Nitrogen Sources and Timing of Application to Improve N-Use Efficiency of Upland Rice in Brazil

Maria da Conceição S. Carvalho[1] and Beata Madari[1]

[1]Embrapa Rice and Beans, Brazilian Agricultural Research Corporation - EMBRAPA, Santo Antônio de Goiás, GO, Brazil. E-mail: conceicao@cnpaf.embrapa.br or concegyn@gmail.com

INTRODUCTION

Nitrogen (N) fertilization is one of the most important production factors of upland rice in Brazil. Urea is the most used source of synthetic N in Brazil, and NH3 volatilization is the main mechanism that contributes to the low fertilizer N recovery by crops, mainly when this fertilizer is applied to the mulch in a no-till system. For the efficient management of N in the cropping systems, adequate rate, appropriate source and timing of application during crop growth cycle play an important role. Using urease inhibitor and polymers covering urea granules are technological options to reduce N losses and to improve N use efficiency.

This study aimed at evaluating the influence of N fertilizer sources and timing of application on upland rice grain yield, apparent fertilizer N recovery (Nrec), and agronomic efficiency.

MATERIAL AND METHODS

The field study was carried out on a clayey Rhodic Ferralsol at Capivara Farm of Embrapa Rice and Beans (16°29‘46"S and 49°17‘47 "W). Upland rice, cv. Primavera CL® was cultivated in 2010/11 growing season under no-tillage with straw of soybean. The soil of this area contained 13 g dm^{-3} of organic matter in the 0-20 cm layer.

The experiment was carried out in a complete randomized block design with four replications and ten treatments arranged in a 3x3+1 factorial scheme: three N sources (common urea, urea with NBPT urease inhibitor, and polymer coated urea), three timing of application (100% at sowing, 50% at sowing + 50% at tillering, and 100% at tillering), and one control. We used the rate of 80 kg N ha^{-1}. Besides nitrogen application according to the treatments, fertilization at sowing time was performed using 400 kg/ha of 5-30-15 fertilizer, which corresponds to 20 kg ha^{-1} N, 120 kg ha^{-1} P_2O_5, and 60 kg ha^{-1} K_2O.

The agronomic efficiency (AE) of N sources tested, at each time of application, was calculated using the yield recorded (kg ha^{-1}) and the dose of N applied (80 kg ha^{-1}), using the formula: AE= (yield with N fertilizer – yield of control treatment)/80. Total precipitation during the rice growing period was 1,338 mm, well distributed along the days of high water use by the crop.

The results were evaluated using variance analysis (F test, $P<0.05$). When significant, the means were compared using the Tukey’s test ($P<0.05$), and when we compared groups of treatments, the means were contrasted using the F test ($P<0.05$).

RESULTS

Regardless of the sources and timing of application, the nitrogen fertilization increased tillering, dry matter production, N accumulation in dry matter, and grain yield of rice (Table 1). The variance analysis indicated that there was no effect of N sources and also no interaction between sources and timing of application on measured variables. Regardless of N sources, the anticipation of the whole or half the dose of N for seeding resulted in increase of shoot dry matter and N uptake at 30 days after sowing. The application of N fertilizers at sowing also increased grain yield, apparent fertilizer N recovery, and agronomic efficiency, compared to the application of the total dose of N at early tillering (Table 1).

CONCLUSIONS

There was no significant difference among N sources for any measured variable. Results were similar when N fertilizers were applied 100% at sowing or divided 50% at sowing and 50% at tillering; however, the total rate applied at tillering decreased rice yield, apparent fertilizer N recovery, and agronomic efficiency for the three fertilizer sources evaluated.

Table 1 – Results of components of production, rice grain yield, shoot dry matter, N uptake, N leaf content, agronomic efficiency, and apparent fertilizer N recovery, according to nitrogen sources and timing of application. Santo Antonio de Goias, GO, Brasil, 2010/11 growing season.

Treatments	Number of tiller	Number of panicles	Yield	Shoot dry matter 30 days after sowing	N uptake 30 days after sowing	Shoot dry matter at flowering	N uptake at flowering	N content in flag leaf	Agronomic efficiency	Apparent fertilizer N recovery
	-------- Number m^{-2} --------		---------- kg ha^{-1} ----------					%		%
Control vs. Factorial										
Control	211 a	204 a	2464 b	256 b	7.1 b	2436 b	48.5 b	30.7 a	-	-
Factorial 3x3 (N sources x Timing)	224 a	203 a	3419 a	532 a	15.7 a	4692 a	90.8 a	31.5 a	11.9	52.9
Effect of N sources (average of three timing of application)										
Urea	236 a	212 a	3381 a	526 a	15.5 a	4562 a	91.1 a	32.3 a	11.5 a	53.3 a
Urea + NBPT	227 a	213 a	3501 a	485 a	14.5 a	4673 a	89.3 a	31.6 a	13.0 a	51.1 a
Polymer coated urea	208 a	183 a	3366 a	506 a	15.2 a	4650 a	90.0 a	30.6 a	11.3 a	52.0 a
Effect of timing of application (average of three N sources)										
100 % at sowing	206 b	179 b	3493 a	573 a	17.3 a	4768 a	89.5 a	32.8 a	12.9 a	51.2 ab
50 % at sowing and 50 % at tillering	223 ab	209 ab	3556 a	523 a	15.6 a	4730 a	94.5 a	31.1 ab	13.7 a	57.6 a
100 % at tillering	243 a	220 a	3199 a	421 b	12.3 b	4387 a	86.5 a	30.6 b	9.2 b	47.6 b

FUNARBE Fundação de Apoio à Universidade Federal de Viçosa
Rede FertBrasil
Embrapa
Ministry of Agriculture, Livestock and Food Supply
GOVERNO FEDERAL BRASIL PAÍS RICO É PAÍS SEM POBREZA