ha. The combined application of prilled urea at 75 kg N/ha with green leaf manure at 50 kg N/ha proved to be the next best. Application of nitrogen at 175 kg N/ha was found to be necessary for getting higher grain yield in rice during both the crop seasons when the ordinary prilled urea was used.

KEY WORDS : Neem Cake Coated Urea, Urea Gypsum, Prilled Urea, Wetland Rice

The yield of rice can be improved only through an effective N source. Recovery of N by rice also depends on management and agro- ecological conditions. The present study therefore was undertaken to see the influence of N sources in improving the yield of rice under wetland condition.

MATERIALS AND METHODS

Two field experiments, one in *kharif* (July-Oct) and the other in *rabi* (Oct-Feb) crop seasons of 1991-92 with rice varieties ADT 36 and IR 20 respectively were conducted in the Typic Ustropept sandy clay wetland rice soil of Thambirabarani tract to study the effective N source in improving the yield of rice. The properties of the soil are as follows: alkaline (pH 8.1 and 8.0), available $KMnO_4$-N 210 & 240 kg/ha, available Olsen's-P 22 and 27 kg/ha, available NH_4OAc-K 222 and 246 kg/ha, cation exchange capacity 18 and 21 cmol (P^+)/hg, organic C 0.43 and 0.48 per cent for the *kharif* and *rabi* seasons respectively. The treatments were control (NoN), prilled urea (PU) at 75, 125, 175 and 225 kg N/ha, ammonium chloride (AC) at 125 kg N/ha, neem cake coated urea (NCU) at 125 kg N/ha, combined application of PU at 75 kg N/ha with *Gliricidia speciosa* cuttings containing 1 per cent N at 50 kg N/ha, which is equivalent to 5 t/ha (PU+GLM) urea gypsum (UG) at 125 kg N/ha and PU at 75 kg N/ha (PU+GLM) urea gypsum (UG) at 125 kg N/ha and PU at 75 kg N/ha with *Azospirillum* (PU+Azos). The trials were conducted in randomised block design with three replications. In all the treatments, inorganic N source was applied by broadcast one third basally at planting followed by one third top dressed at the tillering stage and the rest one third top dressed at the panicle initiation stage of the crop growth. All the treatments received uniform doses of 50 kg P/ha and 50 kg K/ha as single super phosphate and muriate of potash respectively as basal dressings. In the treatment of urea nitric phosphate (UNP) after deducting the P added through the complex fertilizer, the rest of the P was broadcasted basally in the form of super phosphate.

The green leaf manure at the rate of 50 kg N/ha was applied and incorporated in the respective plots seven days prior to transplanting. In the case of treatments involving *Azospirillum* application, the methodology adopted was as per the recommended schedule *viz.*, seed treatment using 3 packets of culture for the seed required for one ha, 5 packets for seedling root dip and 10 packets for one ha of main field.

At maturity the above ground portion of plants were harvested from each plots. The crop was thrashed, cleaned and dried. Dry weights of grain (14% moisture) and straw were recorded. Ground samples of the grain and straw were analysed for total N by micro-Kjeldahl method (Humphries, 1956), total P by colorimetric method (Piper, 1966) and total K by flame photometer method (Piper,

Table 1. Yield of rice (kg/ha) at harvest during different crop seasons.

Treatments	*Kharif* '91		Rabi '92	
	Grain	Straw	Grain	Straw
Control (N_0)	2985	3150	4663	5685
PU (N_{75})	3538	4090	5529	6728
PU (N_{125})	4221	5090	6595	7450
PU (N_{175})	4474	8150	7234	8663
PU (N_{225})	4434	8160	6928	9293
AC (N_{125})	4230	5110	6619	7586
NCU (N_{125})	4723	7200	7380	8557
PU (N_{75}) + GLM	4446	6050	6947	8091
UG (N_{125})	4718	7000	7372	8526
UNP (N_{125})	4223	5100	6598	7495
PU (N_{75}) + Azos.	3577	4100	5590	6781
Mean	4143	5745	6496	7714
CD at 5%	166	127	263	154

PU : prilled urea; AC : Ammonium chloride; NCU : Neem cake coated urea; GLM : Green leaf manure; UG : Urea gypsum; UNP : Urea nitricphosphate; Azos : *Azosprillum*

1966) and uptake computed. The response ratio was calculated by using the formula given by Yoshide (1981). Apparent N recovery (Fagi and De Datta 1981) and the output efficiency (IRRI, 1984) were assessed. The benefit cost ratio for the various N sources used in the experiment was worked out, taking into account the unit cost of N under the different N sources, also the unit price of the grain and straw prevailed at the time of experimentation.

RESULTS AND DISCUSSION

The data on the grain and straw yield are presented in the Table 1. Application of NCU and UG at 125 kg N/ha recorded the highest grain yield in both the seasons and found superior to the rest of the treatments in the *kharif*, but comparable with PU at 175 kg N/ha in the *rabi*. Combined application of PU + GLM proved to be the next best and all the above three N sources recorded

Table 2. Nutrients uptake in rice at harvest.

Treatments	*Kharif* '91			Rabi '92		
	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
Control (N_0)	33	7.0	50	61	15.2	91
PU (N_{75})	52	11.5	72	86	22.7	117
PU (N_{125})	76	20.5	106	119	32.8	160
PU (N_{175})	113	24.9	148	165	39.9	193
PU (N_{225})	116	26.5	148	170	41.3	197
AC (N_{125})	75	19.3	104	122	35.0	167
NCU (N_{125})	109	32.9	156	156	50.7	214
PU (N_{75}) + GLM	95	27.8	133	145	45.5	199
UG (N_{125})	106	31.4	150	151	47.5	205
UNP (N_{125})	74	19.4	96	116	34.5	152
PU (N_{75}) + Azos.	53	12.4	75	89	23.9	126
Mean	82	21.2	113	125	35.4	165
CD at 5%	6	2.0	13	11	2.7	11

PU : prilled urea; AC : Ammonium chloride; NCU : Neem cake coated urea; GLM : Green leaf manure; UG : Urea gypsum; UNP : Urea nitricphosphate; Azos : *Azosprillum*

Table 3. Nitrogen use efficiency in rice during different crop seasons.

Treatments	*Kharif* '91			Rabi '92		
	Response ratio (kg rice/kg N)	Apparent N recovery (%)	Output efficiency	Response ratio (kg rice/kg N)	Apparent N recovery (%)	Output efficiency
Control (N_0)	--	--	--	--	--	--
PU (N_{75})	7.4	23.0	--	11.5	33.9	--
PU (N_{125})	10.0	33.4	1.00	15.5	46.6	1.00
PU (N_{175})	8.5	44.9	--	14.7	59.5	--
PU (N_{225})	6.4	36.1	--	9.9	48.3	--
AC (N_{125})	10.0	32.5	0.99	15.6	48.4	1.01
NCU (N_{125})	14.0	59.8	1.40	21.7	75.6	1.41
PU (N_{75}) + GLM	11.7	48.3	1.35	18.3	67.3	1.19
UG (N_{125})	13.9	57.2	1.40	21.7	71.8	1.41
UNP (N_{125})	9.9	31.5	1.00	15.5	44.2	1.00
PU (N_{75}) + Azos.	7.9	24.9	--	12.4	37.2	--
Mean	10.0	39.2	1.19	15.7	53.3	1.17
CD at 5%	1.6	8.0	--	2.6	8.2	--

PU : prilled urea; AC : Ammonium chloride; NCU : Neem cake coated urea; GLM : Green leaf manure; UG : Urea gypsum; UNP : Urea nitricphosphate; Azos : *Azosprillum*

higher grain yield than the application of 125 kg N/ha of AC, PU and UNP. It is to be recorded that the application of NCU and UG at 125 kg N/ha proved superior to even the higher doses of PU *viz.*, 175 and 225 kg N/ha during Kharif season but comparable with PU at 175 kg N/ha during *rabi* season. This could be attributed to the slow and steady release of N leading to higher N use efficiency by the crop. The rice crop responded favourably upto 175 kg N/ha during both the seasons, and beyond this level, the grain yield remained static during *Kharif*, but it declined markedly during *rabi*. Application of *Azospirillum* failed to produce appreciable increase in the grain yield of rice. Application of PU at 225 kg N/ha recorded only significantly higher straw yield than the rest of the treatments (Vinaya Rai and Murthy, 1979) in both the seasons and it was comparable with PU at 175 kg N/ha in the *Kharif* season. In the *rabi* season, the straw yield of NCU and UG applied at 125 kg N/ha were comparable with PU 175 kg N/ha. The treatment PU + GLM was the next best (Ramaswami, 1974), and found superior to AC, PU and UNP at 125 kg N/ha during both the seasons.

Table 4. Benefit-cost ratio under the different N sources.

Treatments	Unit cost of N (Rs./kg)	Additional cost on N over control (Rs./ha)	*Kharif* '91	*Rabi* '92
			Net profit/rupee invested	Net profit/rupee invested
Control (N_0)	-	-	-	-
PU (N_{75})	6.17	463	5.10	6.85
PU (N_{125})	6.17	771	6.70	8.75
PU (N_{175})	6.17	1080	7.50	8.65
PU (N_{225})	6.17	1388	5.80	6.30
AC (N_{125})	8.24	1030	5.10	6.70
NCU (N_{125})	8.11	1013	8.15	9.60
PU (N_{75}) + GLM	7.98	998	7.60	8.20
UG (N_{125})	7.91	989	8.20	9.80
UNP (N_{125})	6.20	775	6.68	8.70
PU (N_{75}) + Azos.	7.37	553	4.50	6.10

PU : prilled urea; AC : Ammonium chloride; NCU : Neem cake coated urea; GLM : Green leaf manure; UG : Urea gypsum; UNP : Urea nitricphosphate; Azos : *Azosprillum*

The total N,P and K uptake of the rice crop is presented in Table 2. Application of PU at 225 kg N/ha followed by PU at 175 kg N/ha recorded the highest N uptake in both the seasons. NCU applied at 125 kg N/ha was comparable with at 175 kg N/ha during both the seasons. Combined application of PU+GLM was comparable with NCU and UG in the *rabi* season (Halepyati and Sheelavantar, 1990). The P uptake was significantly higher with NCU and UG during both the seasons and found superior to PU at 175 and 225 kg N/ha. The performance of the combined application of PU + GLM was found to be the next best. With respect to the K uptake, the application of NCU was found to be comparable or better to higher levels of N through PU *viz.*, 175 and 225 kg N/ha and the NCU was followed by UG during both the seasons.

The response ratio, apparent N recovery and the output efficiency are shown in Table 3. Among the N sources, the application of NCU and UG which were comparable, recorded significantly higher response ratio than all other N sources in both the seasons, which could be attributed to the increased grain yield of rice. This was followed by the combined application of PU + GLM being superior to the rest of the treatments, but comparable with AC at 125 kg N/ha in the *Kharif* season. The response ratio in rice increased with increasing levels of N upto 125 kg N/ha which was on a par with 175 kg N/ha and further increase in the N levels markedly decreased the response ratio of the crop during both the seasons, could be attributed to the decline in the incremental grain yield of rice for the successive increase in the level of applied N (Rani Perumal *et al.*, 1985). With regard to the apparent N recovery, the application of NCU which was comparable with the combined application of PU + GLM in *rabi* but comparable with UG during both the seasons recorded significantly higher apparent N recovery over the other N sources during both the seasons, could be attributed to higher N uptake by the crop. The apparent N recovery in rice showed a marked increase with increasing levels of N upto 175 kg N/ha, beyond which it declined markedly during both the crop seasons, might be due to the decline in the incremental N uptake for the successive increase in the levels of applied N. Application of NCU and UG recorded uniformly higher output efficiency than the other treatments during both the seasons. The output efficiency of the combined application of PU + GLM was almost comparable with that of NCU and UG during *Kharif*, but during *rabi* it recorded relatively lower output efficiency than these two N sources (Velu and Ramanathan, 1985).

The benefit - cost ratio is shown in Table 4. The N source, UG and NCU recorded uniformly higher benefit-cost ratio over PU, AC and UNP applied at 125 kg N/ha during both the seasons, which was due to the higher N, P and K uptake by the crop, leading to increased grain yield of rice. The benefit cost ratio of PU at 175 kg N/ha and the combined application of PU + GLM were almost comparable during both the seasons.

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