

Nitrogen Use Efficiency in Short-duration Lowland Rice With Different Forms of Urea

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An experiment on nitrogen use efficiency with different forms of urea was conducted with a short duration rice variety, Rasi (IET 1444), during summer 1978 at Tamil Nadu Agricultural University farm. Application of paper packed and mud ball urea in the reduced zone of rice soil recorded the maximum grain yield of 49.1 q/ha and 46.9 q/ha respectively, compared to 36.1 q/ha with untreated urea. The treated forms of urea were found to be 24 to 35 per cent more efficient than untreated urea. Reduced zone placement of urea and *necm* seed crush treated urea recorded higher N recovery and response ratio. The maximum net return was achieved with paper packed urea, followed by *necm* seed crush treated urea.

The current high prices and low supplies of fertilizers will likely limit, in the next few years, the quantity of fertilizers, especially nitrogen, needed to increase rice yields in the Asian tropics. This has led to increased interest in methods of maximising yields using low rates of fertilizers. Parr (1967) reported that all commonly used nitrogen fertilizers have an efficiency of only about 30 per cent under many soil and cropping conditions, which would be further less under flooded conditions. De Datta and Magnaye (1969) have reported that much of the applied N was not taken up by rice since applied N was subject to leaching, denitrification and volatilization losses which made it unavailable to crop. If the N is applied to the soil properly or at correct time by split application, placement at proper depth and foliar application, the loss of N can be minimised. The efficiency of urea has

also been reported to be increased by using large sized urea granules, coating the fertilizer and using nitrification inhibitors (Anon, 1977). Experiments conducted at IRRI indicated that 68 per cent of the N fertilizer was recovered when the fertilizer was applied at a depth of 10 cm, compared to 28 per cent recovery when fertilizer N was broadcast (De Datta *et al.* 1974). Pillai and Vamadevan (1978) have reported that placement of urea in small paper bits in the reduced zone of rice soil improved the N recovery as well the grain yield. The present investigation was, therefore undertaken to study the response of short duration rice to different forms of urea applications under low land condition.

MATERIAL AND METHODS

A field experiment was conducted during summer (Feb - June), 1978 with

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rice variety IET 1444 to evaluate the N use efficiency of different forms of urea at the Agricultural College and Research Institute, Coimbatore. The soil was clay loam, low in available N (218.1 kg/ha), medium in available P_2O_5 (13.2 kg/ha) and high in available K_2O (320.1 kg/ha). Six forms of urea (untreated urea (F_1), mudball urea (F_2), paper packed urea (F_3), soil incubated urea (F_4), FYM enriched urea (F_5) and *neem* (*Azadirachta indica* L.) seed crush treated urea (F_6)) and two levels of N (50 kg and 100 kg N/ha) were tested. Two times

of application, viz., Single basal application (T_1) and split application (75 per cent as basal and the remaining 25 per cent at panicle initiation) were also tested. P_2O_5 and K_2O were applied as basal dressing each at 50 kg/ha. The experiment was laid out in a Factorial randomised block design replicated thrice. Adequate plant protection measures were adopted. The crop was harvested at full field maturity. Nitrogen recovery was worked out based on the N uptake at harvest stage using the following formula :

$$\text{N recovery \%} = \frac{\text{N uptake in treated plot} - \text{N uptake in control plot} \times 100}{\text{Quantity of N applied in the treated plot}}$$

RESULTS AND DISCUSSION

On equal N basis, mud ball and paper packed urea exerted a significant influence in increasing the plant height and LAI at flowering (Table I). *Neem* seed crush treated urea was found to be the next best. Similarly, yield components like number of productive tillers/hill, number of panicles/m², filled grains/panicle and test grain weight were more favourably influenced by the above mentioned three treatments compared to the rest of the treatments.

Maximum grain yield of 49.1 q/ha was obtained with paper packed urea, which was 28.7 per cent more than with untreated urea (36.1 q/ha). (Table II) Mud ball urea was on par with paper packed urea by registering an yield of 46.9 q/ha. *Neem* seed crush treated urea and FYM enriched urea exerted a similar influence on grain yield. The least yield was obtained with untreated

urea among the different forms of urea tried and was higher only to no-nitrogen. This is in consonance with the findings of Pillai and Vamadevan (1978) who have reported an yield of 48.1 q/ha when 56 kg N/ha was placed in the reduced zones as paper packed urea, compared to control (30.5 q/ha) in the rice variety IET 2254. Higher levels of N increased the grain yield, especially when untreated urea was applied in two splits, while no significant difference was noticed between times of application, when treated forms of urea was applied.

Mud ball or paper packed urea recorded the maximum recovery of applied N (55.1 and 52.5 per cent respectively). *Neem* seed crush treated urea was superior to soil incubated and FYM enriched urea in use efficiency, since the NH_4^+ form of N in the latter forms are more prone to loss through *hydrolysis*, *deni-*

TABLE 1. Effect of Forms of Urea on Growth and Yield components of rice (IET. 1444)

| Treatments | Plant height at flowering (cm) | LAI at flower- ing | No. of produc- tive tillers/hill | Number of panicles/m ² | Number of filled grain/panicle | 1000 grain weight (g) |
|----------------|--------------------------------------|--------------------------|-------------------------------------|--------------------------------------|--------------------------------------|--------------------------|
| F ₁ | 78.2 | 5.42 | 7.51 | 257.2 | 92.7 | 23.04 |
| F ₂ | 86.6 | 6.15 | 8.04 | 301.2 | 104.1 | 24.30 |
| F ₃ | 85.4 | 6.41 | 8.10 | 316.1 | 103.4 | 24.11 |
| F ₄ | 79.1 | 5.55 | 7.61 | 266.4 | 93.1 | 23.40 |
| F ₅ | 80.2 | 5.61 | 7.75 | 266.7 | 94.5 | 23.50 |
| F ₆ | 82.1 | 5.91 | 7.88 | 273.4 | 97.2 | 23.89 |
| S. E. | 0.41 | 0.19 | 0.12 | 1.32 | 0.72 | 0.10 |
| C. D. at 5% | 1.42 | 0.55 | 0.35 | 3.84 | 2.14 | 0.29 |
| N50 | 79.5 | 5.38 | 7.29 | 262.8 | 92.4 | 23.40 |
| N100 | 84.4 | 6.12 | 8.32 | 197.3 | 102.6 | 24.02 |
| S. E. | 0.22 | 0.11 | 0.07 | 0.71 | 0.41 | 0.06 |
| C. D. at 5% | 0.84 | 0.33 | 0.20 | 2.20 | 1.22 | 0.16 |
| T ₁ | 81.3 | 5.82 | 7.48 | 273.4 | 94.9 | 23.67 |
| T ₂ | 82.4 | 6.03 | 8.12 | 287.8 | 100.2 | 23.75 |
| S. E. | 0.22 | 0.11 | 0.07 | 0.20 | 0.41 | 0.06 |
| C. D. at 5% | 0.84 | N.S | 0.20 | 2.20 | 1.22 | N.S |
| Control (No) | 67.4 | 3.91 | 4.12 | 231.2 | 78.2 | 22.97 |

trification and leaching. N recovery was more at lower levels of N with *split application* of urea, compared to single basal application of higher levels of N. This is in line with the findings of Pillai and Vamadevan (1978) who found that placement of N as urea briquettes recorded 66 and 57 per cent recovery of added N at 28 and 56 kg N/ha levels respectively.

Maximum response ratio (kg of grain produced per kg of applied N) was obtained with paper packed (36.8) and mud balls urea (34.4) treatment and the least by untreated urea (20.6). Split

application improved the response ratio over basal application and higher response ratio was obtained with lower level of N application. The relative efficiency of different forms of urea at the N levels and the methods of application adopted was worked out, taking the grain yield of untreated urea as 100. Here too root zone placement of urea was found to be 29 to 34 per cent more efficient than untreated urea in increasing the final grain yield, while other forms of urea were only 2 to 12 per cent more efficient. Ramiah (1976) reported that pre-plant application of sulphur coated urea (SCU) and isobuty-

TABLE II. Effect of forms of urea on grain and straw yield on Nitrogen use efficiency

| Treatments | Grain yield (kg/ha) | Straw yield (kg/ha) | Nitrogen recovery (%) | Response ratio (kg of grain/kg N) | Urea equivalents | Net return Rs/ha |
|----------------|---------------------|---------------------|-----------------------|-----------------------------------|------------------|------------------|
| F ₁ | 3613 | 4594 | 36.4 | 20.6 | 100.0 | 1377 |
| F ₂ | 4699 | 5741 | 55.1 | 34.4 | 129.2 | 1712 |
| F ₃ | 4913 | 5672 | 52.5 | 36.8 | 134.6 | 2460 |
| F ₄ | 3705 | 4374 | 44.7 | 22.2 | 102.6 | 1660 |
| F ₅ | 3883 | 4821 | 47.5 | 25.1 | 107.7 | 1866 |
| F ₆ | 4042 | 5028 | 49.6 | 27.8 | 112.3 | 2009 |
| S.E. | 89 | 90 | — | — | — | 103 |
| C.D. (P=0.05) | 254 | 258 | — | — | — | 298 |
| N 50 | 3612 | 4552 | 52.1 | 29.7 | 113.4 | 1540 |
| N 100 | 4673 | 5525 | 43.2 | 25.5 | 121.2 | 2216 |
| S.E. | 51 | 52 | — | — | — | 59 |
| C.D. (P=0.05) | 146 | 148 | — | — | — | 139 |
| T ₁ | 4071 | 4928 | 46.2 | 26.6 | 119.4 | 1817 |
| T ₂ | 4214 | 5148 | 48.5 | 28.7 | 124.2 | 1818 |
| S. E. | 51 | 52 | — | — | — | 59 |
| C. D. (P=0.05) | N.S | 148 | — | — | — | N.S. |
| Control | 2121 | 3214 | — | — | — | 310 |

lidene diurea (IBDU) were 10.2 and 12.0 per cent more effective than pre-plant application of untreated urea.

With regard to economics of fertilizer application, among the different forms of urea tested, paper packed urea gave the maximum net return of Rs. 2460/ha, followed by *neem* seed crush treated urea (2009). Mud ball urea recorded higher grain yield, N recovery and gross returns but it was found to be less remunerative due to high cost of preparation and placement of mud balls. Its economic viability will be always under question, unless and until, a machinery has been developed for the pre-

paration and placement of mud ball in the reduced zone of paddy soils.

From the results it can be inferred that for short duration varieties of rice like IET 1444, application of 100 kg N/ha as paper packed or *neem* seed crush treated urea is more remunerative and advantageous.

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