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Performance of Five Selected Hybrid Rice Varieties in Aman Season

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Abstract: The performance of five hybrid rice varieties namely Shakti 2, Suborna 8, Tia, Aloron and BRRI hybrid dhan 2 in *Aman* season was conducted and inbred BRRI dhan 33 was used as check variety. The result showed that the hybrid varieties exhibited superiority in respect of growth characters such as tillers hill^{-1}, leaves hill^{-1}, total dry matter (TMD) hill^{-1}, leaf area hill^{-1}, Leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) over the inbred. The highest TDM hill^{-1} (84.0 g), maximum leaf area hill^{-1} (1787cm^2), average highest CGR and RGR (40.63 g m^{-2} d^{-1} and 17.9 mg g^{-1} d^{-1}) were observed Tia and lowest TDM hill^{-1} (70.10 g), minimum leaf area hill^{-1} (1198cm^2), average lowest CGR and RGR (27.26 g m^{-2} d^{-1} and 13.35 mg g^{-1} d^{-1}) were observed in BRRI dhan 33. These hybrid varieties also showed higher yield attributes *viz*. effective tillers hill^{-1}, 1000-grain weight, biological yield and harvest index (HI) over the inbred. The highest grain yield was achieved from Tia (7.82 t ha^{-1}), which was closely followed by Shakti 2 (7.65 t ha^{-1}). These two hybrid varieties produced 24.0% higher yield over the inbred BRRI dhan 33. Effective tillers hill^{-1} and higher filled grains panicle^{-1} mainly contributed to the higher grain yield of hybrid varieties.

Keywords: Hybrid Rice, Inbred Rice, Aman Season, Growth Characters

1. Introduction

Rice (*Oryza Sativa* L.) is the staple food for the half of the world's population. Bangladesh ranks 4th in both area and production and 6th in the production of per hectare yield of rice. The three seasons of Rice namely, Aus, Aman and Boro covers total 80% of the total cultivable area of the country. Bangladesh will require about 27.26 million tons of rice for the year 2020 due to increase of population. The increase rate of population is 1.42% (BBS, 2010) and the decreasing rate of agricultural land is 1%. Higher yield can be achieved by two processes, firstly through the cultivation of hybrid varieties, and secondly by following improved management practices (IRRI, 1993). Physiologist defines growth generally as increase in dry mass. According to Tanaka (1980) growth is quantitative and qualitative changes that facilitate increased dry matter production and ultimate grain weight. The growth analysis means the calculation of the components viz. crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) etc. These components are widely used by plant physiologists and provide some indices of the plant response to its environment (Ahlawal and Saraf, 1983). The yield of rice depends on its different growth parameters, i.e. leaf area index, dry matter production and its partitioning, tillering, etc. (Shams, 2002). High dry matter production, leaf area index, leaf area duration (LAD), CGR, NAR and RGR are reflection in high grain yield of rice (Thakur and

Patel, 1998). Hybrid rice technology has been introduced through IRRI and BRRI and commercial seed companies of India and China during the last ten years and has already gained positive experience in the *Boro* season. It is therefore a prime need to conduct more research work to find out and develop sustainable technologies regarding hybrid rice cultivation under the prevailing local conditions in the *Aman* season. Julfiquar et al. (1998), observed that the modern inbred rice varities in Bangladesh had longer growth duration of 135-150 days in *Aman* season with a low daily yield, while high daily yield in hybrid rice was due to its short duration of 120-130 days. Therefore, it is postulated that if hybrid rice is introduced, crop duration can be reduced by 20-40 days. However, some of the newly introduced hybrid rice varities are Shakti 2, BRRI hybrid dhan-2, Suborna 8, Tia, Aloron. So it is prime need to evaluate their performances in *Aman* season. Under these circumstances, the study was undertaken to compare the performance of aforementioned hybrid and inbred rice varieties in *Aman* season.

2. Materials and Methods

The study was conducted in the experimental farm, Sher-e-Bangla Agricultural University, Bangladesh during the period from April to November 2013. Five hybrid varieties (Aloron, BRRI hybrid dhan 2, Shakti 2, Suborna 8 and Tia) and one inbred check variety (BRRI dhan 33) were used as treatments for this study followed by Randomized Complete Block Design with three replications, where the experimental area was divided into three blocks representing the replications to reduce soil heterogenetic effects. These hybrid varieties were selected as based on market demands. The experimental land was first opened with a tractor and prepared thoroughly by ploughing and cross ploughing. Finally each plot was prepared by puddling for transplanting seedlings. Cowdung at the rate of 10 t ha^{-1} was applied at the first ploughing and then fertilized with 120, 60, 80 and 50 kg of Urea, TSP, MP and Gypsum, respectively. One third urea and all other fertilizers were applied toincorporate into the soil at the time of final land preparation, and the rest amount of urea was top dressed in two equal splits, at 25 DAT and 50 DAT.

Data were collected on the following crop characters:

2.1. Plant Morphology

2.1.1. Plant Height, Tillers $Hill^{-1}$ and Leaves $Hill^{-1}$

These three indexes were measured at the time of 50, 70 and 90 DAT (Days after transplanting) and at harvest.

2.1.2. Leaf Area $Hill^{-1}$ and Leaf Dry Weight

Leaf area was measured by an electronic area meter (LI 3000, USA) and their corresponding dry weight was recorded after drying at 72±2°C for 72 hours. Sub-sampling was done when the sample volume was excess and difficult to handle. Finally, leaf area was calculated $hill^{-1}$.

2.1.3. Leaf Area Index

Leaf area index (LAI) was measured at the time of 50, 70 and 90 DAT and at harvest. Data were recorded as the average of 03 plants selected at random the inner rows of each plots. The final data calculated multiplying by a correction factor 0.75 as per Yoshida (1981).

2.1.4. Root, Stem and Leaf Dry Matter $Hill^{-1}$

Root, Stem and leaf dry matter $hill^{-1}$ were recorded at 50, 70 and 90 DAT and at harvest from 10 randomly collected root $hill^{-1}$ of each plot from inner rows and their corresponding dry weight was recorded after drying at 72±2°C for 72 hours.

2.1.5. Total Dry Matter $Hill^{-1}$

Total dry matter $hill^{-1}$ was recorded at 50, 70 and 90 DAT and at harvest by adding stem dry matter and leaves dry matters $hill^{-1}$.

2.2. Plant Growth

2.2.1. Crop Growth Rate (CGR)

Increase of plant material per unit of time per unit of land area.

$$\mathrm{CGR} = \frac{1}{\mathrm{A}} \times \frac{\mathrm{W_2} - \mathrm{W_1}}{\mathrm{T_2} - \mathrm{T_1}} \mathrm{g}\, m^{-2} d^{-1}$$

2.2.2. Relative Growth Rate (RGR)

Increase of plant material per unit of material present per unit of time.

$$\mathrm{RGR} = \frac{\mathrm{L_n W_2} - \mathrm{L_n W_1}}{\mathrm{T_2} - \mathrm{T_1}} \mathrm{mg}\, g^{-1} d^{-1}$$

2.2.3. Net Assimilation Rate (NAR)

Increase of plant material per unit of leaf area per unit of time

$$\mathrm{NAR} = \frac{\mathrm{W_2\text{-}W_1}}{\mathrm{T_2\text{-}T_1}} \times \frac{\mathrm{L_n LA_2\text{-}L_n LA_1}}{\mathrm{LA_2\text{-}LA_1}} \mathrm{g}\, m^{-2} d^{-1}$$

Where,

A = Ground area (m^2)

L_n = Natural logarithm

LA_1 = Leaf area at time T_1 (m^2)

LA_2 = Leaf area at time T_2 (m^2)

W_1 = Total plant dry matter at time T_1 (g)

W_2 = Total plant dry matter at time T_2 (g)

2.3. Yield Parameters

Harvesting was done when 80 to 90% of the grains become golden yellow on color. The harvested crops then threshed and cleaned. The grain weight was recorded after proper drying in the sun (14% moisture). Data were recorded on the following yield parameters:

2.4. Days to Maturity

Days to maturity were recorded by counting the number of

days required to harvest in each plot.

2.5. Tillering Character

2.5.1. Effective and Non-effective Tillers Hill^{-1}

The total number of effective and non-effective tillers hill^{-1} were counted as the number of panicle bearing tiller during harvesting. Data were counted from 10 selected hills and average value was recorded.

2.5.2. Filled and Unfilled Grains Panicle^{-1}

The total numbers of filled andunfilled grain were collected randomly from selected 10 plants of a plot on the basis of grain in the spikelet and then average numbers of filled grains panicle^{-1} was recorded.

2.5.3. Weight of 1000 Grain

One thousand clean oven dried (72 ± 2°C for 72 hours with 14% moisture) grains were counted from seed stock obtained from hill^{-1} in each plot and weighed by using an electronic balance.

2.6. Yield

2.6.1. Grain and Straw Yield

The dry weight of grains, straw of central 1 m^2 area and five sample plants were added to the respective unit plot yield to record the final grain yield plot^{-1} and finally converted to ton hectare^{-1} (t ha^{-1}).

2.6.2. Biological Yield

Grain yield and straw yield together were regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield + Straw yield.

2.7. Harvest Index

Harvest index (HI) was calculated from the grain and straw yield of rice for each plot and expressed in percentage.

$$HI = \frac{Economic\ yierd\ (grain\ weight)}{Biological\ yierd\ (total\ dry\ weight)} \times 100$$

2.8. Statistical Analysis

The data obtained for different parameters were statistically analyzed to obtain the level of significance using the computer MSTAT package program developed by Russel (1986). The significance of the differences among the treatment means were estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

3. Result and Discussion

3.1. Plant Height

Plant height increased progressively with the advancement of time and growth stages (Fig. 1). At 50, 70, 90 DAT and harvest, tallest plant was Tia (78.46, 101.32, 108.3 and 110.10 cm respectively) which was statistically identical with Shakti 2 and Suborna 8. The shortest was Aloron (63.88 cm) at 50 DAT, and at 70, 90 DATit was in BRRI dhan 33 (83.33 and 87.62 cm, respectively). At the time of final harvest, the shortest was in BRRI dhan 33 (87.6 cm) followed by BRRI hybrid dhan 2 (94.24 cm) with same statistical rank. Rest of the hybrid rice showed intermediate status. Om *et al*. (1998) and Kabir*et al.* (2004) also observed variation in plant height due to varietal differences.

3.2. Tillers Hill^{-1}

Significant variation in the total number of tillers hill^{-1} among the hybrid and inbred rice varieties at all growth stages (Fig. 2). At different growth stages (50, 70 and 90 DAT) maximum number of tillers hill^{-1} was found from Tia (16.23, 21.34 and 21.45 respectively) and the lowest number of total tiller was recorded in BRRI hybrid dhan 2 (11.66, 16 and 15.76 respectively). At final harvest, Tia had the maximum number of tillers hill^{-1} (19.1) and the lowest was in BRRI hybrid dhan 2 (14.34). With the decrease of tillers hill^{-1}, yield also decease considerably (Hoque, 2004).

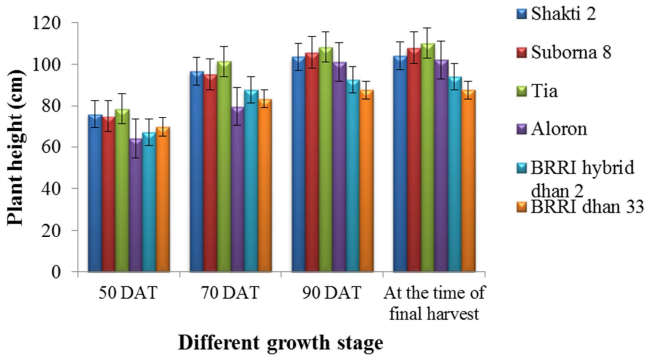

Figure 1. *Plant height at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

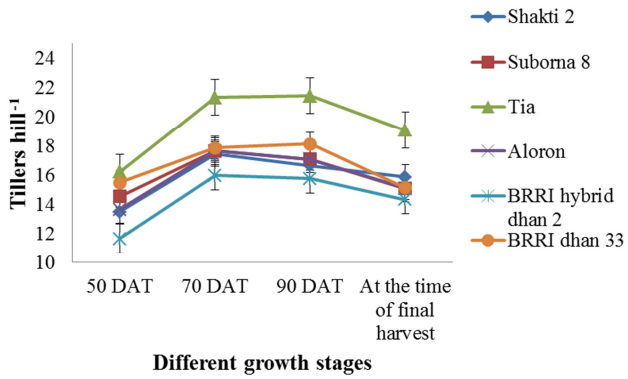

Figure 2. *Tillers hill^{-1} at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

3.3. Leaves Hill^{-1}

The total number of leaves was continued to increase up to 70 DAT and thereafter declined (Fig. 3). At 50, 70 and 90 DAT, the highest number of leaves was observed in Tia (78.67, 94.35 and 91.34 respectively) followed by Suborna 8

and shati 2 and they were statistically different at 5% level of probability. BRRI hybrid dhan 2 produced the lowest number of leaves (64.34, 58.68 and 73.00, respectively) at 50, 70 and 90 DAT followed by BRRI dhan 33.

3.4. Leaf Area Hill^{-1}

The development of leaf area (LA) over time in test rice varieties was significantly varied during the vegetative and reproductive growth phases (Fig. 4). At 50 and 70 DAT, the highest leaf area hill^{-1} was produced by Tia (1312 and 2082 cm^2 respectively) that was significantly different from others followed by Shakti 2 and the lowest leaf area was in BRRI dhan 33 (756 and 1425 cm^2 respectively). At 90 DAT, the highest and the lowest were recorded in Tia (1967 cm^2) and BRRI dhan 33 (1413 cm^2). The result is also supported by the result of Chandra and Das (2007) in rice. The result indicated that hybrid rice varieties produced the higher leaf area than the check variety and the variation in leaf area.

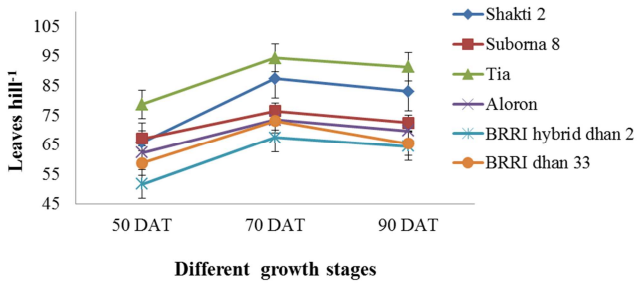

Figure 3. *Leaves hill^{-1} at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

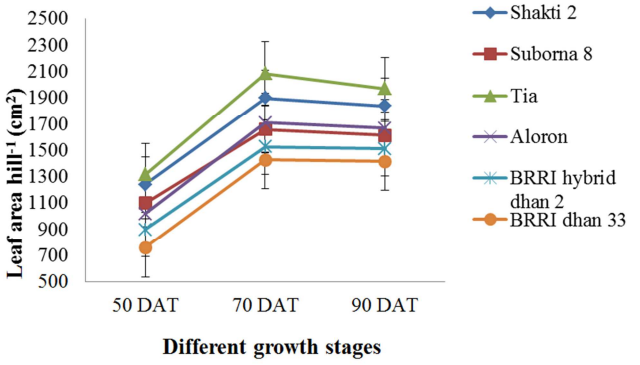

Figure 4. *Leaf area hill^{-1} at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

3.5. Leaf Area Index (LAI)

Significant difference on leaf area index (LAI) in the studied rice varieties was observed from 50 DAT to 90 DAT (Fig. 5). At 50 DAT, the maximum LAI was observed in Tia (3.38) followed by Shakti 2 (3.23). At 70 DAT, the maximum LAI was observed in Tia (4.91) followed by Shakti 2 (4.55). In contrast, at 50 and 70 DAT, BRRI dhan 33 showed the lowest LAI (2.28 and 3.62, respectively) over their growth period. On the other hand, at 90 DAT the hybrid rice variety Tia and inbred BRRI dhan 33 showed the highest and the lowest LAI (4.72 and 3.59) respectively. The high yielding varieties possessed higher LAI values throughout the whole growth period which led to the higher biomass production and yield (Reddy *et al*., 1995).

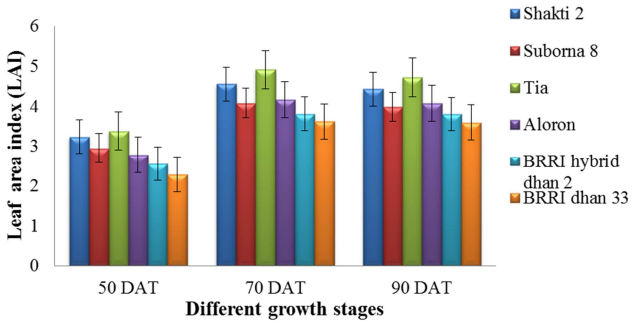

Figure 5. *Leaf area Index (LAI) at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

3.6. Root Dry Matter Hill^{-1}

There was a significant variation observed in root dry matter production among test rice varieties at different growth stages (Table 1). At 50, 70 and 90 DAT maximum root dry matter was observed in Tia and the lowest was found in BRRI dhan 33. Result revealed that root dry matter gradually increased with time.

3.7. Stem Dry Matter Hill^{-1}

There was significant difference observed in stem dry matter among the hybrid and inbred rice varieties at different growth stages (Table 1). At vegetative and reproductive stages the maximum stern dry matter was again found in Tia and the lowest was found in the inbred variety.

3.8. Leaf Dry Matter Hill^{-1}

At 50DAT maximum leaf dry matter was observed in Tia and the lowest was found in BRRI dhan 33. At reproductive stage (70 and 90 DAT) the maximum leaf dry matter was found in Tia (14.33 and 15.9 g) and the lowest was found in the inbred variety BRRI dhan 33. Result revealed that leaves dry matter gradually increased with time (Table 1).

3.9. Total Dry Matter Hill^{-1}

This result revealed that dry matter production increased with age of rice plant (Fig. 6). At 90 DAT, Tia showed the highest dry matter hill^{-1} (84.0 g) followed by Tia. On the other hand, BRRI dhan 33 produced the lowest TDM hill^{-1} (70.10 g) preceded by BRRI hybrid dhan 2 and they were significantly different. At 50 and 70 DAT, the highest TDM hill^{-1} was observed in Tia (27.33 and 56 g, respectively) and the lowest TDM was recorded in BRRI dhan 33 (20.63 g and 44.56 g, respectively). The increase of TDM was dependent on the leaf area production as reported by Chandra and Das (2007).

Table 1. *Dry matter accumulation of hybrid and inbred rice varieties at different days after transplanting (DAT) in Aman Season.*

Treatments	Root dry matter Hill^{-1} (g)			Stem dry matter Hill^{-1} (g)			Leaf dry matter Hill^{-1} (g)		
	50 DAT	70 DAT	90 DAT	50 DAT	70 DAT	90 DAT	50 DAT	70 DAT	90 DAT
Shakti 2	6.2a	8.3b	13.8b	15.03b	33.53c	53.9b	6.7b	14.0b	15.0b
Suborna 8	5.4b	6.7d	13.5c	13.10d	31.02d	50.2d	5.7d	12.70d	14.2d
Tia	6.3a	8.4a	14.2a	15.13a	35.7a	54.2a	6.9a	14.33a	15.9a
Aloron	4.51c	8.2c	11.5e	14.96c	33.7b	53.2c	6.6c	13.2c	14.8c
BRRI hybrid dhan 2	5.5b	6.56e	12.2d	10.53e	27.16e	45.58e	5.6e	11.8e	14.1e
BRRI dhan 33	4.4c	6.4f	11.4f	10.13f	24.83f	44.5f	5.1f	11.7f	13.3f
CV (%)	8.65	7.26	6.1	9.87	7.04	8.92	8.87	7.48	9.3

Values with common letter (s) within a column do not differ significantly at 5% level of probability analyzed by DMRT.

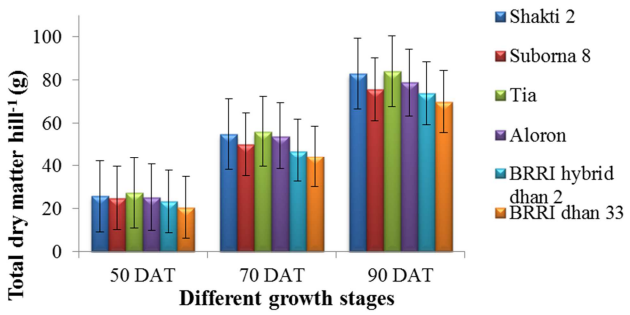

Figure 6. *Total dry matter hill^{-1} (TDM) at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

3.10. Crop Growth Rate

At vegetative stages (50 -70 DAT), the hybrid rice Shakti 2 showed the highest CGR value (44.71 g m^{-2} d^{-1}) followed by Tia (42.9 g m^{-2} d^{-1}). In contrast, the lowest CGR was observed in BRRI dhan 33 (28.27 g m^{-2} d^{-1}) followed by BRRI hybrid dhan 2 (31.25g m^{-2} d^{-1}). At reproductive stage (70 -90 DAT), the highest CGR was observed in Tia (38.36g m^{-2} d^{-1}) followed by Shakti 2 (34.4 g m^{-2} d^{-1}) The lowest CGR value at 70-90 DAT was observed in BRRIdhan 29 (26.25 g m^{-2} d^{-1}1) preceded by BRRI hybrid dhan 2 (29.05 g m^{-2} d^{-1}). Decline of CGR at the latter stage might attributed to the decrease in LAI at the latter stage (Table 2). So, the CGR increased along with increases in LAI. This result is in agreement with the finding of Yang*et al*. (2011).

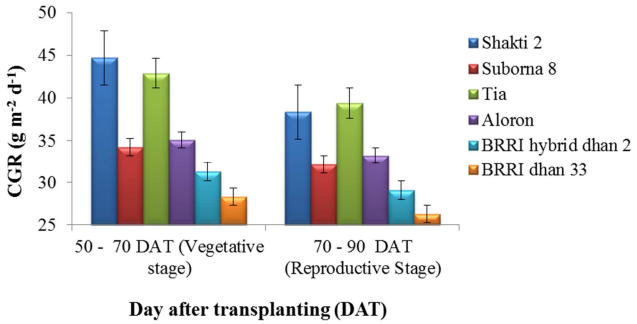

Figure 7. *Crop growth rate (CGR) at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

3.11. Relative Growth Rate

It was observed an inverse relationship between RGR and plant age (Fig. 8). The RGR showed the higher values at vegetative stages (50 -70 DAT) than the reproductive stage (70-90 DAT). Shakti 2 produced the highest RGR value (22.75 mg g^{-1} d^{-1}) at 50-70 DAT followed by Tia (21.95 mg g^{-1} d^{-1}. In contrast, the lowest was observed in BRRI dhan 33 (18.65 mg g^{-1} d$^{-1)}$ at 50-70 DAT. At 70-90 DAT, the highest was in Tia (13.85 mg g^{-1} d^{-1}) and the lowest was in BRRIdhan 33 (8.05 mg g^{-1} d^{-1}). Generally, with the advancement of the plant age, the RGR decreased in most of the field crops (Dutta and Mondal, 1998).

3.12. Net Assimilation Rate

At 50-70 DAT, the highest NAR (7.2 g m^{-2} d^{-1}) was in Shakti 2 followed by Tia (6.9 g m^{-2} d^{-1}) and the lowest (5.3 g m^{-2} d^{-1}) was in BRRI dhan 33 preceded by BRRI hybrid dhan 2 (5.1 g m^{-2} d^{-1}). At reproductive stage (70-90 DAT); the highest NAR (4.8 g m^{-2} d^{-1}) was recorded in Tia followed by Shakti 2 (4.6 g m^{-2} d^{-1}) with the same statistical rank while the lowest NAR value in BRRI dhan 33 (3.3 g m^{-2} d^{-1}) (Fig. 9). This result is agreed with result of Hoque (2004) who reported that high yielding rice had greater NAR than the low yielding ones.

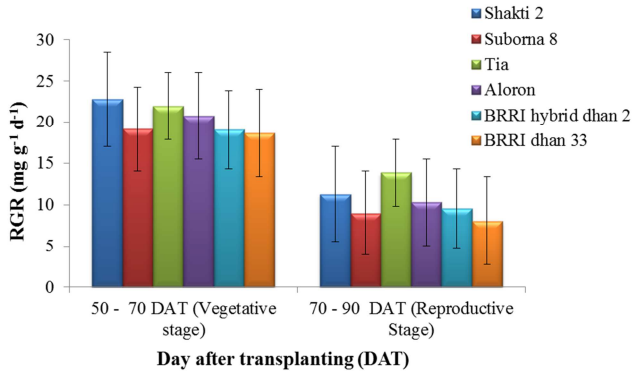

Figure 8. *Relative growth rate (RGR) at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

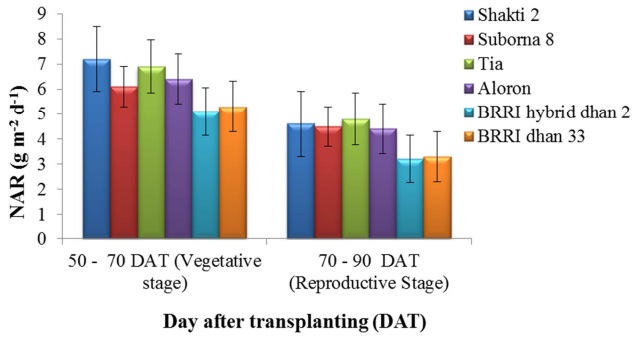

Figure 9. *Net assimilation rate (NAR) at different days after transplanting (DAT) in hybrid and inbred rice varieties.*

3.13. Panicle Length

The longest panicle was observed in Tia (26.34 cm) followed by Aloron (26.32 cm) and Shakti 2 (26.26 cm). The shortest was in BRRI dhan 33 (24.33 cm) preceded by BRRI hybrid dhan 2 (25.00 cm) (Fig. 10). Salam *et al.* (1990) reported that higher yield in rice can be achieved from panicle length.

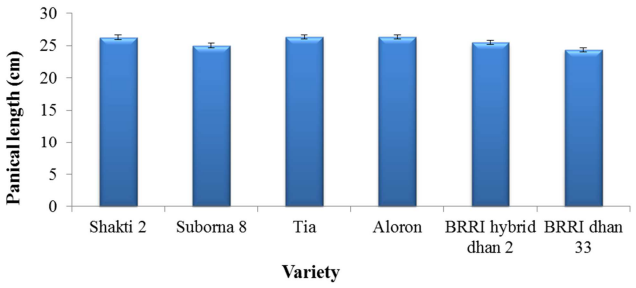

Figure 10. *Panicle length of five selected hybrid and inbred rice varieties.*

4. Yield Parameters

4.1. Days to Maturity

The maximum days to maturity (138.86) were observed from Shakti 2 which were statistically similar (135.29) with Suborna 8 and closely followed (128.26) Tia, while the minimum days (115.68) was found from Aloron (Fig. 11). Similar results also reported by Mondal*et al*. (2005); and Chowdhury *et al*. (1999) from their earlier experiment.

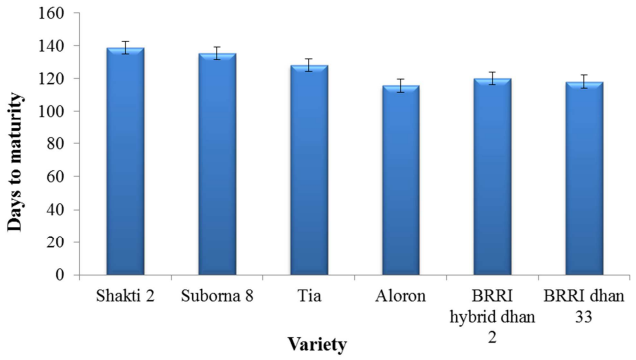

Figure 11. *Days to maturity of five selected hybrid and inbred rice varieties.*

4.2. Effective Tillers Hill^{-1}

The highest number of effective tillers hill^{-1} was recorded in Tia (13.38) followed by Shakti 2 (11.67) and the lowest number of effective tillers hill^{-1} was observed in BRRI dhan 33 (7.05) preceded by BRRI hybrid dhan 2 (8.32) (Table 2). The above result of variability in effective tillers hill^{-1} are also in agreement with many workers (Yang el al., 2007; Shrirame and Muley, 2003; Munshi, 2005).

4.3. Non-effective Tillers Hill^{-1}

The highest number of non-effective tillers (5.25) was recorded in BRRI dhan 33 followed by BRRI hybrid dhan 2 (3.15) (Table 2). In contrast, the lowest number of non-effective tillers hill^{-1} was observed in Shakti 2 (2.30) followed by Tia (2.33).

4.4. Filled Grains Panicle^{-1}

Tia produced the highest number (222.30) followed by Shakti 2 (212.30). This result showed that there was no significant difference between Tia and Shakti 2. On the other hand, BRRI hybrid dhan 2 produced the lowest (159.90) preceded by BRRI dhan 33 (192.05) and they differed significantly (Table 2). This result is in agreement with the result of Dutta *et al.* (2002) who observed that yield was affected by the filled grains panicle^{-1}.

4.5. Unfilled Grains Panicle^{-1}

Shakti 2 produced the highest number (20.33) followed by Jagoron (17.33) and they differed significantly. On the other hand, the lowest number was recorded in BRRI hybrid dhan 2 (8.33) followed by Aloron (11.98) and Tia (13.33) (Table 2). Chowdhary*et al.* (1999) reported differences in number of unfilled grains panicle^{-1} due to varietal character.

4.6. Thousand Grain Weight

Aloron showed the highest 1000 – grain weight (29.95 g) due to heavier grain followed by Suborna 8 (28.65 g) which were significantly different. On the other hand, BRRI dhan 33 showed the lowest 1000 grain weight (22.56 g) due to lighter grain which showing significant difference with Shakti 2 (27.75g) (Table 2). Mondal*et al.* (2005) studied with 17 modern cultivars of transplant *Aman* rice and reported that 1000-grain weight differed significantly among the cultivars studied.

4.7. Grain Yield

Tia produced the highest grain yield (7.82 t ha^{-1}) followed by Shakti 2 (7.65 t ha^{-1}) and they were significantly different. On the other hand, BRRI dhan 33 had the lowest grain yield (4.36 t ha^{-1}) (Table 3). The yield was higher in Tia including other hybrid rice might be attributed to the production of higher LAI, CGR, NAR, TDM, higher number of effective tillers hill^{-1} and higher number or filled grains panicle^{-1}. Mondal*et al.* (2005) and Pruneddu and Spanu (2001) reported that the hybrid rice produced higher number of

effective tillers hill^{-1} and higher number of filled grains panicle^{-1} also showed higher grain yield ha^{-1}.

4.8. Straw Yield

Shakti 2 produced significantly higher (8.42 t ha^{-1}) straw yield followed by Tia (7.85 t ha^{-1}). The lowest was found in BRRI dhan 33 (5.74 t ha^{-1}) (Table 3). The result was in agreement with the findings of Pheloung and Siddique (1991), who reported that the straw yield could be assigned to plant height.

4.9. Biological Yield

The highest biological yield hill^{-1} was recorded in Shakti 2 (16.07 t ha^{-1}) followed by Tia (15.67 t ha^{-1}). In contrast, the lowest in BRRI dhan 33 (10.10 t ha^{-1}) preceded by Aloron (11.36 t ha^{-1}) (Table 3). Result revealed that hybrid rice produced more biological yield than inbred. Munshi (2005) and Chowdhury *et al.* (1999) reported that grain yield was positively correlated with biological yield in rice.

Table 2. *Yield contributing characters for selected hybrid and inbred rice variety in Aman season.*

Treatments	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Filled grain panicle^{-1}	Unfilled grain panicle^{-1}	1000- grain weight (g)
Shakti 2	11.67b	2.30d	212.30a	20.33a	27.75b
Suborna 8	8.95c	2.85c	205.20b	17.33b	28.65b
Tia	13.38a	2.35d	222.30a	13.33cd	28.05b
Aloron	8.50d	3.05b	202.00b	11.98d	29.95a
BRRI hybrid dhan 2	8.32d	3.15b	159.90e	8.33e	27.88b
BRRI dhan 33	7.05e	5.25a	192.05c	15.25bc	25.56c
CV (%)	8.57	3.03	5.56	7.43	9.97

Values with common letter (s) within a column do not differ significantly at 5% level of probability analyzed by DMRT.

Table 3. *Yield of selected hybrid and inbred rice varieties in Aman season.*

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})
Shakti 2	7.65a	8.42a	16.07a
Suborna 8	5.43b	6.27b	11.70c
Tia	7.82a	7.85a	15.67a
Aloron	5.12b	6.24b	11.36c
BRRI hybrid dhan 2	5.64b	7.20a	12.84ab
BRRI dhan 33	4.36c	5.74c	10.10d
CV (%)	6.86	5.99	8.3

Values with common letter (s) within a column do not differ significantly at 5% level of probability analyzed by DMRT

4.10. Harvest Index

Tia recorded significantly the highest harvest index (49.91%). It means dry matter partitioning to economic yield was superior in Tia to the other rice. BRRI dhan 33 recorded significantly the lowest harvest index (43.17%) Fig. 12. From this present study, it appears that hybrid rice maintained higher harvest index. Chandra and Das (2007), Cui *et al.* (2000) and Reddy *et al.* (1995) also found higher harvest index in the hybrid varieties compared to the inbred.

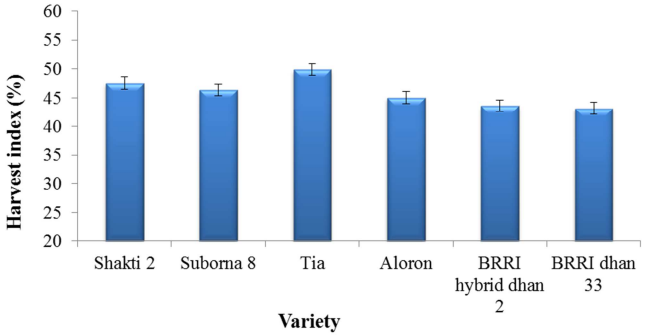

Figure 12. *Harvest index of five selected hybrid and inbred rice varieties.*

5. Conclusion

The hybrid rice variety, Tia showed superiority in respect of growth parameters like tillers hill^{-1} (16.23, 21.34 and 21.45 at different DAT), leaf area hill^{-1} (78.67, 94.35 and 91.34 cm^2 at different DAT), TDM hill^{-1} (27.33, 56.00 and 84.00 g at different DAT), LAI (3.38, 4.91 and 4.72 at different DAT), CGR (41.90 and 39.4 g m^{-2} d^{-1} at different growth stage), RGR (21.95 and 13.85 mg g^{-1} d^{-1} at different growth stage), and NAR (6.9 and 4.8 g m^{-2} d^{-1} at different growth stage) over the rest varieties. Tia also showed the highest yield contributing characters like effective tillers hill^{-1} (16.38), panicle length (26.34 cm) grain yield (8.32 t ha^{-1}), HI (49.91%) to the check variety, BRRI dhan 33 (10.05, 24.33cm, 4.36 t ha^{-1} and 43.17%, respectively). Results indicated that Tia and Shakti 2 produced higher biological yield (16.67 and 17.07 t ha^{-1}, respectively) because of higher total dry matter production, net assimilation rate (NAR), crop growth rate (CGR), harvest index (HI) and finally they have 24.0% yield advantage over the inbred BRRI dhan 33. Tia was superior in *Aman*season in consideration of growth and yield attributes among the afore-mentioned five hybrid and one popular inbred rice varieties.

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