Evaluation of growth and yield attributing characteristics of indigenous Boro rice varieties

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Abstract: A field experiment was conducted to evaluate the growth, yield and yield attributing characteristics of 12 indigenous *Boro* rice varieties collected from South-Western regions of Bangladesh namely; Nayon moni, Tere bale, Bere ratna, Ashan boro, Kajol lata, Koijore, Kali boro, Bapoy, Latai balam, Choite boro, GS one and Sylhety boro. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. Parameters on, growth parameter *viz.* plant height and number of tillers hill^{-1}(at different days after transplanting); yield contributing characters such as effective tillers hill^{-1}, panicle length, number of grains panicle^{-1}, filled grains panicle^{-1}, thousand grain weight, grain yield, straw yield, biological yield and harvest index were recorded. The plant height and number of tillers hill^{-1} at different days after transplanting varied significantly among the varieties up to harvest. At harvest, the tallest plant (123.80 cm) was recorded in Bapoy and the shortest (81.13 cm) was found in GS one. The maximum number of tillers hill^{-1} (46.00) was observed in Sylhety boro and the minimum (19.80) in Bere ratna. All of the parameters of yield and yield contributing characters differed significantly at 1% level except grain yield, biological yield and harvest index. The maximum number of effective tillers hill^{-1} (43.87) was recorded in the variety Sylhety boro while Bere ratna produced the lowest effective tillers hill^{-1} (17.73). The highest (110.57) and the lowest (42.13) number of filled grains panicle^{-1} was observed in the variety Koijore and Sylhety boro, respectively. Thousand grain weight was the highest (26.35g) in Kali boro and the lowest (17.83g) in GS one. Grain did not differ significantly among the varieties but numerically the highest grain yield (5.01 t ha^{-1}) was found in the variety Koijore and the lowest in GS one (3.17 t ha^{-1}).

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1. Introduction

Rice (*Oryza sativa* L.) is life for more than 60% of the world's population and one of the most potential grain crops that could contribute to the efforts for the realization of food security (Gebrekidan and Seyoum, 2006). Rice cultivation is the principal activity and source of income for millions of households around the globe (FAO, 2009). Bangladesh is an agro-based country where agriculture is the single largest sector and the main stay of the country's economy. Agriculture in Bangladesh is predominated by intensive rice cultivation and about 80% of the total arable lands are used for rice (aus, aman and boro) cultivation (BBS, 2002). Nevertheless, the national average yield of rice in Bangladesh (2.77 t ha^{-1}) is lower than other rice growing countries of Asia such as, China, Taiwan, Indonesia and Japan (5.72, 4.60, 4.38, and 5.97 t ha^{-1}, respectively) (Quayum *et al.,* 1996). In Bangladesh, the area under rice cultivation was 470,6875 hectares in *Boro* season in 2009-2010, which produced 180,58962 MTs (metric tonnes) of grains with an average yield of 3.837 MTs (BBS, 2010). With the expansive culture of modern varieties, the number of traditional rice cultivars has significantly reduced. The promotion of high yielding variety (HYV) rice mono-culture has led to loss of diversity including 7000 traditional rice varieties (Singh *et al.,* 2000). Now a days, cultivation of modern rice varieties is under threat due to abiotic stresses such as salinity, drought, pests, flash flood etc. Rice scientists have been giving effort to develop stress tolerant rice varieties. There are thousands of local rice varieties in our country which are well adapted to various stress situations. The local rice varieties are usually said poor yielder but they are superior to modern varieties in terms of resilience and resistance to biotic and abiotic factors, quality characters, etc. A number of reports showed that indigenous rice cultivars from Bangladesh possess a wide diversity in ecological, morphological and physiological characteristics (Bhowmik *et al.,* 2000; Islam, 1990; Jahan, 2003). It was also reported that a number of local rice varieties, if managed efficiently, would potentially produce high yield (Jahan, 2003).

Hence, the present study was undertaken to evaluate the growth and yield performance of local Boro rice varieties.

2. Material and Methods

A field experiment was conducted at Dr. Purnendu Gain Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna, Bangladesh during the period from November 2011 to May 2012. The experimental field is situated in the Agro ecological Zones (AEZ) 13, i.e., Gangetic Tidal Floodplain. The geographical situation of the experimental field is at latitude of $22^{0}47^{'}$ N and longitude of $89^{0}34^{'}$ E having subtropical climate characterized by moderately high temperature and heavy rainfall during *Kharif* Season (March to October) and low rainfall and low temperature during the *Robi* Season (November to February). The experimental field was a typical rice highland growing medium of black coloured clay-loam with slightly alkalic (pH 8.0). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The selected field was firstly divided into three equal blocks and each block was further divided into twelve unit plots. The size of each unit plot was 10 m^2 (4 m x 2.5 m). The total number of plots was thirty six. All blocks were separated by a 1.0 m buffer-zone (non cultivated area) and a 50 cm gap was set up between each plot.. In this research work twelve local *Boro* rice varieties were included *viz.* Nayon moni, Tere bale, Bere ratna, Ashan boro, Kajol lata, Koijore, Kali boro, Bapoy, Latai balam, Choite boro , GS one and Sylhety boro. Pre germinated seeds were sown in the wet seedbed during *Boro* season on 26th November, 2011. Transplanting was done with three seedlings $hill^{-1}$ maintaining 20 cm hill to hill and 25 cm line to line spacing on 16th January, 2012. The experimental location was uniformly fertilized with urea, TSP (Triple Super Phosphate), MoP (Muriate of Potash), gypsum and zinc sulphate at 110, 60, 45, 30 and 10 kg ha^{-1} respectively. The total TSP, MoP, gypsum, zinc sulphate and one third of urea were applied as basal dose. The rest of the urea was applied at two equal split doses at 30 days after transplanting (DAT) and at 50 DAT. Two hand weeding were done to check weed infestation in the experimental field at 25 DAT and 40 DAT. The experimental field was irrigated regularly up to dough stage depending upon the moisture content of the field and flood irrigation method was practiced. During the experimentation, common rice insect pests such as grass hopper, stem borer, rice bug and nematode were found to infest the crop. Write the active ingredient (Semcup 50 EC) @ 1L ha^{-1} was applied to control grass hopper, stem borer, and rice bug, while nematode was controlled by application of active ingredient (Furadan 5G) @ 10 kg ha^{-1}. Nayonmoni, Ashan boro, Kajol lata, Bapoy, Latai balam and Choite boro were harvested on 23rd April, 2012 and GS one, Bere ratna, Kali boro were harvested on 2nd May 2012 & Koijore, Sylhety boro, Tere bale were also harvested on 5th May 2012. Data were recorded on growth parameters (at 50, 65 and 80 day after transplanting) and yield parameters at final harvest. All the collected data were analyzed following the Analysis of Variance (ANOVA) and differences between means were adjudged by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using a computer operated program MSTAT-C (Version 2.6).

3. Results and Discussion

Rice plant height

Table 1. Plant height of local *boro* rice varieties at different days after transplanting

Variety	Plant height (cm) at			
	50 DAT	65 DAT	80 DAT	Harvest
Nayonmoni	62.06bc	75.00d-g	104.73bc	111.40bc
Tere bale	51.13cd	63.00f-h	79.00ef	86.00fg
Bere ratna	67.93ab	78.80c-e	95.20cd	97.60de
Ashan boro	62.80bc	73.33e-h	88.20de	92.13ef
Kajol lata	71.26ab	91.13bc	103.86bc	108.67bc
GS one	47.26d	59.20h	70.93f	81.13g
Koijore	49.00d	61.20gh	76.06f	91.33e-g
Kali boro	61.93bc	76.86c-f	108.53ab	114.87ab
Bapoy	68.80ab	88.26bcd	116.20a	123.80a
Latai balam	67.93ab	95.33b	110.13ab	117.20ab
Choite boro	77.33a	110.00a	117.73a	122.93a
Sylhety boro	51.53cd	62.06gh	95.46cd	103.47cd
Level of significance	0.01	0.01	0.01	0.01
CV (%)	8.19	7.82	4.73	4.33

In a column figures having similar letter(s) did not differ significantly where as dissimilar letter(s) differed significantly and DAT = Days after transplanting.

Plant height is one of the important growth parameters of any crop as it determines or modifies yield contributing characteristics and finally shapes the grain yield (Reddy and Redd, 1997). Variation in plant height among the varieties might be due to the differences in their genetic makeup. Plant height among all varieties increased progressively, and differed significantly, reaching a maximum at harvest (Table 1). At the growth stage 50 DAT, 65 DAT and at 80 DAT the variety Choite boro produced the highest plant height (77.33 cm, 110.0 cm and 117.73 cm respectively), whereas the variety Bapoy produced the highest plant height (123.80 cm) at harvest. On the other hand at 50 DAT the shortest plant height (49 cm) was observed in the variety Koijore and at 65 DAT, 80 DAT and at harvest the variety GS one produced the shortest plant height (49.2 cm, 70.93 cm and 81.14 cm respectively). This result was in consistent to those of Khatun (2001) and Das *et al*. (2012) who observed variable plant height among the rice varieties.

Number of tillers per hill

Tiller numbers in most of the treatments increased exponentially up to harvest (Table 2). Variety had significant effect on effective tillers hill^{-1} (Table 3). The maximum number of tillers hill^{-1} (46.13) was recorded in the variety Sylhety boro followed by Nayon moni (33.00). The minimum number of tillers (18.13) was observed in the variety Koijore.

Table 2. Number of tillers hill^{-1} of local *Boro* rice varieties at different days after transplanting

Variety	Number of tillers hill^{-1} at			
	50 DAT	65 DAT	80 DAT	Harvest
Nayon moni	20.36abc	25.66b	29.66 bc	33.00b
Tere bale	12.66c	21.87bc	31.26b	29.80bc
Bere ratna	15.00bc	16.60c	19.13de	19.80e
Ashan boro	17.00abc	19.86bc	20.40cde	22.07de
Kajol lata	19.66abc	23.86bc	24.73b-e	29.60bc
GS One	18.46abc	24.26bc	23.40b-e	24.47cde
Koijore	23.93a	20.53bc	18.13e	20.40e
Kali boro	22.20ab	26.26b	27.26b-e	29.13bc
Bapoy	19.20abc	27.00b	28.20bcd	29.93bc
Latai balam	20.86abc	22.33bc	23.80b-e	25.60cd
Choite boro	25.00a	23.33bc	27.00b-e	27.27bcd
Sylhety boro	25.40a	36.33a	46.13a	46.00a
Level of significance	0.05	0.01	0.01	0.01
CV (%)	22.34	13.33	14.68	9.12

In a column figures having similar letter(s) did not differ significantly where as dissimilar letter(s) differed significantly and DAT = Days after transplanting

The highest number of effective tillers hill^{-1} (43.87) was produced by Sylhety boro. The lowest number of effective tiller hill^{-1} (17.73) was observed in Bere ratna which was preceded by Kaijore and Ashan boro. The reason of difference in number of effective tiller hill^{-1} is the variation in the genetic makeup of the variety. Similar result was also reported by Ramasamy *et al*. (1987) who stated that number of tillers hill^{-1} differed due to varietal variation. Tillering ability plays a vital role in determining rice grain yield. Too few tillers result fewer panicle, but excessive tillers enhance high tiller mortality, small panicle, poor grain filling and consequent reduction in grain yield (Peng *et al*., 1994). Among the various yield components productive tillers are very important as the final yield is mainly a function of the number of panicles bearing tillers per unit area.

Panicle length

Increasing panicle length and plant height might have increased grain yield of rice indirectly by increasing the number of spikelet's per panicle and panicle length, respectively (Behera, 1998). The highest panicle length (21.62 cm) was recorded in the variety Bapoy which was followed by the variety Kajol lata and Bere ratna. The lowest panicle length (15.13 cm) was found with the variety Sylhety boro which was preceded by Nayon moni, GS one, Kali boro and Choite boro (Table 3.a). Similar results were also recorded by Idris and Matin (1990) and Anonymous (1993) who reported that panicle length influenced by variety.

Number grains/spikelet's per panicle

The number of grains panicle^{-1} was the highest (132.80) with the variety Koijore which was statistically identical with Bere ratna and GS one. The lowest number of grains panicle^{-1} (45.32) was recorded with the variety Kali boro which was statistically identical with Nayon moni and Latai balam (Table 3.a).

The results revealed that number of filled grains panicle^{-1} was the highest (110.57) with the variety Koijore which was statistically identical with Bere ratna. The lowest number of filled grains panicle^{-1} (40.52) was recorded in the variety Kali boro which was statistically similar to Sylhety boro (Table 3.b). The results were also supported by Singh and Gangwer (1989) who opined that varietal differences regarding the number of filled grains panicle^{-1} might be due to their differences in genetic constituents.

Thousand grain weight (g)

Thousand-grain weight, an important yield-determining component, is a genetic character least influenced by environment (Ashraf *et al.,* 1999). Among the tested varieties the highest 1000-grain weight (26.35 g) was produced by Kali boro which might be due to its larger grain size and that was statistically similar to Nayon moni and Latai balam. The lowest 1000-grain weight (17.83 g) was found in GS one for its smaller grain size which was statistically similar to Koijore (Table 3.b). Similar results were reported by Gupta and Sharma (1991).

Grain yield (t/ha)

The highest grain yield (5.01 t ha^{-1}) was recorded in Koijore which might be due to its highest number of filed grains panicle^{-1} and the lowest grain yield (3.17 t ha^{-1}) was found in GS one (Figure 1). Results showed that the grain yield did not vary significantly among the varieties but varied numerically. Grain yield is a function of interplay of various yield components such as number of productive tillers, spikelets per panicle and thousand grain weights (Hassan *et. al.,* 2003).

Straw yield (t/ha)

Varieties differed significantly in their straw yield (Figure 1). The highest straw yield (5.44 t ha^{-1}) was obtained from the variety Sylhety boro which might be due to its highest number of tillers $hill^{-1}$. The lowest straw yield (2.77 t ha^{-1}) was observed in the Kajol lata. The result was supported by Hossain (2002).

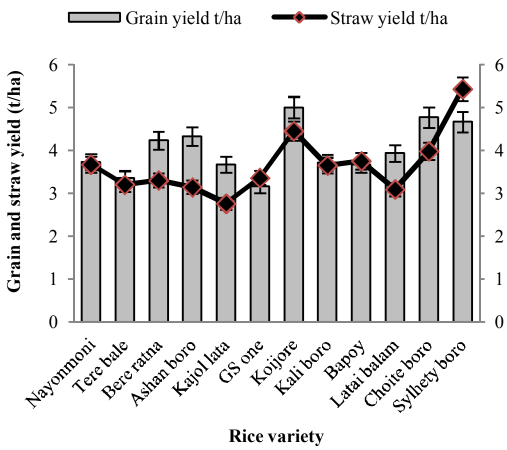

Figure 1. Grain and straw yield of different rice varieties

Table 3(a). Yield and yield contributing characters of different indigenous Boro rice varieties

Variety	No. of effective tiller hil^{-1}	Panicle length (cm)	No. of grains $panicle^{-1}$
Nayonmoni	30.73b	17.71c	53.77e
Tere bale	27.13bc	19.11bc	74.01cde
Bere ratna	17.73f	20.22ab	113.17ab
Ashan boro	20.00def	18.82bc	96.57bc
Kajol lata	26.13bcd	21.54a	88.17bcd
GS one	22.00c-f	18.32c	108.95ab
Koijore	18.00ef	18.58bc	132.80a
Kali boro	27.13bc	17.66c	45.32e
Bapoy	27.06bc	21.62a	86.75bcd
Latai balam	23.60c-f	18.26c	55.81e
Choite boro	24.53b-e	18.34c	62.81de
Sylhety boro	43.87a	15.13d	47.69e
CV (%)	10.61	3.98	14.59
Level of significance	0.01	0.01	0.01

In a column figures having similar letter(s) did not differ significantly where as dissimilar letter(s) differed significantly, NS = Not significant

Biological yield (t/ha)

Biological yield did not vary significantly among the varieties (Table 3). However, numerically the highest biological yield (10.11 t ha^{-1}) was obtained from the variety Sylhety boro. The lowest biological yield (6.45 t ha^{-1}) was found in the Kajol lata. These results are in agreement with the results of Sohel *et al.* (2009).

Table 3(b). Yield and yield contributing characters of different indigenous Boro rice varieties

Variety	No. of filled grains $panicle^{-1}$	1000 grain wt. (g)	Biological yield (t ha^{-1})	Harvest index (%)
Nayonmoni	46.51de	26.28a	7.42cd	50.08
Tere bale	61.36cde	20.92cd	6.57de	51.26
Bere ratna	97.42ab	22.02bc	7.55bc	55.68
Ashan boro	83.29bc	21.86bc	7.49bc	57.52
Kajol lata	74.96bc	24.80ab	6.45f	56.74
GS one	83.36bc	17.83e	6.77de	51.48
Koijore	110.57a	18.88de	9.47ab	53.01
Kali boro	40.52e	26.35a	7.39cd	49.85
Bapoy	66.69cd	24.34ab	7.43cd	49.38
Latai balam	49.17de	25.74a	7.04d	56.13
Choite boro	48.64de	24.34ab	8.77b	54.52
Sylhety boro	42.13e	24.19ab	10.11a	46.07
CV (%)	14.44	5.50	18.28	8.36
Level of significance	0.01	0.01	NS	NS

In a column figures having similar letter(s) did not differ significantly where as dissimilar letter(s) differed significantly, NS = Not significant

Harvest index (%)

Varieties did not follow any regular trend in case of harvest index and did not vary significantly (Table 3). However, numerically the highest harvest index (57.52%) was recorded from the variety Ashan boro and that of the lowest (46.07%) was recorded in Sylhety boro. The result was supported by Sohel *et al.* (2009).

Conclusions

From the findings of the study it can be concluded that among the studied local aman rice varieties in southwest region of the country some varieties have high yield potentiality, such as Koijore ($5.01tha^{-1}$), Choite boro, Sylhety boro, Ashan boro, Bere ratna (> $4.0tha^{-1}$) which are comparable to modern varieties. Other varieties have moderate yield (> $3.0tha^{-1}$). Moreover these varieties are well adapted to the agro-ecology of this region. So, farmers can cultivate these local varieties instead of modern varieties without significant yield loss.

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