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Time of application of low dose of nitrogen to rainy-season rice (*Oryza sativa*) for increasing N-use efficiency

M M PANDA[1] and S K MOHANTY[2]

Central Rice Research Institute, Cuttack, Orissa 753 006

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A better return could be obtained from a given amount of nitrogen when it is applied in fractions synchronizing with the stages of vigorous absorption and efficient N assimilation by the plant than when it is applied entirely at puddling (Mahapatra *et al.* 1990). Recent rise of fertilizer prices has forced the resource-poor farmers to go in for suboptimal doses of N. Further, many a time it is not possible for them to stick to the recommended time of application for reasons beyond their control. Thus under conditions of limited and irregular availability of this costly input, time of its application becomes critical for getting maximum return. A field study was therefore planned to find out the time of N application at low dose to high-yielding rice (*Oryza sativa* L.) grown under shallow submergence (0–30 cm) in a wet season to achieve the highest attainable yield and N-use efficiency.

The field experiment was conducted during the wet season of 1992 at Cuttack with 7 treatments (Table 1). The treatments were: T_1, the control; T_2, N application @ 60 kg/ha in 3 split doses, ie 30 kg/ha at transplanting and 15 kg/ha each at 21 and 75 days after transplanting; T_3, N @ 15 kg/ha at transplanting + 7.5 kg/ha each at 21 and 75 days after transplanting; T_4, N @ 30 kg/ha at transplanting; T_5, N @ 30 kg/ha at 10 days after transplanting; T_6, N @ 30 kg/ha at 21 days after transplanting; and T_7, N @ 30 kg/ha at 75 days after transplanting. The soil was an alluvial sandy clay-loam (Aeric Fluvaquepts), having *p*H 6.2, total N 1 360 kg/ha, organic carbon 0.43%, available P 46 kg/ha, exchangeable K 0.35 meq/100 g and cation-exchange capacity 15.1 meq/100 g soil. These treatments were tried in randomized block design with 3 replications. P @ 13.20 kg/ha as single superphosphate and K @ 25.2 through muriate of potash were applied basal at final puddling. Seedlings of high-yielding 'Savitri' rice at 35 days were transplanted on 31 July 1992 at a spacing of 20 cm x 10 cm. Dried samples of straw and grain were analysed for N content following the method outlined by Jackson (1973) and N uptake was computed. Apparent recovery, nitrogen-use efficiency and production efficiency were also worked out by the difference method (Mohapatra *et al.* 1983).

There was significant and progressive increase in grain and straw yields with application of N up to 60 kg/ha, applied in 3 splits doses (Table 1). The result confirms the finding of Samantaray *et al.* (1991). At 30 and 60 kg N/ha, the response in grain yield was 1.0 and 1.7 tonnes/ha, and in straw yield 1.1 and 1.6 tonnes/ha respectively compared with the

[1]Associate Director of Research, Regional Research Station (Judia farm), Keonjhar, Orissa 758 002

[2]Head, Division of Soil Science and Microbiology

control. Single application of 30 kg N/ha at different stages up to maximum tillering gave grain yield of 3.0–3.1 tonnes/ha, being significantly superior to that obtained when N applied at panicle-initiation stage only. Single application at maximum tillering stage, however, produced more straw than that applied at other stages. However, application of 30 kg N/ha in 3 splits was comparable to single application up to 3 weeks after transplanting in terms of both grain and straw yields. Jindal and Sharma (1971) reported that the application of N at tillering was more effective than at panicle-initiation stage. But Shiga *et al.* (1977) found top-dressing of N at early panicle-initiation stage inadequate for obtaining high yield. The total N uptake at harvest (Table 1) showed a significant progressively increasing trend with increase in N application. N uptake in various treatments receiving a total of 30 kg N/ha through fertilizer was comparable with one another. This indicated that though the N applied during panicle initiation was taken up by the crop, it was not reflected in grain yield. It confirms the report of Jindal and Sharma (1971). Nitrogen-use efficiency, apparent recovery and production efficiency of applied N (Table 1) were higher at lower levels of N (30 kg N), especially when applied in 3 splits. De Datta (1981) also reported similar result. The apparent recovery (58%) and nitrogen-use efficiency (35 kg grain/kg N applied) was highest under split application than under single application of 30 kg N/ha, which however were comparable with one another. But the lowest nitrogen-use efficiency and production efficiency were recorded under single application of 30 kg N/ha at panicle-initiation stage. Mikkelsen *et al.* (1967) reported that the crop should be top-dressed at early growth stages (30–40 days after sowing) and not at 60 days after seeding, although the later application seemed to improve crop appearance.

Therefore, under conditions of limited and irregular supply of nitrogen, the farmers should apply whatever small dose of N they can afford to rainy-season, high-yielding rice crop at any time up to 21 days after transplanting under shallow submergence in alluvial

Table 1 Effect of time and rate of nitrogen application on yield and nitrogen-use efficiency of rice

Treatment	Yield (tonnes/ha)		N uptake (kg/ha)	N-use efficiency*	Apparent recovery (%)	Production efficiency** absorbed
	Grain	Straw				
T_1	2.2	2.9	29.9			
T_2	3.9	4.5	61.4	29.5	52.6	56.1
T_3	3.2	4.0	47.4	34.7	58.4	59.4
T_4	3.1	3.8	44.6	30.0	49.1	61.1
T_5	3.0	3.9	45.1	28.7	50.6	56.6
T_6	3.1	4.3	44.0	30.7	47.2	65.0
T_7	2.6	3.6	43.9	13.3	46.8	28.5
CD (P = 0.05)	0.3	0.3	5.7			

Details of treatments are given in text

*Grain (kg)/N (kg) applied; **grain (kg)/N (kg) absorbed

sandy clay-loam soil of the Mahanadi delta. Split application is preferred, synchronizing with important stages of crop growth, to harvest profitable yield through increased nitrogen-use efficiency.

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