Progressive Agriculture 30 (2): 186-193, 2019 **ISSN: 1017 - 8139**

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

Performance of hybrid Boro rice in coastal area of Bangladesh

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Abstract

The present experiment was conducted at the research field of Patuakhali Science and Technology University (PSTU), Patuakhali to evaluate the Performance of hybrid boro rice (genotypes) in coastal area of Bangladesh. The experiment consisted of five rice varieties as treatment such as *Arize Tej*, *Tea Sakti*, *Shathi* and BRRI Dhan 28. Data were collected on morphological characters such as plant height, number of leaves plant^{-1} and leaf area hill^{-1}, growth characters such as leaf area index (LAI), crop growth rate (CGR) and relative growth rate (RGR), yield and yield components such as number of effective tillers hill^{-1},number of non effective tillers hill^{-1}, panicle length, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, 1000 grain weight, grain yield, straw yield, biological yield and harvest index (%) were recorded. The experiment was laid out in a completely randomized block design (RCBD) with three replications. The collected data were analyzed statistically and means were adjudged by DMRT at 5% level of probability. Among the five varieties the *Arize Tej* gave the highest performance. From the above investigated results, it was observed that the *Arize Tej* was the most efficient for better growth and higher yield of hybrid boro rice genotypes grown in coastal area of Bangladesh.

Key words: Performance, hybrid *Boro* rice, coastal area, Bangladesh

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Introduction

Rice (*Oryza sativa* L.) is the dominant food crop in Bangladesh. Bangladesh ranks 3rd position in rice growing area and 4th position in production among rice growing countries of the world (FAO 2008). In Bangladesh among cereals, the primary position is occupied by rice with about 80 percent of the total arable land is dedicated to rice cultivation (BBS 2014). Integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility (Tilahun *et al.,* 2013).

In Bangladesh, rice scientists from Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) developed many modern rice cultivars. Many suitably adapted modern rice cultivars have been in cultivation from many years by farmers in Bangladesh and had a tremendous impact on rice production. Those cultivars released by BRRI and BINA still could not replace the local cultivars totally. As these cultivars have been under production since long time, there should be a strategy to increase their productive potentials through genetic manipulation. It is also essential to know the morphological and physiological limitations which actually denote genetic expression under a certain environmental and micro climatic condition. The present study was to find out the most suitable variety regarding to morpho-physiological and yield attributing characters of some boro rice varieties under the agro-ecological zone-13 or salinity affected area of Patuakhali region. In

Bangladesh, among the various factors limiting rice yield, salinity is one of the oldest and most serious environmental problems in the world (Mcwilliam, 1986). The rice production is also hampered due to variation of rainfall and temperature patterns (Rokonuzzaman *et al*., 2018). Moreover salinity causes secondary limitation of other physiological process of crop plant. Around the world, 100 million ha, or 5% of arable land, is adversely affected by high salt concentrations, which reduce crop growth and yield (Gunes *et al.,* 2007). In Bangladesh, over thirty percent of the net cultivable area is in the coastal area. Out of 2.85 million hectare of the coastal and off-shore areas, about 0.833 million hectares are arable lands, which constitute about 52.8 percent of the net cultivable area in 64 thanas of 13 districts (Karim *et al.*, 1990). However, from the above discussion, the present study was carried out on the study the growth performance of five hybrid boro rice genotypes in coastal region of Bangladesh.

Materials and Methods

An experiment was conducted at the research farm of Patuakhali Science and Technology University, Patuakhali during the period from December, 2011 to May, 2012. The research farm is located at $22^0 37'$ N latitude and $89^0 10'$ E longitudes. The area is covered by Gangetic Tidal Floodplains and falls under Agroecological Zone "AEZ–13". The area lies at 0.9 to 2.1 meter above mean sea level (Iftekhar and Islam, 2004). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experiment consisted of five rice varieties as treatment such as Arize Tej, Tea, Sakti, Shathi and BRRI Dhan 28. The urea, triple super phosphate (TSP), muriate of potash (MP) fertilizers were applied in the experimental plots at the rate of 86, 135, 65 kg ha^{-1}, respectively. The entire amount of triple super phosphate, muriate of potash were broadcast and incorporated into the soil at final land preparation. Whole urea was applied in three equal splits at 15 days after transplanting, active tillering and panicle initiation stages (FGR, 2012). The seedling of boro rice was transplanted in the research field on January 05, 2012. The distances between row to row and plant to plant were 20 and 15 cm, respectively. Morphological characters such as plant height, number of leaves $plant^{-1}$ and leaf area $hill^{-1}$, growth characters such as leaf area index (LAI), crop growth rate (CGR) and relative growth rate (RGR), yield and yield components such as number of effective tillers $hill^{-1}$,number of non effective tillers $hill^{-1}$, panicle length, number of filled grains $panicle^{-1}$, number of unfilled grains $panicle^{-1}$, 1000 grain weight, grain yield, straw yield, biological yield and harvest index (%) were recorded. The crop growth rate values at different growth stages were calculated using the following formula:

$$LAI = \frac{LA}{P}$$

$$CGR = \frac{1}{GA} \times \frac{W_2 - W_1}{T_2 - T_1} \text{ mgcm}^{-2}\text{day}^{-1}$$

$$RGR = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} \text{ mgcm}^{-2}\text{day}^{-1},$$

Leaf area=Length of leaf (cm)×Width of leaf (cm),

Biological yield=Grain yield+Straw yield,

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100.$$

Where, LA=leaf area (cm^2), P=ground area, W_1=Total dry matter production at previous sampling date, W_2= Total dry matter production at current sampling date, T_1=Date of previous sampling, T_2=Date of current sampling, GA=Ground area (m^2), Log_e=Natural logarithm. The data obtained from experiment on various parameters were statistically analyzed in MSTAT–C computer program (Russel, 1986). The mean values for all the parameters were calculate and the analysis of variance for the characters was accomplished by Duncan's Multiple Range Test (DMRT) and the significance of difference between pair of means was tested by the Least Significant

Differences (LSD) test at 5% levels of probability (Gomez and Gomez, 1984).

Results and Discussion

Responses of different boro rice varieties on the morphological characteristics

Plant height: Plant height was recorded at 60, 70, 90 DAT and at harvest which was significantly affected among the varieties (Table 1). It was observed that plant height increased progressively with the advancement of time and growth stages. At 60 days after transplanting, the tallest plant was recorded in Arize Tej (73.57 cm) followed by the variety Shathi (71.40 cm). The shortest plant was recorded from the check variety BRRI dhan-28 (59.25 cm). In contrast, the variety Arize Tej also recorded the tallest plant (93.94 cm) at 75 DAT while the variety BRRI dhan-28 noticed the shortest plant (70.13 cm). On the other hand, the tallest plant (111.393 cm) was found in Arize Tej, which was statistically similar (107.66 cm) with the variety Shathi and the shortest plant (94.81 cm) was found from the check variety BRRI dhan-28 at 90 DAT. At final harvest, Arize Tej had the highest plant height (117.83 cm) followed by the variety shathi (112.80 cm) while check variety BRRI dhan-28 recorded the shortest plant (101.43 cm). These results revealed that, the variation in plant height due to the variation in genetic variability. Similar findings were also obtained by Zubaer *et al*. (2010) who found that the variation in plant height among the genotypes which was due to their different genetic makeup. Similar findings were also obtained by Uddin *et al*. (2010), Hossain *et al*. (2005), Ashrafuzzaman *et al*. (2009) and many other scientists.

***Number of leaves hill^{-1}*:** Significant difference in number of leaves hill^{-1} was found due to the effect of rice varieties at different days after transplanting (Table 1). At 60 DAT, the maximum number of leaves plant^{-1} (84.93) was found in Arize Tej which was statistically differed among other varieties and the minimum number of leaves plant^{-1} (67.73) was found in BRRI dhan-28. Similar trend were also observed at 75, 90 DAT and at harvest. However, the maximum production of leaves plant^{-1} (101.93) was obtained by the variety Arize Tej at 90 DAT where BRRI dhan produced the minimum leaves plant^{-1} (85.80). So, the maximum leaves production was attaining at the stage of 90 DAT. These results revealed that Arize Tej produced the maximum number of leaves and BRRI dhan-28 produced the minimum number of leaves and also indicated that number of leaves increase up to 90 DAT and then declined at harvest due to the full maturity stages. The greater number of leaves gave the higher photosynthesis which will ultimately result the higher yield.

Table1. Performance of different boro rice varieties on plant height and number of leaf plant^{-1}.

Varieties	Plant height(cm)				Number of leaves plant $^{-1}$			
	60	75	90	Harvest	60	75	90	Harvest
Arize Tej	73.57 a	93.94 a	111.39 a	117.83 a	84.9 a	94.2 a	101.9 a	99.0 a
Tea	65.3 b	78.6 b	95.3bc	106.2b	74.3 bc	82.9 d	91.1 c	86.9 d
Sakti	66.4b	79.4b	98.5 b	107.6b	76.9 b	86.9 c	93.7 c	90.4 c
Shathi	71.14 a	82.6b	107.6 a	112.8 a	71.9 c	90.0 b	98.9 b	94.9 b
BRRI dhan-28	59.25 c	70.13 d	94.81 c	101.43 c	67.7 d	78.8 e	85.8 d	81.9 e
CV%	3.52	4.32	3.65	2.44	4.53	2.48	2.41	2.66
Sig. level	**	**	**	**	**	**	**	**

**=Significant at 1% level of probability and *=Significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%

***Leaf area hill^{-1}*:** The leaf area (LA) of rice plants was significantly affected by different rice varieties during the data recording stage (Table 2). The Table 2, indicated that the highest LA (1597.36 cm^2) was observed in Arize Tej which was closely followed by Shathi (1515.27 cm^2) at 60 DAT while BRRI dhan-28 recorded the lowest LA (1270.84 cm^2), which was also closely followed by Sakti (1354.98 cm^2). At 75 DAT, the highest LA hill^{-1} was produced by Arize Tej (2328.15 cm^2) that was significantly different with other varieties and the both variety BRRI dhan-28 and Sakti produced statistically similar and lower LA hill^{-1} at all growth stages (1694.15 and 1773.94 cm^2, respectively). The highest LA hill^{-1} (2657.00 and 2479.25 cm^2) was recorded from the variety Arize Tej which was statistically similar with Shathi (2551.97 and 2426.38 cm^2) at 90 DAT and at harvest, respectively whereas, the lowest LA hill^{-1} (2275.68 and 2039.21 cm^2) was noticed in BRRI dhan-28 which was also statistically close with Sakti (2346.58 and 2117.00 cm^2, respectively). The result obtained from the present study is consistent with the result of Zubaer *et al*. (2010). Similar study was also found by Sharma and Haloi (2001) in aromatic rice, who stated that variation in LA could be attributed to the changes in number of leaves.

***Leaf area index*:** Significant difference in leaf area index (LAI) was observed due to the effect of different rice varieties at different days after transplanting (Table 2). At 60 and 75 DAT, the maximum LAI was observed in Arize Tej (5.32, 7.76, respectively) followed by Shathi (5.05 and 7.02, respectively) and the minimum LAI was found in BRRI dhan-28 (4.24 and 5.65, respectively) whereas LAI were statistically differed among the varieties. At 90 DAT, the highest LAI was taken from the variety Arize Tej (8.86) and it was closely followed by Shathi (8.51) and the lowest LAI was found in BRRI dhan-28 (7.59). Similar result was also obtained by Baset Mia and Shamsuddin (2011). They found that among the varieties LAI increased progressively from tillering to panicle initiation stage and thereafter declined after flowering.

Table 2. Performance of different boro rice varieties on leaf area (plant^{-1}) and leaf area index (LAI).

Varieties	Leaf area (plant^{-1})				Leaf area index (LAI)			
	60	75	90	Harvest	60	75	90	Harvest
Arize Tej	1597.4 a	2328.2 a	2657.0 a	2479.3 a	5.32 a	7.76 a	8.86 a	8.26 a
Tea	1429.9 bc	1914.7 c	2431.5 b	2198.2 b	4.77 c	6.38 c	8.11 bc	7.33 b
Sakti	1354.9 cd	1773.9d	2346.6 bc	2117.0 bc	4.52 d	5.91 d	7.82 cd	7.06 c
Shathi	1515.3 ab	2104.7 b	2551.9 a	2426.4 a	5.05 b	7.02 b	8.51 ab	8.09 a
BRRI dhan-28	1270.8 d	1694.2 d	2275.7 c	2039.2 c	4.24 e	5.65 e	7.59 d	6.80 d
CV%	4.53	2.48	2.41	2.66	1.08	1.11	2.94	1.46
Sig. level	**	**	**	**	**	**	**	**

**=Significant at 1% level of probability and *=Significant at 5% level of probability. Figures followed by same letter(s) are statistically similar as per DMRT at 5%

***Relative growth rate (RGR)*:** The RGR showed the highest value at the stage between 60-75 DAT followed by a decline at the stage between 75-90 DAT (Table 3). The result revealed that the variety Arize Tej produced the highest RGR value (1.021 g cm^{-2} day^{-1}) at 60-75 DAT which was statistically differed with other varieties and the lowest RGR (0.745 g cm^{-2} day^{-1}) was found in BRRI dhan-28. At 75-90 DAT, the highest RGR was found in Arize Tej (0.995 g cm^{-2} day^{-1}) and the lowest RGR value was found in BRRI dhan-28

(0.579 g cm^{-2} day^{-1}) which was statistically similar with Tea (0.620 g cm^{-2} day^{-1}) and Sakti (0.626 g cm^{-2} day^{-1}). The results of the present study are in agreement with the results of Aktar (2005) in rice, who stated that the maximum RGR was observed during the vegetative stage and declined rapidly with the advancement of growth stages.

Table 3. Performance of different boro rice varieties on the Crop growth rate (CGR) and Relative growth rate (RGR) at different days after transplanting (DAT).

Varieties	Crop growth rate CGR (g m^{-2} day^{-1}) at different growth stages		RGR (g g^{-2} day^{-1}) at different growth stages	
	60-75	75-90	60-75	75-90
Arize Tej	0.340 a	0.331 a	1.021 a	0.995 a
Tea	0.299 ab	0.207 b	0.898 b	0.620 c
Sakti	0.262 b	0.208 b	0.787 c	0.626 c
Shathi	0.309 ab	0.299 a	0.927 b	0.897 b
BRRI dhan-28	0.248 b	0.193 b	0.745 c	0.579 c
CV%	3.43	5.63	4.12	1.77
Sig. level	**	**	**	**

**=Significant at 1% level of probability and *=Significant at 5% level of probability; Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Responses of different boro rice varieties on yield and yield contributing parameters

***Number of effective tillers hill^{-1}*:** Number of effective tillers $hill^{-1}$ had shown significant difference amongst the studied varieties (Table 4). The highest number of effective tillers $hill^{-1}$ (16.80) was recorded in Arize Tej followed by Shathi (16.20) and the lowest number of effective tillers $hill^{-1}$ was observed in BRRI dhan-28 (13.53).

***Panicle length*:** Significant variation in panicle length was noticed in different hybrid rice varieties (Table 4). The longest panicle was observed in Arize Tej (24.46 cm) which was statistically at par with Shathi (23.41 cm) and they also followed by Sakti (23.15 cm). The shortest panicle was observed in BRRI dhan-28 (19.26 cm) followed by Tea (21.32 cm). This result is in agreement with the findings of Islam *et al*. (2007), who found that the panicle length was different among genotypes under salinity stress. Chakma (2006) also reported that panicle length was significantly varied in varieties.

***Number of unfilled grains per panicle*:** The variety BRRI dhan-28 produced the highest number of unfilled grains $panicle^{-1}$ (52.6) followed by Sakti (39.20) but they differed significantly. On the other hand, the lowest number of unfilled grains $panicle^{-1}$ was recorded in Arize Tej (27.93) which was statistically at per with Shathi (29.07). Such result also reported by Bakul *et al*., 2009 who reported that the genotype differed significantly for unfilled grains production in their panicle.

Number of filled grains per panicle: Filled grains $panicle^{-1}$, the most important yield attribute, was significantly different among the varieties (Table 4). Arize Tej produced the highest number of filled grains $panicle^{-1}$ (243.07) and the lowest number of filled grains $panicle^{-1}$ (168.40) recorded in BRRI dhan-28. This result is in agreement with the result of Dutta *et al.* (2002) who stated that yield was affected by the number of filled grains $panicle^{-1}$.

***Thousand-grain weight (g)*:** Thousand grains weight represents grain size while was ultimately related to

grain yield. The effect of rice varieties on 1000-grain weight was significant (Table 5). Genotype Arize Tej showed the highest 1000-grains weight (29.02 g) which was statistically at par Shathi (26.7 g). On the other hand, BRRI dhan-28 showed the lowest 1000-grains weight (24.29 g) which were statistically at par with Sakti (24.46 g) and Tea (25.76 g). Mondal *et al*. (2005) studied with 17 modern cultivars of transplanted boro rice and reported that 1000-grains weight differed significantly among the cultivars studied, which supported the present experimental result. Hossain *et al*. (2008 and 2005) reported the similar findings with the present study who reported that the variation in 1000-grains weight may be due to the varietal differences.

Table 4. Performance of different boro rice varieties on yield contributing characteristics and yield of boro rice.

Varieties	Effect tiller hill^{-1} (No.)	Non effective tiller hill^{-1} (No.)	Panicle length (cm)	Unfilled grains panicle^{-1}	Filled grains panicle^{-1}
Arize Tej	16.80 a	1.80 c	24.46 a	27.93 d	243.07 a
Tea	15.33 d	2.47 b	21.32 b	33.87 c	203.00 c
Sakti	15.73 c	2.67 b	23.15 ab	39.20 b	180.00 d
Shathi	16.20 b	2.07 c	23.41 a	29.07 d	224.87 b
BRRI dhan-28	13.53 e	3.47 a	19.26 c	44.87 a	168.40 e
CV%	3.41	4.33	4.51	3.18	2.69
Sig. level	**	*	**	**	**

**=Significant at 1% level of probability and *=Significant at 5% level of probability; Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

***Grain yield (t ha^{-1})*:** There was a significant difference among the varieties in respect of grain yield (Table 5). Among the varieties, Arize Tej produced the highest grain yield (6.68 t ha^{-1}). On the other hand, BRRI dhan-28 produced the lowest grain yield (5.12 t ha^{-1}) which was statistically identical with Sakti (5.29 t ha^{-1}). Hossain *et al*. (2008), Uddin *et al*. (2010), Hossain *et al*. (2003), Pruneddu and Spanu (2001) and many other workers reported that the varieties which produced higher number of effective tillers hill^{-1} and higher number of filled grains panicle^{-1} also showed higher grain yield.

***Straw yield*:** Statistical analysis of variance data showed significant difference among the varieties regarding to straw yield (Table 5). The variety Arize Tej recorded the highest straw yield (9.49 t ha^{-1}) followed by Shathi (8.83 t ha^{-1}) and Tea (8.80 t ha^{-1}) where Shathi and Tea were statistically identical. The lowest straw yield (7.88 t ha^{-1}) produced BRRI dhan-28 which was statistically identical with Sakti (8.07 t ha^{-1}).

***Biological yield (t ha^{-1})*:** A significant variation was found due to varieties in respect of biological yield (Table 5). The highest biological yield was recorded in Arize Tej (16.17 t ha^{-1}) followed by Shathi (14.77 t ha^{-1}) and Tea (14.59 t ha^{-1}) where the variety Shathi and Tea were statistically at per similar rank. The lowest biological yield was recorded in BRRI dhan-28 (13.00 t ha^{-1}) which was also statistically at par with Sakti (13.36 t ha^{-1}). Similar result was also reported by Munshi (2005) in rice.

***Harvest index (%)*:** Harvest index was significantly influenced due to different boro rice varieties. Among the varieties, the variety Arize Tej recorded significantly the highest harvest index (41.31%). Check variety BRRI dhan-28 recorded significantly the lowest harvest index (36.37%) which was statistically at per similar rank with Sakti (39.60%), Tea (39.71%) and Shathi (40.19%). Chandra and DAT (2000), Cui-Jing *et al.* (2000) and Reddy *et al.*(1994) also observed that higher grain yield and higher 1000-grain weight

significantly increased harvest index (HI). Besides, Uddin *et al*. (2011) reported that the variation in harvest index was found due to different genetic constitution of the varieties.

Table 5. Performance of different boro rice varieties on yield contributing characteristics and yield of boro rice.

Varieties	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Arize Tej	29.02 a	6.68 a	9.49 a	16.17 a	41.31 a
Tea	25.76 b	5.79 b	8.80 b	14.59 b	39.71 b
Sakti	24.46 b	5.29 c	8.07 c	13.36 c	39.60 b
Shathi	28.17 a	5.94 b	8.83 b	14.77 b	40.19 b
BRRI dhan-28	24.29 b	5.12 c	7.88 c	13.00 c	39.37 b
CV%	3.43	2.70	1.83	3.88	1.39
Sig. level	**	**	**	**	**

**=Significant at 1% level of probability and *=Significant at 5% level of probability; Figures followed by same letter(s) are statistically similar as per DMRT at 5%.

Conclusion

From the above investigated results, it was observed that the boro rice variety Arize Tej was the most efficient for better growth and higher yield of hybrid boro rice genotypes grown in coastal area of Bangladesh.

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