LOWLAND RICE GENOTYPES EVALUATION FOR NITROGEN USE EFFICIENCY IN BRAZILIAN ACID SOIL

Fageria N.K.[1], **Santos A.B.**[1] **and Moreira A.**[2] **and Moraes L.A.C.**[2]

[1]National Rice and Bean Research Center of EMBRAPA, Caixa Postal 179, Santo Antônio de Goiás, Go, CEP 75375-000, Brazil
[2]National Soybean Research Center of EMBRAPA, Caixa Postal 231, Londrina, PR, CEP 86001-970, Brazil.
Email : fageria@cnpf.embrapa.br

Abstract

Nitrogen is one of the most yield limiting nutrients in rice production under all agro-ecological conditions. A greenhouse experiment was conducted to evaluate N responses to 12 lowland rice genotypes. Soil used in the experiment was an Inceptisol. The N rates used were 0 mg kg^{-1} (low) and 300 mg kg^{-1} (high) of soil. Straw yield, grain yield and panicle density were significantly increased with the addition of N fertilization and genotype treatment. The N X genotype interaction also was significant for these traits, indicating different responses of genotypes with variation in N rates.

Introduction

Rice is an important food crop for a large proportion of the world's population. Every year about 90 million people are added to world population. This increase mostly occurs in developing countries. Hence, total rice production will need to increase to feed an increasing world population. Rice is produced under both upland and lowland ecosystems with about 76% of the global rice produced from irrigated-lowland rice systems (Fageria et al. 2003). To improve rice yield, use of adequate technology is fundamental. Among the technologies which improves crop yields are use of adequate rate of fertilizers and crop genotypes with high yield potential and higher nutrient use efficiency. Nitrogen is one of the most important nutrients in improving crop yields, including rice under most agro ecosystems (Fageria and Baligar, 2001; Fageria, 2007). Under these situations, use of adequate rate, source and methods of N application along with efficient genotypes is an important strategy to reduce cost of production as well as environmental pollution. The objective of this study was to evaluate lowland rice genotypes for nitrogen use efficiency

Materials and Methods

A greenhouse experiment was conducted at the National Rice and Bean Research Center of EMBRAPA, Santo Antônio de Goiãs, Brazil to evaluate N use efficiency of lowland rice genotypes. The soil used in the experiment was an Inceptisol. Initial soil properties (0-20 cm depth) were: pH 3.8 in water, Ca 2.88 $cmol_c$ kg^{-1}, Mg 0.91 $cmol_c$ kg^{-1}, Al 1.0 $cmol_c$ kg^{-1}, P 46.8 mg kg^{-1}, K 50 mg kg^{-1}, S 7.9 mg kg^{-1}, Cu 7.4 mg kg^{-1}, Zn 1.6 mg kg^{-1}, B 1.5 mg kg^{-1}, Fe 380 mg kg^{-1} and Mn 60 mg kg^{-1} and organic matter 23 g kg^{-1}. Textural analysis showed 420 g kg^{-1} clay, 200 g kg^{-1} silt and 380 g kg^{-1} sand. The N rates used were 0 mg kg^{-1} (low) and 300 mg kg^{-1} of soil (high) and 12 lowland rice genotypes. These genotypes were advanced lines or cultivars from breeding program of National Rice and Bean Research Center. A split-plot with sub-plot treatments arranged in a randomized complete block design was used, with N rate in the main plots, and genotypes in the sub-plots. The treatments were replicated three times. Basal fertilizer rate used were 200 mg P kg^{-1} applied with triple superphosphate and 200 mg K kg^{-1} applied with potassium chloride. Half of the N was applied at sowing and remaining half applied as topdressing at active tillering growth stage. Each pot also received 10 g dolomitic lime. Lime was added 4 weeks before sowing and pots were subjected to wet and dry cycling during 4 weeks period. After germination, thinning was done and four plants were maintained in each pot. Pots were flooded with a water depth of about 3 to 4 cm two weeks after sowing and drained at harvest.

Data were analyzed by analysis of variance, and treatment means were compared with Turkeys test.

Results and Discussion

Nitrogen X genotype interactions were significant for straw and grain yield and panicle density, indicating that some genotypes were highly response to N fertilization while others were not. Straw yield varied from 14.12 g $plant^{-1}$ produced by genotype BRA 051108 to 20.31 g $plant^{-1}$ produced by genotype BRA 051135, with an average value of 16.06 g $plant^{-1}$ at low N rate. At high N rate, straw yield varied from 27.76 g per plant produced by genotype BRA 051250 to48.56 g per pant produced by genotype BRA 051108, with an average value of 39.62 g per plant. The increase in shoot dry weight with the addition of 300 mg N kg^{-1} soil was 147% compared with 0 mg N kg^{-1} of soil. Fageria and Barbosa Filho (2001) reported significant increase in shoot dry weight with the addition of 304 mg N kg^{-1} of soil compared to zero N application treatment in Brazilian lowland soils. Shoot dry weight was having significant linear relationship with grain yield ($Y = 8.5484 + 0.3005X$, $R^2 = 0.7298^{**}$). Fageria and Barbosa Filho (2001) and Fageria (2007) reported significant association with shoot dry weight and grain yield of lowland rice. Grain yield varied from 9.12 g plant^{-1} produced by genotype BRA 051135 to 15.16 g plant^{-1} produced by genotype BRS Jaçanã, with an average value of 12.92 at low N rate. Similarly, at high N rate, grain yield varied from 17.05 g plant^{-1} produced by genotype BRA051135 to 24.43 g plant^{-1} produced by genotype BRS Tropical., with an average value of 20.91 g plant^{-1}. The increase in grain yield at high N rate was 62% compared with low N rate. Increase in grain yield of lowland rice with the addition of N fertilizer has been reported by Fageria and Barbosa Filho (2001), and Fageria et al. (2003).Panicle density varied from 5.00 per plant produced by genotype BRA 051134 to 8.08 per plant produced by genotype BRA 051083, with an average value of 6.58 at low N rate. At high N rate, panicle density varied from 10.00 per plant produced by genotypes BRA 051134 and BRA 051135, with an average value of 12.85 per plant. The increase in panicle number was almost double at high N rate compared with low N rate. Panicle number was significantly and linearly related with grain yield ($Y = 4.6694 + 1.2607X$, $R^2 = 0.9350^{**}$). Fageria and Barbosa Filho (2001) reported highly significant correlation ($r = 96^{**}$) between grain yield and panicle number in lowland rice grown in Brazilian Inceptisol.

Table 1 : Straw yield (SY), grain yield (GY) and panicle density (PD) of 12 lowland rice genotypes as influenced by N rate and genotype treatments. Low N = 0 mg N kg^{-1} and high N 300 mg N kg^{-1} soil

Genotype	SY (g plant^{-1})		GY (g plant^{-1})		PD (plant^{-1})	
	Low N	High N	Low N	High N	Low N	High N
BRS Tropical	16.11bcd	47.14a	12.53abc	24.43a	7.25abcd	15.00a
BRS Jaçanã	14.28d	34.28de	15.16a	20.47cd	7.08abcd	13.50ab
BRA 02654	15.21cd	38.45cd	14.27ab	22.63ab	7.75ab	13.91ab
BRA 051077	14.66d	38.76cd	13.54abc	21.91bc	6.33bcde	14.00ab
BRA 051083	14.44d	38.53cd	13.17abc	22.34bc	8.08a	14.33a
BRA 051108	14.12d	48.56a	14.80ab	22.07bc	7.50abc	14.00ab
BRA 051126	14.48d	41.91bc	12.45abc	19.61de	6.42bcde	12.48bc
BRA 051129	18.65ab	32.35ef	11.09cd	18.10ef	5.25e	11.33cd
BRA 051130	16.65bcd	45.68ab	13.00abc	22.37bc	5.83de	13.33ab
BRA0511344	18.08abc	40.69bc	12.28bc	18.02ef	5.00e	10.00d
BRA 051135	20.31a	41.31bc	9.12d	17.05f	6.00cde	10.00d
BRA 051250	15.68bcd	27.76f	13.61abc	21.91bc	6.50abcde	12.25bc
Average	16.06b	39.62a	12.92b	20.91a	6.58b	12.85a
F-Test						
N rate (N)	**		**		**	
Genotype (G)	**		**		**	
N X G	**		**		**	
CV(%) N	7.49		4.23		7.28	
CV(%) G	4.95		4.91		5.84	

** Significant at the 1% probability level. Means followed by the same letter in the same column are not significantly different at the 5% probability level by the Turkeys test.

References

Fageria, N. K. 2007. Yield physiology of rice. J. Plant. Nutr. 30:843-879.

Fageria, N. K., and V. C. Baligar. 2001. Lowland rice response to nitrogen fertilization. Commun. Soil Sci. Plant Anal.32:1405-1429.

Fageria, N. K., and M. P. Barbosa Filho. 2001. Nitrogen use efficiency in lowland rice genotypes. Commun. Soil Sci. Plant Anal. 32:2079-2090.

Fageria, N. K., N. A. Slaton, and V. C. Baligar. 2003. Nutrient management for improving lowland rice productivity and sustainability. Adv. Agron. 80:63-152.