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RELATIVE EFFICIENCY OF CONVENTIONAL AND SLOW RELEASE NITROGEN FERTILIZERS FOR RICE GROWN ON A *UDIC HAPLUSTALF*

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Low recovery of fertilizer N during this era of energy crisis is a serious setback to fertilizer management in flooded paddy rice. This resulted into nitrification retardants and slow release N sources. pakistan is producign 80% of its N fertilizers in the form of urea which is vulnerable to N losses through several pathways under anaerobic conditions prevailing in rice field. Nitrogen fertilizers, Sulphur coated urea (SCU) which releases N slowly, urea super granule (USG) which faciitiate deep placement of N and a nitrification retardant, N serve, were compared with split application of prilled urea for rice (IRRI-6) on a sility clay loam (Gujranwala series) uner farmer's conditions. Urea applied in three splits produced maximum paddy yield followed by SCU, USG and urea N-serve. Agronomic efficiency and N recovery also followed the same trend.

Application of prilled urea in three equal splits at the time of sowing, tillering and panical initiation can be practiced for maximum rice production and higher N fertilizer use efficiency.

Key words: Flooded rice, N efficiency, Slow release.

INTRODUCTION

During 1983-84 rice in Pakistan was cultivated on about two million (1998 thousands) hectares of land [2]. To grow rice crop on this area Zia *et al.* [14] have calculated that 109.72 thousand tons of N worth of Rs. 559.97 million was used. However, they further calculated 30% fertilizer use efficiency and N fertilizer worth of Rs. 391.68 million was not recovered in plants, hence considered lost. Country's major (80%) production of N fertilizers is in the from of urea which is lost upto 60-80% under rice. Progress has been make in different directions to improve fertilizer use efficiency. Genetic improvement of rice varieties for higher yields requiring more and efficient supply of N could be one of them [4]. Introduction of nitrification inhibitors (N-serve) and recent development of slow release concept using SCU and deep placement concent using super granule (USG), and briquits of urea have been reported superior to prilled urea [10, 11]. But these specially manufactured imported fertilizer products are expensive. Hence cheaper fertilizer management practices adoptable by our common rice growers should be evolved. The present study was therefore initiated to compare SCU, USG slow release N fertilizers and nitrification inhibitor with split applied prilled urea to evaluate N fertilizer use efficiency for rice production.

MATERIALS AND METHODS

The study was conducted on Gujranwala series (*Udic haplustalf*) under farmer's field conditions in rice growing area of Punjab province durign kharif, 1985. Various characteristics of the site, estimated according to standard procedures of USDA [7], are described in Table 1. Split application of a uniform dose of 150 kg N/ha as urea was compared each with SCU, USG, Urea + N-serve and control treatment on 6 x 4 m^2 plot size. All N eithe from SCU USG and urea N-serve was applied at the beginning of the experiment. Urea was applied either in two or three spilits. For two splits 2/3 urea was applied in the beginning and 1/3 was added one week before panical initiation. For application of urea into three splits, 50 kg N/ha was applied each before transplanting, 20 days after transplanting and one week before panical initiation. Different N fertilizers were applied in their conventional recommend way. Urea was

Table 1. Physico-chemical properties of the experimental site.

Property	Unit	Gujranwala series
Sand	%	8.00
Silt	"	63.00
Clay	"	29.00
Textural class	—	Silty clay loam
pH	—	7.70
Ec	ds/m	3.20
Total-N	%	0.04
$NaHCO_3$-P	ppm	7.10
Available K	ppm	105.00

broadcasted in standing water while SCU was incorporated before transplanting and USG was applied in the middle of alternate 4 rice hills 7-10 days after transplanting at about 10 cm depth. Phosphorus, Zn and K were applied at uniform level of 33, 10 and 62 kg/ha as single superphosphate, $ZnSO_4$ and potassium sulphate, respectively. The treatments were imposed in quadruplicate according to randomized complete block design. Two seedligns of 30 days old nursery of IRRI-6 was transplanted per hole according to the recommended procedures for the area. Field was kept flooded throughout the growth period for proper rice growth. Furadan and saturn was used according to standard practices recommended to control insect pests and weed in the area. Data regardign tillers per hill, plant height, straw and grain yield were recorded. Grain and straw samples were analysed for total N contents to calculate following N use efficiencies [5]:

$$\text{Agronomic efficiency: } \frac{\text{Grain yield}_F - \text{Grain yield}_C}{\text{Fertilizer N applied (kg/ha)}}$$

$$\text{Physiological efficiency: } \frac{\text{Grain yield}_F - \text{Grain yield}_C}{\text{N-uptake}_F - \text{N uptake}_C \text{ (kg/ha)}}$$

$$\text{N recovery efficiency: } \frac{\text{N uptake}_F - \text{N uptake}_C}{\text{Fertilizer N applied}} \times 100\ (\%)$$

Where F is fertilized crop and C is un-fertilized control.

RESULTS AND DISCUSSIONS

Different fertilizer treatments have significant effect on number of productive tillers per hill ($P < 0.01$) and plant height ($P < 0.05$). Maximum number of productive tillers per hill and plant height was recorded for SCU (Table 2). SCU, USG and urea applied in 3 splits have statistically similar effect on productive tillers and plant height. Minimum number of productive tillers per hill and plant height were observed in plots without N application.

Various N fertilizer treatments also had a significant ($P < 0.05$) effect on straw and paddy yield of rice. For their effect on paddy grian yield different N fertilizers followed the trend that: Urea 3 splits > SCU ≥ USG > urea N-serve > Urea 2 splits > control. Straw yield wa sin the order of SCU > USG > urea 3 splits > urea 2 splits > Urea N-serve > control. There was no significant effect of various N fertilizer treatments on harvest index (Table 2).

Rice in Pakistan is grown under anaerobic conditions of flooded soil situation during moonsoon when both rainfall and temperture are high which of cours,e are not conductive for organic matter build up in soil. Hence N is one of the most commonly deficient plant nutrient and is generally applied as an inorganic chmical fertilizer to ensure its adequate supply in soil for plant growth [13]. Losses of N through various pathways under anaerobic soil conditions of flooded rice are understood [4, 6, 12]. Application of all N fertilizer levels recommended for a crop is deemed advisable only if either the plant is very efficient user of N or release of fertilizer N is manipulated to match plant N uptake through minimizing N losses. Concerning to second option, slow release N fertilizers like SCU, deep placed USG have been found efficient by several investigators [1, 3, 8, 10] but they are imported expensive fertilizer products and their application requires extra efforts. Nitrification inhibitors like N-serve have also been used with certain success [9] but their effect on other soil microflora, probably not determined sofar, is there. Nevertheless, application of urea in three splits, a major (80%) N fertilizer product of Pakistan, seems a better option since it not only produced maximum kg paddy per unit of applied N but its percent N recovery was also statistically comparable with SCU (Table 3). With 56% efficiency of N by application of urea in 3

Table 2. Comparison of nitrogen fertilizers for their effect on growth and paddy yield of IR-6 rice.

Fertilizer treatment	Number of productive tillers/hill	Plant height (cm)	Straw yield (t/ha)	Paddy yield (t/ha)	Harvest index	Grain: straw ratio
1. Control	7.13_b	72.6_b	9.00_c	4.29_e	0.435_a	0.48
2. Urea applied 2/3 as basal and 1/3 one week before PI*	9.47_{ab}	90.5_{ab}	14.64_b	6.43_d	0.449_a	0.44
3. Urea applied 1/3 basal + 1/3 20 DAT** + 1/3 one week before PI*	10.53_a	104.0_{ab}	16.04_{ab}	7.62_a	0.388_a	0.48
4. Urea N serve all basal	10.63_{ab}	91.9_{ab}	13.33_b	6.90_b	0.436_a	0.52
5. USG all basal	11.63_a	107.8_a	18.51_a	7.31_b	0.450_a	0.39
6. USG all basal	10.97_a	99.6_a	16.19_{ab}	7.21_b	0.420_a	0.45

*Panicle initiation, **DAT-Days after transplanting.

Table. 3. Agronomic, physiological and nitrogen recovery efficiencies of different N fertilizers.

Fertilizer treatment	Agronomic efficiency (kg paddy/kg N)	Physiological efficiency (kg paddy/kg N)	Nitrogen efficiency (Grain + straw) (%)
1. Control	—	—	—
2. Urea applied 2/3 as basal and 1/3 one week before PI**	28.9_a	14.3_d	24.26_b
3. Urea applied 1/3 basal + 1/3 20 DAT* + 1/3 one week before PI**	32.7_a	22.2_a	56.3_a
4. Urea N serve all basal	30.4_a	17.4_c	36.0_{ab}
5. USG all basal	31.4_a	20.1_b	54.0_a
6. USG all basal	30.8_a	19.6_b	50.5_a

*DAT-days after transplanting, **PI-panical initiation.

splits Rs. 391.68 million losses of N as calculated by Zia *et al.* [14] can be reduced about 50% to Rs. 196.66 million.

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