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Effect of integrated nitrogen nutrition techniques on yield, N content, uptake and use efficiency of rice (*Oryza sativa*)

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) seasons of 2000 and 2001 at Raipur, Chhattisgarh, to study the effect of different integrated nitrogen nutrition techniques on yield, N content, N uptake and N-use efficiency of rice (*Oryza sativa* L.). The grain yield, straw yield, N content and uptake were significantly higher under 100% recommended dose of N (RDN) blended with FYM and 100% RDN + 5 tonnes FYM than other treatments on pooled data basis. The per cent increase in grain yield with 100% RDN blended with FYM, 100% RDN + 5 tonnes FYM and 100% RDN as urea: FYM: soil over 100% RDN were 13.4, 14.2 and 8.2% respectively. The nitrogen-use efficiency parameters revealed that the factor productivity and recovery efficiency were highest with 100% RDN as urea: FYM: soil. But the recovery efficiency under 100% RDN as urea : FYM : soil, 100% RDN + 5 tonnes FYM and 100% RDN blended with FYM were higher than other treatments. However, the agronomic efficiency of 100% RDN blended with FYM and 100% RDN + 5 tonnes FYM were the same (0.48), followed by 100% RDN as urea : FYM soil (0.47).

Key words : Blending, *Azospirillum,* Yield, N uptake, N-use efficiency

Nitrogen is the key nutrient element limiting the yield of rice. Fertiliser N-use efficiency varies from 18 to 40% in rice soils, because applied inorganic N is rapidly lost from the soil by ammonia volatilization and denitrification (Natarajan and Pushpavalli, 1994). Urea is the principal nitrogenous fertilizer in rice-growing Asian countries. Large loss of N from urea necessitates an innovative application technique for increasing the N-use efficiency. Urea blended with organic materials minimizes N loss and increases N-use efficiency (Mishra, 1992). Therefore, a quantitative understanding of the effect of organic blended urea on yield, N content, N uptake and N-use efficiency of rice is necessary.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* seasons of 2000 and 2001 at the Instructional farm of Indira Gandhi Agricultural University, Raipur. The soil of the experimental field was sandy loam in texture, neutral in reaction (pH 7.5), low in organic carbon (0.42%) and available N (190.0 kg/ha), medium in available P (13.2 kg/ha) and high in available K (315.5 kg/ha). Ten treatments, viz. T_1, no nitrogen; T_2, 100% recommended dose of N (100% RDN); T_3, 100% RDN + 5 tonnes FYM; T_4, 80% RDN + 3 tonnes FYM; T_5, 100% RDN blended with FYM; T_6, 80% RDN blended with FYM; T_7, 60% RDN blended with FYM + *Azospirillum;* T_8, 100% RDN as urea: FYM : soil; T_9, 80% RDN blended with poultry manure: T_{10}, 60% RDN blended with poultry manure + *Azospirillum,* were replicated thrice in randomized block design. The recommended dose of N was 100 kg/ha as urea was applied in 3 equal splits at transplanting, tillering and panicle-initiation stages. In T_3 and T_4 treatments, well decomposed FYM, as per the dose was incorporated a day before transplanting but in T_5 and T_6, for each split application, required quantity of N was blended with FYM @ 1 tonne/ha, followed by incubation for 48 prior to application. In T_7, blending of urea with FYM was made in similar way but before blending *Azospirillum* @ 2 kg/ha was mixed with FYM only during basal application. In T_8, urea: FYM: soil (1:3:1) were blended for each split application by thoroughly mixing urea with equal weight of dried powdered soil and 3 times FYM, followed by incubation for 48 hr prior to application. In T_9, urea was blended with 0.5 tonne/ha poultry manure for each split application. In T_{10}, urea was blended with poultry manure as in T_7. Application of P_2O_5 and K_2O were uniform @ 60 kg and 40 kg/ha as single superphosphate and muriate of potash respectively. All P_2O_5 and K_2O were applied basally. The FYM contained 11.2% C, 0.61% N, 0.19% P,

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0.53% K, 18.2% moisture and poultry manure contained 26.5% C, 1.6% N, 0.66% P, 1.0% K, 14.6% moisture. Seedlings of 'Mahamaya' (125–130 days) rice were transplanted at 20 cm × 10 cm at an age of 27–29 days. The yield data were adjusted to 14% moisture content. Nitrogen use efficiency such as factor productivity for applied N (FP_N), recovery efficiency (RE) and agronomic efficiency (AE) were computed as described by Stalin *et al.* (1999).

RESULTS AND DISCUSSION

Grain yield, straw yield and harvest index

Rice grain yield under 100% RDN blended with FYM and 100% RDN + 5 tonnes FYM remained at par with each other on the basis of pooled analysis and were significantly superior to all other treatments (Table 1). The performance of 100% RDN was on a par with 80% RDN blended with FYM but was significantly superior to 80% RDN+ 3 tonnes FYM, 80% RDN blended with poultry manure and 60% RDN blended with either FYM or poultry manure along with *Azospirillum.* The increase in grain yield owing to 100% RDN blended with FYM, 100% RDN + 5 tonnes FYM and 100% RDN as urea: FYM : soil over 100% RDN was 13.4, 14.2 and 8.2% respectively. The straw yield was also maximum with 100% RDN + 5 tonnes FYM, being on a par with 100% RDN blended with FYM based on pooled analysis. The influence of treatments on harvest index was significant in pooled data. However, treatments involving integrated N application were statistically similar but remained superior to no-nitrogen and 100% RDN. Though in case of 100% RDN blended with FYM, the quantity of organic matter was less, compared to 100% RDN + 5 tonnes FYM, the former could produce comparable yield with latter owing to slow and steady release of N, resulting in efficient utilization (Lakpale *et al.,* 1999). The superior performance of these 2 treatments may also be owing to improvement in physical, chemical and microbiological environment of soil favouring increased availability of macro and micronutrients (Sengar *et al.,* 2000).

N content and uptake

The mean data on N content in grain and straw of rice for 2 years are presented in Table 1. The treatments 100% RDN applied either being blended with FYM or as urea: FYM: soil or along with 5 tonnes FYM were comparable and recorded significantly higher grain N content than the others during both the years and on the basis of pooled data (Table 1). A similar trend was noticed in case of N content in straw.

Significantly higher uptake of nitrogen in total of grain and straw was observed under 100% RDN + 5 tonnes FYM than the other treatments (Table 1). But comparable N uptake was also recorded from 100% RDN blended with FYM. The treatment of no-nitrogen showed the lowest N uptake.

Nitrogen-use efficiency

The nitrogen-use efficiency was computed through factor productivity, recovery efficiency and agronomic efficiency and the mean values revealed that the factor productivity was highest with 100% RDN as urea: FYM:soil (59.3), followed by 80% RDN blended with FYM (58.5) (Table 1). This is indicative of the fact that these treatments increase the production capacity per kg N applied, which might be due to prolonged N availability (Lakpale

Table 1. Grain yield, straw yield, harvest index, N content, N uptake and N-use efficiency of rice as influenced by nitrogen management techniques (mean data of 2 years)

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	N content (%)		Total N uptake (kg/ha)	N-use efficiency		
				Grain	Straw		Factor productivity	Recovery efficiency	Agronomic efficiency
No N	37.73	57.25	39.8	1.15	0.38	55.9			
100% RDN	55.61	83.03	39.9	1.28	0.44	93.0	55.8	17.9	0.38
100% RDN + 5 tonnes FYM	63.53	92.05	40.8	1.39	0.50	115.0	50.9	20.7	0.48
80% RDN + 3 tonnes FYM	51.59	78.32	39.7	1.18	0.42	80.2	52.7	14.6	0.26
100% RDN blended with FYM	63.05	88.12	41.7	1.39	0.47	110.5	54.9	20.1	0.48
80% RDN blended with FYM	55.51	76.83	42.0	1.21	0.42	85.0	58.5	18.8	0.31
60% RDN blended with FYM + *Azospirillum*	51.42	72.55	41.5	1.17	0.40	76.8	57.2	15.2	0.24
100% RDN as urea : FYM: soil	60.17	83.99	41.8	1.35	0.47	103.8	59.3	22.1	0.47
80% RDN blended with poultry manure	50.96	74.44	40.1	1.19	0.41	78.3	51.1	13.4	0.22
60% RDN blended with poultry manure + *Azospirillum*	51.47	72.80	41.4	1.17	0.40	76.5	54.2	14.5	0.22
CD (P=0.05)	3.17	4.32	1.7	0.08	0.04	6.3			

et al., 1999). The recovery efficiency of 100% RDN as urea: FYM: soil was the highest (22.1), followed by 100% RDN + 5 tonnes FYM (20.7) and 100% RDN blended with FYM (20.1). This could be attributed to higher N uptake under these treatments. Similar results were also reported by Upadhyaya *et al.* (2000). Higher agronomic efficiency under these treatments could be a reflection of their higher recovery efficiency.

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