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Yield performance of different aromatic rice genotypes and their morpho-physiological attributes

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Abstract

From July 2022 to December 2022, an experiment was conducted to examine the morpho-physiological traits and yield performance of various genotypes of aromatic rice. The aim was to identify the significant morpho-physiological and yield-contributing characteristics that could potentially lead to increased yield. Treatments consisted of twelve different types of rice. Three replications and a Randomized Complete Block Design (RCBD) were used to set up the experiment. Records were kept on various morpho-physiological parameters, yield, and yield-contributing characters. To assess the treatment effect, statistical analysis was performed on the gathered data. Findings showed that variety V_{11} (BRRI dhan37) had the highest number of total tillers hill^{-1}, dry weight hill^{-1}, crop growth rate, absolute growth rate, flag leaf area, SPAD value of flag leaf, number of effective tillers plant^{-1}, number of ineffective tillers plant^{-1}, panicle length, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, grain yield (3.30 tons ha^{-1}), straw yield (6.10 tons ha^{-1}), biological yield (9.4 tons ha^{-1}), and harvest index (35.11%). The variety V_6 (Modhumala) had the lowest harvest index (26.59%), the lowest number of effective tillers, the lowest number of filled grains panicle^{-1}, the lowest number of grains panicle^{-1}, the grain yield (1.42 tons ha^{-1}), the straw yield (3.92 tons ha^{-1}), the biological yield (5.34 tons ha^{-1}), and the lowest number of tillers overall.

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Introduction

Roughly 12.5% of all Aman rice has been cultivated using aromatic rice varieties (BBS, 2005). Furthermore, compared to HYV coarse varieties, aromatic rice produces even less (BBS, 2005). This nation is home to thousands of local land races, many of which have positive traits like taste, aroma, fitness, and protein content (Kaul *et al.*, 1982). Because of its superior nutritional value, palatability, taste, cooking quality, and fragrance, consumers are more in demand for fine rice genotypes (Kaul *et al.*, 1982). The majority of buyers favour aromatic, fine-grained rice genotypes that cook well. Aromatic rice has a unique flavour and taste that makes it very popular. The development of aromatic rice varieties is closely linked to several morpho-physiological functions, including respiration, photosynthesis, enzyme activity, and so forth. The computation of the components, such as CGR, RGR, AGR, etc., is referred to as growth analysis. Plant physiologists use these components extensively because they offer comparable indicators of how plants react to their surroundings. The various growth parameters of rice, such as the leaf area index, the production of dry matter and how it is divided, tillering, etc., affect its yield (Idris *et al.*, 1990) and high crop growth rate, leaf area duration (LAD), leaf area index, and dry matter production (Yusuf *et al.*, 1997).

In order to obtain the highest yield possible, it is necessary to assess the performance of aromatic rice genotypes using suitable cultural practices. However, there hasn't been much research done in Bangladesh on the morpho-physiological traits of the regional aromatic rice genotypes.

The objectives are to ascertain the morpho-physiological characteristics of various locally grown aromatic rice cultivars and assess their yield performance.

Materials and methods

Twelve varieties of aromatic rice were taken into consideration as the treatment for this study, which was a single-factor experiment. The following were the reputable varieties: V_1= Kalijira, V_2= Chiniatap1, V_3= BRRI dhan50, V_4= Kataribhog 1, V_5= Badshabhog, V_6= Modhumala, V_7= Zirabhog, V_8= Shakkhorkhora, V_9= Chiniatap 2, V_{10}= Kataribhog 2, V_{11}= BRRI dhan37, V_{12} = BRRI dhan38.

After being stored in a water bucket for a full day, healthy seeds were firmly packed in gunny bags. After 48 hours, or roughly two days, the seeds began to sprout, and after 72 hours, or roughly three days, they were sown. The seedbed was prepared with a width of one meter and nutrients added according to the soil's requirements, following the advice of BRRI. To transplant the seedlings in the main field, seeds were sown in the seedbed in July 2022. The Bangladesh Rice Research Institute (BRRI) recommended the following fertilizer dosages, which were used when cultivating crops.

Three replications (blocks) of the experiment were set up using a Randomized Complete Block Design (RCBD). Initially, 12 subplots were created for each block, and different types of rice were assigned to each. Consequently, there were 12×3=36 unit plots in total. The unit plot measured 3 meters by 1.8 meters. There was one meter between columns and 0.5 meters between rows. Each block's plots received a random assignment of treatments or varieties.

On August 5, 2022, the seedlings were moved into the main field, 20 cm apart from column to column and 25 cm apart from row to row. Each plot's rice was manually harvested, with the harvesting process contingent upon the plant's maturity.

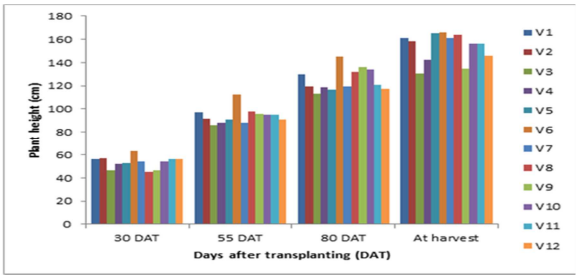
Results and discussion

The following headings contain a presentation and discussion of the results along with a potential interpretation.

Morpho-physiological parameters

Plant height

Different aromatic rice varieties' plant heights on different days after transplanting displayed various significant differences, as shown in Fig. 1. Plant height also gradually increased as time and growth stages went by.



Here, V_1= Kalijira, V_2= Chiniatap 1, V_3= BRRI dhan50, V_4= Katari bhog 1, V_5= Badshabhog, V_6= Modhumala, V_7= Zirabhog, V_8= Shakkhorkhora, V_9= Chiniatap 2, V_{10}= Katari bhog 2, V_{11}= BRRI dhan37, V_{12}= BRRI dhan38.

Fig. 1. Plant height of different aromatic rice varieties

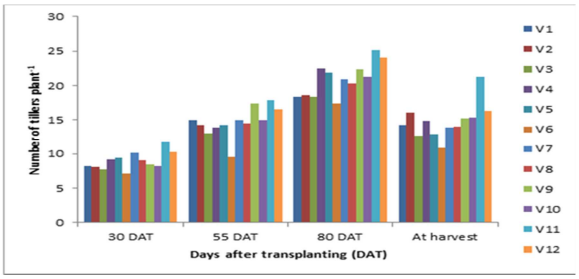


Fig. 2. The number of tillers plant^{-1} of different aromatic rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability

The variety V_6 (Modhumala) had the highest plant height (62.97 cm) at 30 DAT (Days after Transplanting). It was followed by varieties V_1, V_2, V_{11}, V_{12}, V_7, and V_{10}, all of which had statistically similar plant heights. Conversely, variety V_8 (Shakkhorkhora) had the lowest plant height (45.15 cm), which was statistically comparable to varieties V_3 and V_9.

At 55 DAT, among the varieties, variety V_6 (Modhumala) had the highest plant height (112.8 cm), followed by varieties V_1, V_8, V_9, V_{10}, and V_{11}, all of which had statistically similar plant heights. Conversely, variety V_3 (BRRI dhan50) had the lowest plant height (85.86 cm), which was statistically comparable to varieties V_4 and V_7.

At 80 DAT, the variety V_6 (Modhumala) had the highest plant height of any of the varieties, measuring 145.1 cm. Varieties V_9 and V_{10} came in second and third, respectively, but they were statistically similar. Conversely, variety V_3 (BRRI dhan50) had the lowest plant height (113.2cm), which was statistically comparable to variety V_5.

At harvest, the variety V_6 (Modhumala) had the tallest plant height (165.7 cm) out of all the varieties; it was followed by varieties V_5 and V_8, though their statistical differences were not significant. In contrast, the variety V_3 (BRRI dhan50) had the lowest plant height (130.3cm).

Sinha *et al.* (2009) also reported similar results. When they examined the performance of aromatic rice varieties, they discovered that after transplanting, plant height varied greatly between the varieties and increased until maturity, which argues in favor of the current experiment.

Number of leaves plant^{-1}

Table 1 displays the significant differences in the number of leaves plant^{-1} of various aromatic rice varieties on different days after transplanting. The total number of leaves increased until 60 days after transplanting, at which point it began to decline. The main determinants of rice leaf number are temperature, photoperiod, and genetic traits (Yin and Kropff, 1998., Streck *et al.*, 2008 and Sie *et al.*, 1998).

Number of tillers plant^{-1}

Fig. 2 illustrates the notable variations in the number of tillers plant^{-1} of various aromatic rice varieties on different days following transplanting. At 30 DAT, the variety with the greatest (11.68) number of tillers plant^{-1} was V_{11} (BRRI dhan37), followed by V_7 and V_{12}, though their statistical differences were not significant. However, the variety V_6 (Modhumala) had the lowest number of tillers plant^{-1} (7.167), which was statistically comparable to the variety V_3.

At 55 DAT, among the varieties, variety V_{11} (BRRI dhan37) had the highest number of tillers plant^{-1} (17.83), followed by variety V_9, though the two had statistically similar numbers. Conversely, the variety V_6 (Modhumala) had the lowest number of tillers plant^{-1} (9.853).

Table 1. Number of leaves plant^{-1} of different aromatic rice varieties

Variety	Number of leaves plant^{-1} at different DAT			
	30 DAT	55 DAT	80 DAT	At harvest
V_1	24.25 e	57.25 e	64.17 b	62.83 b
V_2	24.25 e	55.75 e	57.58 cd	55.92 c
V_3	21.50 f	51.75 g	41.17 f	39.33 g
V_4	24.83 de	72.00 b	64.33 b	62.42 b
V_5	23.00 ef	52.25 fg	53.00 e	50.17 f
V_6	28.50 bc	55.00 ef	43.00 f	40.25 g
V_7	31.00 a	62.75 d	53.08 e	50.42 ef
V_8	26.75 cd	60.75 d	55.58 de	52.83 de
V_9	31.67 a	75.25 a	71.33 a	68.50 a
V_{10}	25.00 de	63.75 d	58.00 cd	55.17 cd
V_{11}	24.00 e	67.50 c	59.58 c	56.67 c
V_{12}	30.25 ab	67.00 c	63.25 b	60.50 b
LSD $_{(0.05)}$	2.232	2.945	3.606	2.437
CV (%)	8.06	9.99	11.97	12.96

Values followed by the same letter(s) did not differ significantly at a 5% level of probability. Here, V_1= Kalijira, V_2= Chiniatap 1, V_3= BRRI dhan50, V_4= Katari bhog 1, V_5= Badshabhog, V_6= Modhumala, V_7= Zirabhog, V_8= Shakkhorkhora, V_9= Chiniatap 2, V_{10}= Katari bhog 2, V_{11}= BRRI dhan37, V_{12}= BRRI dhan38

Table 2. Leaf area index of different aromatic rice varieties

Variety	Leaf area index hill^{-1} at different DAT		
	30 DAT	55 DAT	80 DAT
V_1	1.06	5.32 b	5.05 b
V_2	0.88	4.73 c	4.46 d
V_3	0.52	3.34 g	3.12 g
V_4	0.67	3.80 f	3.57 f
V_5	0.98	5.19 b	4.88 bc
V_6	0.49	3.26 g	3.05 g
V_7	0.91	4.90 c	4.69 c
V_8	0.74	4.10 e	3.86 e
V_9	0.84	4.46 d	4.23 d
V_{10}	0.60	3.70 f	3.48 f
V_{11}	1.14	5.92 a	5.64 a
V_{12}	1.08	5.81 a	5.49 a
LSD $_{(0.05)}$	NS	0.214	0.227
CV (%)	3.15	5.48	5.31

Variety V_{11} (BRRI dhan37) had the highest number of tillers plant^{-1} (25.08) among the varieties; variety V_{12} came in second, but the results were statistically similar. However, the variety V_6 (Modhumala) had the lowest number of tillers plant^{-1} (17.42), which was statistically comparable to the varieties V_1 and V_3.

The variety V_{11} (BRRI dhan37) had the greatest number of tillers plant^{-1} (21.25) at harvest, followed by varieties V_2 and V_{12}, though their numbers were statistically similar. Conversely, V_6 (Modhumala) showed the lowest (10.92) number of tillers plant^{-1}. Hossain *et al.* (2008) provided support for this outcome. They studied five local and three contemporary aromatic rice genotypes to determine the relationship between grain yield and morphological characteristics. They discovered that BRRI dhan37 produced the most fertile tillers per hill.

Leaf area index (LAI)

Significant differences were observed in the Leaf Area Index (LAI) of various aromatic rice varieties on different days after transplanting, as indicated in Table 2. Additionally, significant variation in LAI was noted among the aromatic rice genotypes examined from 55 DAT to 80 DAT.

Venkateswarlu and Maduley (1976) supported the idea that genetic, climatic, and nutritional factors

could account for these variations. This study also supports the findings of Shahidullah *et al.* (2009), which indicated that there were significant differences in leaf area index (LAI) between different genotypes of aromatic rice.

Flag leaf length (cm)

Out of all the varieties, variety V_{11} (BRRI dhan37) had the longest flag leaf length (37.72 cm), followed by variety V_9. Variety V_6 (Modhumala) had the shortest flag leaf length (29.05 cm).

Flag leaf breadth (cm)

The varieties with the greatest flag leaf breadth (1.98 cm) were V_8 (Shakkhorkhora), followed by V_3 and V_{11}, and the varieties with the lowest flag leaf breadth (0.58 cm) were V_6 (Modhumala).

Flag leaf area (cm²)

The variety with the highest flag leaf area (60.39 cm²) among the varieties was V_8 (Shakkhorkhora), followed by V_{11}, and the variety with the lowest flag leaf area (16.85 cm²) was V_6 (Modhumala).

Sheela *et al.* (1990) reported similar results. After researching how rice cultivars' flag leaves affected spikelet sterility and grain yield, they found a positive correlation between flag leaf area and yield-related characteristics as well as grain yield. Grain yield, spikelet fertility, panicle size, grain size, and weight are all significantly influenced by the flag leaf.

SPAD (Soil and Plant Analysis Development) value of flag leaf

Significant differences were found in the SPAD value of the flag leaf (chlorophyll content) of various aromatic rice varieties, as shown in Table 3. Out of all the varieties, variety V_{11} (BRRI dhan37) had the highest SPAD value (44.95) for flag leaf chlorophyll content, followed by variety V_{12}. Variety V_6 (Modhumala) had the lowest SPAD value (31.27) for flag leaf chlorophyll content.

Munshi (2005) reported a similar outcome. They found a positive correlation between rice grain yield and chlorophyll content, and they demonstrated that genotypes with higher yields also had higher chlorophyll contents.

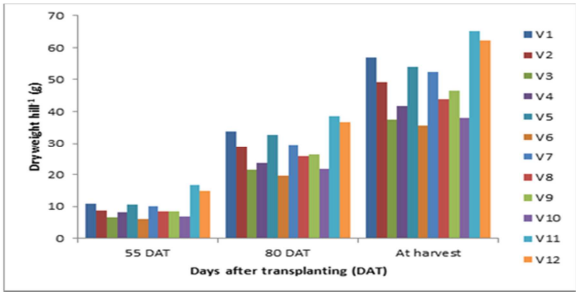


Fig. 3. Dry weight hill^{-1} of different aromatic rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability

Dry weight hill^{-1}

Different aromatic rice varieties' dry weight hill^{-1} revealed various noteworthy variations, as shown in Fig. 3. It was observed that of the varieties, variety V_{11} (BRRI dhan37) had the highest dry weight hill^{-1} at 55 DAT, 80 DAT, and harvest, followed by variety V_{12}. Conversely, variety V_6 (Modhumala) had the lowest dry weight hill^{-1} at 55 DAT, 80 DAT, and harvest, with variety V_3 following. Higher tiller numbers and grain yields were associated with higher dry-weight hill^{-1} values.

Crop growth rate (mg cm^{-2} d^{-1})

Table 4 presents notable variations in the crop growth rate of various aromatic rice varieties. The increased CGR can be attributed to elevated leaf area index values and light interception, which in turn boost photosynthetic rate and dry matter production. The highest crop growth rate (2.21 mg cm^{-2} d^{-1}) among the varieties was found in variety V_5 (Badshavog) at 55-80 DAT. This variety was followed by varieties V_1, V_{11}, and V_{12}, and at harvest, variety V_{11} (BRRI dhan37) had the highest crop growth rate (2.67 mg cm^{-2} d^{-1}). This variety was followed by variety V_{12}.

However, at 55-80 DAT and 80 DAT-at harvest, the variety V_6 (Modhumala) showed the lowest crop growth rate, followed by variety V_3. These findings agree with those of Miah *et al.* (1994) and Shahidullah *et al.* (2009), who found significant varietal differences in CGR at various growth stages.

Table 3. Flag leaf length, breadth, area and SPAD value of flag leaf of different aromatic rice varieties

Variety	Morpho-physiological parameters			
	Length of flag leaf (cm)	Breadth of flag leaf (cm)	Flag leaf area hill^{-1} (cm^2)	SPAD value of flag leaf
V_1	32.97 c	0.97 d	31.98 c	42.42 b
V_2	32.04 d	0.69 fg	22.11 f	42.04 b
V_3	31.97 d	1.23 b	39.32 b	39.69 c
V_4	32.50cd	1.27 b	41.28 b	42.10 b
V_5	30.99 e	0.76 ef	23.55 ef	38.83 c
V_6	29.05f	0.58 g	16.85 g	31.27 e
V_7	30.38 e	0.90 de	27.34 de	42.61 b
V_8	30.50 e	1.98 a	60.39 a	39.23 c
V_9	35.08 b	0.90 de	31.57 cd	38.03 cd
V_{10}	30.94 e	0.75 ef	23.21 ef	36.20 d
V_{11}	37.72 a	1.15 bc	43.38 b	44.95 a
V_{12}	32.60 cd	1.04 cd	33.90 c	43.17 ab
LSD ($_{0.05}$)	0.6580	0.1417	4.324	1.892
CV (%)	8.30	4.12	6.58	10.84

Table 4. Crop growth rate, relative growth rate and absolute growth rate of different aromatic rice varieties

Variety	Crop growth rate (CGR) (mg cm^{-2} day^{-1})		Relative growth rate (RGR) (mg g^{-1} day^{-1})		Absolute growth rate (AGR) (cm hill^{-1} day^{-1})	
	55–80 DAT	80 DAT at harvest	55 – 80 DAT	80 DAT at harvest	30 – 55 DAT	55 – 80 DAT
V_1	2.29 a	2.32 bc	19.75 cd	9.08 de	1.36 c	1.31 b
V_2	2.01 ab	2.03 cd	20.72 a	9.23 cd	1.39 c	1.13 cd
V_3	1.48 cd	1.60 e	20.39 ab	9.65 bc	1.58 bc	1.09 d
V_4	1.55 cd	1.82 de	18.62 e	9.94 b	1.44 c	1.24 bc
V_5	2.21 a	2.12 cd	19.58 d	8.69 e	1.54 bc	1.02 d
V_6	1.34 d	1.62 e	20.09 bc	10.5 a	2.28 a	1.29 b
V_7	1.94 ab	2.29 bc	18.62 e	9.97 b	1.37 c	1.24 bc
V_8	1.73 bc	1.82 de	19.40 d	9.29 cd	2.12 a	1.36 b
V_9	1.78 bc	2.01 cd	19.49 d	9.83 b	1.96 ab	1.62 a
V_{10}	1.50 cd	1.62 e	20.28 b	9.66 bc	1.65 bc	1.56 a
V_{11}	2.19 a	2.67 a	14.56 g	9.14 de	1.55 bc	1.03 d
V_{12}	2.19 a	2.53 ab	15.68 f	9.09 de	1.38 c	1.06 d
LSD ($_{0.05}$)	0.3213	0.3076	0.3935	0.4544	0.435	0.1312
CV (%)	4.864	5.233	7.217	6.899	7.62	5.38

Relative growth rate (mg g^{-1} d^{-1})

Significant variances in the relative growth rates of various aromatic rice varieties are displayed in Table 4. Among the varieties, it was found that the variety V_2 had the highest relative growth rate (20.72 mg g^{-1} d^{-1}) between 55 and 80 DAT. Variety V_3 was next in line, and variety V_6 (Modhumala) had the highest relative growth rate (10.5) at harvest time of 80 DAT. However, at 55-80 DAT, the variety V_{11} (BRRI dhan37) showed the lowest relative growth rate (14.5 mg g^{-1} d^{-1}) and at harvest, at 80 DAT, the variety V_5, which was followed by varieties V_{11} and V_{12}, showed the lowest relative growth rate (8.69 mg g^{-1} d^{-1}). With increasing crop age, the relative growth rate (RGR) dropped.

Absolute growth rate (cm hill^{-1} day^{-1})

Table 4 presents the significant differences in the absolute growth rate of various aromatic rice varieties. It indicates a gradual increase in absolute growth rate up to 30-55 DAT across all genotypes studied. Between 55 and 80 DAT until harvest, AGR values among the genotypes dropped. It was noted that, of the varieties, variety V_6 (Modhumala) had the highest absolute growth rate (2.28 cm hill^{-1} day^{-1}) at 30-55 DAT. Variety V_8 was next in line, and variety V_9 (Chiniatap 2) had the highest absolute growth rate (1.62 cm hill^{-1} d^{-1}) at 55-80 DAT.

Conversely, variety V_1 (Kalijira) had the lowest absolute growth rate (1.36 cm hill^{-1} d^{-1}) at 30-55 DAT, followed by variety V_2, and variety V_{11} (BRRI dhan11)

had the lowest absolute growth rate (1.03 cm hill^{-1} d^{-1}) at 55-80 DAT, followed by variety V_{12}. Mondal *et al.* (2010) also reported similar variations in the AGR values in aromatic rice mutants.

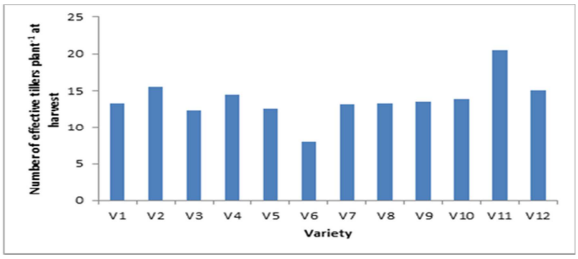


Fig. 4. The number of effective tillers plant^{-1} of different aromatic rice varieties. Values followed by the same letter(s) did not differ significantly at a 5% level of probability

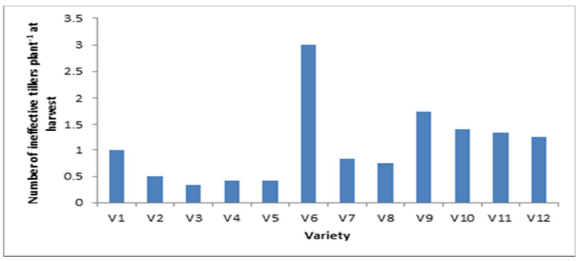


Fig. 5. Number of ineffective tillers plant^{-1} of different aromatic rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability

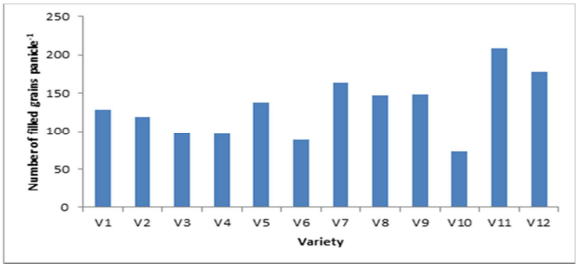


Fig. 6. Number of filled grains panicle^{-1} of different aromatic rice varieties. Values followed by the same letter(s) did not differ significantly at a 5% level of probability

Yield and yield contributing character

Number of effective tillers plant^{-1}

Significant variations were observed in the number of effective tillers plant^{-1} of various aromatic rice varieties, as illustrated in Fig. 4. The variety V_{11} (BRRI dhan37) had the greatest number of effective tillers (20.50) out of all the varieties; it was followed by varieties V_2 and V_{12}. Conversely, variety V_6 (Modhumala) had the lowest number of effective tillers (7.917). Similar results were also reported by Jisan *et al.* (2014) and Yang *et al.* (2001).

Number of ineffective tillers plant^{-1}

Fig. 5 presents the significant differences in the number of ineffective tillers plant^{-1} of various aromatic rice varieties. The variety V_6 (Modhumala) had the highest percentage of ineffective tillers (3.00) out of all the varieties; Variety V_9 came in second. On the other hand, variety V_4 (Kataribogh 1) had the fewest ineffective tillers (0.42), followed by varieties V_2, V_4, and V_5.

Number of filled grains panicle^{-1}

Fig. 6 illustrates the significant variation in the number of filled grains panicle^{-1} of various aromatic rice varieties. The variety V_{11} (BRRI dhan37) had the greatest number (208.0) of filled grains panicle^{-1} among the varieties; it was followed by variety V_{12}. Conversely, the variety V_{10} (kataribhog 2) had the lowest (72.67) number of filled grains panicle^{-1}, followed by variety V_6. Similar results were also observed by Kusutani *et al.* (2000) and Chowdhury *et al.* (2005).

Number of unfilled grains panicle^{-1}

As seen in Fig. 7, there were notable differences in the number of unfilled grains panicle^{-1} between various aromatic rice varieties. The variety V_{12} (BRRI dhan38) had the greatest number of unfilled grains panicle^{-1} (42.92) among all the varieties, followed by V_4 and V_{10}. Conversely, variety V_8 (Shakkhorkhora) had the lowest number of unfilled grains, panicle^{-1} (9.167), followed by varieties V_6 and V_{11}. Similar result was also observed by Chowdhury *et al.* (2005).

Spikelet fertility (%)

Significant differences in spikelet fertility (%) between various aromatic rice varieties are displayed in Table 5. Out of all the varieties, variety V_{11} (BRRI dhan37) had the highest number of spikelets fertilized (93.65%), followed by varieties V_1 and V_8. Conversely, the variety V_{10} (Kataribhog 2) had the lowest number of spikelet fertility (69.94%), followed by variety V_4.

Table 5. Yield contributing parameters of different aromatic rice varieties

Variety	Yield contributing parameters			
	Number of total grains panicle^{-1}	Spikelet fertility (%)	Panicle length (cm)	Weight of 1000 grains (g)
V_1	134.4 f	95.24 a	27.47 cd	15.57 c
V_2	134.7 f	88.64 b	28.89 b	13.93 e
V_3	111.2 h	87.98 b	22.78 h	17.33 b
V_4	130.0 g	74.10 d	26.98 de	17.13 b
V_5	160.3 d	86.28 b	24.65 g	13.15 f
V_6	100.6 i	87.64 b	22.55 h	22.45 a
V_7	187.2 b	87.34 b	25.99 f	12.93 f
V_8	153.9 e	95.39 a	26.20 ef	14.03 e
V_9	168.3 c	88.12 b	27.87 c	13.27 f
V_{10}	103.9 i	69.94 e	27.06 cd	14.97 d
V_{11}	222.1 a	93.65 a	29.90 a	15.87 c
V_{12}	221.2 a	80.61 c	29.07 b	17.70 b
$LSD_{(0.05)}$	4.257	3.329	0.787	0.5461
CV(%)	13.56	8.314	4.78	11.77

Table 6. Yield parameters of different aromatic rice varieties

Variety	Yield parameters		
	Straw yield (tons ha^{-1})	Biological yield (tons ha^{-1})	Harvest index (%)
V_1	5.44 b	8.15 bc	33.25 bc
V_2	4.88 d	7.22 de	32.41 c
V_3	3.98 f	5.50 g	27.64 e
V_4	4.60 de	6.37 f	27.79 e
V_5	5.24 bc	7.81 c	32.91 bc
V_6	3.92 f	5.34 g	26.59 f
V_7	4.92 cd	7.40 d	33.51 b
V_8	4.52 e	6.42 f	29.60 d
V_9	4.78 de	6.83 e	30.01 d
V_{10}	4.18 f	5.71 g	26.80 ef
V_{11}	6.10 a	9.40 a	35.11 a
V_{12}	5.48 b	8.29 b	33.90 b
LSD 0.05	0.321	0.394	0.9504
CV (%)	6.85	8.44	9.42

Panicle length (cm)

Significant variations in panicle length (cm) between various aromatic rice varieties are displayed in Table 5. Variety V_{11} (BRRI dhan37) had the longest panicle length (29.90 cm) out of all the varieties; it was followed by varieties V_2 and V_{12}. On the other hand, variety V_6 (Modhumala) had the lowest number of panicle length (22.55 cm), followed by variety V_3.

Weight of 1000 grains (g)

Table 5 presents the weight of 1000 grains (g) of various aromatic rice varieties, highlighting significant differences. The variety V_6 (Modhumala) had the highest value of all the varieties, 22.45 g, and was followed by varieties V_3, V_4, and V_{12}. On the other hand, the variety V_7 (Zirabhog) had the lowest weight value of 1000 grains (12.93 g), followed by variety V_5. Similar results were also observed by Murshida *et al.* (2017) and Sarkar *et al.* (2014).

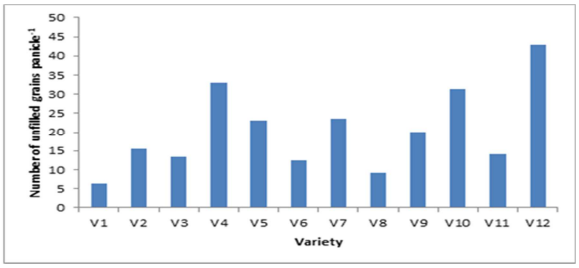


Fig. 7. The number of unfilled grains panicle^{-1} of different aromatic rice varieties. Values followed by the same letter(s) did not differ significantly at 5% level of probabilit

Grain yield (tons ha^{-1})

Fig. 8 presents notable variations in the grain yield of several aromatic rice varieties. Variety V_{11} (BRRI

dhan37) had the highest grain yield value (3.30 tons ha^{-1}) among the varieties, with variety V_{12} coming in second. On the other hand, the variety V_6 (Modhumala) had the lowest grain yield value, followed by variety V_3. Similar result was also observed by Haque *et al.* (2013), Murshida *et al.* (2017), and Sarker *et al.* (2013).

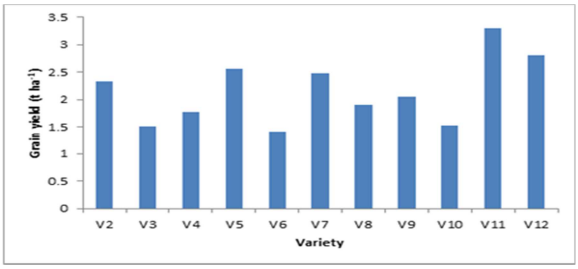


Fig. 8. Grain yield of different aromatic rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability

Straw yield (tons ha^{-1}), Biological yield (tons ha^{-1}), and Harvest index (%) of different aromatic rice varieties also showed significant differences presented in Table 6. Similar result was also observed by Chowdhury *et al.* (2005). They showed that grain yield was positively correlated with biological yield in rice.

Conclusion

After taking into account the previous discussion, it can be said that twelve aromatic rice varieties differed significantly in their various morpho-physiological traits. Because it had the most total tillers plant^{-1}, dry weight hill^{-1}, effective tillers plant^{-1}, panicle length, number of grains panicle^{-1}, 1000 grain weight, grain yield, biological yield, straw yield, and harvest index of any aromatic rice variety, V_{11} (BRRI dhan37) outperformed the others. Based on the aforementioned data, it can be said that, in comparison to other aromatic rice varieties, V_{11} (BRRI dhan37) performed better in terms of its morpho-physiological and yield characteristics. It is recommended that more thorough research be done on aromatic rice plants using more parameters to obtain more information. Additional experiments with the varieties I used in my experiment at various locations in Bangladesh are also necessary to make a final recommendation.

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