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EFFECT OF MODIFIED UREA FORMS ON THE PERFORMANCE OF WET-SEEDED RICE IN ACID LATERITE SOILS

T. K. Bridgit, Jose Mathew and C. Sivakumar
Regional Agricultural Research Station, Pattambi 679 306, India

Abstract : Field studies were conducted at the Regional Agricultural Research Station. Pattambi for three dry seasons during 1991 to 1993 tu evaluate the efficiency of modified urea forms in wet-seeded rice under puddled condition. The results indicated the remarkable response of wet-seeded rice to new urea forms over prilled urea in respect of growth, yield attributes and yield and N use efficiency. Split application on nimin coated urea (NCU) and inussorie rock phosphate coated urea (MRPU) recorded significant yield improvement over prilled urea (PU) and large granule urea (LGU) applied either fully as basal or in split doses.

Key words : Acid soil, laterite, modified urea forms, rice.

INTRODUCTION

Though transplanting is the common method of rice establishment in major rice tracts of India, wet-seeding is gaining importance in recent years due to acute scarcity of agricultural labourers during peak season and increasing wage rate. Though labour saving, wet-seeding technology also confronts several constraints. As in transplanted rice, the use efficiency of applied N fertilisers is too low under wet-seeding also, particularly in acid laterite soils such as in Kerala, due to various unavoidable losses accentuated by the peculiar soil properties (Joseph *et al.*, 1993) and hence rice yields are badly affected. Soaring prices and inadequate availability warrants the most judicious and efficient use of N fertilisers. This necessitates the formulation of new technologies to improve the efficiency of mineral N fertilisers. Slow release forms of urea are reported to be very efficient as they regulate the nitrogen supply in consonance with the crop demand at the various growth stages (Army and Wora, 1964; Singh *et al.*, 1990). The superiority of slow release fertilisers in transplanted rice is well established in calcareous soils (Raju *et al.*, 1989) but its performance in acid laterite soils is not promising (Anilakumar, 1989). However, there was no study on the performance of slow release N fertilisers in wet-seeded rice and hence the present investigation.

MATERIALS AND METHODS

Experiments were conducted at the Regional Agricultural Research Station, Pattambi (10 48'N 46 12'E and 25 m above mean sea level) during the dry (October to January) seasons of 1991 to 1993. The soil was sandy clay loam in texture, and acidic in reaction with pH 5.5 and CEC 9.8 cmol kg^{-1}. The soil was medium in fertility with 1.2% organic carbon, 240 kg ha^{-1} N, 14.6 kg ha^{-1} P and 160 kg ha^{-1} K. Available N content of soil was determined by alkaline permanganate method (Subbiah and Asija, 1956). Available P of soil was extracted with Bray-I extractant and determined colorimetrically by ascorbic acid blue colour method (Watanabe and Olsen, 1965). Available K of soil was extracted with neutral *N* NH_4OAc and estimated by using an EE1 flame photometer (Jackson, 1958). The treatments under evaluation were prilled urea, basal or split application (PUb and PUs); mussorie rock phosphate coated urea, basal or split application (MRPUb and MRPUs); large granule urea, basal or split application (LGUb and LGUs) and no N control. The nine treatments were arranged in randomised block design with three replications. Pre-germinated seeds of rice cv. Jyothi were sown at the rate of 90 kg ha^{-1} during the first week of October in a thin film of water in well puddled fields. The field was drained 24 h after seeding. Water was again let in on the fifth day and the depth of water was gradually increased afterwards according to plant growth. All the treatments received a uniform fertiliser dose of 100:35:35 kg of $N:P_2O_5:K_2O$ per ha. Basal dose of fertiliser was applied at final puddling and mixed thoroughly with the soil. Two-third dose of N was applied basally and the remaining at panicle initiation stage in the case of treatments involving split application of N. Phosphorus was applied fully as basal and K in two equal splits at basal and at panicle initiation stage. The crop was harvested during the third week of January in all the three years. Apart from grain and straw yields, important growth and yield attributes were recorded and N use efficiency was worked out. Grain yield was recorded at 14% moisture basis.

RESULTS AND DISCUSSION

Growth characters

Application of N appreciably enhanced the plant height and tiller production. Split application of N was found to be invariably superior to basal application of N (Table 1). Among the treatments NCUs recorded maximum plant height but was on par with MRPUs. The increased vegetative growth in NCUs and MRPUs clearly indicated the favourable release of N to rice crop from these sources in accordance with the nutrient demand of the crop.

Yield components

The four most important yield determinants, namely, panicles per m^2, panicle weight, fertile spikelets per panicle and 1000 grain weight were studied (Table 1).

Appreciable improvement was observed with N application in the case of almost all yield attributes. Split application of N markedly increased the panicle production over basal application. MRPUs recorded maximum panicle density but was comparable with NCUb and NCUs and was significantly superior to other treatments. Similar results have been reported by Singh and Singh (1984), Singh *et al.* (1990) and Thakur and Singh (1987). The trend of response was almost similar in respect of panicle weight. There was significant difference in the number of filled spikelets per panicle. Irrespective of sources of N, application of N was found to enhance fertile spikelet production per panicle over basal application. Split application of nimin coated urea produced more filled spikelets per panicle followed by MRPUs. Significant difference between treatments was not observed with regard to 1000 gram weight and the results corroborate the findings of Singh *et al.* (1990). Grain filling was highly influenced by N application. Among the treatments, NCUs and NCUb recorded maximum filling percentage followed by MRPUs. Split application of N, particularly in the form of modified urea ensured continuous supply of mineral N to the crop in consonance with its growth and effectively translocated it from source to sink resulting in improved grain filling. Results of the study thus indicated the marked superiority of NCU closely followed by MRPU in respect of yield attributes.

Grain yield

Significant increase in grain yield over control was recorded with all the treatments during all the three years (Table *2).* During the first year MRPUs recorded maximum yield closely followed by NCUs and NCUb while during the third year NCUs recorded the highest yield. No significant difference between treatments was observed during second year. Pooled analysis of the data on grain yield indicated the excellent performance of modified urea forms when applied in splits. NCUs recorded the highest grain yield but was on par with MRPUs and NCUb. PUs and LGU also produced comparable yields with that of highest yielding treatments. Sagar and Reddy (1992) reported similar results with split application of modified urea forms. Higher panicle and fertile spikelet number and higher filling percentage were the contributing attributes for higher yield in these treatments. This is in corroboration with the findings of Saheb *et al.* (1990), Singh *et al.* (1990), Sagar and Reddy (1992) and Kumar and Thakur (1993).

Nutrient release from the new urea forms such as NCU and MRPU reaches maximum at the ninth day of application whereas in PU the maximum concentration was on the sixth day of application in acid laterite soils (Anilakumar, 1989; Joseph *et al.*, 1993).

Reddy and Prasad (1975) and Thomas and Prasad (1982) observed higher retention of urea N with neem cake blended urea. NH_4-N release from neem oil coated urea reaches maximum at the eighth day of application and decreased steadily afterwards up to 42nd day, after which almost levelled off. In the case of PL), maximum concentration of NH_4-N was observed on fourth day of application and thereafter decreased to low values up to 28th day (Shinde and Mangruee, 1993). The N release from the new urea forms might have been adequate enough to meet the growing need of N by the plants in wet-seeded rice which reaches active growth a little later than transplanted rice. The reduction in the volatilisation loss of ammonia (Army and Wora, 1964; Joseph el al., 1993) and rate of nitrification (Shinde and Mangniee, 1993) as compared to PU would have also contributed to the better crop performance under modified urea forms.

Table 1. Influence of urea forms on growth and yield attributes and N use efficiency of rice (mean over three years)

Treatment	Height cm	Tiller m^{-2}	Panicles m^{-2}	Panicle wt, g	Filled spike-let/panicle	1000 grain wt., g	Filling %	N use efficiency*
No N	63.9	418	36.7	1.98	64.8	2.7	74.3	-
PUb	64.7	410	346	1.98	71.5	2.8	80.4	2.9
MRPUb	64.8	446	396	2.10	62.6	2.7	82.8	2.1
LGUb	63.4	446	396	2.16	69.9	2.7	82.0	3,9
NCUb	65.0	504	453	2.10	67.7	2.8	85.0	7.1
PUs	66.6	410	374	2.30	74.1	2.7	81.2	5.1
MRPUs	67.1	504	460	2.30	72.2	2.8	82.2	7.8
LGUs	66.0	392	353	2.20	68.1	2.7	83.3	4.3
NCUs	68.6	504	446	2.40	80.4	2.9	86.0	8.4
CD (0.05)	1.9	72.1	67.6	0.22	7.5	NS	-	-
CV (%)	3.3	17.4	18.2	12.48	11.7	6.29	-	-

*kg grain per kg N

Straw yield

Application of N recorded significantly higher straw yield than control(Table 2). Among the sources of N, LGUs recorded significantly higher straw yield followed by LGUb and NCUs in the first year of study. The trend of response was different during the second year wherein LGUs produced maximum straw yield followed by NCUs. The treatment did not show any significant difference dining the third year. However, NCUs recorded maximum straw yield closely followed by NCUb. Pooled analysis of the data revealed the superiority of N application over control. All the treatments receiving N application recorded comparable yields irrespective of the sources of N or times of application.

N use efficiency

Split application was found to be very efficient in utilising applied N over complete basal application (Table 1).Among the sources of N coated urea materials recorded higher N use efficiency than PU and LGU. NCUs recorded the highest N use efficiency closely followed by MRPUs and NCUb. The micro-meteorological situation with the rice canopy might have been conducive for heavy loss of N from applied PU particularly since the canopy in wet-seeded rice closes only after a long period

Table 2. Influence of urea forms on grain and straw yield of rice

Treatment	Grain yield kg ha^{-1}				Straw yield kg ha^{-1}			
	1991	1992	1993	Mean	1991	1992	1993	Mean
No N	4042	3799	4296	4046	3784	2476	2485	2915
PUb	4995	4003	4719	4572	5012	3556	3066	3878
MRPUb	5186	3857	4437	4494	5098	2931	2733	3566
LGUb	4842	4001	5164	4669	5516	3268	3314	4032
NCUb	5357	3851	5638	4949	4917	3447	3457	3940
PUs	5224	4425	4729	4792	4745	3654	3057	3819
MRPUs	5491	4220	5346	5054	5100	3595	2952	3882
LGUs	4957	4290	4950	4709	5224	3932	2837	3998
NCUs	5320	4299	5796	5138	5228	3704	3638	4190
CD (0.05)	206	NS	834	456	155	439	NS	426
CV (%)	2.3	8.3	9.5	10.4	1.8	8.5	9.4	12.1

after sowing. But the losses from modified urea form such as NCU and MRPU was minimised due to slow release of N as well as the immediate absorption of the released nutrient by the plant. This indicates more efficient utilisation of applied N through the modified urea forms which ultimately resulted in higher grain yield in wet seeded rice.

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