Pak. J. Agri. Sci.
25(2) 110, 1988

EFFICIENCY OF VARIOUS METHODS OF APPLICATION OF PRILLED UREA AND UREA SUPERGRANULES TO RICE

M. Aslam Mian, Ihsan-ul-Haq Mahmood and M. Khalid
Department of Soil Science, University of Agriculture, Faisalabad.

A field experiment was conducted during 1982 on rice variety KS-282 in order to evaluate the efficiency of prilled urea (PU) and urea supergranules (USG) as affected by various methods (split versus basal application) on a moderately calcareous, sandy clay loam soil. The nitrogen rates tested as PU and USG were 30, 60, 90, 120 and 150 kg ha^{-1}.

The results revealed that USG applied as split was superior in increasing the number of tillers per hill, 1000-grain weight, grain and straw yield to PU split, which in turn gave better yield than USG applied as basal dose. It was further observed that nitrogen uptake was increased significantly with an increase in nitrogen application rates. Greater nitrogen recovery was found with USG split applications compared to PU split both being superior to USG basal application.

INTRODUCTION

Nitrogen is the most deficient nutrient in Pakistan soils which is applied through fertilizers because of the volatilization, leaching and denitrifiaction losses the recovery of applied nitrogen by flooded rice rarely exceeds 40% according to present management practices (De Datta, 1981). Recoveries are particularly low when fertilizer N is applied to floodwater soon after transplanting but may be higher when deep placed at transplanting or applied to the floodwater at a later stage of crop growth (Craswell and Vlek, 1979). Some workers obtained higher paddy yield by splitting of nitrogen application (Patrick and Hoskins, 1974; Reddy and Patrick, 1976). Several investigators observed point placement of N fertilizer to be superior to traditional broadcast and split application methods (Singa *et al.*, 1977; Mian and Ahmad, 1982). Yoshida *et al.* (1977) recorded higher amount of fertilizer nitrogen by rice plant when incorporated before transplanting than when applied as basal (broadcast).

Placement of urea in the form of supergranules in the reduced zone of soil to rice crop seven days after tranplanting, was a better method of application (Mian, 1979; Mian *et al.*, 1985) but is labour intensive and time consuming. In this study it was contemplated to test a relatively simple method of split and broadcost application of USG as compared to prilled urea.

MATERIALS AND METHODS

A field experiment on rice cv. KS-282 was conducted during 1982. The soil was alkaline, moderately calcareous, sandy clay loam having pH_s 8.1 and EC_e 1.7 and 1.5 dS m^{-1}, organic matter 0.68 and 0.45%, total N 0.08 and 0.04%, $CaCO_3$ 3.7 and 3.8%, available P 8.7 and 7.4 ppm for 0-15 and 15-30 cm depths, respectively.

Nitrogen sources tested were : Prilled urea (PU) and urea supergranules (USG, 46% N) each applied at the rate of zero, 30, 60, 90, 120 and 150 kg N ha^{-1}. All the rates of PU and USG were applied in two equal splits, half of the dose was broadcasted on dry soil and incorporated in soil before puddling and the balance was topdressed one week after panicle initiation. In the case of USG basal, total quantity of fertilizer was broadcasted and incorporated in soil before puddling. All plots received a blanket application of 90 kg ha^{-1} P_2O_5 as single superphosphate and 60 kg ha^{-1} K_2O as potassium sulphate. In all, there were 18 treatments replicated thrice in a Randomized Complete Block Design and a plot size of 2 m x 9 m with row to row and plant to plant spacing 25 cm and 20 cm, respectively.

Rice was transplanted on 10.7.1982 and harvested on 18-10-1982. The crop received 22 irrigations. Paddy and straw samples were collected, processed and analysed for Kjeldhal N Soil samples were analysed by standard methods of the U. S. Salinity Lab. Staff (1954). The data were analysed statistically by ANOVA. Technique and treatment differences were subjected to the Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Fertilizer treatments, growth parameters and paddy yield

Increasing rate of N application caused a corresponding increase in

Table 1. *Effect of fertilizer treatments on tillering, thousand grain weight, straw and paddy yield of rice.*

N rate (kg ha^{-1})	Av. tillers hill^{-1}	1000-grain wt. (g)	Straw yield (kg ha^{-1})	Paddy yield (kg ha^{-1})
		USG basal		
0	11.1 g	23.55 hij	4525 h	2897 f
30	11.9 fg	23.78 ghij	4869 gh	3070 f
60	12.1 efg	23.92 fghij	4906 gh	3259 ef
90	12.5 efg	24.02 fghi	4916 gh	4140 d
120	12.8 efg	24.20 efgh	6515 de	4349 d
150	13.1 efg	23.47 ij	5687 f	3256 ef
Average	12.5	23.88	5379	3615
		PU split		
0	11.5 fg	23.29 j	4424 h	3067 f
30	14.8 cdef	23.85 fghij	5347 fg	3948 de
60	15.6 bcde	24.19 efgh	6680 cde	3918 cd
90	16.8 bc	24.51 def	6919 bcde	4555 cd
120	18.4 ab	24.80 cde	7206 abc	5448 b
150	20.4 a	25.27 bc	7505 ab	5761 b
Average	17.2	24.62	6731	4846
		USG split		
0	11.1 g	23.43 ij	4614 h	2890 f
30	13.3 defg	24.26 efg	5454 fg	4342 d
60	15.5 bcde	24.78 cde	6646 e	5111 bc
90	15.6 bcde	25.09 bcd	7081 abcd	5420 b
120	16.6 bcd	25.57 ab	7472 ab	5442 b
150	18.8 ab	25.98 a	7562 a	6479 a
Average	16.0	25.13	6843	5359

Means followed by the same letter (s) within the columns, are statistically alike at P = 5%.

Table 2. *Effect of fertilizer treatments on nitrogen content, its uptake by rice and percent fertilizer N recovery.*

N rate (kg ha^{-1})	% N		N uptake (kg ha^{-1})	Fert. N recovery (%)
	Straw	Paddy		
		USG basal		
0	0.401 k	1.063 n	48.94 h	—
30	0.440 hi	1.106 m	55.38 h	21.47
60	0.481 g	1.127 l	60.30 g	18.93
90	0.534 e	1.200 i	74.49 f	28.72
120	0.557 d	1.232 h	89.91 d	34.14
150	0.498 f	1.162 a	65.72 g	11.18
Average	0.502	1.163	69.22	22.89
		PU split		
0	0.414 j	1.037 o	60.16 h	—
30	0.432 i	1.074 n	65.48 g	51.09
60	0.444 h	1.176 j	82.77 ef	54.36
90	0.481 g	1.246 g	90.08 d	44.36
120	0.551 d	1.298 e	110.40 c	50.21
150	0.627 b	1.410 b	128.29 b	52.09
Average	0.507	1.241	95.40	50.42
		USG split		
0	0.408 k	1.037 o	48.61 f	—
30	0.434 i	1.278 f	74.26 f	85.48
60	0.477 g	1.299 e	97.46 d	81.41
90	0.568 d	1.315 d	110.79 c	69.09
120	0.584 c	1.335 c	116.32 c	58.42
150	0.635 a	1.468 a	144.44 a	63.88
Average	0.541	1.339	108.65	71.26

Means followed by the same letter (s), within the columns, are statistically alike at P = 5%.

average tillers per hill and one thousand grain weight which was well marked and significantly different with PU and USG split applications compared to the control (Table 1). Low response of USG basal application may partially be explained due to phyto-toxic effect of urea concentration in localized spots. The toxic effects of urea caused by the accumulation of ammonia were also observed by court *et al.* (1964). A similar trend was evident for one thousand grain weight. Superiority of split application of PU and USG for tillering was also reported by Reddy and Patrik (1976) and Sabir *et al.* (1978). It can further be seen that USG split applications at equal N rates were more effective in increasing one thousand grain weight compared to PU split, whereas USG basal application exhibited the lowest response. This revealad more efficient utilization of N from USG split than PU split.

With regard to straw and paddy yield (Table 1) it is apparent that greater increase in straw and paddy yield were obtained with USG split application than PU split. All the amounts of USG applied as basal were the least efficient for increasing paddy yield. Superior performance of split application over broad-cast was also reported by Patrick and Haskins (1974) and Sabir *et al.* (1978). In fact at the highest rate of N (150 kg ha^{-1}), a yield decline occured compared to 120 kg ha^{-1} N rate implying thereby adverse effect on plant growth of USG basal application such ill effects were not noticed at higher rates of PU and USG split applications.

Fertilizer nitrogen, its uptake and recovery by rice

Nitrogen uptake and fertilizer N recovery data are presented in Table 2. In general, greater N uptake was recoverded with increasing level of N application which was more pronounced in the case of USG and PU split applications (Table 2). The increase in N uptake with an increase in N application rate was also reported by Singa *et al.* (1977) and Khan (1979).

It is evident that greater N uptake (%N x yield) took place for the USG split application, followed by PU split application and USG basal application.

Percent N recovery values by rice crop for various fertilizer treatments were calculated as under :

$$\% \text{ N recovery} = \frac{(\text{N uptake for a fert. treatment} - \text{N uptake in control}) \times 100}{\text{Fertilizer applied}}$$

From the percent N recovery values it transpires that higher N utilization efficiency can be obtained by the split application of USG which may be explained, among other factors, to reduced leabing, volatilization and denitrification losses from the bigger size of the urea granule. On the contrary, Yoshida *et al.* (1977) found higher % N recovery with N application before transplaning.

This finding is of great practical importance because paddy yield advantage from USG application can be achieved from the same split application technique used for ordinary PU which is convenient and more economical compared to USG point placement already tested (Mian, 1979; Mian and Ahmad, 1982; and Mian *et al.* 1985).

REFERENCES

Court, M. N., R. C. Stephen and J. S. Waid. 1984. Toxicity as a cause of inffiiency of urea as a fertilizer. J. Soil Sci. : 15 : 49-65.

Craswell, E. T. and P. L. G. Vlek. 1979. Fate of fertilizer nitrogen applied to wetland, rice. In Nitrogen and Rice Int. Rice Res. Inst., Los Banos, Philippines. pp. 175-192.

De Datta, S. K. 1981. Principles and practices of Rice Production. John Wiley and Sons, New York.

Duncan, D.B. 1955. Multiple Range and Multiple F.Test. Biometrics 11 : 1-42.

Jackson, M. L. 1958. Soil Chemical Analysis Constable Co. Ltd., London.

Khan, Z. 1979. Nitrogen uptake by rice as affected by soure, rate and method of application. M. Sc. Thesis, Univ. Agri., Faisalabad.

Mian, M. Aslam. 1979. Effect of nitrogen rate, source and placement method on rice Proc. 2nd National Seminar Rice Res. and Prod. Feb. 19-22, Pak. Agri. Res. Coun. Islamabad. pp. 315-322, Mian, M. Aslam and R. Aslam. 1982. Nitrogen efficiency improvement under flooded paddy conditions. Proc. Ninth Int. Plant Nutr. Coll. Commonwealth Agri. Bur. UK, Vol. pp. 384-389.

Mian M. Aslam, M. Aslam and M. A. Saeed. 1985. Comparative efficiency of nitrogen fertilizer for rice. Internl. Symp. Nitrogen and the environment Jan. 7-12, 1984, Lahore, Pakistan. pp. 355-359.

Patrick, R. M. and F. M. Hoskins. 1974. Protein and aminoacid content of rice as affected by application of nitrogen fertilizer. Cereal Chemistry 61 : 84-95.

Reddy, K. R. and W. H. Patrick. 1976. Yield and nitrogen utilization by method and time of application of labelled nitrogen. Agron. J. 68:965-969.

Sabir, B. A., G. Haider and M. M. Iqbal. 1978. Evaluation of sulphur coated urea as a source of nitrogen for rice. Proc. 2nd National Seminar Rice Res. and prod. Feb. 19-22. Pakistan Agri. Res. Coun., Islamabad. pp. 236-243.

Singa, H., W. B. Ventura and T. Yoshida. 1977. Effect of deep placement of ball type fertilizer at different growth stages on yield and yield components of rice plant in the Philippines. Plant and Soil 47 (2) : 351-361.

U.S. Salinity Lab. Staff. 1954. Diagnosis and Improvement of Saline and Alkali Soils. U. S. D. A. Handbook No. 60. Washington, D. C.

Yoshida, T., C. Benjamin and Jr. Padre. 1977. Transformations of soil and fertilizer nitrogen in paddy soil and their availability to rice plant. Plant and Soil 47 (1) 113-123.