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NITROGEN RESPONSE BEHAVIOUR OF DEVELOPED PROMISING LINES OF T.AMAN RICE

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Abstract

Nitrogen is the most limiting nutrient for rice. Modern high yielding rice varieties may have differences in accumulating and using N from soil and applied fertilizer. A field experiment with 8 rice genotypes was conducted during 2008 wet season (T.Aman season) to study the effect of different rates of N fertilization on the yield performance and nitrogen nutrition under irrigated condition. Among the tested varieties/lines, BR7155-20-1-3 produced the significantly highest grain yield of 5.04 t/ha at N_{30} level followed by Swarna (4.66 t/ha) at the same level of N with similar growth duration (140 days). Agronomic efficiency of added N ranged from 0.7 to 23.3 for the promising line BR7155-20-1-3 and 3.3 to 27.0 for variety Swarna. Grain yield at No was the highest in BR7155-20-1-3 followed by the variety Swarna and the lowest in BR7870-5 *(Nils)- I 0-HR8. Percent nitrogen recovery ranged from 50 to 63 for variety Swarna and 13 to 30 for promising line BR7155-20-1-3. The promising line BR7155– 20-1-3 and the variety Swarna may be economically advantageous over the other varieties/ lines.

Keywords: Rice genotypes, nitrogen uptake, nNitrogen use efficiency, nitrogen recovery.

Introduction

Among the essential plant nutrients, N is the key element for growing rice. This important element is found to be at a deficient level in most agricultural soils of the world including Bangladesh. The importance of N fertilizer in increasing yield is especially true for the modern high yielding varieties (HYVs) of rice (Lakhdive and Prasad, 1970; De Datta *et al.,* 1974). But the estimated N use efficiencies by cereal crops in developing and developed countries are actually very low, namely 29 and 42 %, respectively (Raun and Johnson, 1999). A great part of the applied N is escaped to the environment through denitrification and volatilization (De Datta *et al.,* 1991). Variety-specific N fertilizer recommendation may be one of the important options to increase N use efficiency in rice. Recent studies show that the modern rice varieties are different in the efficiencies in acquisition and physiological efficiencies (Bufogle *et al.,*

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1997; Tirol-Padre *et al.,* 1996 and Singh *et al.,* 1998). It is necessary to know the N response behaviour of newly developed promising lines before recommending as varieties. So, this investigation was undertaken to determine the N response behaviour of 6 ALART materials viz. BR7155-20-1-3, BR7870-5*(Nils)-2-HR2, BR7870- 5*(Nils)-2-HR8, BR7870-5*(Nils)-7-HR1, BR7870-5*(Nils)-8-HR4, BR7870-5 *(Nils)- 10- HR8 compared with two check varieties viz. Swarna and Guti-swarna

Materials and Method

The field experiment was conducted at the experimental farm of the Bangladesh Rice Research Institute, Gazipur, Bangladesh located at 23°59' N latitude, 90°24 E longitude during 2008 wet season (T.Aman season). The site is about 30 m above the mean sea level and has a subtropical climate, which is strongly influenced by south-western monsoons. The average annual rainfall is 2000 mm with more than 80% of it occurring from mid-June to the end of September. Mean temperature is the lowest (15°C) in January and highest (30°C) in May.

The soil of the experimental field is Grey-Terrace (Chhiata series). It is clay-loam in texture with pH 6.8. Organic C, total N, available P, and exchangeable K of the soil was 1.1 %, 0.13%, 6.04 ppm, and 0.15 meq /100 g soil, respectively. The available S and Zn (EDTA extracted) of the soil were 6.78 ppm and 2.1 ppm, respectively. Five doses of N i.e. 0, 30, 60, 90, and 120 kg/ha were imposed as treatment. The experiment was laid out in a split-plot design with three replications. Nitrogen doses were assigned in the main plot and the varieties in the sub- plot. Each plot received a blanket dose of P, K, S, and Zn at the rate of 14-56-14-0 kg/ha, respectively, as STB. Six ALART materials viz. BR7155-20-1-3, BR7870-5*(Nils)-2-HR2, BR7870-5*(Nils)-2-HR8, BR7870-5*(Nils)-7-HRl, BR7870-5*(Nils)-8-HR4, BR7870-5 *(Nils)- 10-HR8 and two check varieties viz. Swarna and Guti-swarna were tested in T.Aman season. Thirty days old seedlings of each material were transplanted at 20cm x 20cm spacing. Nitrogen from urea was applied in three equal splits (1/3 as basal + 1/3 at active tillering stage (22 DAT) + 1/3 at 5-7 days before panicle initiation). Necessary intercultural operations were done as and when required. At maturity, the crop was harvested from 5 m^2 areas at the centre part of each plot and 16 hills were collected for straw yield. The grain yield was recorded at 14% moisture content and straw yield as oven dry basis. Total nitrogen content from plant samples (grain and straw) of two materials (BR7155-20-1-3 and Swarna) was determined by the standard analytical procedure (Yoshida *et al.,* 1976). Data were analyzed as per standard statistical procedure (IRRI, 1998).

Results and Discussion

Grain yield and agronomic efficiency

All the varieties/lines, except BR7870-5*(Nils)-7-HRI and Guti-swarna (Ck), responded to applied N up to certain levels (Table 1). The variety Swarna (Ck), and the promising lines BR7155-20-1-3, BR7870-5*(Nils)-8-HR4 responded significantly to applied N up to 30 kg/ha, beyond this rate, grain yield decreased or increased slightly but the difference was not significant (Table 1). In case of BR7870-5*(Nils)-2-HR2 and BR7870-5 * (Nils)- 10-HR8, yield increase was significant up to 60 kg N/ha. In case of BR7870-5*(Nils)-2-HR8, N application only @ 90 kg N/ha significantly increased the grain yield over control. Analysis of variance for grain yield showed that the interaction effect of N rates and varieties/lines was highly significant ($P<0.01$). Among the tested materials, BR7155-20-1-3 produced the significantly highest grain yield of 5.04 t/ha at N_{30} level followed by Swarna (Ck) (4.66 t/ha) at the same level of N with the same growth duration (140 days) (Table 1).

Table 1. Effect of N rates on the grain yield (t/ha) of T. Aman rice (ALART materials) at BRRI Farm, Gazipur, 2008.

N rate (kg/ha)	Grain yield (tha-)							
	BR7155-20-1-3	BR7870-5*(Nils)-2-HR2	BR7870-5*(Nils)-2-HR8	BR7870-5*(Nils)-7-HR1	BR7870-5*(Nils)-8-HR4	BR7870-5*(Nils)-10-HR8	Swarna (Ck)	Guti-swarna (Ck)
N_0	4.34	2.96	3.09	3.17	2.40	2.29	3.85	3.26
N_{30}	5.04	3.38	3.60	3.58	3.54	3.06	4.66	3.08
N_{60}	4.81	3.62	3.19	3.32	3.62	3.88	4.05	3.12
N_{90}	5.17	3.77	3.88	3.70	3.93	3.28	4.46	3.23
N_{120}	4.43	3.36	3.55	3.21	4.10	3.16	5.02	1.89
Variety mean	4.76	3.42	3.46	3.39	3.52	3.13	4.41	2.91
Duration (days)	140	118	118	126	118	118	140	140

LSD 0.05 for Treat. X Var. =0.56, LSD 0.05 for Treat. mean=0.40, LSD 0.05 for Var. mean=0.25. CV (%) =9.5

At zero N, the promising line BR7155-20-1-3 produced the highest grain yield of 4.34 t/ha followed by Swarna (Ck) (3.85 t/ha) and Guti-swarna (Ck) (3.26 t/ha), while the promising line BR7870-5 *(Nils)- 10-HR8 produced the lowest yield (2.29 t/ha). BR7155-20-1-3, BR7870-5*(Nils)-8-HR4 and Swarna (Ck) responded sharply to a low N dose, 30, kg/ha, no appreciable response of other lines/varieties was observed at that rate. The grain yield benefits obtained with N fertilization at 30 kg N/ha were more than 1 t/ha for BR7870- 5*(Nils)-8-HR4, 0.8 t/ha for Swarna (Ck) and 0.7 t/ha for BR7155-20-1-3. At 60 kg N/ha,

the grain yield benefit of 0.7 t/ha for BR7870-5*(Nils)-2-HR2, 1.59 t/ha for BR7870- 5*(Nils)-I0-HR8 and at 90 kg N/ha, 0.8 t/ha for BR7870-5*(Nils)-2-HR8 was obtained. Without applying any N fertilizer, the promising line BR7155-20-1-3 produced the highest grain yield (4.34 t/ha) followed by Swarna (3.85 t/ha). This finding suggested that the promising line BR7155-20-1-3 and the variety Swarna had the higher potential for utilizing native soil N for grain production than the other variety or promising lines. For this reason, the promising line BR7155-20-1-3 and the variety Swarna may be used as low input varieties for marginal farmers. It is worth while to mention that the variety Swarna and the promising line BR7155-20-1-3 have the same growth duration.

The differences in N response pattern among the studied varieties/lines were simply due to varietal difference. Varietal difference in N response was found in many previous investigations (De Datta, 1985; BRRI, 1985 and 1988; IRRI, 1987 and 1988, Choudhury and Bhuiyan, 1991). Agronomic efficiency (kg grain/kg added N) also varied among the varieties /lines (Table 2). All the varieties/lines, except Guti-swarna, had the positive agronomic efficiency. Agronomic efficiency (kg grain/kg added N) ranged from 0.7 to 23.3 in case of BR7155-20-1-3, 3.3 to 14.0 in case of BR7870-5*(Nils)-2-HR2, 3.8 to 17.0 in case of BR7870-5*(Nils)-2-HR8, 0.3 to 13.7 in case of BR7870-5*(Nils)-7-HR1, 14.2 to 38.0 in case of BR7870-5*(Nils)-8-HR4, 7.3 to 26.5 in case of BR7870-5 * (Nils)- 10-HR8, 3.3 to 27.0 in case of Swarna and -0.3 to -11.4 in case of Guti-swarna. From the Table 2, it was shown that at lower N level, the value of AE is higher than that of higher N level.

Table 2. Agronomic efficiency of two modern varieties and 6 promising lines as affected by rates of N fertilization.

N-rate (kg/ha)	Agronomic efficiency (kg grain/kg added N)							
	BR7155-20-1-3	BR7870-5*(Nils)-2-HR2	BR7870-5*(Nils)-2-HR8	BR7870-5*(Nils)-7-HR1	BR7870-5*(Nils)-8-HR4	BR7870-5*(Nils)-10-HR8	Swarna (Ck)	Guti-swarna (Ck)
N_{30}	23.3	14.0	17.0	13.7	38.0	25.7	27.0	-6.0
N_{60}	7.8	11.0	1.7	2.5	20.3	26.5	3-3	-2.3
N_{90}	9.2	9.0	8.8	5.9	17.0	11.0	6.8	-0.3
N_{120}	0.7	3.3	3.8	0.3	14.2	7.3	9.8	-11.4

Straw yield

All the varieties/lines, except BR7870-5*(Nils)-8-HR4 and BR7870-5*(Nils)-10-HR8, responded to applied N up to certain levels (Table 3). The variety Swarna responded significantly to applied N up to 120 kg/ha. The variety Guti-swarna and BR7870-5*(Nils)-2- HR8 responded significantly up to 30 kg N/ha. But in case of BR7870-5* Nils)-2-HR2, straw yield increase was significant up to 60 kg

N/ha. In case of BR7155-20-1-3 and BR7870-5*(Nils)-7-HR1 yield increase was significant up to 90 kg N/ha. The interaction effects of N rates and varieties/lines on the straw yield was also highly significant ($P<0.01$). Among the tested varieties/lines Swarna significantly produced the highest straw yield of 7.60 t/ha at N_{120} level followed by the Guti-swarna (5.80 t/ha at N_{30} level) and the promising line BR7155-20-1-3 (5.77 t/ha at N_{90} level).

Table 3. Effect of N rates on the straw yield (t/ha) of T.Aman rice (ALART materials) at BRRI Farm, Gazipur, 2008.

N-rate (kg/ha)	Straw yield (t/ha)							
	BR7155-20-1-3	BR7870-5*(Nils)-2-HR2	BR7870-5*(Nils)-2-HR8	BR7870-5*(Nils)-7-HRI	BR7870-5*(Nils)-8-HR4	BR7870-5*(Nils)-10-HR8	Swarna (Ck)	Guti-swarna (Ck)
N_0	5.14	3.12	3.24	3.23	3.96	3.20	3.86	5.19
N_{30}	5.26	3.69	4.29	3.06	3.66	3.66	5.30	5.80
N_{60}	5.53	4.77	4.50	3.28	4.06	3.47	5.41	5.35
N_{90}	5.77	3.83	4.03	4.11	3.30	3.68	6.51	6.28
N_{120}	5.84	3.91	3.60	3.83	3.75	3.13	7.60	5.91
Variety mean	5.51	3.86	3.93	3.50	3.75	3.43	5.74	5.71

LSD 0.05 for Treat. X Var. =0.59, LSD 0.05 for Treat. mean =0.58, LSD 0.05 for Var. mean = 0.26. CV (%) = 8.1

Nitrogen nutrition, apparent N recovery and production efficiency

From the above discussion, it may be concluded that the promising line BR7155-20-1-3 and the variety Swarna may be used as low input varieties for marginal farmers. So, the study of nitrogen nutrition, apparent N recovery and production efficiency was done on these two rice genotypes only.

Nitrogen concentration in grain was increased gradually due to increased , rate of N application up to 90 kg N/ha in case of variety Swarna and up to 120 kg N/ha in case of BR7155-20-1-3 (Table 4). Nitrogen concentration in grain ranged from 1.12% to 1.68% for variety Swarna and 1.38% to 1.60% for promising line BR7155-20-1-3. Nitrogen content in straw ranged from 0.66% to 0.87% for variety Swarna and 0.60% to 0.72% for promising line BR7155-20-1-3. Total N uptake increased gradually due to N fertilization in both varieties/lines. Total N uptake (kg/ha) ranged from 74 to 136 for variety Swarna and 94 to 115 for promising line BR7155 -20-1-3 (Table 4).

Apparent recovery (%) of added N varied due to variation of N rates and variety/line. Apparent recovery of added N decreased as N rate increased. It ranged from 50% to 63% for variety Swarna and 13% to 30% for promising line BR7155-20-1-3 (Table 4). Production efficiency (kg grain/kg absorbed N) also

varied due to variation of N rates and varieties/lines. It ranged from 34 to 52 for variety Swarna and 40 to 49 for the promising line BR715 5-20-1-3 (Table 4) and also decreased gradually as N rate increased in both varieties /line.

Table 4. Nitrogen nutrition, production efficiency and apparent recovery of added N by one variety and one promising line as affected by N fertilization.

Variety /line	N rate (kg/ha)	N content (%)		Nitrogen uptake (kg/ha)			Apparent recovery of added N	Production efficiency (kg grain/kg absorbed N)
		Grain	Straw	Grain	Straw	Total		
Swarna (Ck)	N_0	1.12	0.79	43	31	74	-	52
	N_{30}	1.21	0.66	56	35	91	57	51
	N_{60}	1.66	0.68	67	37	104	50	39
	N_{90}	1.68	0.87	75	56	131	63	34
	N_{120}	1.61	0.73	81	55	136	52	37
BR7155-20-1-3	N_0	1.38	0.67	60	34	94	-	46
	N_{30}	1.40	0.60	71	31	102	27	49
	N_{60}	1.49	0.72	72	40	112	30	43
	N_{90}	1.47	0.68	76	39	115	23	45
	N_{120}	1.60	0.66	71	39	110	13	40
LSD (0.05)	-	0.27	NS	14.56	6.47	14.87	-	-
CV (%)	-	10.2	10.0	11.8	9.0	7.6	-	-

Conclusion

It may be concluded that among the tested materials, BR7155-20-1-3 and Swarna (Ck) produced the highest grain yield at N_{30} level with the same growth duration (140 days) in T.Aman season.

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