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PERFORMANCE OF THREE BORO RICE VARIETIES UNDER DIFFERENT LEVELS OF NITROGEN APPLICATION

Md. Anamul Haque Razib[1]*, Ahamed Ullah Sarker[2], Nadira Sultana[3], Mohammad Nazrul Islam[4] and Rakhi Podder[5]

[1]Department of Agronomy, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh; [2]Department of Agronomy, and [3]Department of Plant Pathology, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh; [4]Agricultural Extension and information system, Sher-e-Bangla Agricultural University, Dhaka; [5]Horticulture Center, Agricultural Extension Jamalpur.

***Corresponding author:** Md. Anamul Haque Razib; **E-mail:** zenithbau@gmail.com

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ABSTRACT

A field experiment was carried out to study the effect of levels of nitrogen on the performance of three *Boro* rice varieties e.g. cv. BRRI dhan28, cv BRRI dhan29 and cv. Surjomoni. The experiment comprised four levels of nitrogen viz. 0 kg N ha^{-1}, 60 kg N ha^{-1}, 120 kg N ha^{-1} and 180 kg N ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The highest grain yield (4.23 t ha^{-1}) was obtained from cv. BRRI dhan29 because of production of the highest number of both total tillers m^{-2} and effective tillers m^{-2}. BRRI dhan28 produced higher grain yield (3.39 t ha^{-1}) compared to that of Surjomoni (3.07 t ha^{-1}). Application of 120 kg N ha^{-1} produced the highest grain yield (4.23 t ha^{-1}) because of the production of the highest number of both total tillers m^{-2} and effective tillers m^{-2} in the treatment. Application of 180 kg N ha^{-1} produced the second-highest grain yield (3.70 t ha^{-1}) and 0 kg N ha^{-1} produced the lowest grain yield (2.76 t ha^{-1}). Interaction between variety and levels of nitrogen significantly influenced all parameters studied except plant height, total tillers $hill^{-1}$, effective tillers $hill^{-1}$, non-effective tillers $hill^{-1}$, length of panicle, number of sterile spikelets $panicle^{-1}$ and 1000-grain weight. The highest grain yield (4.60 t ha^{-1}) was obtained from BRRI dhan29 with the application of 120 kg N ha^{-1} and the lowest grain yield (2.40 t ha^{-1}) was obtained from the treatment combination of Surjomoni and 0 kg N ha^{-1}. Rice variety BRRI dhan29 can be provided with 120 kg N ha^{-1} to get the highest and economic production of the crop.

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INTRODUCTION

Bangladesh is an agrarian country and Rice (*Oryza sativa L*.) is synonymous with food in this country and has been used as a traditional source of carbohydrates since the pre-historic days. Rice is grown in a wide range of climatic conditions covering one-third of the world's total cropped area and is consumed by 50 % of the world's population (Jahan *et al*., 2020). Bangladesh stands in the third position globally in rice production. The average yield of rice in Bangladesh is very low (54.3 Million tons) compared to that of other rice growing countries like China (211.9 million tons) and India (178. Million tons) (FAOSTAT, 2020). The annual production of rice is 37.6 million metric tons from 11.70 million ha of land. In Bangladesh, there are three distinct classes of rice, based mainly on the seasons of cultivation, namely Aus, Aman and Boro. Among them Boro rice covered more than 40.91% of total rice cultivated areas covering 11.828 million acres area and the production was 19.885 million M tons (BBS, 2022). Nitrogen is the key nutrient that plays a vital role in the yield of rice. To increase rice production, nitrogenous fertilizer application must be considered properly. Additionally, the application of relatively high N concentration results in enhanced growth and nitrogen metabolism, which increases plant stress tolerance like increasing the plasticity of root development under drought stress (Wang *et al*., 2016; Ferdous *et al*., 2019; Zhong *et al*., 2017**)** reported that nitrogen has a positive influence on the production of effective tillers. An increase in the yield of rice by 70-80% may be obtained by the proper application of nitrogen fertilizer (IFC, 1982).

As nitrogen fertilizer is a costly input and its response varies from variety to variety, it is very much essential to find out the optimum level of nitrogen application as efficient fertilizer management gives a higher yield of rice and reduces the cost of production (Hossain and Islam, 1986). Because of the above discussion, the present experiment was undertaken to find out the effect of variety on yield and plant characteristics of *Boro* rice, to find out the effect of levels of nitrogen on yield and plant characteristics of *Boro* rice and to find out the effect of interaction between variety and levels of nitrogen on the yield and plant characters of *Boro* rice.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the period from November 2008 to June 2009 to study the effect of variety and levels of nitrogen on the growth and yield of *Boro* rice. The experimental field was medium-high land having sandy loam soil with a $_{P}$H of around 6.2. The soil of the experimental field was low in organic matter content and its general fertility level was also low. The experimental area was under the sub-tropical climate, which is characterized by high temperature, high humidity and heavy precipitation with occasional gusty winds in the Kharif season (April-September) and scanty rainfall associated with moderately low temperature during the Rabi season (October-March). The experiment was laid out in RCBD with three replications. Treatment combinations were assigned at random within a block. Total numbers of unit plots were 36 and each plot size was 2.5m x 2.0 m (5 m^2). Two factors included in the experiment were factor A: Variety- 3- a) BRRI dhan28, b) BRRI dhan29 c) Surjomoni; and factor B: Levels of nitrogen - 4 – a) 0 kg N ha^{-1} (N_0), b) 60 kg N ha^{-1} (N_1), c) 120 kg N ha^{-1} (N_2) and d) 180 kg N ha^{-1} (N_3). Seeds were soaked in water in a bucket for 24 hours. Then they were taken out of water, covered with wet gunny bags and kept for sprouting. After 24 hours the sprouted seeds were sown uniformly in a well prepared nursery bed on 20 November 2008. Proper care was taken to protect the weeds and to raise healthy seedlings. The land was opened with a power tiller on 15 December 2008. The field was thoroughly prepared with the help of a country plough and ladder. Weeds and stubbles were removed from the field during land preparation. The land was finally prepared on 18 December, 2008 and the field layout was done on the next day. Fertilizers were applied to the plots at the rate of 100, 70, 60 and 10 kg ha^{-1} of triple superphosphate, muriate of potash, gypsum and ZnSO4 respectively, as per recommendation of BRRI (1999). Nitrogen was applied as per treatment in the form of urea as top dressed in three equal splits at 15, 30 and 45 days after transplanting (DAT). Thirty-day old seedlings were uprooted on 20 December 2008 carefully from the nursery bed and transplanted at the rate of two seedlings per hill maintaining standard spacing. Gap filling was done on 12 January 2009 using the seedlings from the same source. Weed infestation appeared to be a severe problem during the early stages of crop establishment. Two times hand weeding were done on 20 and 40 days after transplanting. Crop was irrigated as and when necessary to maintain adequate moisture in the field for successful crop production. Excess water was drained out of the plots before 15 days of harvest to enhance

maturity. Sumithion 50 EC was applied at the rate of 1.0 liter ha^{-1} to control the infestation of stem borer at the stage of panicle initiation. The crop was harvested at full maturity. The date of harvesting was determined when 90% of the seed became golden yellow. Five hills were selected randomly from each unit plot and uprooted before harvesting for recording data. 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 (cm), total number of tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, panicle length (cm), number of grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, weight of 1000 grains (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%). Collected data were analyzed using "Analysis of Variance Technique" with the help of computer package MSTAT. The mean differences among the treatments were tested with Duncun's Multiple Range test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Results obtained from the study on the effect of variety and levels of nitrogen on the yield of *Boro* rice have been presented and discussed in this chapter. The effect of variety on various plant characters and yield has been presented in table 2. The effects of levels of nitrogen on various plant characters and yield have been presented in graph. The effect of interaction between variety and levels of nitrogen has been presented in table 3. Analysis of variance (mean squares) for plant characters and yield of *Boro* rice as influenced by variety and levels of nitrogen has been presented in Table 1.

Effect of variety on growth and yield parameters

All the growth and yield attributing characters (except thousand grain weight) were significantly influenced by rice cultivars (Table 1). The highest plant height (101.46 cm) was recorded from BRRI dhan29 followed by Surjomoni (99.17cm) and BRRI dhan28 (95.96 cm) (Table 2). Chowdhury *et al.* (1993) found a consistent result with these findings. The tallest plant (86.59 cm) was also observed in the cultivar BRRI dhan29 (Afroz *et al.*, 2019). The genetic makeup and varietal characteristics of the cultivar determine the plant's height, which varies amongst cultivars. Tillering is an important trait for rice production. The highest number of total tillers $hill^{-1}$ (16.49), effective tillers $hill^{-1}$ (11.86) and lowest of non-effective tillers $hill^{-1}$ (4.59) was in BRRI dhan29 followed by BRRI dhan28 and Surjomoni (Table 2). This may be since BRRI dhan29 had the highest tiller production potentiality than other cultivars (Afroz *et al.,* 2019). It was also concluded that the genetic capacity of the varieties contributed to the variances in the tillering pattern, besides the fact the medium and traditional varieties' tillering patterns differed from one another genetically (Badshah *et al*., 2014). The genetic heterogeneity of the varieties impacted by their inheritance can be the cause of the differences in the number of effective tillers $hill^{-1}$ among the varieties (Tyeb *et al*., 2013)**.** The variety BRRI dhan29 produced the highest particle length (25.52 cm) followed by BRRI dhan28 and Surjomoni (Table 2). The evaluated variance may be caused by genetic traits of the varieties that are predominantly influenced by inheritance. Additionally, panicle length differed amongst varieties and different hybrid rice cultivars showed a noticeable difference in panicle length (Diaz *et al*., 2000). The highest number of grains $panicle^{-1}$ (133.06) was produced by BRRI dhan29 and the lowest number (110.46) by Surjomoni (Table 2). The maximum number of grains $panicle^{-1}$ was found in BRRI dhan29 was mostly determined by heredity. However, variances in the number of grains $panicle^{-1}$ can also arise owing to variations in photosynthetic assimilate accumulation, particularly after heading **(**Chamely *et al*., 2015; Afroz *et al*., 2019). The lowest number of sterile spikelets $panicle^{-1}$ (24.26) was produced by BRRI dhan29 (Table 2). The differences might be due to genotypic variation. Chowdhury *et al*. (1993) also reported varietal differences in number of sterile spikelets $panicle^{-1}$. The highest weight (25.33 g) of 1000 grains was produced by BRRI dhan29 and the lowest was by BRRI dhan28 (24.96 g). The highest grain yield (4.23 t ha^{-1}) was in the variety BRRI dhan29 followed by BRRI dhan28 (3.39 t ha^{-1}) and (3.07 t ha^{-1}) in Surjomoni (Table 2).

Table 1. Analysis of variance table

Sources of variance	df	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spiklets panicle^{-1}	1000- grains weight	Grain yield (t ha^{-1})	Straw yields (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index(%)
Replication	2	10.324	0.769	1.084	0.96	0.852	6.358	2.893	0.574	0.006	0.045	0.081	0.46
Factor A (Variety)	2	91.71	29.767**	29.7	0.049**	6.216**	1531.291	27.703	0.402 Ns	3.291	1.78**	9.677**	44.291**
Factor B (Levels of nitrogen)	3	9.434*	30.277**	68.131**	9.629**	3.623**	1185.666	118.824*	0.482 Ns	3.395**	2.191	10.793**	35.4
AB	6	10.11^{NS}	0.841 ^{NS}	0.86 ^{NS}	0.178 ^{NS}	1.235 ^{NS}	210.494**	1.674 ^{NS}	1.023 NS	0.229**	0.111*	0.331**	15.122**
Error	22	23.177	0.893	1.275	0.334	1.111	5.42	2.416	1.022	0.004	0.019	0.031	0.37

* = Significant at 5% level of probability; **= Significant at 1% level of probability; NS = Not significant

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

Variety	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spiklets panicle^{-1}	1000- grains weight	Grain yield (t ha^{-1})	Straw yields (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1	95.96c	14.26b	9.63b	4.63b	24.36b	122.01b	26.78ab	24.96c	3.39b	4.69b	8.08b	41.96b
V_2	101.46a	16.45a	11.86a	4.59c	25.52a	133.06a	24.26b	25.33a	4.23a	5.35a	9.58a	44.15a
V_3	99.17b	13.54b	8.82b	4.72a	24.20b	110.46c	26.99a	25.14b	3.07c	4.68b	7.75c	39.61c
Sx̄	1.34	0.23	0.15	0.19	0.23	0.23	0.43	0.39	0.02	0.04	0.05	0.16
Level of significance	*	**	**	**	**	**	*	NS	**	**	**	**

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly (as per DMRT). Significant at 5% level of probability = Significant at 1% level of probability; NS = Not significant

V_1=BRRI dhan28
V_2=BRRI dhan29
V_3= Surjomoni

Table 3. Effect of interaction (variety and levels of nitrogen) on yield and plant characters of Boro rice

Variety x Levels of nitrogen	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spiklets panicle^{-1}	1000- grains weight	Grain yield (t ha^{-1})	Straw yields (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1N_0	94.05	13.42	8.33	5.09	24.33	114.90f	31.08	25.17	2.89h	4.05h	6.94h	41.64d
V_1N_1	96.32	16.37	11.35	5.02	25.01	120.89e	27.54	24.95	3.45e	4.56fg	8.01 f	43.07bc
V_1N_2	96.81	17.61	12.45	5.16	24.87	124.3 de	24.26	25.98	3.32f	5.03cd	8.34e	39.81e
V_1N_3	94.67	12.3	9.07	3.23	25.01	127.95cd	24.24	25.22	3.92c	5.1 Ic	9.03d	43.41 b
V_2N_0	102.47	11.65	6.53	5.12	24.53	125.14cd	30.46	24.01	3-00g	4.44g	7.44g	40.32e
V_2N_1	100.87	12.67	7.27	5.4	24.46	97.54g	24.48	24.83	3.97c	5.43b	9.40c	42.23cd
V_2N_2	103.75	18.28	15.3	2.98	25.77	144.68a	20.34	25.98	4.60a	5.74a	10.34a	44.49a
V_2N_3	98.78	15.52	12.4	3.12	24.68	137.27b	20.75	24.65	4,01b	5.81a	9.82b	40.84b
V_3N_0	98.01	12.48	6.99	5.49	23.32	90.90h	31.37	24.95	2.40j	4.13h	6.53i	36.75 f
V_3N_1	98.74	13.62	8.27	5.35	24.54	129.09c	27.43	24.7	2.71 i	4.50de	7.21g	37.59 g
V_3N_2	97.68	14.72	9.67	5.05	24.22	133.32b	24.53	25.37	3.41 of	4.67ef	8.08ef	42.20cd
V_3N_3	102.27	13.72	8.74	4.98	24.73	116.15f	24.62	25.55	3.75d	5.06cd	8.82d	42.52bcd
S(x)	2.67	0.55	0.65	0.33	0.61	1.34	0.9	0.58	0.04	0.07	0.1	0.32
Level of significance	NS	NS	NS	NS	NS		NS	NS	**	*	**	**

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differs significantly (as per DMRT)

V_1 = BRRI dhan28 No = 0 kg N ha^{-1} * Significant at 5% level of probability

V_2 = BRRI dhan29 N_1 = 60 kg N ha^{-1} ** = Significant at 1% level of probability

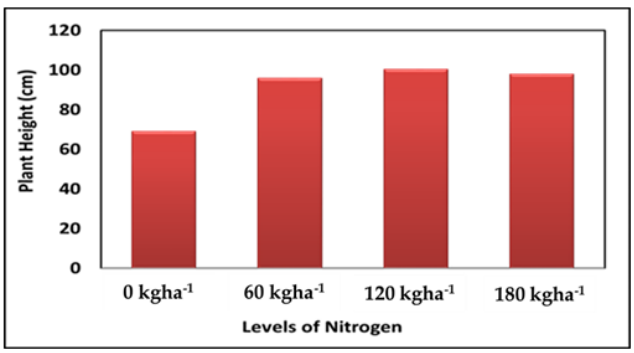
V_3 = Surjomoni N_2 = 120 kg N ha^{-1} NS = Not significant

N_3 = 180 kg N ha^{-1}

The highest grain yield of BRRI dhan29 was probably achieved due to the number of total tillers hill^{-1}, the highest number of effective tillers and the highest number of grains panicle^{-1}. The highest grain yield (5.17 t ha-1) was recorded in BRRI dhan29 cultivar due to the fact of producing highest number of total and effective tillers hill^{-1}, highest number of grains panicle^{-1}, lowest number of sterile spikelets panicle^{-1} and heaviest 1000-grain weight of the cultivar BRRI dhan29 (Afroz *et al.*, 2019**)**. Because of the genetic makeup of the cultivars, grain yield may also vary (Kabir *et al.,* 2004). Different workers also reported the similar results on grain yield due to the effect of rice varieties. The highest straw yield (5.35 t ha^{-1}) was produced by BRRI dhan29 and the lowest (4.68 t ha^{-1}) was produced by Surjomoni which was statistically similar to BRRI dhan28 (Table 2). The highest straw yield (5.80 t ha^{-1}) was found in BRRI dhan29 (Afroz *et al.,* 2019). The highest biological yield (9.58 t ha^{-1}) was found in BRRI dhan29 and the lowest (7.75 t ha^{-1}) in Surjomoni. The highest harvest index (44.15%) was recorded in BRRI dhan29 whereas the lowest harvest index (39.61 %) was observed in Surjomoni (Table 2). Kabir *et al.* (2004) reported variable harvest indices among the varieties and also showed the similar result that BRRI dhan29 had significantly highest HI (%) (50.53).

Effect of different levels of nitrogen on growth parameter

All the growth and yield attributing characters (except thousand grain weight) were significantly influenced by the levels of nitrogen (Table 1). The highest plant height (100.23 cm) was recorded when 120 kg N ha^{-1} was applied and the lowest plant height (68.84 cm) was recorded from 0 kg N ha^{-1} (Fig 1)**.** The role of N in enhancing rice growth, internode elongation, photosynthesis and metabolism, and assimilation production may be the cause of the greater plant height with N application. Increased plant height due to application of N might be due to increased cell division and cell enlargement**.** Murthy *et al*. (2012) had congruity with this result, as increasing doses of nitrogenous fertilizer increase plant length. Geethadevi *et al* (2000) recorded different plant heights due to different nitrogen rates. The highest number of total tillers hill^{-1} (18.66), number of effective tillers hill^{-1} (13.76) was obtained from 120 kg N ha^{-1}. The lowest total tillers hill^{-1} (12.68) and number of effective tillers hill^{-1} (7.28) was recorded from 0 kg N ha^{-1} (Fig 2)**.** The results agreed with Thakur (1993)**.** Karim *et al*. 2019 reported that the crop received from 120 kg N ha^{-1} produced higher number (12.8) of tillers. Salam *et al*. (2020) also recorded a positive effect of nitrogen management on number of total tillers hill^{-1}. Nitrogen is an element that enhances the vegetative growth of plants. Therefore, with the positive physiological effects the number of tillers hill-1 increased with the increase in nitrogen dose. Growth promoting effect of N on plant can be explained based on the fact that N supply increases the number and size of meristematic cells which leads to formation of new shoots. Similar result was also supported by Ahmed *et al.* (2005) who opined that number of effective tillers hill^{-1} increased with the better response to nitrogen. The improvement in the formation of effective tillers with nitrogen management might be due to availability of higher amount of nitrogen that enhanced effective tillering. Adequacy of N probably favored the cellular activity during panicle initiation and development that led to increase the number tillers hill^{-1}. It is necessary to apply much N fertilizer to help rice plants to accelerate the N absorption for increased tillering (Matsua *et al*., 1995). 160 kgha^{-1} N applications on rice plants increased the production of tillers Alam *et al*. (2009). The highest number of non-effective tillers hill^{-1} (5.40) was produced by 0 kg N ha^{-1}. The lowest number of non-effective tillers hill^{-1} (4.9) was produced with 120 kg N ha^{-1} (Figure 2).



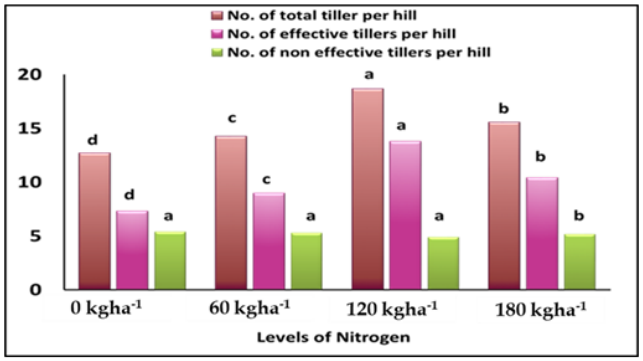


Figure 1. Effect of different levels of nitrogen on plant height; **Figure 2.** Effect of different levels of nitrogen on total number of tillers hill^{-1}, number of effective tillers hill^{-1} and non-effective tillers hill^{-1}

Panicle number is a major yield determining factor of rice. Nitrogen contributes to rice panicle formation by stimulating cell division in the reproductive stage of crop growth. The highest panicle length 25.37 cm was produced by 120 kg N ha^{-1} and the lowest (23.98 cm) by the treatment 0 kg N ha^{-1} (Fig 3). The increase in panicle number and panicle length with N fertilization was reported by Gewaily *et al*. (2018); Yoseftabar (2013). The highest number of grains $panicle^{-1}$ (136.63) was produced when the nitrogen rate was 120 kg ha^{-1} and the lowest number of grains $panicle^{-1}$ (110.31) was obtained from the control treatment (Fig 4). The highest number of sterile spikelets $panicle^{-1}$ (30.97) was obtained when 0 kg N ha^{-1} was applied and the lowest number of sterile spikelets $panicle^{-1}$ (23.20) was recorded in the treatment with 120 kg N ha^{-1} (Fig 4).

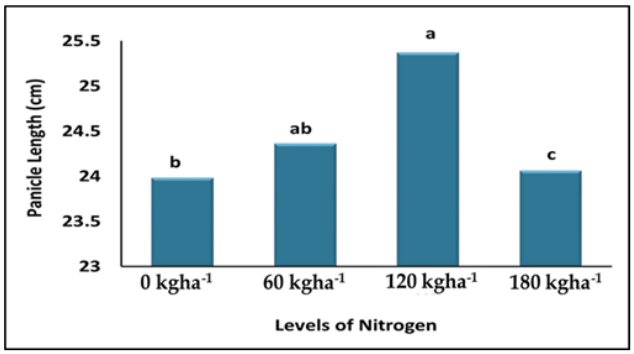


Figure 3. Effect of different levels of nitrogen on panicle length;

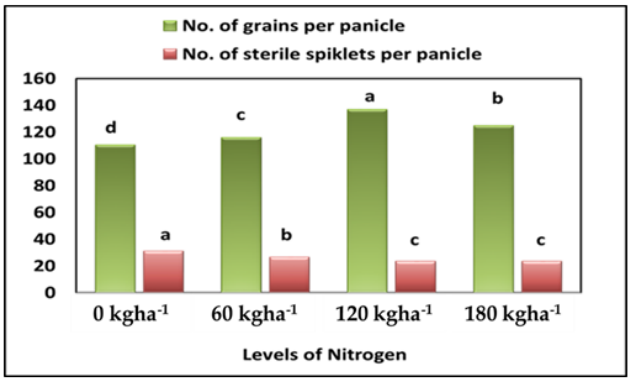


Figure 4. Effect of different levels of nitrogen on number of grains $panicle^{-1}$ and sterile spikelets $panicle^{-1}$

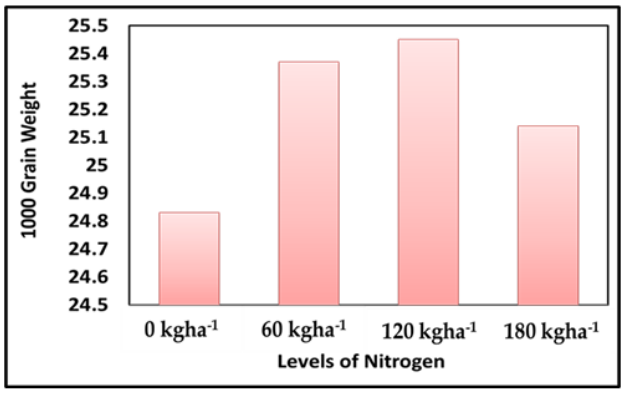


Figure 5. Effect of different levels of nitrogen on thousand grain weight;

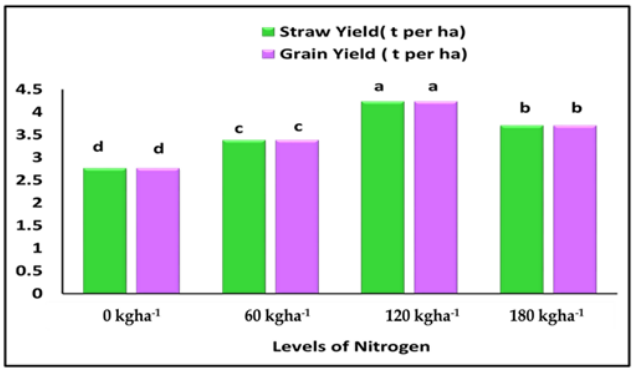


Figure 6. Effect of different levels of nitrogen on Grain yield and straw yield

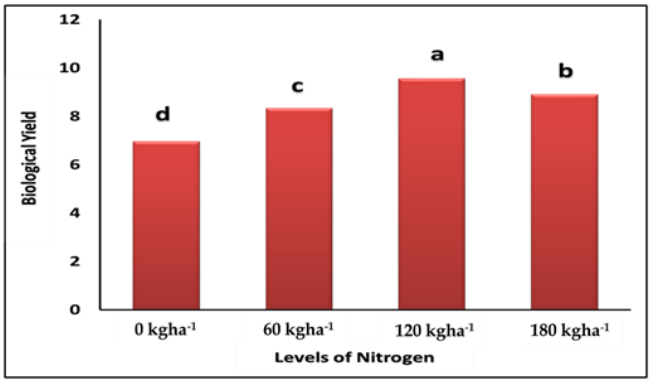


Figure 7. Effect of different levels of nitrogen on Biological Yield;

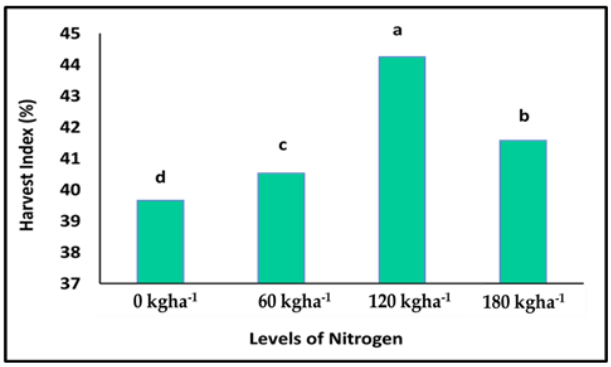


Figure 8. Effect of different levels of nitrogen on harvest index (%)

The numbers of spikelets per panicle and filled grains per panicle of individual plants declined under decreased nitrogen application according to Liu *et al.* 2019. However, numerically the highest weight of 1000 grains (25.45g) was obtained from 120 kg N ha-1 and the lowest (24.83g) from 0 kg N ha^{-1} (Fig 5). An increase in grain weight at higher nitrogen rates might be primarily due to increase in the chlorophyll content of leaves which led to a higher photosynthetic rate and ultimately plenty of photosynthates available during grain development. The highest grain yield (4.23 t ha^{-1}) was produced when the crop was fertilized with 120 kg N ha^{-1} and the lowest grain yield (2.76 t ha^{-1}) was recorded with 0 kg N ha^{-1} (Fig 6)**.** The recorded highest grain yield might be due to the effect of higher number of effective tillers $hill^{-1}$ and field grain $panicle^{-1}$. Improvement of yield components such as number of effective tillers $hill^{-1}$ and number of filled grains $panicle^{-1}$ ultimately resulted in high yield of grains. Many researchers reported that the application of nitrogen increased the yield of rice (Carress *et al.,* 2000). Brohi *et al.* (1998) reported application of 150 kg N ha-1 is sufficient for rice cultivation. Puteh and Mondal, 2014 explained that 120 kg N ha-1 resulted the highest grain yield. Chamely *et al.* (2015) also observed variation in grain and straw yields due to different nitrogen rates. The highest straw yield (5.33 t ha^{-1}) was produced by 120 kg N ha^{-1} and the lowest straw yield (4.20 t ha^{-1}) was recorded from 0 kg N ha^{-1} (Fig 6)**.** Nitrogen fertilization aided rice's vegetative development in terms of plant height and the number of tillers, which eventually increased the yield of straw **(**Mishra *et al.,* 2003**).** The highest biological yield (9.56 t ha^{-1}) was produced by 120 kg N ha^{-1} and the lowest (6.96 t ha^{-1}) by 0 kg N ha^{-1} (Fig 7)**.** The highest harvest index (44.25%) was recorded when the nitrogen rate was 120 kg N ha^{-1}. The lowest harvest index (39.66%) was found with 0 kg N ha^{-1} (Fig. 8)**.**

Effect of interaction between variety and levels of nitrogen on growth parameters

Effect of interaction between variety and nitrogen rates on plant height, number of total tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, panicle length, sterile spikelets $panicle^{-1}$, thousand grain weight were not significant but number of grains $panicle^{-1}$, grain yield, straw yield , biological yield, harvest index (%) were significant (Table 1). Chamely *et al.* (2015) and Hossain *et al.* (2018) disclosed that number of grains $panicle^{-1}$, grain yield and straw yield of rice were significantly affected by the interaction of variety and level of nitrogen. Numerically the highest plant height (103.75 cm) was recorded from the treatment combination BRRI dhan29 with 120 kg N ha^{-1}. The shortest plant height (94.05 cm) was recorded from the treatment combination BRRI dhan28 with 0 kg N ha^{-1} (Table 3)**.** The highest number of total tillers $hill^{-1}$ (18.28) was found in BRRI dhan29 with 120 kg N ha^{-1} and the lowest number (11.65) were produced by BRRI dhan29 with 0 kg N ha^{-1} (Table 3)**.** The highest number of effective tillers $hill^{-1}$ (15.30) was obtained from treatment combination BRRI dhan29 with 120 kg N ha^{-1}. The lowest number of effective tillers $hill^{-1}$ (6.53) was obtained from BRRI dhan29 in control treatment (Table 3)**.** Numerically highest number of non-effective tillers $hill^{-1}$ (5.49) was obtained from the treatment combination Surjomoni with 0 kg N ha^{-1}. The lowest number of non-effective tillers $hill^{-1}$ (2.98) was found in BRRI dhan29 with 120 kg N ha^{-1}. However, numerically the longest panicle length (25.77 cm) was found in BRRI dhan29 with 120 kg N ha^{-1} and the shortest panicle length (23.32cm) was found in Surjomoni with 0 kg N ha^{-1} (Table 3)**.** The highest number of grains $panicle^{-1}$ (144.68) was found in BRRI dhan29 with 120 kg N ha^{-1} treatment combination and the minimum number (90.90) in Surjomoni with controlled treatment. Higher number of grains per panicle at higher nitrogen rate might be due to higher nitrogen absorption which favored formation of higher number of branches per panicle (Rahman *et al*., 2007)**.** However, the highest number of sterile spikelets $panicle^{-1}$ (31.37) obtained from Surjomoni with 0 kg N ha^{-1}. The lowest number (20.34) obtained from the combination BRRI dhan29 with 0 kg N ha^{-1} (Table 3)**.** The highest weight of 1000 grains (25.98 g) was found in BRRI dhan28 with 120 kg N ha^{-1} and in BRRI dhan29 with 120 kg N ha^{-1} treatment combination whereas the lowest 1000 grain weight (24.01g) was found in BRRI dhan29 with 0 kg N ha^{-1}. It can be seen that the highest grain yield (4.60 t ha^{-1}) was obtained from BRRI dhan29 with 120 kg N ha^{-1}. The lowest grain yield (2.40t ha^{-1}) was obtained from Surjomoni with 0 kg N ha^{-1}(Table 3)**.** On the other hand, BRRI dhan 29 showed highest grain production using 150 kg N/ha which is confirmed with the findings of (Ray *et al*., 2018; Osmel *et al*., 2020). As a result, the study revealed optimum use of nitrogen level influences all the parameters of different rice varieties as well as productivity. It can be seen that numerically highest straw yield (5.81t ha^{-1}) was obtained from the treatment combination BRRI dhan29 with 180 kg N ha^{-1} and the lowest straw yield (4.05 t ha^{-1}) was obtained from BRRI dhan28 with 0 kg N ha^{-1} (Table 3)**.** The highest biological yield (10.34 t ha^{-1}) was obtained from the treatment combination BRRI dhan29 with 120 kg N ha^{-1} and the lowest biological yield (6.53 t ha^{-1}) was obtained from Surjomoni with 0 kg N ha^{-1} (Table 3)**.** Numerically highest harvest index (44.49%) was obtained from BRRI dhan29 with 120 kg N ha^{-1} treatment combination. The lowest (36.75%) was obtained from Surjomoni with 0 kg N ha^{-1}

treatment combination (Table 3)**.** Variety-specific N fertilization is the best N management practice to maximize rice yield avoiding the excess use of N fertilizer. The optimum N rates for maximum yield also differed with rice varieties and growing seasons indicating that N fertilization should be based on considering rice cultivar and climatic conditions Jahan *et al.* 2022.

CONCLUSION

Boro rice varieties exerted a significant effect on yields and plant characters except for plant height, 1000-grain weight and panicle length. The highest number of total tillers hill^{-1} (16.49), effective tillers hill^{-1} (11.86), grains panicle^{-1} (133.06), grain yield (4.09 t ha^{-1}) and biological yield (9.45 t ha^{-1}) were found from BRRI dhan29. The highest harvest index (43.06%) and highest straw yield (5.35 t ha^{-1}) were also recorded from the same variety. On the other hand, the lowest number of total tillers hill^{-1} (13.41), effective tillers hill^{-1} (8.82), grains panicle^{-1} (110.46), grain yield (3.07 t ha^{-1}), biological yield (7.75 t ha^{-1}) and harvest index (39.33 %) were recorded from the variety Surjomoni. Levels of nitrogen had a significant effect on yield and plant characteristics of *Boro* rice except for 1000-grain weight. The highest plant height (100.23cm), number of total tillers hill^{-1} (16.87), effective tillers hill^{-1} (13.76), grains panicle^{-1} (136.63), grain yield (4.23 t ha^{-1}), biological yield (9.56 t ha^{-1}) and harvest index (44.11 %) were recorded from nitrogen dose 120 kg N ha^{-1}. The lowest plant height (68.84 cm) was recorded from controlled plot (0 kg N ha^{-1}). The lowest number of grains panicle^{-1} (110.31), lowest grain yield (2.76 t ha^{-1}), lowest biological yield (6.97 t ha^{-1} and lowest harvest index (39.60 %) were recorded from controlled plot. The interaction effect between variety and levels of nitrogen were found significant except on plant height, number of total tillers hill^{-1}, number of effective tillers hill^{-1}, number of non-effective tillers hill^{-1}, panicle length, number of sterile spikelets panicle^{-1} and 1000-grain weight. The highest number of grains panicle^{-1} (144.68), grain yield (4.23 t ha^{-1}) and biological yield (10.83 t ha^{-1}) were recorded from BRRI dhan29 wth 120 kg N ha^{-1}. The lowest number of grains panicle^{-1} (90.90), grain yield (2.40 t ha^{-1}), straw yield (4.13 t ha^{-1}) and biological yield (6.53 t ha^{-1}) were recorded from the combination of Surjomoni with 0 kg N ha^{-1}. Based on the result of the study, it can be suggested that *Boro* rice variety cv. BRRI dhan29 should be fertilized with 120 kg N ha^{-1} for having maximum yield. After certain period maximization of the levels of nitrogen only results in lowering the yield and ROI (Return on Investment), minimization of the levels of nitrogen also undoubtedly reduces the yield and ROI. So, *Boro* rice cv. BRRI dhan29 with 120 kg N ha^{-1} might be the best treatment for producing profitable crop under Old Brahmaputra Floodplain (AEZ-9). However, further study may be suggested for drawing the final recommendation.

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CONFLICT OF INTEREST

Author has declared that no competing interest exists.

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