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Growth and Yield of Traditional Aromatic Rice Cultivars in *Boro* Season

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Authors' contributions

This work was carried out in collaboration among all authors. Authors SA and FAB planned the experiment and lead the research. Authors SA, FAB and NS designed and carried out the research. Authors FAB and MEH performed the statistical analysis. Authors SA, NS and MJR carried out the research on the field. Authors MJR, MBN and AS collected the data. Authors SA, MBN and MEH wrote the manuscript. Authors MJR, NS, MBN and AS managed the literature searches. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at agronomy field, Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207 during the period from November 2017 to May 2018 to evaluate the growth, yield and grain quality of traditional aromatic rice cultivars in *Boro* season. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Eleven aromatic rice genotypes viz. T_1 = Kataribhog-1, T_2 = Kataribhog-2 (awned), T_3 = BRRI dhan34, T_4 = Badshabhog, T_5 = BRRI dhan38, T_6 = Chinigura, T_7 = Madhumala, T_8 = BRRI dhan50, T_9 = Zirabhog, T_{10} = Chiniatap-1 and T_{11}= Chiniatap-2. Chinigura produced the tallest plant

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(151.23 cm), higher number of tillers hill^{-1} (25.66), and leaves hill^{-1} (65.00). The maximum leaf area index (5.5) was obtained from Chinigura (T_6) which was statistically differed from all other varieties. Days to 50% flowering (92.66 days) was more for Chinigura (T_6) which was statistically similar with all varieties except BRRI dhan38 (T_5) and Madhumala (T_7). BRRI dhan34 (T_3) produced the highest chlorophyll content in leaves which was statistically identical with BRRI dhan38 (T_5), Chinigura (T_6) and Chiniatap-2 (T_{11}). Grain length and breadth ratio is the lowest (2.26: 1) in Kataribhog-1. Chinigura provided the highest grain yield (3.46 t ha^{-1}) followed by Kataribhog-1 (3.32 t ha^{-1}), Badshabhog (3.20 t ha^{-1}), BRRI dhan38 (2.80 t ha^{-1}) and BRRI dhan50 (2.65 t ha^{-1}). Chinigura also provided the highest straw yield (8.11 t ha^{-1}) and biological yield (11.10 t ha^{-1}). So, Chinigura exhibited higher adaptability in *Boro* season compared to rest of the cultivars. Chinigura can be cultivated in *Boro* season compared to rest of the cultivars.

Keywords: Adaptability; aromatic rice; Boro season; growth and yield.

1. INTRODUCTION

Aromatic rice is known for its characteristic fragrance when cooked. It fetches higher price in market than non-aromatic ones. Infact aromatic rice is very popular in the national and in the international markets [1]. Cultivation of aromatic rice has been gaining popularity in Bangladesh on the recent years, because of its huge demand both for internal consumption and export [2]. However, the choice of grain quality depends of the consumers' income. The demand for scented fine grain rice has been increased due to economic development of the people of Bangladesh [3]. Most of the well-off people preferred long, slender scented fine grain rice [4, 5]. Despite the generally favorable agro-climatic conditions, area of aromatic rice cultivation is less than 2% of the national rice acreage of Bangladesh [6,7].

The traditional fine-grained aromatic rice genotypes are comparatively taller than modern ones and more suitable for low-lying areas. But most of the traditional fine-grained rice genotypes are photoperiod-sensitive, well adopted to the local environment and suitable for in growing in the *Boro* season [8]. However, aromatic rice varieties have occupied about 12.5% of the total transplant *Boro* rice cultivation [9]. Most of the high quality rice cultivars are low yielding. Due to low yield, farmers have little interest to growing these aromatic rice cultivars.

Being the 4th largest rice producer of the world, Bangladesh comprises an area of about 11.10 million hectares for rice production [10] of which around 27% is occupied by fine rice varieties [11]. Most of the consumers prefer fine rice varieties with good cooking quality that have aroma. Due to special flavor and taste, aromatic rice is highly favored. This quality of rice receives a premium price in the market and has export potential [12]. Bangladesh produces several fine aromatic rice varieties with excellent eating quality for regular consumption as steamed rice as well as for polao, biriani, jarda, firni type preparations which are served on special occasions. Yield and quality of rice depends on the genetic potential of cultivars, it surrounding environment and management practices. Selection of right type of variety is most important factors for maximizing rice production. Yield of rice changes due to growing environment, such as different locations, seasonal fluctuations, different dates of planting etc. [5].

Based on the above proposition, the present research programme has been undertaken to investigate the variations in morpho-physiological characters in aromatic rice cultivars and their relation with grain yield of the same. With this background the present experiment was taken up to investigate the growth yield and the adaptability of the traditional aromatic rice cultivars in *Boro* season.

2. MATERIALS AND METHODS

2.1 Experimental Site and Experimental Framework

The experiment was conducted at the Agronomy Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during the period from 2017 - 2018. It was located in 23°77' N latitude and 90°35' E longitude with an elevation 8.6 m from the sea level under the Agro-ecological Zone of Modhupur Tract, AEZ-28. Soil was having the texture of sandy loam with p^H 5.6. Eleven aromatic rice genotypes *viz*. T_1 = Kataribhog-1, T_2= Kataribhog-2 (awned), T_3= BRRI dhan34, T_4 = Badshabhog, T_5 = BRRI dhan38, T_6 = Chinigura, T_7 = Madhumala, T_8 = BRRI dhan50, T_9 = Zirabhog, T_{10} = Chiniatap-1 and T_{11} = Chiniatap-2 were used as treatment for

experiment. The experiment was laid out following the Randomized Complete Block Design (RCBD) with three replications. There were 33 plots of size 2 m × 1.5 m in each of 3 replications. The treatments of the experiment were assigned at random into each replication following the experimental design. There were 0.75 m width and 10 cm depth for drains between the blocks. Each treatment was again separated by drainage channel of 0.5 m width and 10 cm depth. Two seedlings hill^{-1} were used during transplanting. Data were collected on growth and yield attributes.

2.2 Fertilizer Application

A recommended dose of 180 kg urea, 165 kg TSP and 180 kg MP ha-1 and 90 kg gypsum was applied as N, P_2O_5, K_2O and S respectively. Entire quantity of phosphorus and half of potassium and one third of the N were applied at the time of final land preparation just before transplanting. The remaining one third of the N and half of K were applied at two installment.

2.3 Statistical Analysis

The data obtained for different characters were statistically analyzed by using MSTAT-C computer package program to find out the significance of the difference. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment combinations of means was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Crop Growth Characters

3.1.1 Plant height

The data pertaining to plant height of rice at different days after transplantation presented in Table 1. It was inferred that irrespective of varieties of plant height increased gradually up to at harvest. But the rate of increase was much higher up to 85 DAT. After that it reduced slightly. Among the varieties, Chinigura (T_6) showed tallest plant than other tested varieties for all sampling dates. At 40 DAT, the tallest plant (36.81 cm) was observe in Chinigura (T_6) which was statistically identical with Kataribhog-1 (T_1), BRRIdhan34 (T_3) and similar with Badshabhog (T_4). The shortest plant found (25.96 cm) in BRRI dhan50 (T_8) which was statistically similar with Kataribhog-2 (T_2), BRRI dhan38 (T_5), Madhumala (T_7), Zirabhog (T_9) Chiniatap-1 (T_{10}) and Chiniatap-2 (T_{11}). At 55 DAT, The tallest plant (61.14 cm) was recorded in Chinigura (T_6) which was statistically similar with all varieties except BRRI dhan50 (T_8) and the shortest plant (51.87 cm) in BRRIdhan50 (T_8) which was statistically similar with all varieties except Chinigura (T_6). At 70 DAT, The tallest plant (100.00 cm) was recorded in Chinigura (T_6) which was statistically similar with BRRI dhan34 ((T_3), Badshabhog (T_4) and BRRI dhan38 (T_5). The shortest plant (67.42 cm) was in BRRI dhan50 (T_8). At 85 DAT, the tallest plant (137.30 cm) was found in Chinigura (T_6) which was statistically identical with Kataribhog-1 (T_1) and similar with Chiniatap-1 (T_{10}). The shortest plant (82.03cm) was in BRRI dhan50 (T_8). At harvest, the tallest plant (151.23 cm) was exerted in Chinigura (T_6) which was statistically differed from all other varieties. The shortest plant (86.87 cm) was found in BRRIdhan50 (T_8). The difference in plant height of varieties might be due to difference in their genetic makeup. Difference in plant height with different varieties was also observed by Priyadarsini [13].

3.1.2 Number of tillers hill^{-1}

The number of plant tillers hill^{-1} of rice at different days after transplanting as influenced by the varieties are presented in Table 2. It is noticed that the number of tillers hill^{-1} was increased rapidly at 40 DAT to 70 DAT and it reached the highest at 90 DAT. Than number of tillers ware reduced due to dry and rotten some non-effective tillers. Among the tested varieties, the maximum tillers (7.66, 14.50, 24.33, 27.66 and 25.66 at 40, 55, 70, 85 DAT and at harvest at sampling dates, respectively) was found in Chinigura (T_6) which was statistically similar with Kataribhog-2 (T_2), Badshabhog (T_4), BRRI dhan50 (T_8) at 40 DAT; Kataribhog-1 (T_1), Kataribhog-2 (T_2), BRRI dhan34 (T_3), BRRI dhan38 (T_5), BRRI dhan50 (T_8), Chiniatap-2 (T_{11}) at 55 DAT; Kataribhog-1 (T_1), Kataribhog-2 (T_2), Chiniatap-2 (T_{11}) at 70 DAT; Kataribhog-1 (T_1) Kataribhog-2 (T_2), Chiniatap-2 (T_{11}) at 85 DAT and statistically similar with all varieties except Badshabhog (T_4) and BRRI dhan50 (T_8) at harvest which might be due to its higher tillering ability compared to other varieties. The lowest tiller (8.33, 13.75, 17.66 and 13.66 at 55, 70, 85 DAT and at harvest,) was observed in Badshabhog (T_4). At 40 DAT, the minimum tiller (4.08) was observed Zirabhog (T_9). The present findings are in accordance with those of Priyadarsini [13] who reported that different varieties produced different tillers hill^{-1}.

Table 1. Effect of variety on plant height at different days after transplanting of traditional aromatic rice in *Boro* season

Treatments	Different Days After Transplanting (DAT)				
	40	55	70	85	At harvest
T_1	36.2 a	55.62 ab	98.67 a	133.45 a	138.53 b
T_2	29.54 bc	58.55 ab	87.83 b-d	116.07 bc	131.43 bc
T_3	37.17 a	57.96 ab	94.08 a-c	114.00 bc	130.40 bc
T_4	32.04 ab	53.62 ab	96.42 ab	118.42 bc	123.80 c
T_5	30.38 bc	54.27 ab	94.58 a-c	115.33 bc	130.07 bc
T_6	36.81 a	61.14 a	100.00 a	137.30 a	151.23 a
T_7	31.12 bc	56.99 ab	83.50 d	96.65 d	112.00 d
T_8	25.96 c	51.87 b	67.42 e	82.03 e	86.87 e
T_9	26.48 bc	53.73 ab	79.08 d	97.00 d	122.30 cd
T_{10}	30.43 bc	57.78 ab	81.33 d	126.83 ab	132.73 bc
T_{11}	29.02 bc	54.0 ab	85.42 cd	109.03 cd	122.30 cd
LSD $_{(O.O5)}$	5.60	7.60	10.40	13.7	11.40
CV (%)	10.33	7.97	6.93	7.12	5.35

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. T_1 = Kataribhog-1, T_2= Kataribhog-2 (awned), T_3= BRRI dhan34, T_4 = Badshabhog, T5 = BRRI dhan38, T_6 = Chinigura, T_7 = Madhumala, T_8 = BRRI dhan50, T_9 = Zirabhog, T_{10} = Chiniatap-1 and T_{11} = Chiniatap-2

Table 2. Effect of variety on tillers hill^{-1} at different days after transplanting of traditional aromatic rice in *Boro* season

Treatments	Different Days After Transplanting (DAT)				
	40	55	70	85	At harvest
T_1	4.75 cd	12.50 a-d	22.57 a-c	24.08 ab	22.33 a-c
T_2	6.16 a-c	13.16 a-c	20.33 a-d	23.16 a-c	21.33 a-c
T_3	4.08 d	13.83 -ac	16.08 de	20.33 bc	18.33 a-c
T_4	6.91 ab	8.33 e	13.75 e	17.66 c	13.66 c
T_5	5.41 b-d	12.16 a-d	19.16 b-d	20.91 bc	17.00 a-c
T_6	7.66 a	14.50 a	24.33 a	27.66 a	25.66 a
T_7	4.83 cd	10.50 c-e	16.33 de	20.83 bc	18.33 a-c
T_8	6.25 a-c	13.41 a-c	17.66 de	18.00 c	15.33 bc
T_9	4.08 d	9.41 de	18.33 cd	21.50 bc	19.33 a-c
T_{10}	5.58 b-d	10.66 b-e	19.33 b-d	22.16 a-c	20.33 a-c
T_{11}	5.83 bc	14.16 ab	22.66 ab	27.83 a	24.00 ab
LSD $_{(O.O5)}$	1.63	3.64	4.28	5.84	9.03
CV (%)	10.10	13.74	7.59	8.92	15.62

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. T_1 = Kataribhog-1, T_2= Kataribhog-2 (awned), T_3= BRRI dhan34, T_4 = Badshabhog, T5 = BRRI dhan38, T_6 = Chinigura, T_7 = Madhumala, T_8 = BRRI dhan50, T9 = Zirabhog, T_{10} = Chiniatap-1 and T_{11} = Chiniatap-2

3.1.3 Leaves hill^{-1}

The leaves hill^{-1} of aromatic rice varieties were significantly influenced by varieties at harvest (Table 3). The results revealed that at harvest, the highest leaves hill^{-1} (65.00) were recorded from Chinigura (T_6) which was statistically similar with Madhumala (T_7) and Chiniatap-1 ((T_{10}) whereas; the lowest leaves hill-1 (38.33) were recorded from Kataribhog-2 (T_2) which was statistically similar with Kataribhog-1 (T_1), Kataribhog-2 ((T_2), BRRI dhan38 (T_5), BRRI dhan38 (T_5) and Chiniatap-2 (T_{11}). The results substantiate with the findings of Luh and Stefanou [14] who observed that might be due to cause of genotypic characters of varieties and proper nutrient availability.

3.1.4 Leaf area index

The data leaf area index at harvest was significantly affected by varieties has been

shown in Table 3. The maximum leaf area index (5.5) was obtained from Chinigura (T_6) which was statistically differed from all other varieties. This might be due to cause of proper nutrient supply mechanism from soil to the plants, light intensity and light holding capacity of a variety and above all phenotypic characters of the varieties. The finding was also observed by several researchers such as [15,16]. The minimum leaf area index (3.10) was observed in Kataribhog-2 (T_2) which was statistically similar with Kataribhog-1 (T_1), Kataribhog-2 (T_2), BRRI dhan34 (T_3), Badshabhog (T_4), BRRIdhan38 (T_5), Zirabhog (T_9), Chiniatap-1 (T_{10}) and Chiniatap-2 (T_{11}).

3.1.5 SPAD value

The chlorophyll content of aromatic rice varieties were significantly influenced by varieties (Fig. 1). The results revealed that BRRI dhan34 (T_3) produced the highest chlorophyll content (47.28 mg g^{-1}) which was statistically identical with BRRI dhan38 (T_5), Chinigura (T_6) and Chiniatap-2 (T_{11}) and similar with Kataribhog-1 (T_1), Madhumala (T_7), BRRI dhan50 (T_8), Zirabhog (T_9) and Chiniatap-1 (T_{10}). Kataribhog-2 (T_2) produced the lowest chlorophyll content (39.38 mg g^{-1}) which was statistically similar with Kataribhog-1 (T_1), Badshabhog (T_4), Madhumala (T_7) BRRI dhan50 (T_8) and Chiniatap-1 (T_{10}).

3.1.6 50% flowering

Data presented on days to 50% flowering revealed significant variations due to varieties (Fig. 2). A considerable variation in days to 50% flowering was observed among the cultivars due to variation in the duration of cultivars. Days to 50% flowering (92.66 days) was more for Chinigura (T_6) which was statistically similar with all varieties except BRRI dhan38 (T_5) and Madhumala (T_7). On the other hand the variety, BRRI dhan38 (T_5) was the earlier to reach to 50% flowering (72.30 days) which was statistically similar with Madhumala (T_7) (72 days). BRRI dhan38 (T_5) was being a short duration (135 to 145 days) variety, reached 50% flowering earlier compared to that of other cultivars. Chinigura (T_6) has the maximum duration (145 days) and hence, it took more number of days to attain 50% flowering. Attainment of 50% flowering as per the duration of cultivars was also reported by Sinha et al. [17] who observed considerable variation in days to 50% flowering in rice. Similar results were observed by Rajuet al. [18] and Shehu et al. [19].

Table 3. Effect of variety on leaves hill^{-1} and leaf area index (LAI) of traditional aromatic rice in *Boro* season

Treatment	Leaves hill^{-1}	Leaf area index
T_1	44.91ef	3.32 cd
T_2	38.33 f	3.10 d
T_3	48.00 de	3.50 cd
T_4	51.00 c-e	3.64 b-d
T_5	43.00 ef	3.21 cd
T_6	65.00 a	5.50 a
T_7	57.00 a-c	4.50 b
T_8	55.00 b-d	4.14 bc
T_9	43.00 ef	3.43 cd
T_{10}	62.00 ab	3.87 b-d
T_{11}	46.00 ef	3.43 cd
$LSD_{(O.O5)}$	8.62	0.94
CV (%)	5.81	8.43

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. T_1 = Kataribhog-1, T_2= Kataribhog-2 (awned), T_3= BRRI dhan34, T_4 = Badshabhog, T5 = BRRI dhan38, T_6 = Chinigura, T_7 = Madhumala, T_8 = BRRI dhan50, T9 = Zirabhog, T10 = Chiniatap-1 and T11 = Chiniatap-2

3.2 Yield Attributes

3.2.1 Number of effective tillers hill^{-1}

The data regarding the number of effective tillers hill^{-1} exerted significant influence due to varieties used in the present study (Table 4). The highest effective tillers hill^{-1} (18.23) was observed in Chinigura (T_6) which was statistically differed from all other varieties. The lowest (11.12) effective tillers hill^{-1} was recorded in Badshabhog (T_4) which was statistically similar with BRRI dhan50(T_8).This might be due to its high tillering ability and conversion of total number of tillers into more effective tillers. The results were in conformity with the findings of Shehu et al. [19].

3.2.2 Number of Non effective tiller hill^{-1}

The number of non-effective tiller hill^{-1} was significantly influenced due to different varieties (Table 4). Result revealed that the maximum non effective tillers hill^{-1} (10.90) was observed in Chiniatap-2 (T_{11}) which was statistically differed from all other varieties. Lowest non effective tillers hill^{-1} (2.33) was obtained from Badshabhog (T_5) which was statistically identical with BRRIdhan38 (T_4).

3.2.3 Panicle length

Panicle length was significantly affected by rice varieties (Table 4). The longest panicle (25.43 cm) was obtained from Chinigura (T_6) which was statistically similar with all varieties except BRRI dhan50 (T_8). The shortest panicle (18.76 cm) was found in BRRI dhan50 (T_8) which was statistically similar with all varieties except Kataribhog-2 (T_2). This may due to the genetic makeup of varieties that panicle length varied with variety to variety among the varieties.

3.2.4 Filled grains panicle^{-1}

Number of filled grain panicle^{-1} differed significantly due to varieties (Table 4). Significantly highest number of filled grains (137.00) was recorded in Chinigura (T_6) which was statistically identical with Badshabhog (T_4). Variation in grains panicle^{-1} might be due to difference in panicle size of the varieties, which is a genetic character and specific to each variety. Similar relation with different varieties on total grains panicle^{-1} were reported by Sharma et al. [20]. The lowest number of filled grains (78.00) was recorded with BRRI dhan38 (T_5).

3.2.5 Unfilled grains panicle^{-1}

The data pertaining to number of unfilled grains panicle^{-1} as influenced by varieties has been presented in the Table 4. Significantly highest number of unfilled grains panicle^{-1} (35.00) was recorded in BRRI dhan34 (T_3) which was statistically identical with Badshabhog (T_4) and the lowest (8.00) was obtained from Madhumala (T_7) followed by BRRI dhan38 (T_5) and Chiniatap-1 (T_{10}).

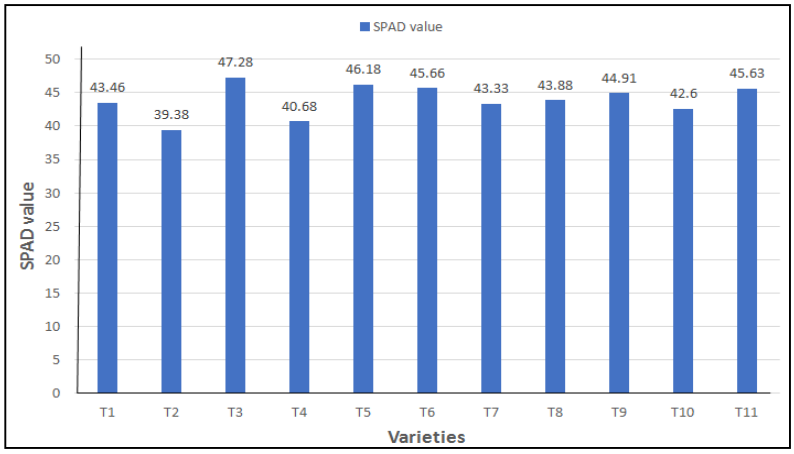

Fig. 1. Effect of varieties on SPAD value of traditional aromatic rice in *Boro* season (LSD=4.94 at 5% level of significance)

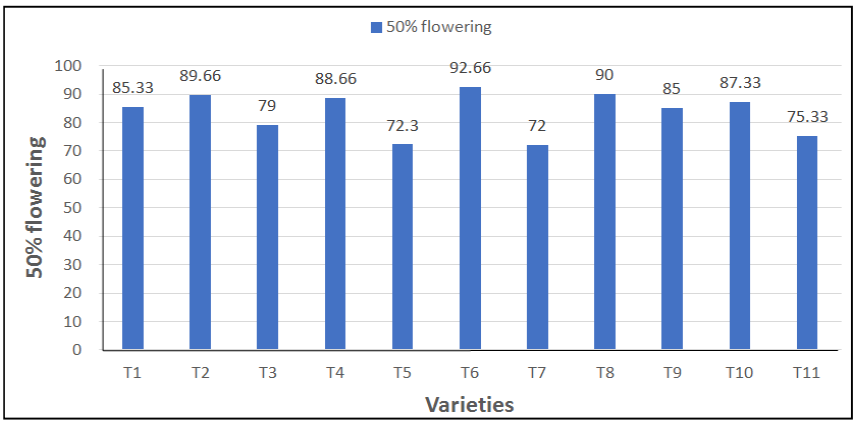

Fig. 2. Effect of varieties on 50% flowering of traditional aromatic rice in *Boro* Season (LSD=18.37 at 5% level of significance)

Table 4. Effect of varieties on yield attributes of traditional aromatic rice in *Boro* season

Treatments	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length(cm)	Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	Weight of 1000 grain (g)
T_1	16.89 b	5.44 d	25.09 ab	104.50 d	23.00 b	14.84 ab
T_2	16.10 b	5.23 d	22.20 ab	90.65 e	17.00 cd	13.98 b
T_3	14.67 c	6.32 c	23.21 ab	124.00 b	35.00 a	13.55 b
T_4	11.12 g	2.54 g	21.86 ab	135.00 a	30.00 a	8.10 c
T_5	14.67 c	2.33 g	24.21 ab	78.00 f	10.00 ef	11.23 bc
T_6	18.23 a	7.43 b	25.43 a	137.00 a	21.00 bc	19.30 a
T_7	14.05 cd	4.28 e	23.21 ab	85.40 ef	8.00 f	11.87 bc
T_8	12.12 fg	3.21 f	18.76 b	116.00 bc	22.00 bc	15.00 ab
T_9	12.81 ef	6.52 c	23.70 ab	110.00 cd	14.00 de	10.87 bc
T_{10}	13.76 c-e	6.57 c	25.12 ab	112.00 cd	12.00 d-f	10.92 bc
T_{11}	13.10 d-f	10.90 a	24.32 ab	109.00 cd	21.00 bc	9.80 bc
LSD $_{(O.O5)}$	1.2319	0.5838	6.5586	10.899	5.4075	5.3164
CV(%)	2.92	3.58	9.52	3.38	9.47	14.22

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. T_1 = Kataribhog-1, T_2= Kataribhog-2 (awned), T_3= BRRI dhan34, T_4 = Badshabhog, T5 = BRRI dhan38, T_6 = Chinigura, T_7 = Madhumala, T_8 = BRRI dhan50, T_9 = Zirabhog, T_{10} = Chiniatap-1 and T_{11} = Chiniatap-2

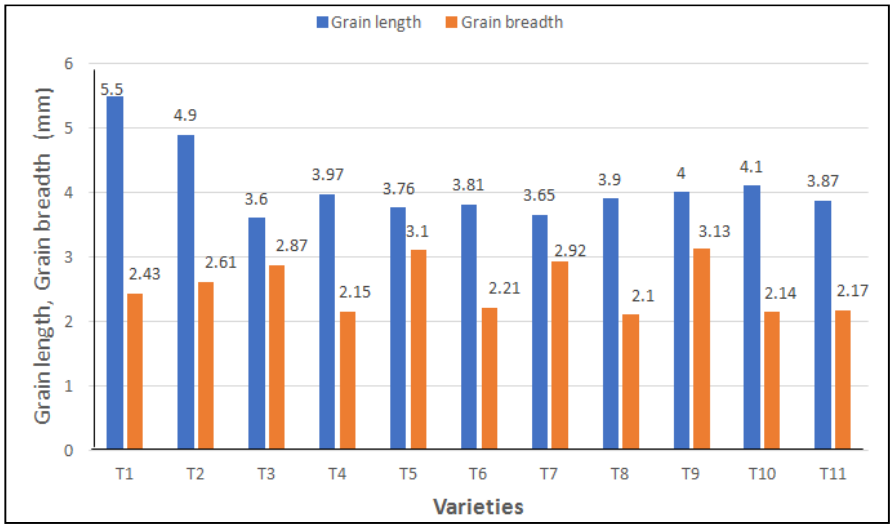

Fig. 3. Effect of varieties on grain length (mm) and grain breadth of traditional aromatic rice in *Boro* season (LSD=0.9612 and 0.1243 for grain length and grain breadth, respectively at 5% level of significance)

3.2.6 Weight of 1000 grain

1000-seed weight of rice was significantly affected due to varieties difference (Table 4). The highest 1000-seed weight (19.30 g) was found with Chinigura (T_6) followed by Kataribhog-1 (T_1) and BRRI dhan50 (T_8). This might be due to the bold size of the grain. Shehu et al. [19] also reported variation in grain weight among the varieties. The lowest test weight (8.10 g) was observed with Badshabhog (T_4) which was statistically similar with Chinigura (T_5), Madhumala (T_7), Zirabhog (T_9), Chiniatap-1 (T_{10}) and Chiniatap-2 (T_{11}). This might be due to the fact that Badshabhog (T_4) being a fine quality rice grain recorded the lower 1000-grain weight.

3.2.7 Grain length

Grain length was significantly influenced due to different varieties (Fig. 3). Result revealed that the tallest grain (5.50 mm) was observed in

Kataribhog-1 (T_1) which was statistically similar with Kataribhog-2 (T_2). The shortest grain (3.60 mm) was obtained from BRRI dhan34 (T_3) which was statistically identical with BRRI dhan38 (T_5), Chinigura (T_6) Madhumala (T_7) BRRI dhan50 (T_8), Chiniatap-2 (T_{11}) and similar with Badshabhog (T_4), Zirabhog (T_9), Chiniatap-1 (T_{10}). This might be due to cause of genotypic characters of varieties and proper nutrient availability from soil.

3.2.8 Grain breadth

Grain breadth of aromatic rice varieties were significantly influenced by varieties (Fig. 3). The results revealed that BRRI dhan38 (T_9) produced the highest grain breadth (3.13 mm) which was statistically identical with Zirabhog (T_9) and similar with BRRI dhan34 (T_3) and Madhumala (T_7). The lowest grain breadth (2.1 mm) found in BRRI dhan50 (T_8) which was statistically identical with Badshabhog (T_4), Chiniatap-1 (T_{10}) and Chiniatap-2 (T_{11}) and similar Kataribhog-1 (T_1).

3.3 Yield and Harvest Index

3.3.1 Grain yield

Grain yield of aromatic rice exerted significant variation due to varieties (Table 5). Among the varieties Chinigura (T_6) out yielded over by producing 3.46% higher yield. However Chinigura (T_6) produced significantly the highest yield (3.46 t ha^{-1}) which was statistically similar with Kataribhog-1 (T_1), Kataribhog-2 (T_2), BRRI dhan34 (T_3), Badshabhog (T_4), BRRI dhan38 (T_5) and BRRI dhan50 (T_8).Lowest (2.00 t ha^{-1}) was observed from Madhumala (T_7) which was statistically identical with Chiniatap-2 (T_{11}). The higher grain yield in Chinigura (T_6) could be attributed to higher panicle length, filled grains panicle^{-1} and 1000-seed weight compared to other varieties. The result corroborates with findings of Priyadarsini [13] and Dhaliwal et al. [21] who observed yield variation among the varieties.

3.3.2 Straw yield

Straw yield of rice differed significant due to tested varieties (Table 5). Higher straw yield of 8.11 t ha^{-1} was recorded with Chinigura (T_6) which was statistically identical with Badshabhog (T_4) and similar with Kataribhog-1 (T_1). Significant effect on straw yield of varieties might be due to their significant influence on plant height and bold tiller. The result agreed with the finding of Priyadarsini [13] that straw yield of rice varied among the varieties.

3.3.3 Biological yield

Biological yield of rice was significantly influenced by the variety (Table 5). The highest biological yield (11.10 t ha^{-1}) was obtained from Chinigura (T_6) which was statistically identical with Kataribhog-1 (T_1) and BRRI dhan50 (T_8), Badshabhog (T_4) and similar with BRRI dhan38 (T_5) and BRRI dhan50 (T_8). The lowest (6.60 t ha^{-1}) from Chiniatap-2 (T_{11}) which was statistically identical with Kataribhog-2(T_2),

Table 5. Effect of variety on yield and harvest index of traditional aromatic rice in *Boro* Season

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	3.32 ab	7.23 ab	10.69 a	31.74 c-e
T_2	2.40 a-d	4.33 d	6.73 c	35.65 ab
T_3	2.52 a-d	4.70 d	7.22 bc	34.92 a-c
T_4	3.20 a-c	7.90 a	10.76-a	28.80 e
T_5	2.80 a-d	6.50 bc	9.30-ab	30.08 e
T_6	3.46 a	8.11 a	11.10 a	24.62 f
T_7	2.00 d	4.80 d	6.80-c	29.34 e
T_8	2.65 a-d	5.50 cd	8.82 a-c	37.64 a
T_9	2.30b cd	4.50 d	6.80 c	33.82 b-d
T_{10}	2.20 cd	4.80 d	7.00 c	31.426 de
T_{11}	2.10 d	4.50 d	6.60 c	31.80c de
LSD $_{(O.O5)}$	0.46	1.21	2.30	3.50
CV (%)	14.17	7.20	9.33	3.72

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. T_1 = Kataribhog-1, T_2= Kataribhog-2 (awned), T_3= BRRI dhan34, T_4 = Badshabhog, T_5 = BRRI dhan38, T_6 = Chinigura, T_7 = Madhumala, T_8 = BRRI dhan50, T_9 = Zirabhog, T_{10} = Chiniatap-1 and T_{11} = Chiniatap-2

Chinigura (T_3), Madhumala (T_7), BRRI dhan50 (T_8), Zirabhog (T_9) and Chiniatap-1 (T_{10}). Rahman et al. [22] reported that hybrid variety produced higher biological yield compared to inbred variety due to higher grain yield and straw yield.

3.3.4 Harvest index (%)

Statistically analyzed data on harvest index are presented in Table 5. The result revealed that harvest index was significant regarding the varieties and highest harvest index (37.64) was obtained from BRRI dhan50 (T_8) followed by BRRI dhan34 (T_3). The lowest harvest index (24.62) found in Chinigura (T_6) which is similar with the finding of Rahman et al. [22].

4. CONCLUSION

The observations were recorded on plant height (cm), number of tillers hill^{-1}(no), Leaves hill^{-1} Leaf area index, SPAD value, 50% flowering, panicle length (cm), effective tillers hill^{-1}, non-effective tillers hill^{-1}, filled grains panicle^{-1} , unfilled grains panicle^{-1}, Grain length (mm), Grain breadth (mm), weight of 1000 seed (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield(t ha^{-1}) and harvest index(%). The effect of variety on plant height showed dissimilar at different growth stage. Among the test aromatic rice varieties Chinigura exhibited higher values for growth parameters (height, leaf numbers and tillers and LAI) compared to others. Chinigura provided the highest grain yield (3.46 t ha^{-1}) followed by Kataribhog-1 (3.32 t ha^{-1}), Badshabhog (3.20 t ha^{-1}), BRRI dhan38 and BRRI dhan50 (2.65 t ha^{-1}) Grain length and breadth ratio is the lowest (2.26: 1) in Kataribhog-1. Chinigura presented higher adaptability in *Boro* season compared to rest of the cultivars.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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