Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Effect of variety and nitrogen rate on the yield performance of *boro* rice

SG Chamely[1], N Islam[1], S Hoshain[2], MG Rabbani[3], MA Kader[1], MA Salam[1*]

[1]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh; [2]Department of Coastal Agriculture, Noakhali Science & Technology University, Sonapur, Noakhali-3814, Bangladesh; [3]Research Cell, Noakhali Science & Technology University, Sonapur, Noakhali-3814, Bangladesh

Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from November 2010 to May 2011 to study the effect of variety and rate of nitrogen on the performance of *Boro* rice. The experiment comprised three varieties viz., BRRI dhan28 (V_1), BRRI dhan29 (V_2) and BRRI dhan45 (V_3); and five rates of nitrogen viz., control (N_0), 50 kg (N_1), 100 kg (N_2), 150 kg (N_3) and 200 kg (N_4) N ha^{-1}. The experiment was laid out in a randomized complete block design with four replications. The growth analysis results indicate that the tallest plant (80.88 cm) and the highest number of total tillers $hill^{-1}$ (13.80) were observed in BRRI dhan29 at 70 DATs and the highest total dry matter (66.41 g m^{-2}) was observed in BRRI dhan45. The shortest plant (78.15 cm) and the lowest number of tillers $hill^{-1}$ (12.41) were recorded from BRRI dhan45 and the lowest dry matter (61.24 g) was observed in BRRI dhan29. The tallest plants (84.01 cm), highest number of tillers $hill^{-1}$ (14.06) and the highest dry matter (69.58 g m^{-2}) were obtained from 200 kg N ha^{-1}. The tallest plants (86.48 cm) and maximum dry matter (72.30 g m^{-2}) were recorded from BRRI dhan28 with 200 kg N ha^{-1} and BRRI dhan45 with 200 kg N ha^{-1}, respectively. The highest number of tillers $hill^{-1}$ (15.14) was obtained from BRRI dhan29 with 50 kg N ha^{-1}. The harvest data reveal that variety had significant effect on total tillers $hill^{-1}$, effective tillers $hill^{-1}$, non-effective tillers $hill^{-1}$, panicle length, grain yield, straw yield and harvest index. The highest grain yield (4.84 t ha^{-1}) was recorded from BRRI dhan29. The results of the experiment also indicate that total tillers $hill^{-1}$, effective tillers $hill^{-1}$, grains $panicle^{-1}$, sterile spikelets $panicle^{-1}$, grain yield, straw yield and harvest index were significantly affected by levels of nitrogen, while plant height, panicle length, 1000-grain weight were not significantly affected by levels of nitrogen. The highest grain yield (5.58 t ha^{-1}) was obtained from 200 kg N ha^{-1}. Interaction effect of variety × 200 kg N ha^{-1} produced the highest grain yield (5.82 t ha^{-1}). From the results of the study it may be concluded that BRRI dhan29 rice may be cultivated with 200 kg N ha^{-1} for obtaining higher yield in AEZ 9 of Bangladesh.

Key words: Boro rice, N level, variety, yield

***Corresponding Author:** salamma71@yahoo.com

Introduction

The population of our country is increasing but the cultivable land is decreasing due to urbanization and industrialization resulting in more shortage of food. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020. Since it is not possible to have horizontal expansion of rice area, rice yield should be increased to meet this ever increasing demand of food. The rainfed *Aus*, the rainfed *Aman* and irrigated *Boro* rice are cultivated in 10%, 51% and 39% in the total cropped area in Bangladesh, respectively (BADC, 2008). But according to BBS Report 2008 *Aus*, *Aman* and *Boro* produced 1.51, 9.66 and 17.76 million metric tons of rice. Therefore, *Boro* rice is one of the most important rice crops for Bangladesh with respect to its high yield and contribution to rice production.

Variety plays an important role in augmenting yield of rice. Use of HYV has been increased remarkably

in recent years and the country has almost reached a level of self sufficiency in food. National Commission of Agriculture projected that to remain self-sufficient Bangladesh will need to produce 47 million MT of paddy (31.6 million MT of rice) by the year 2020, implying a required rate of growth of production at 1.7% per year. An earlier Agricultural Research Strategy document prepared by the Bangladesh Agricultural Research Council projected the required paddy production by 2020 of 52 million MT (34.7 million MT of rice), which would require a production growth of 2.2% per year. The adoption of HYV rice technology, which enabled Bangladesh to double the yield rate during 1969-70 to 1998-99, was not however an unmixed blessing (GOB, 1998). The lion share of self sufficiency is obtained through the expansion of HYV rice cultivation in the *Boro* season. However, many of them are not known to have been studied to their yield and yield contributing characters. Bangladesh Rice Research Institute (BRRI) released a number of cultivars to cultivate in *Boro* season with detailed study for their different agronomic traits to furnish worth information regarding yield and possibilities for varietal improvement. Among the *Boro* rice varieties, BRRI dhan28, BRRI dhan29 and BRRI dhan45 are most popular varieties and produced higher yield than other *Boro* rice varieties.

Nitrogen is a major essential plant nutrient and a key input for increasing crop yield. Rice plants require a large amount of nitrogen at the early and mid-tillering stage to maximize the number of panicles. In order to exploit the full yield potential of modern rice cultivars, N-fertilizer application is necessary in most soils. Nitrogen is the most deficient nutrient element in Bangladesh soils and almost every farmer has to apply the costly N-fertilizer to get a desirable yield of rice. Optimum dose of nitrogen fertilization plays a vital role in growth and development of rice plant. Rice growth is seriously hampered when lower dose of nitrogen is applied which drastically reduces yield. Nitrogen has a positive influence on the production of effective tillers per plant, yield and yield attributes. On the other hand, excessive nitrogen fertilization encourages excessive vegetative growth which makes the plant susceptible to insects, pests and diseases and ultimately reduces yield. Rice grain yield was recorded significantly highest between ranges of 90-250 kg ha^{-1} nitrogen application (Marazi *et al*., 1993; Daniel and Wahab, 1994; Bali *et al*., 1995; Meena *et al*., 2003). A significant increase in tillering (Hussain *et al*., 1989; Meena *et al*., 2003) with increase in nitrogen supply was observed. By applying proper dose we can save money and can also keep our environment sound. A suitable combination of variety and rate of nitrogen is necessary for better yield.

Keeping above facts in mind the present study was, therefore, undertaken to observe the varietal performance of *Boro* rice, to evaluate the effect of rate of nitrogen on the yield of *Boro* rice and to find out the interaction effect of variety and nitrogen rate, if any, on the yield of *Boro* rice.

Materials and Methods

Location

The experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the period from November 2010 to May 2011 to study the effect of variety and nitrogen rate on the growth and yield performance of *Boro* rice.

Soil

The experimental site belongs to the Sonatola soil series under the Old Brahmaputra Floodplain Agro-ecological zone (AEZ-9) having non-calcareous dark grey floodplain soil (UNDP and FAO, 1988). Soil of the experimental site was more or less neutral in reaction, low in organic matter content and its general fertility level was also low.

Experimental treatment and design

The study consisted of two factor A: Variety- three- i) BRRI dhan28 (V_1), (ii) BRRI dhan29 (V_2), and (iii) BRRI dhan45 (V_3); and factor B: Level of nitrogen- (i) 0 or control treatment (N_0), (ii) 50 (N_1), (iii) 100 (N_2), 150 (N_3) and 200 (N_4) kg nitrogen ha^{-1}. The experiment was laid out in a randomized complete block design with four replications. Each of the replication represented a block in the experiment. Each block was divided into 15 unit plots where 15 treatment combinations were

allocated at random. There were 60 plots in the experiment. The size of unit plot was 4.0 m × 2.5 m. The distance maintained between two unit plots was 0.50 m and between blocks was 1 m. Treatments were randomly allocated in the experiment.

Seedling emergence

Seeds were immersed in water in bucket for 24 hours. Then seeds were taken out of water and kept thickly in gunny bags. The seeds started sprouting after 48 hours and were sown after 72 hours. Then the sprouted seeds were sown in the nursery bed on 30 November 2010.

Field preparation and fertilization

The land was puddled thoroughly by repeated ploughing and cross ploughing with a country plough and subsequently leveled by laddering. The field layout was made on 5 January 2011. In the experiment, full doses of fertilizers viz., triple super phosphate (120 kg ha^{-1}), muriate of potash (70 kg ha^{-1}), gypsum (60 kg ha^{-1}) and zinc sulphate (10 kg ha^{-1}) were applied at the time of final land preparation. Urea (0, 50, 100, 150 and 200 kg ha^{-1}) was top dressed in equal installments at 15, 30 and 45 DAT.

Rice transplanting

Thirty five-day-old seedlings were uprooted carefully from the nursery bed and transplanted on 5 January 2011 at the rate of three seedlings $hill^{-1}$ maintaining a spacing of 25 cm × 15 cm. Three weedings were done in order to keep the crop weed free at 15, 30 and 45 DAT.

Data collection

Three hills (excluding border hill) were selected at random from each plot and tagged for measuring plant height and counting the number of tillers at 25, 40, 55 and 70 DAT. Maturity of the crop was determined when 90% of the seeds become golden yellow in color. The crops were harvested at full maturity on 17 April 2011 (BRRI dhan28), 28 April 2011 (BRRI dhan45) and 8 May 2011 (BRRI dhan29). In each plot central 1 m × 1 m area was harvested to record the yields of grain and straw. Three hills that are randomly selected for measuring growth parameters were used to record the data on yield contributing characters. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The harvested crops were threshed by pedal thresher and the fresh weight of grain and straw was recorded plot-wise. Grains were cleaned and dried to a moisture content of 14%. Straws were sun dried properly. Final grain and straw yields $plot^{-1}$ were recorded and converted to t ha^{-1}. At vegetative stage data were collected on plant height, total tillers $hill^{-1}$ and total dry matter (g m^{-2}). To determine dry matter the sample plants were first air dried for 6-8 hours. Then the samples were packed in labeled brown paper bag and dried in the oven at 85 ± 5^{0}C for 24 hours until constant weight was reached. After oven drying, the samples were weighed by using electric balance.

Statistical analysis

Collected data were compiled and tabulated in proper form for statistical analysis. The recorded data in variation plant characters were statistically analyzed to find out the significance of variation resulting from the experimental treatments. At harvest, data were collected on plant height, total tillers $hill^{-1}$, effective tillers $hill^{-1}$, non effective tillers $hill^{-1}$, length of panicle, grains $panicle^{-1}$, sterile spikelets $panicle^{-1}$, 1000-grain weight, grain yield, straw yield and harvest index. Collected data were analyzed using "Analysis of Variance Technique" with the help of a computer package programmes MSTAT and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Effect of variety on growth parameters

Variety exerted significant influence on plant height at 25 and 70 D ATs, number of total tillers $hill^{-1}$ at 40 and 55 DATs and dry matter production at all sampling dates (Fig.1, 3 and 5). At 25 and 70 DATs, the tallest plant (33.40 cm and 80.88 cm) was found in the variety BRRI dhan29 (Fig. 1). Plant height is a varietal character and it is the genetic constituent of the cultivar, therefore, plant height was different among the cultivars. At all sampling dates except 25 DAT, variety BRRI dhan29 produced the highest number of total tillers hil^{l-1} (Fig. 3). The results indicate that tillering pattern of different varieties differed due to genetic potentiality of the varieties.

BRRI (1985) and Babiker (1986) also found varietal differences of tillering in the medium and traditional varieties. The increasing pattern of dry matter (DM) production was not similar among the varieties. Variety BRRI dna28 produced the highest DM at different DATs (Fig. 5). The significant variation in DM production among the varieties was also reported by Shamsuddin *et al.* (1988).

Effect of level of nitrogen on growth parameters

Plant height, total tillers hill^{-1}, leaf area and total DM production was significantly affected by different nitrogen levels at all sampling dates (Fig. 2, 4 and 6). The tallest plant was recorded at 200 kg N ha^{-1} at all sampling dates and the lowest one was recorded in control (0 kg N ha^{-1}) treatment at all sampling dates (Fig. 2). The highest number of total tillers hill^{-1} was obtained from 200 kg ha^{-1} at all sampling dates but at 55 and 70 DATs , it was statistically identical with 100 kg N ha^{-1} (Fig. 4). At all sampling dates, the highest dry matter (13.49, 23.47, 53.89 and 69.58 g m^{-2}) was produced from 200 kg N ha^{-1} (Fig. 6). Similar research finding was also reported by Kumar *et al.* (1996).

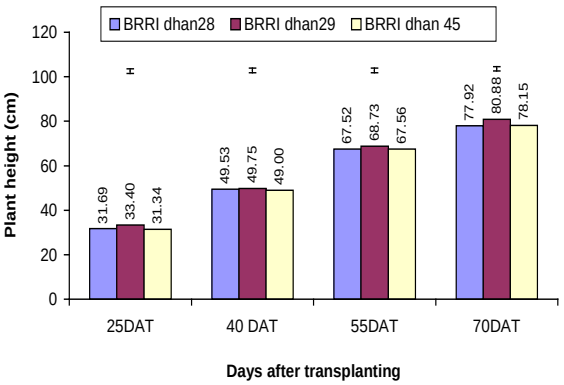

Fig. 1 Effect of variety on the plant height of *Boro* rice

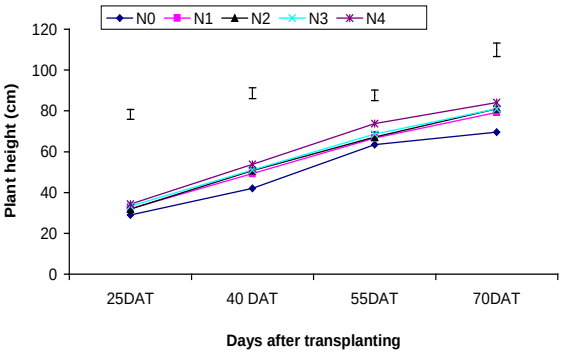

Fig. 2 Effect of levels of nitrogen on the plant height of *Boro* rice

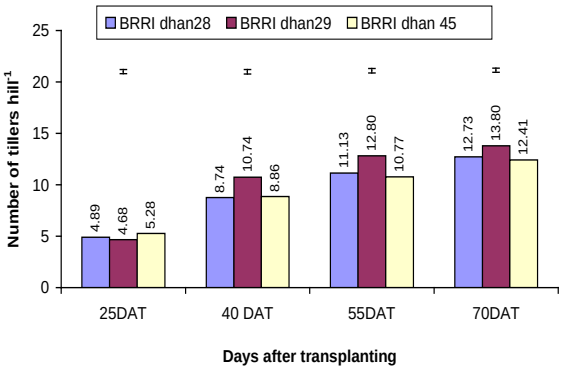

Fig. 3 Effect of variety on the number of tillers hill^{-1} of *Boro* rice

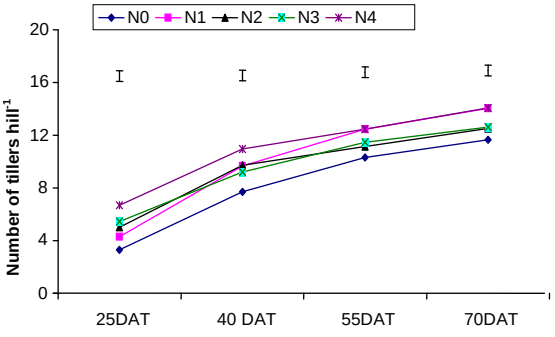

Fig. 4 Effect of levels of nitrogen on the tillers hill^{-1} of *boro* rice

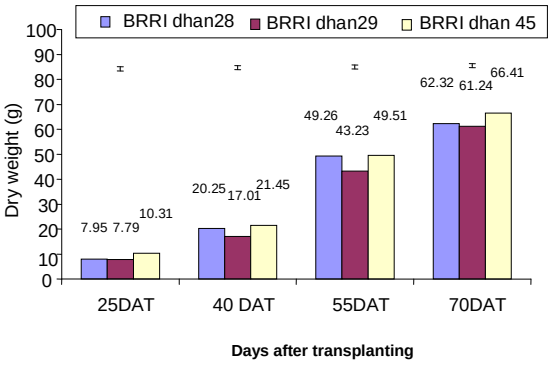

Fig. 5 Effect of variety on dry weight (g) of *Boro* rice

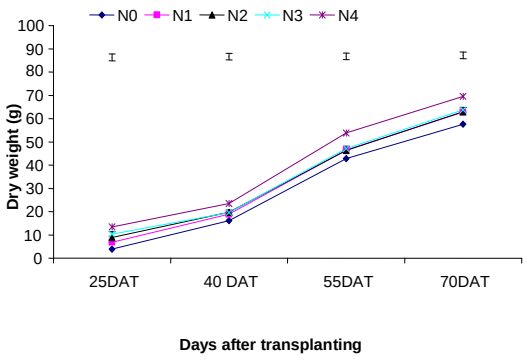

Fig. 6 Effect of levels of nitrogen on dry weight (g) of *Boro* rice

Effect of interaction of variety and level of nitrogen on growth parameters

The interaction between variety and level of nitrogen was significant on plant height at 55 and 70 DAT, was not significant on number of total tillers hill^{-1} and significant on dry matter production at 50 and 70 DAT (Table 1). The tallest plant (86.48 cm), was recorded from BRRI dhan28 with 200 kg N ha^{-1}, the highest number of tillers hill^{-1} (15.14) and the highest dry matter (72.30 g m^{-2}) was produced by BRRI dhan45 with 200 kg N ha^{-1}.

Yield and yield contributing characters of *boro* rice as influenced by variety and level of nitrogen

Effect of variety

Variety exerted significant effect on all the yield and yield contributing characters of *boro* rice except plant height (Table 2). The highest number of total tillers hill^{-1} (12.71) was recorded in the variety BRRI dhan29 which was statistically similar with the variety BRRI dhan28 and the lowest number of total tillers hill^{-1} was observed in BRRI dhan45. The highest number of effective tillers hill^{-1} (11.07) was recorded in the variety BRRI dhan29 and the lowest one was observed in BRRI dhan45. The reasons for differences in producing bearing tillers hill^{-1} might be due to the variation in genetic make-up of the variety that might be influenced by heredity. This was consistent with Chowdhury *et al.* (1993). The longest panicle (23.19 cm) was found in the variety BRRI dhan29 and the smallest one was observed in BRRI dhan45. The variation as assessed might be due to genetic characters of the varieties primarily influenced by the heredity. Diaz *et al.* (2000) also reported that panicle length varied among varieties. The highest number of grains panicle^{-1} (159.55) was recorded in the variety BRRI dhan29 which was about double compare to the variety BBRI dhan45 and about 1.5 fold more than the variety BRRI dhan28. Differences in number of grains panicle^{-1}, due to varieties were reported by BRRI (1994). Varietal differences regarding the number of grains panicle^{-1} was probably due to their genetic makeup and also due to the variation in photosynthetic assimilate accumulation especially after heading. The highest grain yield was recorded from the variety BRRI dhan29 which might be due to the highest number of total tillers hill^{-1}, highest number of effective tillers hill^{-1} and highest number of grains panicle^{-1} in the cultivar BRRI dhan29. The highest straw yield was observed in the variety BRRI dhan28. This was due to the higher total DM production in the cultivar BRRI dhan28. The highest harvest index was found in the variety BRRI dhan29 (Table 2).

Effect of level of nitrogen

The result of the study reveals that number of total tillers hill^{-1}, effective tillers hill^{-1}, number of grains panicle^{-1}, grain yield, straw yield and harvest index varied significantly due to different levels of nitrogen (Table 3). The highest number of total tillers hill^{-1} (14.05) was found with the application of 200 kg N ha^{-1} and the lowest number of total tillers hill^{-1} was found in control treatment. Nitrogen is an element which enhances vegetative growth of plants. Therefore, with the positive physiological effects the number of tillers hill^{-1} increased with the increase in nitrogen dose. The highest number of effective tillers hill^{-1} (12.57) was observed when N was used at the rate of 200 kg ha^{-1} and the lowest one was observed in control (0 kg N ha^{-1}) treatment (Table 4). Adequacy of N probably favored the cellular activity during panicle initiation and development that led to increase the number tillers hill^{-1}. The results agreed with those of Balasubramaniyan (1984), Gosh *et al.* (1991), Pandey *et al.* (1991) and Thakur (1993). Panicle length was not significantly influenced by different levels of nitrogen. The highest number of grains panicle^{-1} (125.90) was recorded with the application of 200 kg N ha^{-1} and the lowest one was found from control (0 kg N ha^{-1}) treatment which is the indication of grains panicle^{-1} increased with the increased use of N level. The highest number of sterile spikelets panicle^{-1} was observed in control (0 kg N ha^{-1}) and the lowest number of grains panicle^{-1} was recorded with the application of 200 kg N ha^{-1}. This result indicates that increasing N level decreased the sterile spikelets panicle^{-1}. The highest grain yield (5.58 t ha^{-1}) was found with the application of 200 kg N ha^{-1} and the lowest grain yield was obtained from control (0 kg N ha^{-1}). Increase in grain yield due to increased level of nitrogen was mainly due to the improvement of

growth parameters like number of total tillers hill^{-1} and DM production at different DATs, and improvement of yield and yield contributing characters like number of effective tillers hill^{-1} and number of grains panicle^{-1}. The highest straw yield (6.12 t ha^{-1}) and harvest index (47.66%) were obtained from 200 kg N ha^{-1} (Table 3).

Table 1. Interaction effect of variety and level of nitrogen on plant height, tillers hill^{-1} and crop dry weight at different DATs

Variety × N level	Plant height (cm)				Tillers hill^{-1} (no.)				Crop dry weight (g m^{-2}.)			
	25 DAT	40 DAT	55 DAT	70 DAT	25 DAT	40 DAT	55 DAT	70 DAT	25 DAT	40 DAT	55 DAT	70 DAT
V_1N_0	28.70	40.80	61.83f	64.31e	2.66	7.70	9.02	9.41	3.06	16.90	46.15de	60.45e
V_1N_1	29.00	47.00	64.50ef	76.06bcd	3.40	8.36	12.30	13.92	6.18	19.68	47.94cd	59.42e
V_1N_2	30.65	50.10	70.35a-d	79.85abc	5.27	9.08	10.56	12.70	8.04	19.91	47.28cde	60.56e
V_1N_3	35.62	54.11	73.60ab	82.90ab	6.18	8.55	10.96	13.13	9.93	21.02	50.15bc	63.44cde
V_1N_4	34.50	55.65	63.38f	86.48a	6.96	10.03	12.81	14.47	12.55	23.74	54.80a	67.76abc
V_2N_0	30.62	42.11	65.65def	73.65cd	3.11	8.02	11.51	12.81	3.97	13.01	38.35g	53.71f
V_2N_1	33.90	50.40	65.45c-f	82.15ab	4.14	11.37	13.90	15.14	6.26	15.89	41.31fg	61.86de
V_2N_2	34.75	53.55	67.45c-f	82.70ab	4.05	10.94	12.07	12.75	7.63	18.17	41.48fg	60.28e
V_2N_3	32.35	49.60	71.50abc	82.85ab	5.37	11.01	13.01	13.86	9.43	16.56	41.83fg	61.70de
V_2N_4	35.40	53.10	75.68a	83.05ab	6.73	12.36	13.52	14.44	11.65	21.40	53.20ab	68.67ab
V_3N_0	27.80	43.28	65.18def	70.89d	4.13	7.44	10.38	12.72	4.55	18.50	44.13ef	58.40e
V_3N_1	33.45	50.66	70.05b-e	79.48abc	5.35	9.22	11.19	13.08	8.22	21.01	50.11bc	67.07bc
V_3N_2	30.30	48.75	66.55c-f	80.35abc	5.71	9.12	10.81	12.07	10.78	21.04	50.13bc	67.93abc
V_3N_3	31.90	49.45	63.85f	77.55bcd	4.83	8.05	10.44	10.88	11.72	21.41	49.50cd	66.34bcd
V_3N_4	33.23	52.88	72.15abc	82.49ab	6.37	10.48	11.03	13.28	16.27	25.28	53.68a	72.30a
CV(%)	9.54	7.03	5.05	5.45	5.27	6.22	11.00	25.13	3.56	4.36	3.02	2.96
Level of significance	NS	NS	0.01	0.05	NS	NS	NS	NS	NS	NS	0.01	0.01

In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly (as per DMRT), NS = Not significant, V_1 = BRRI dhan28, V_2 = BRRI dhan29, V_3 = BRRI dhan45
N_0 = 0 (Control), N_1 = 50 kg N ha^{-1}, N_2 = 100 kg N ha^{-1}, N_3 = 150 kg N ha^{-1} and N_4 = 200 kg N ha^{-1}

Table 2. Effect of variety on yield and yield contributing characters of *Boro* rice

Variety	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1}(no.)	Sterile spikelets panicle^{-1} (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
BRRI dhan28	73.44	12.11a	9.55b	21.30b	97.12b	14.76b	22.67b	4.73b	5.83a	44.63b
BRRI dhan29	74.93	12.71a	11.07a	23.19a	159.55a	17.81ab	22.53b	4.84a	5.51ab	46.51a
BRRI dhan45	74.16	9.29b	7.52c	19.21c	65.57c	18.57a	27.75a	4.39c	5.32b	45.15ab
CV (%)	19.34	10.94	13.04	15.89	7.48	10.58	9.31	14.82	10.14	4.97
Level of significance	NS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

In a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), NS = Not significant.

Table 3. Effect of levels of nitrogen on yield and yield contributing characters of three varieties of *Boro* rice

Levels of nitrogen (kg ha^{-1})	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
0	73.77	7.46e	5.43e	21.47	79.96e	24.85a	24.53	3.54e	4.93e	41.82c
50	74.24	9.95d	7.76d	21.43	100.42d	18.21b	24.38	4.43d	5.33d	45.37b
100	73.10	12.32c	9.89c	21.02	108.27c	16.52b	24.06	4.73c	5.55c	46.05b
150	73.05	13.06b	11.24b	21.08	122.51b	13.04c	24.29	5.00b	5.83b	46.23b
200	76.72	14.05a	12.57a	21.16	125.90a	12.62c	24.33	5.58a	6.12a	47.66a
CV (%)	19.34	10.94	13.04	15.89	7.48	10.58	9.31	14.82	10.14	4.97
Level of significance	NS	0.01	.01	NS	0.01	0.01	0.01	0.01	0.01	0.01

In a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), NS = Not significant.

Table 4. Interaction effect of variety and level of nitrogen on the yield and yield contributing characters of *Boro* rice

Interaction (Variety× Nitrogen)	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$V_1 \times N_0$	72.71	7.99f	5.45	21.67	61.27jk	23.68b	22.83	3.49f	5.04d	40.97d
$V_1 \times N_1$	73.80	10.36e	7.73	21.72	93.60h	13.99fgh	22.45	4.54cd	5.43bcd	45.63bc
$V_1 \times N_2$	72.66	13.11c	9.55	21.36	100.67g	13.95fgh	22.54	4.75c	6.14a	43.61c
$V_1 \times N_3$	70.03	14.15bc	11.83	20.86	115.54f	12.20gh	22.57	5.11b	6.39a	44.47bc
$V_1 \times N_4$	78.00	14.93ab	13.21	20.87	114.52f	10.01h	22.96	5.77a	6.14a	48.45a
$V \times_2 N_0$	75.12	8.43f	6.38	23.57	122.16e	27.77a	22.82	3.55f	5.12cd	40.94d
$V_2 \times N_1$	73.31	10.87de	9.52	23.08	143.72d	21.68bcd	23.21	4.57cd	5.38bcd	45.95b
$V_2 \times N_2$	73.51	13.91bc	11.96	22.89	156.20c	16.97ef	22.38	5.07b	5.35bcd	48.65a
$V_2 \times N_3$	74.68	14.69ab	13.29	23.29	182.21b	10.30h	21.87	5.22b	5.62b	48.14a
$V_2 \times N_4$	78.02	15.68a	14.22	23.10	193.45a	12.31gh	22.36	5.82a	6.09a	48.86a
$V_3 \times N_0$	73.47	5.97g	4.47	19.18	56.46k	23.11bc	27.92	3.58f	4.63e	43.57c
$V_3 \times N_1$	75.60	8.64f	6.05	19.49	63.93ij	18.97cde	27.47	4.17e	5.19cd	44.55bc
$V_3 \times N_2$	73.13	9.95e	8.17	18.81	67.95i	18.63de	27.26	4.38de	5.16cd	45.90b
$V_3 \times N_3$	74.45	10.36e	8.62	19.07	69.79i	16.61efg	28.43	4.68c	5.47bc	46.07b
$V_3 \times N_4$	74.14	11.55d	10.27	19.52	69.73i	15.54efg	27.67	5.15b	6.13a	45.67bc
CV (%)	19.34	10.94	13.04	15.89	7.48	10.58	9.31	14.82	10.14	4.97
Level of significance	NS	0.01	NS	NS	0.05	0.01	NS	0.01	0.01	0.01

In a column, figures with same letters or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).
NS = Not significant; V_1 = BRRI dhan28, V2 = BRRI dhan29, V3 = BRRI dhan45
N_0 = 0 (Control), N_1 = 50 kg N ha^{-1}, N_2 = 100 kg N ha^{-1}, N_3 = 150 kg N ha^{-1} and N_4 = 200 kg N ha^{-1}

Interaction effect of variety and level of nitrogen

The interaction of variety and level of nitrogen had significant effect on number of total tiller hill^{-1}, number of grains panicle^{-1}, sterile spikelets panicle^{-1}, grain yield, straw yield and harvest index. On the other hand, plant height (cm), number of effective tillers hill^{-1}, panicle length (cm) and 1000-grain weight (g) were not significantly influenced due to interaction of variety and level of nitrogen (Table 4). The highest number of total tillers hill^{-1} was obtained from the interaction of variety BRRI dhan29 × 200 kg N ha^{-1} which was statistically similar with that of variety BRRI dhan28 × 200 kg N ha^{-1} and BRRI dhan29 × 150 kg N ha^{-1}. The highest number of grains panicle^{-1} was obtained from the variety BRRI dhan29 × 200 kg N ha^{-1} and the lowest one was found from the variety BRRI dhan45 × control (0 kg N ha^{-1}) treatment. The highest number of sterile spikelets panicle^{-1} was recorded from the variety BRRI dhan29 × control (0 kg N ha^{-1}) treatment and the lowest one was observed from the variety BRRI

dhan28 × control treatment and variety BRRI dhan29 × control (0 kg N ha^{-1}). The highest grain yield (5.82 t ha^{-1}) was obtained in BRRI dhan29 with 200 kg N ha^{-1} which was statistically similar to combination of BRRI dhan28 with 200 kg N ha^{-1} (5.77 t ha^{-1}). The lowest grain yield (3.49 t ha^{-1}) was obtained from BRRI dhan28 with 0 kg N ha^{-1}. The highest straw yield was recorded from the interaction of BRRI dhan28 with 150 kg N ha^{-1} which was statistically identical with that of BRRI dhan28 with 200 kg N ha^{-1} and BRRI dhan28 with 200 kg N ha^{-1} and BRRI dhan29 × 200 kg N ha^{-1}. The highest harvest indexwas observed in variety BRRI dhan29 with 200 kg N ha^{-1} which was statistically similar with the interactions of BRRI dhan29 × 100 kg N ha^{-1}, BRRI dhan28 × 200 kg N ha^{-1} and BRRI dhan29 × 150 kg N ha^{-1}. From the results of the study it may be concluded that BRRI dhan29 rice may be cultivated with 200 kg N ha^{-1} for obtaining higher yield in AEZ 9 of Bangladesh.

References

Babiker FSH (1986). The effect of zinc sulphate levels on rice growth and productivity. Alexandria J. Agric. Res. 31 (2): 480-481.

BADC, Bangladesh Agricultural Development Corporation (2008). Minor irrigation survey report 2007–08. Ministry of Agriculture, Dhaka, Bangladesh

Balasubramaniyan P (1984). Nitrogen fertilization for short duration rice. Int. Rice Res. Newsl. 9(5): 29.

Bali AS, Siddique M, Ganai BA, Khan HV, Singh KN, Bali AS (1995). Response of rice *(Oryza sativa)* genotypes to nitrogen levels under transplanted conditions in Kashmir valley. Indian J. Agron. 40(1): 35-37.

BRRI, Bangladesh Rice Research Institute (1985). Annual report for 1981. BRRI Pub. No. 71. Joydebpur, Gazipur, Bangladesh. pp.2-8.

BRRI, Bangladesh Rice Research Institute (1994). Annual Report July 1994-June 1995. Bangladesh Rice Res. Inst. Joydebpur, Gazipur, Bangladesh. pp. 36-37.

Chowdhury MJU, Sarker AU, Sarker MAR, Kashem MA (1993). Effect of variety and number of seedlings hill-1 on the yield and its components on late transplanted *aman* rice. Bangladesh J. Agril. Sci. 20 (2): 311-316.

Diaz SH, Castro R, Morejon R (2000). Morpho-agronomic characterization of varieties of rice. Instituto Nacional de ciencias Agricolas, Gaveta Postall, San Jose, de las, Lajsa, La Habna. 21(3): 81-86.

Daniel KV, Wahab K (1994). Levels and time of nitrogen in semi dry rice. Madras Agric. J. 81(6): 357-358.

Ghosh BC, CV Raghavaian, MK Jana (1991). Effect of seedrate and nitrogen on growth and yield of direct sown rice (*Oryza sativa* L.) under intermediate deep water condition. Indian J. Agron. 36: 227-228.

GOB, Government of Bangladesh (1998). Minor irrigation survey report, 1997–98. Bangladesh Agriculture Development Corporation, Ministry of Agriculture, Dhaka, Bangladesh.

Gomez KA, Gomez AA (1984). Statistical Procedure for Agricultural Research. 2nd Ed. John Wiley and Sons. New York, pp.643-645.

Hussain T, Jilani G Ghaffar A (1989). Influence of rate and time of nitrogen application on growth and yield of rice in Pakistan. Inter. Rice. Res. Newsl. 14(6): 18.

Kumar M, Haque M, Singh SB, Pathak SK (1996). Effect of graded levels of nitrogen on yield and quality of scented rice varieties in southern alluvial Gangetic plants of Bihar. J. Appl. Biol. 6: 61-63.

Marazi AR, Khan GM, Singh KH, Bali AS (1993). Response of rice (*Oryza sativa*) to different N levels and water regimes in Kashmir Valley. Indian J. Agric. Sci. 63(11): 726-727.

Meena SL, Surendra S, Shivay YS, Singh S (2003). Response of hybrid rice (*Oryza sativa*) to nitrogen and potassium application in sandy clay loam soils. Indian J. Agric. Sci. 73(1): 8-11.

Pandey SK, Rajkumar RS, Singh BB (1991). Effect of different doses of nitrogen on dwarf and tall varieties of rice *(Oryza sativa).* Indian J. Agril. Sci. 61(2): 135-138.

Shamsuddin AM, Islam MA, Hossain A (1988). Comparative study on the yield and agronomic characters of nine cultivars of aus rice. Bangladesh. J. Agril. Sci. 15(1): 121-124.

Thakur RB (1993). Performance of summer rice *(Oryza sativa)* to varying levels of nitrogen. Indian J. Agron. 38(2): 187-190.

UNDP, FAO (1988). Land Resources Appraisal of Bangladesh for Agricultural Development. Report 2. Agro-ecological Regions of Bangladesh. United Nation Develop. Prog. Food and Agric. Org. pp. 212-221.