A Comparative study on hybrid and inbred rice grown in Aman season

Abstract

This experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during the period from July to December, with a view to finding out the growth and yield performance of selected hybrid and inbred rice varieties in Aman season. There were seven treatments which comprised seven rice varieties viz. Gold-5, BRRI dhan56, BRRI dhan57, BRRI dhan62, Suborna-3, BRRI hybrid dhan4 and Moyna. The experiment layout was RCBD with three replications. Seedling of 25 days old was transplanted to the main field maintaining spacing with 25cm X 15cm. The plot size was 3X3m2. Collected data were analyzed with statistix10 software following the standard procedure and method. Significant variation was found among the selected inbred and hybrid rice varieties in respect of their different growth and yield characters. All the hybrid varieties contained higher amount of chlorophyll in their flag leaf at flowering to maturity compared to the inbred. BRRI hybrid dhan4 showed superiority over the hybrid and inbred varieties in different growth parameters. BRRI hybrid dhan4 also showed superiority in case of yield parameters such as panicles (14.27), filled grains panicle-1(168.43), 1000-grain weight (26.07 g), biological yield (13.33 t ha-1) and grain yield (6.13 t ha-1). Rest of the hybrid varieties viz. Shuborna 3 (5.60 t ha-1), Gold (5.15 t ha-1) and Moyna (4.86t ha-1) also provided higher grain yield compared to BRRI dhan56 (4.63 t ha-1) and BRRI dhan57 (4.25 t ha-1). Panicles hill-1, filled grains panicle-1 and 1000 grain weight mainly contributed to the higher grain yield of the hybrid varieties over the inbred.

Keywords: Hybrid, inbred, growth and yield performance etc.

1. Introduction

Rice (*Oryza sativa*) belongs to the family Gramineae, In Asian countries, rice is a staple food for at scanty 62.8% of total planet inhabitants and it contributes on an average 20% of apparent calorie intake of the world population and 30% of population. Around the world it is the most important food crop and the foremost food for approximately more than two billion people in Asia (Hien et al., 2006).

An alarming rate for Bangladesh is population increasing and reducing the cultivable land due to urbanization and more shortage of food due to industrialization. About 2.3

million every year of its total of 150 million people were added in nation. Thus, by the year 2030 present population will swell progressively to 223 million which will require additional 48 million tons of food grains instead of current deficit of about 1.2 million tons every year. So, the highest priority has been given to more rice production (Bhuiyan, 2004). At least 60% increase production of rice has to be to meet up food requirement of the increasing population by the year 2020.

Horizontal expansion of rice area and rice yield per unit area is to be increased to meet this ever-increasing demand of food. In Bangladesh, the geographical, climatic and edaphic conditions are favorable for year-round rice cultivation. Rice dominates over all other crops and covers 75% of the total cropped area of which around 79% is occupied by high yielding rice varieties (BBS, 2008). Cross of two distantly related rice varieties obtained hybrid rice (F_1 generation). Due to hybrid vigor, hybrid rice has 15-30% or more yield advantage over the conventional rice that fanners grow. Hybrid rice cultivation start in Bangladesh in 1993. In Bangladesh hybrid rice has a good prospect but very little research work has been done for the development of hybrid. The conventional varieties of rice in Bangladesh are comparatively lower yield. At this stage, hybrid varieties of rice may be a breakthrough, which could overcome perpetual yield stagnancy. Hybrid rice is one of the options for increasing the yield ceiling in rice over the best modern varieties Hybrid rice technology has been introduced through IRRI, BRRI and some commercial seed companies. In Aman season, however available information regarding the yield and yield contributing characters, morpho-physiological characteristics of hybrid rice varieties are meager in Bangladesh. In the year 2014, among the Aman rice varieties high yielding modern varieties covered 72.35 % and yield was 2.66 t ha-1and local varieties covered 22.03% and yield was 1.64 t ha-1 (BBS,2014). The hybrid varieties mostly cultivated in Bangladesh are imported from China by private seed companies. Four hybrid variety named BRRI hybrid dhan1, BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan4, BRRI hybrid dhan5, BRRI hybrid dhan6, BRRI hybrid dhan7 and BRRI hybrid dhan8 have been released for commercial cultivation by Bangladesh Rice Research Institute (BRRI). However, the farmers look confusing about the growth characteristics and genetically yield potential of these hybrids in comparison with high yielding varieties locally cultivated in Bangladesh. The population of Bangladesh is increasing day by day and that is why horizontal expansion

of rice area is not possible due to high population pressure on land. To ensure the food security for increasing population and reduce the extreme poverty and hunger which is one of the MDGs goals given by the United Nation Organization, it is an urgent need of the time to increase rice production through increasing yield. Proper agronomic management practices are the most effective means for increasing yield of rice at farmer level using inbred and hybrid varieties (Alauddin,2004). However, some of the newly introduced hybrid rice varieties are- Shuborna 3, Moyna, Gold, BRRI hybrid dhan4. So, it is prime need to evaluate their performance in Aman season. Under these circumstances, the study was undertaken to compare the performance of a fore mentioned hybrid and inbred rice varieties in Aman season.

Keeping the foregoing problems in view, present investigation was undertaken with the following objectives-

1. To compare the morpho-physiological characters of hybrid and inbred rice varieties in Aman season.
2. To evaluate the yield contributing characters of hybrid rice varieties in Aman season.
3. To observe the yield variation among the hybrid and inbred rice varieties in Aman season.

2. Materials and methods

2.1. Location

The field experiment was conducted at the central research farm of Sher-e- Bangla Agricultural University, Dhaka, under the Agro-ecological zone of Modhupur Tract, AEZ28 during the period from July to December.

2.2. Soil

Soil was sandy loam in texture with distinct dark yellowish-brown mottles in color. The experimental site was a medium high land and pH of the soil was 5.6.

2.3. Planting materials

Three hybrid rice varieties from different private seed companies, one hybrid and three inbred varieties from BRRI were used for this experiment.

Varieties are:

1. Gold
2. BRRI dhan56
3. BRRI dhan57
4. BRRI dhan62

5. Suborna 3
6. BRRI hybrid dhan4
7. Moyna

2.4. Experimental treatments

One factor experiment was conducted to evaluate the performance of hybrid lines comparing to the inbred rice varieties in Aman season.

Design: Randomized Complete Block Design (RCBD)

Replications: 03

Size of unit plot is 3m x 3m. The distances between plot to plot and block to block were 0.5 m and 1m respectively.

The data obtained for different characters were statistically analyzed following the analysis of variance techniques to obtain the level of significance by using Statistix-10. The means were separated by Least Significant Difference (LSD) test at 5% level of significant.

3.Results and discussion Growth parameters

❖ **Growth parameters**

3.1. Plant height

Significant effect on plant height was found in hybrid and inbred rice varieties in Aman rice (Fig. 1). The tallest plant was recorded in Shuborno 3 (81.13 cm) followed by BRRI hybrid dhan4 (80.38 cm) at vegetative phase (50 days after transplanting). On the other hand, the shortest plant was recorded in BRRI dhan62 (70.76 cm) followed by BRRI dhan56 (77.99 cm). Again, at reproductive stages (70 and 90 DAT) the highest plant height was found in BRRI hybrid dhan4 (106.87cm and 111.43 cm respectively) and the lowest plant height was observed in BRRI dhan62 (88.5 cm and 95.27 cm respectively). At harvest BRRI hybrid dhan4 was found as the highest plant (112.97 cm) followed by BRRI dhan57 (112.5 cm) and the shortest plant was BRRI dhan62 (99.57 cm) followed by Gold (101.87 cm) with same statistical rank. From the study it has been found that the highest and the lowest plant height was in BRRI hybrid dhan4 and BRRI dhan62 respectively.

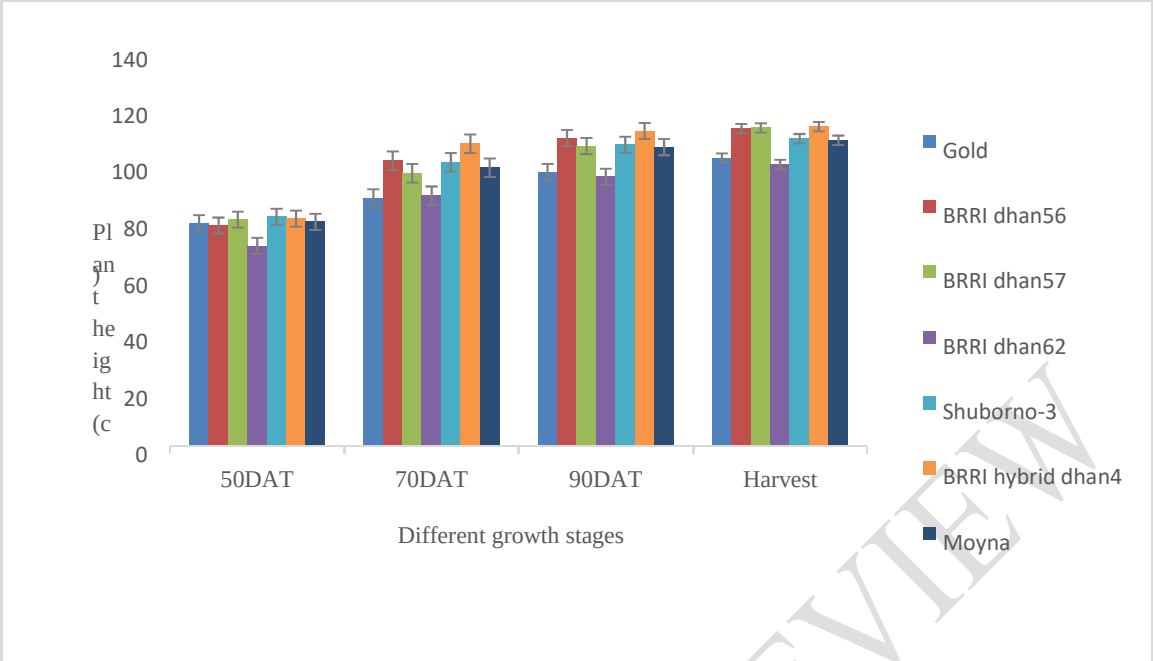

Figure 1. Plant height at different days after transplanting (DAT) in the test hybrid and inbred rice varieties. Vertical, capped lines represent LSD values.

3.2. Tillers hill^{-1}

There was significant variation in the total number of tillers hill^{-1} was found among the hybrid and inbred rice varieties at all growth stages (Fig 2). From the experiment result it has been observed that the number of total tillers hill^{-1} increased with the advancement of vegetative growth stages. But the number of total tillers hill^{-1} decreased at reproductive stage. The maximum number of tillers hill^{-1} was found in BRRI hybrid dhan4 (12.85) at vegetative stages (50 DAT) and the lowest number of tillers hill^{-1} was observed in BRRI dhan62 (8.5). At reproductive stages (70 and 90 DAT) maximum number of tillers hill^{-1} was produced by BRRI hybrid dhan4 (19.59 and 19.66 respectively). On the other hand, the lowest number of tiller hill^{-1} was recorded in BRRI dhan62 (12 and 10.5 respectively). Again, at the time of final harvest the maximum number of tiller hill^{-1} was observed in BRRI hybrid dhan4 (16.62) and the lowest was in BRRI dhan62 (9.15) with same statistical rank. In this experiment it has been found that hybrid produce higher number of tiller than the inbred. Same result was shown by Song *et al.* (2009). He showed that hybrid produced a significantly higher number of tillers than their parental species.

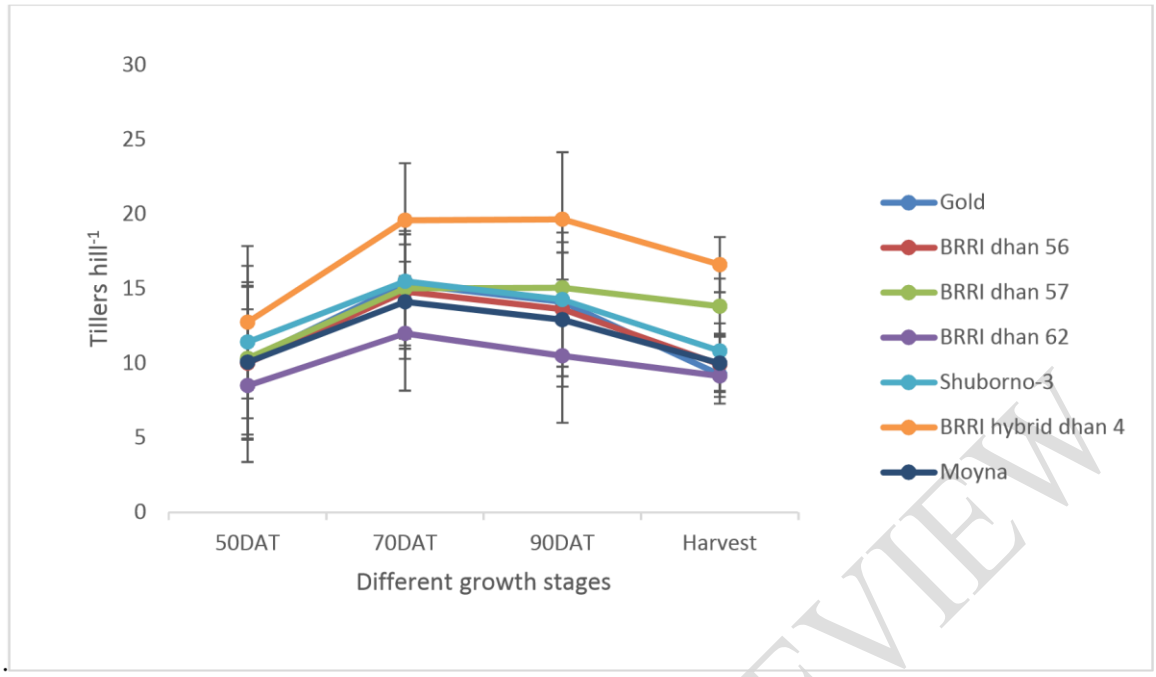

Figure 2. Tillers hill^{-1} at different days after transplanting (DAT) in the test hybrid and inbred rice varieties. Vertical, capped lines represent LSD values.

3.3. Leaf area index

Leaf area index may be defined as the ratio of leaf area to the ground area occupied by the crop. There is significant difference of leaf area index (LAI) among the studied rice varieties from vegetative (50 DAT) to reproductive (90 DAT) stages (Fig. 3). The LAI continued to increase throughout the vegetative stage and with the start of reproductive stage it started to decline. At vegetative phase (50 DAT) BRRI hybrid dhan4 showed the maximum LAI (3.46) and it is followed by Moyna (3.38) and Gold (3.36) respectively. Again at 70 DAT the maximum LAI was found in BRRI hybrid dhan4 (4.82) followed by Moyna (4.77). In contrast, at 50 and 70 DAT, BRRI dhan62 showed the lowest LAI (2.43 and 3.81 respectively) over their growth period. Rest of the varieties showed intermediate values. At reproductive phase (90 DAT) the highest LAI was found in BRRI hybrid dhan4 (4.64) followed by Moyna (4.61). On the other hand, BRRI dhan62 showed the lowest LAI (3.64) at 90 DAT. This result is consistent with the result of Mondal *et al.* (2007) who stated that the variation in LAI could be attributed due to the changes in number of leaves and the rate of leaf expansion and abscission. This result indicated that hybrid rice varieties showed higher LAI than the inbred and the increase in LAI with time could be attributed to increase in number of tillers consequently higher number of leaves hill^{-1}(Fig.2 and 3).

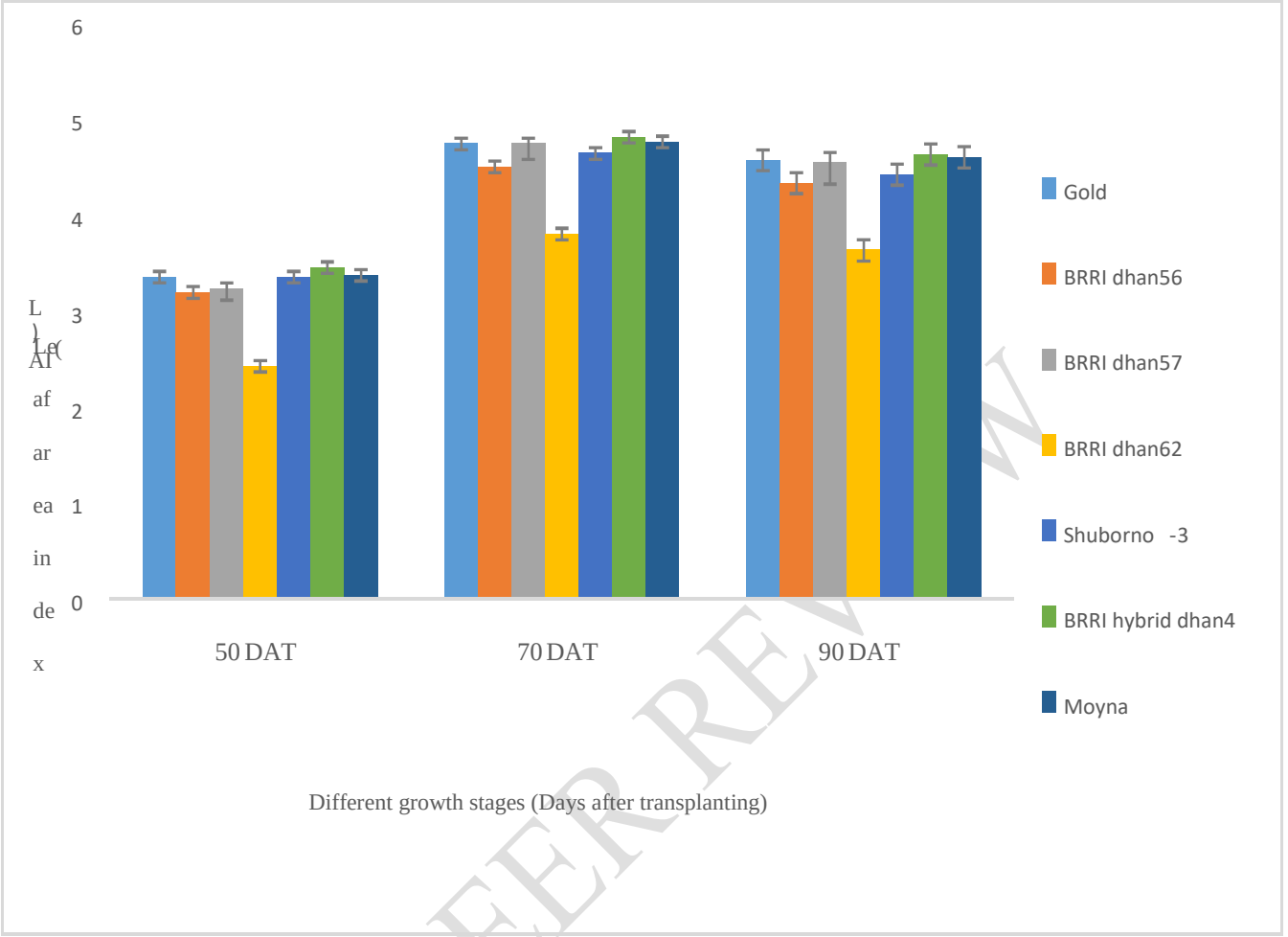

Figure.3. Leaf area index (LAI) at different days after transplanting (DAT) in the test hybrid and inbred rice varieties. Vertical, capped lines represent LSD values.

3.4. Root dry matter hill^{-1}

There has been found a significant variation observed in root dry matter production among the rice varieties at different growth stages (Table 1). Maximum root dry matter was observed in BRRI hybrid dhan4 (6.2 g) followed by Moyna (6.13) at vegetative phase (50 DAT) and the lowest was found in BRRI dhan62 (4.23 g). At reproductive stage (70 and 90 DAT) BRRI hybrid dhan4 showed the highest root dry matter hill^{-1} (8.33 g and 14.33 g respectively). On the other hand, inbred rice variety BRRI dhan62 showed the lowest value (6.30 g and 10.76 g respectively). This result revealed that root dry matter was gradually increased with time.

3.5. Stem dry matter hill^{-1}

From the test rice varieties, it has been found a significant difference in stem dry matter at different growth stages (Table 1). At 50 DAT (vegetative stage) the highest stem dry

matter was found in shuborno 3 (15.23 g) followed by BRRI hybrid dhan4 (14.90 g) and they are statistically same at 5% level of probability. On the other hand, the lowest was found in BRRI dhan56 (10.65 g) followed by BRRI dhan62 (11.17 g) and they also statistically same. Again at reproductive stage (70 and 90 DAT) BRRI hybrid dhan4 showed the highest stem dry matter hill^{-1} (35.10 g and 54.80 g respectively) and BRRI dhan62 showed the lowest values (25.33g and 42.47 g respectively). Result revealed that stem dry matter was gradually increased with time.

3.6. Leaf dry matter hill^{-1}

There was a significant variation observed in leaf dry matter among the tested rice varieties at different growth stages (Table 1). At 50 DAT (vegetative stage) the highest leaf dry matter was observed in BRRI hybrid dhan4 (6.73 g) followed by Moyna (6.53 g). On the other hand, the lowest value was found in BRRI dhan57 (4.90 g) followed by BRRI dhan56 (4.93 g) and BRRI dhan62 (5.06 g) but they all are statistically similar. This result revealed that leaf dry matter was gradually increased with time.

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
Gold	5.00	6.20	11.56	11.70	25.83	46.93	5.10	11.70	12.73
BRRI dhan56	4.96	6.30	11.3	10.67	25.77	45.26	4.93	11.76	12.57
BRRI dhan57	5.20	6.43	11.4	14.20	32.7	53.5	4.90	11.63	12.37
BRRI dhan62	4.23	6.30	10.76	11.17	25.33	42.47	5.06	10.93	12.50
Shuborno3	6.07	6.77	13.4	15.23	33.97	52.87	5.93	12.40	13.86
BRRI hybrid dhan4	6.20	8.30	14.3	14.90	35.10	54.80	6.73	14.20	15.34

Moyna	6.13	8.20	13.23	14.37	30.03	50.30	6.53	12.90	14.00
LSD at 5%	0.53	0.36	0.58	1.57	1.97	3.22	0.48	0.97	0.98
CV (%)	5.48	2.81	2.65	6.72	3.72	3.67	4.87	4.45	4.14

3.7. Total dry matter hill^{-1}

There was significant variation of total dry matter production among hybrid and inbred rice varieties (Fig. 4). At vegetative phase (50 DAT) BRRI hybrid dhan4 produced the highest TDM (27.63 g) followed by Moyna (27.23) and Shuborna 3 (27.23) and they are statistically same. On the other hand, the lowest value was found in BRRI dhan62 (20.50 g). At reproductive stage (70 and 90 DAT) the highest TDM was also produced by BRRI hybrid dhan4 (57.6 g and 84.47 g respectively) and the lowest TDM produced by BRRI dhan62 (42.57 g and 65.73 g respectively) preceded by BRRI dhan56 (43.73g and 69.13g respectively. This result revealed that dry matter production increased with age of plant and the dry matter accumulation in plant was low at vegetative stage and thereafter increased rapidly. It was also consistent with the result of Hoque (2004) who stated that TDM increased with the increase of plant age up to physiological maturity and high yielding rice varieties always maintain higher TDM hill^{-1}. It is clear that the hybrid rice varieties produce higher TDM than the inbred varieties. Increased dry matter in hybrid rice was possibly due to greater leaf area hill^{-1} (Fig. 4).

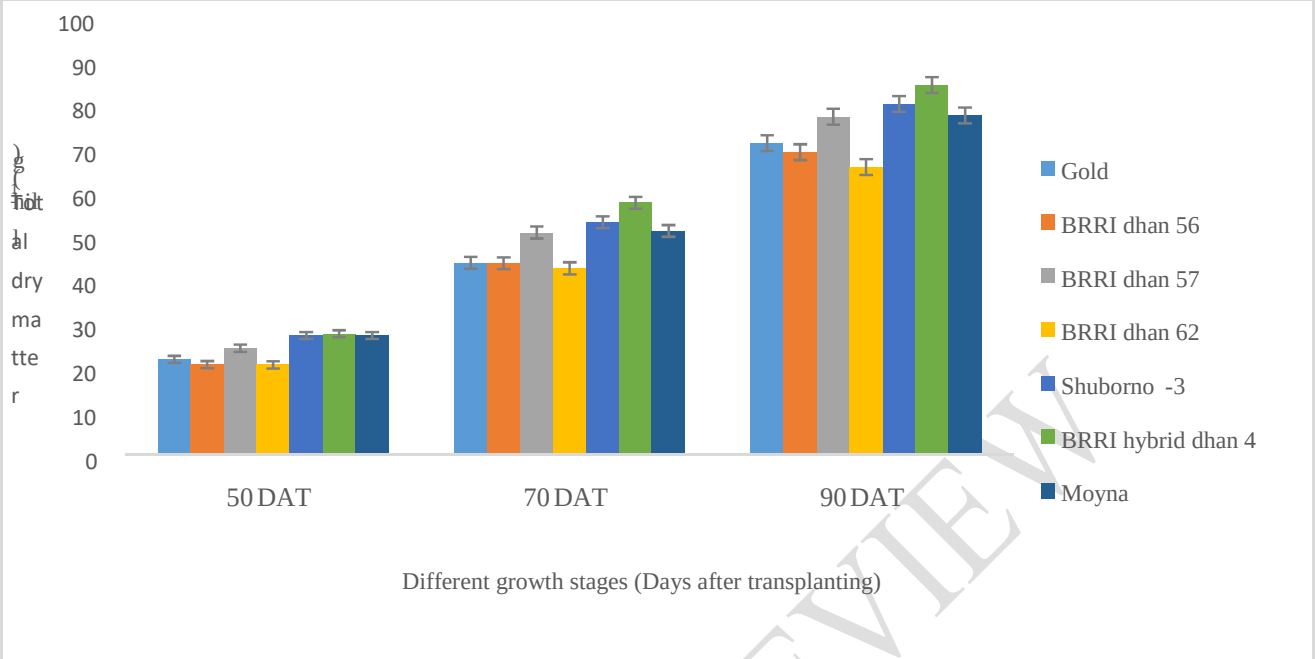

Figure 4. Total dry matter hill^{-1} (TDM) at different days after transplanting (DAT) in the test hybrid and inbred rice varieties. Vertical, capped lines represent LSD values.

3.8. Crop growth rate

The influence of the rice varieties on CGR was observed during the vegetative (50-70 DAT) and reproductive (70-90 DAT) growth phase (Fig. 5). BRRI hybrid dhan4 showed the highest CGR value (40.83 g m^{-2} d^{-1}) at vegetative phase (50-70 DAT) followed by Gold (36.67 g m^{-2} d^{-1}) and there is no significant difference between them. On the other hands the lowest CGR was observed in BRRI dhan62 (30.89 g m^{-2} d^{-1}) preceded by BRRI dhan56 (33.73 g m^{-2} d^{-1}). Again at reproductive stage (70-90 DAT) the highest CGR value was found in BRRI hybrid dhan4 (39.9 g m^{-2} d^{-1}) followed by BRRI dhan57 (35.29 g m^{-2} d^{-1}) and the lowest CGR was observed in BRRI dhan62 (29.29 g m^{-2} d^{-1}) preceded by Gold (29.42 g m^{-2} d^{-1}). It is seen that CGR decline at reproductive stage. The reason declination was might be attributed to the decrease in LAI at reproductive stage (Table 2). That means the CGR increased along with increases in LAI and this was supported by the finding of Yang *et al*. (2010). At vegetative phase (50-70 DAT), the CGR was found to be maximum and it indicated that plants expanded assimilate for growth of leaf area. From the study it can be said that the hybrid varieties give the highest CGR values than the inbred.

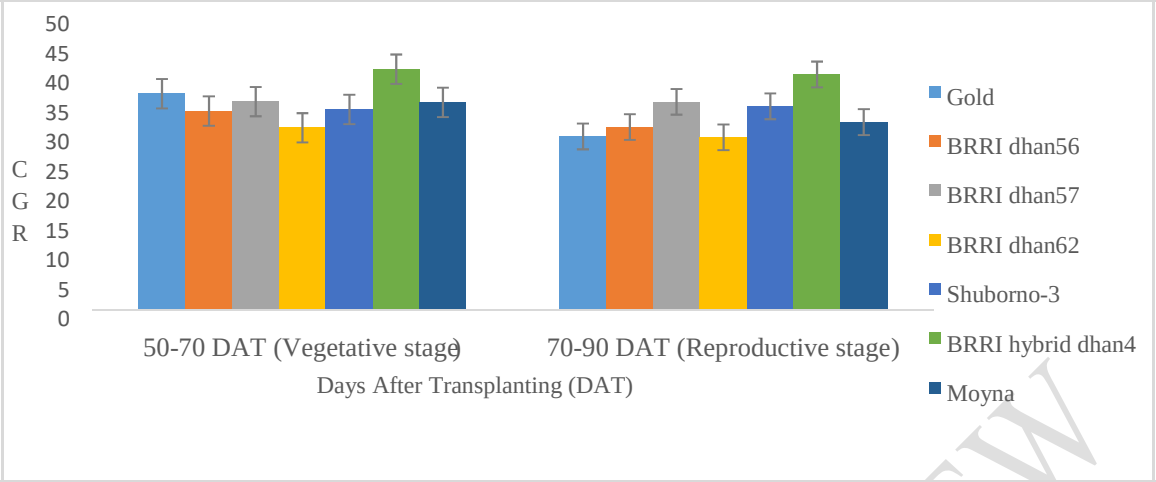

Figure 5. Crop growth rate (CGR) at different days after transplanting (DAT) in the test hybrid and inbred rice varieties. Vertical, capped lines represent LSD values.

3.9. Flag leaf chlorophyll content

The hybrid and inbred varieties showed significant variation in chlorophyll content of flag leaf (Table 2). At 2 days after flowering BRRI hybrid dhan4 (2.40 mg g^{-1} fresh weight) synthesized higher amount of chlorophyll followed by Moyna (2.35 mg g^{-1} fresh weight), Shuborna 3 (2.32 mg g^{-1} fresh weight) and Gold (2.22 mg g^{-1} fresh weight) respectively. On the other hand, the inbred varieties BRRI dhan62 (2.03 mg g^{-1} fresh weight) synthesized the lowest chlorophyll among the seven varieties and it was preceded by BRRI dhan57 (2.14 mg g^{-1} fresh weight) and BRRI dhan56 (2.13 mg g-1 fresh weight) respectively. That means BRRI dhan 62 showed 15.4 % lower chlorophyll content than the BRRI hybrid dhan4. From the table, it can be seen that chlorophyll content decreases with time. The total flag leaf chlorophyll content was decreased by 33.7%, 30.9%, 31.7%, 29%, 33.1%, 19.5% and 28.9% in Gold, BRRI dhan56, BRRI dhan57, BRRI dhan62, Shuborno 3, BRRI hybrid dhan4 and Moyna respectively at 21 DAF compared to the 3 DAF. From the result it is clear that generally hybrid synthesized higher chlorophyll than the inbred and it was supported by Haque M. M et al. (2012). He found significant difference among the inbred and hybrid rice varieties.

Table 2. Flag leaf chlorophyll content of hybrid and inbred rice varieties at different days after flowering (DAF) in *Aman* Season.

Treatments	Total chlorophyll content at different days after flowering (mg g^{-1} fresh weight)			
	3 DAF	9 DAF	15 DAF	21 DAF
Gold	2.22	2.14	2.09	1.60
BRRI dhan56	2.13	2.05	1.76	1.47
BRRI dhan57	2.14	2.06	1.77	1.46
BRRI dhan62	2.03	1.88	1.81	1.44
Shuborno 3	2.32	2.21	2.11	1.55
BRRI hybrid dhan4	2.40	2.33	2.20	1.93
Moyna	2.35	2.23	2.14	1.67
LSD (.05)	0.045	0.024	0.04	0.39
CV (%)	1.14	0.65	1.04	14.21

3.11. Panicle length

The longest panicle was observed in BRRI hybrid dhan4 (27.89 cm) followed by Moyna (25.35 cm) and shuborna 3 (25.15 cm) but they are statistically similar and differ from rest of the varieties. On the other hand, BRRI dhan62 showed the shortest panicle (21.12 cm) preceded by BRRI dhan56 (21.59 cm) (Fig.6) From the study, it was found that panicle length was longer in hybrid rice than the inbred and it possibly due to genetic makeup. This result was supported by the result of Chakma (2006) who stated that panicle length was significantly varied in varieties. Panicle length is related to the higher yield in rice (Salam *et al*., 1990).

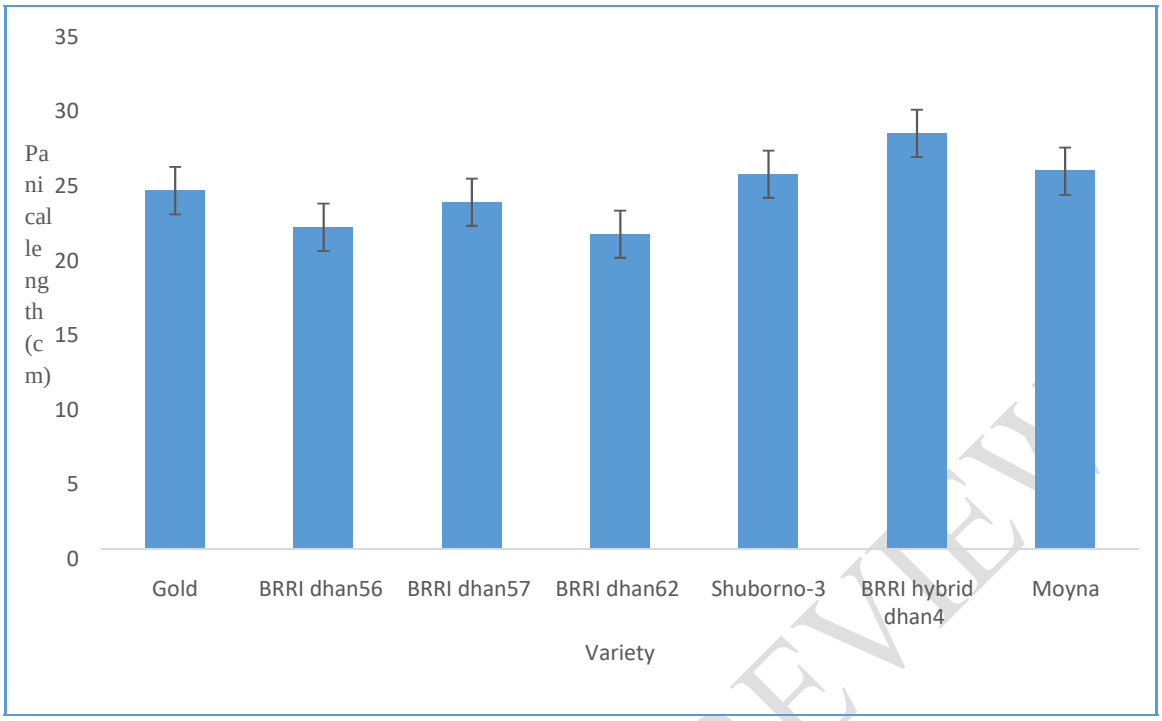

Figure 6. Panicle length of some selected hybrid and inbred rice varieties**.** Vertical, capped lines represent LSD values.

Yield parameters

Effective tillers hill^{-1}

Among these varieties BRRI hybrid dhan4 (14.27) showed the highest number of effective tillers hill^{-1} and it is followed by Gold (11.44) and BRRI dhan57 (11.41) respectively (Table 3). The first one is statistically dissimilar from the rest two varieties at 5% level of significance. On the other hand, BRRI dhan56 (8.72) produced the lowest number of effective tillers hill^{-1} preceded by Moyna (8.90). Result further revealed that generally hybrid rice varieties produced greater number of effective tillers hill^{-1} than the inbred rice varieties. That means yield and effective tiller number are positively correlated. This result is also supported by many researchers (Yang *et al*., 2010; Shrirame and Muley, 2003; Munshi, 2005).

Non- effective tillers hill^{-1}

BRRI dhan62 (2.65) produced the highest number of non-effective tillers hill^{-1} and it is followed by Gold (2.50) and Moyna (2.33) respectively. In contrast BRRI hybrid dhan4 (1.38) produced the lowest number of non-effective tillers hill^{-1} preceded by BRRI dhan56 (1.90) and Shuborna 3 (1.90). This result proved that hybrid rice produced less noneffective tillers than inbred varieties.

Filled grain panicle^{-1}

Filled grain panicle^{-1} had shown a significant variation among the tested rice varieties (Table 3). From the study, it was noticed that BRRI hybrid dhan4 (168.43) produced the highest number of filled grain panicle^{-1} followed by Shuborno 3 (157.23) and Gold (145.63) respectively. The first two is statistically similar but the first and the third are statistically dissimilar at 5 % level of significant. On the other hand, the lowest filled grain panicle^{-1} was observed in BRRI dhan62 (132.58) preceded by BRRI dhan57 (136.65). The result showed that there was no significant difference between BRRI dhan62 and BRRI dhan57. It appears that hybrid varieties produced more filled grain panicle^{-1} than the inbred varieties and it is related with the higher yield. This result was supported by Dutta *et al*. (2002) who stated that yield was affected by the filled grain panicle^{-1}.

Unfilled grain panicle^{-1}

From the analyzed data it was found that number of unfilled grains panicle^{-1} varied significantly among the tested rice varieties (Table 3). The highest number of unfilled grains panicle^{-1} was found in BRRI dhan56 (23.30) followed by BRRI dhan62 (22.02) and Shuborno 3 (20.73) respectively. On the other hand, BRRI hybrid dhan4 (8.93) showed the lowest number of unfilled grain panicle^{-1} preceded by Moyna (9.13) and both are statistically similar at 5% level of significant. It is clear from the experiment that hybrid rice significantly differed in respect of unfilled grain panicle^{-1}. This result was also supported by Dutta *et al*. (2002) who observed a wide range of variability in number of unfilled grain panicle^{-1}. Chowdhary *et al.* (1993) also stated that difference in number of unfilled grains panicle^{-1} was due to varietal character.

1000 grain weight

There was a significant difference in 1000-grain weight among the inbred and hybrid rice varieties (Table 3). Moyna showed the highest 1000-grain weight (32.26 g) followed by BRRI hybrid dhan4 (26.07 g) and both were significantly different from each other. On the other hand, the lowest 1000-grain weight was found in BRRI dhan62 (19.90 g) proceeded by Shuborna 3 (21.79 g) and BRRI dhan56 (22.00 g) respectively and they are statistically similar shown in table 2. This result was supported by Mondal *et al*. (2005) who studied with 17 modern varieties of Aman rice and stated that 1000-grain weight differed significantly among the cultivars studied. Fujia *et al*. (1984) showed that length

and thickness of rice grains were positively correlated with 1000-grain weight. The reason behind the variation in 1000- grain weight was possibly due to genetic makeup of particular rice and sink strength.

Table 3. **Yield contributing characters for selected hybrid and inbred rice varieties in *Aman* season.**

Treatments	Panicle hill^{-1}	Non-effective tiller hill^{-1}	Filled grain panicle^{-1}	Unfilled grain panicle^{-1}	1000-grain weight (g)
Gold	11.44	2.50	145.63	11.87	25.50
BRRI dhan56	8.72	1.9	145.20	13.69	22.00
BRRI dhan57	11.41	2.17	136.65	23.3	22.57
BRRI dhan62	9.4	2.65	132.58	22.07	19.90
Shuborno 3	10.93	1.90	157.23	20.73	21.79
BRRI hybrid dhan4	14.27	1.38	168.43	8.93	26.07
Moyna	8.90	2.33	137.17	9.13	32.26
LSD (0.05)	2.59	1.01	18.21	5.74	1.46
CV (%)	13.57	26.92	7.01	20.60	3.39

Grain yield

There has been found a significant difference in respect of grain yield ha^{-1} (Table 4). The highest grain yield was found in BRRI hybrid dhan4 (6.13 t ha^{-1}) followed by Shuborno 3 (5.60 t ha^{-1}) and they were statistically similar at 5% level of probability. On the other hand, BRRI dhan62 (3.76 t ha^{-1}) showed the lowest grain yield and it was preceded by BRRI dhan57 (4.25 t ha^{-1}). Both are significantly differed from each other. Here it can be noticed that BRRI dhan62 showed about 38.6% lower yield than BRRI hybrid dhan4. The higher yield in hybrid must be attributed to the production of higher LAI, CGR, RGR, TDM, higher number of effective tiller hill^{-1} and higher number of filled grain panicle^{-1}. This result indicated that the hybrid varieties had remarkable superiority to growth, yield attributes and grain yield over other rice varieties. This result was

supported by Mondal *et al*. (2005) and Pruneddu and Spanu (2001) who stated that the hybrid rice produced the higher number of effective tiller hill^{-1} and higher number of filled grains panicle^{-1} and also showed the higher yield ha^{-1}.

Straw yield

The straw yield of different variety was observed to differ significantly (Table 4). From the study it was found that BRRI hybrid dhan4 produced the highest straw yield (7.20 t ha^{-1}) followed by BRRI dhan57 (6.56 t ha^{-1}) and both are statistically similar to each other. In contrast, BRRI dhan62 produced lowest straw yield (5.03t ha^{-1}) preceded by Moyna (5.57 t ha^{-1}) and BRRI dhan56 (5.60 t ha^{-1}) respectively. Straw yield was possibly related to the plant height and tiller hill^{-1} and it was supported by the result of Panda and Leeuwrik (1971) who stated that straw yield could be assigned to plant height.

Biological yield

Grain yield and straw yield together were regarded as biological yield. Biological yield was found statistically different among the hybrid and inbred varieties (Table 4). BRRI hybrid dhan4 was found to give the highest biological yield (13.33 t ha^{-1}) followed by BRRI dhan57 (11.98 t ha^{-1}) both are statistically similar. On the other hand, the lowest biological yield was given by BRRI dhan62 (9.13 t ha^{-1}) proceeded by Gold (10.30 t ha^{-1}) and BRRI dhan56 (10.32 t ha^{-1}) respectively. That means hybrid varieties produced more biological yield than inbred. Munshi (2005) and Chowdhury *et al*. (1995) observed that grain yield was positively correlated with biological yield in rice.

Table 4. 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})
Gold	5.15	5.66	10.30
BRRI dhan56	4.63	5.60	10.32
BRRI dhan57	4.25	6.56	11.98
BRRI dhan62	3.76	5.03	9.13
Shuborna 3	5.60	6.00	11.93
BRRI hybrid dhan4	6.13	7.20	13.33

Moyna	4.86	5.57	10.67
LSD (0.05)	0.83	1.15	1.75
CV (%)	9.53	10.88	8.89

Harvest index

There was significant variation in harvest index among hybrid and inbred rice varieties (Fig 7). The highest harvest index was recorded in BRRI hybrid dhan4 (46.92 %) followed by Shuborno 3 (46.06). That means dry matter partitioning to economic yield was superior in BRRI hybrid dhan4 to the other rice varieties. On the other hand, BRRI dhan62 showed the lowest harvest index (41.07 %) which means dry matter partitioning to economic yield was inferior in BRRI dhan62 to the rest of varieties. From this experiment it appears that hybrid varieties generally maintain higher harvest index. This result is consistent with the findings of Chandra and Das (2010), Cui *et al.* (2000) and Ready *et al*. (1994) who observed that hybrid varieties maintained higher harvest index compared to the inbred.

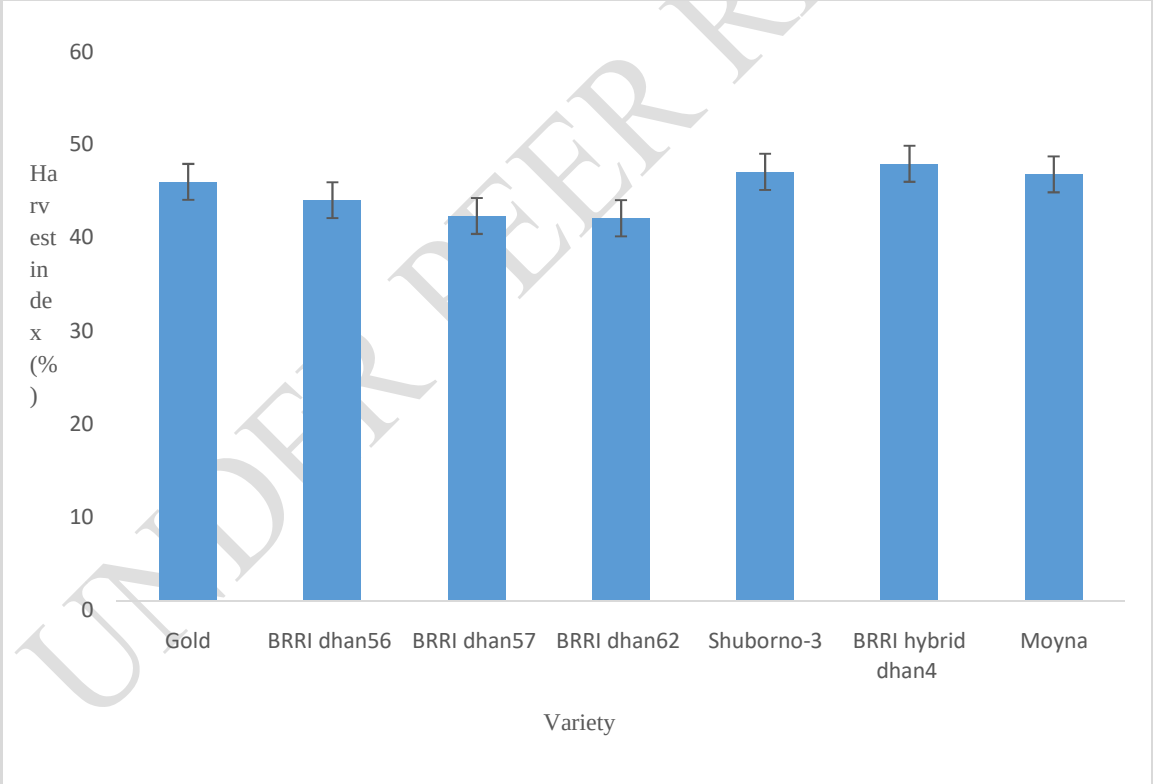

Figure.7. Harvest index (HI) of some selected hybrid and inbred rice varieties**.**

4.Conclusion

Result revealed that a significant variation among the selected inbred and hybrid rice varieties in plant height, tillers hill-1, TDM, LAI, CGR, panicle length, and yield attributes like days to maturity, panicle hill-1, filled and unfilled grains panicle-1, 1000

grain weight, biological yield, grain yield and harvest index (HI). The hybrid rice variety, BRRI hybrid dhan4 was found showing superiority over the rest varieties in respect of different growth and physiological parameters like plant height (106.87 cm, 111.43 cm and 112.97 cm at 70 DAT, 90 DAT and harvest respectively), tillers hill-1 (12.75, 19.59, 19.66 and 16.62 at different DAT), TDM hill-1 (27.63 g, 57.6 g and 84.47 g at different DAT), LAI (3.46, 4.82 and 4.64 at different DAT), CGR (40.83 g m-2 d-1 and 39 gm-2d-1 at vegetative and reproductive stages respectively), flag leaf chlorophyll content (2.40, 2.33, 2.20,1.93 mg g-1 at 3, 9, 15, 21 DAF respectively) and panicle length (27.89 cm). From the study it has been seen that number of total tillers hill-1 gradually increase with the progress of growth. LAI increased up to a certain period (till the start of reproductive phase) and thereafter started to decline. Accumulation of dry matter was low at 50 DAT and thereafter increased rapidly. Relative growth rate was found to increase rapidly in the early stage but it declined in the later growth stage. Again BRRI hybrid dhan4 was also found to show superiority in case of yield parameters like panicle hill1(14.27), filled grains panicle-1 (168.43), 1000- grain weight (26.07 g), biological yield (13.33 t ha-1), grain yield (6.13 t ha-1) and harvest index (46.92 %). On the other hand among seven rice varieties BRRI dhan62 was found inferior in respect of both growth and yield parameters like plant height (70.76, 88.5, 95.27 and 99.57 cm at different growth stages), tillers hill-1 (8.5, 12, 10.5 and 9.15 at different growth stages), TDM hill-1 (20.5, 42.57 and 65.73 mg g-1 d-1), LAI (2.43,3.81 and 3.64 at different growth stages), CGR (30.89 g m-2 d-1 and 29.29 g m-2 d-1 at vegetative and reproductive stages respectively), panicle hill-1 (9.4), filled grains panicle-1 (132.58), 1000- grain weight (19.9), biological yield (9.13), grain yield (3.76 t ha-1) and harvest index (41.07 %). However, hybrid of the tested varieties produced higher grain yield compared to the inbred. Yield components such as effective tillers hill-1, Filled grain panicle-1 and 1000 grain weight mainly contributed to the higher grain yield of the hybrid varieties over the inbred. In respect of biological yield, hybrid rice varieties such as BRRI hybrid dhan4 (13.33 t ha-1), Moyna (10.67 t ha-1) and Shuborna 3 (11.93 t ha-1) performed better than that of inbred varieties like BRRI dhan62 (9.13 t ha-1) and BRRI dhan56 (10.32 t ha-1). This result indicates that BRRI hybrid dhan4 and Shuborna 3 produce higher biological yield because of higher total dry matter production (TDM), harvest index(HI), Crop growth rate (CGR) and finally they have more yield advantages

over the inbred varieties. Among the seven hybrid and inbred varieties, BRRI hybrid dhan4 demonstrated the best performance followed by shuborna 3. All studied hybrids contained higher amount of chlorophyll in their flag leaf and accumulated more dry matter than the inbred. Among the seven varieties the hybrids converted more dry matter into grain compared to inbred varieties. The main determinants for the higher grain yield of the hybrids over the inbred are panicle hill-1 and 1000 grain weight.

Considering the results of the experiment, it could be suggested that-

1. BRRI hybrid dhan4 may be chosen in Aman season.
2. For wider acceptability, the same experiment can be repeated at different agroecological zones of the country.

References

Aladdin, M.H. (2004). Effect of methods of transplanting and seedlings per hill on the growth and yield of transplanting Aman rice cv. BRRI dhan39. M. Sc. (Ag) thesis. Dept. of Agronomy. BAU, Mymensingh.

Anonymous. (1997), Luh (1991). Bangladesh Bureau of Statistics (BBS). Statistical yearbook of Bangladesh. Statistical division. Ministry of Planning, Govt. of the Peoples Republic of Bangladesh.

BBS (Bangladesh Bureau of Statistics). (2014). Monthly Statistical Bulletin, Bangladesh, June, 2014. Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

Chakma, S. (2006). Influence of spacing on the growth and yield attributes of modern oro varieties. M.S. thesis, Dept. Crop Bot., BAU, Mymensingh.

Chandra and Das& Cui et al and Ready et al. (2007). Correlation and inter correlation of physiological parameters in rice under rain fed transplanted condition. Crop Res. *Hisar Assam Agril. Univ*., **19(**2): 251-254.

Chowdhury et al (1993). Variability and association among yield attributes and grain quality in traditional aromatic rice accessions. Department of Plant Breeding and Genetics, IGAU Raipur (CG), India. Crop Improvement. 30(1): 84-90.

Chowdhury, S.A., Majid, M.A., Haque, K.S., Islam, M. and Rahman, M.M. (1995). Effect of variety on yield and nutritive value of rice straw. *Asian J. Animal Sci.* **8**(4): 329–335.

FAO (Food and Agriculture Organization). (2014). FAO Statistics. Internet Edition. http://faostat.fao.org/site/339/default.aspx. Accessed in October, 2014.

Fujia, Y. and Kikuchi, F. (1984). Gene analysis for agronomic traits. In: Biology of rice Tsunoda, S. and Takahashi, N.(eds.). *Japan Sci. Soc. Press.* Tokyo, pp. 275-291.

Ghosh, P.K. and Hossain, M. (1988). Genetics evaluation and regression analysis of yield and yield attributes in rice. *Oryza*. 25: 485-509.

Haque, M.N. (2004). Morpho-physiological studies in aromatic and modern rice cultivars. M.S. Thesis, Dept. Bot.., Bangladesh Agric. Univ., Mymensingh.

Haque M. M. (2012). Performance of hybrid and inbred rice grown in different planting dates and seasons. Ph D. Thesis, Dept. Bot.., Bangladesh Agric. Univ., Mymensingh.

Hien, T et al (2006). Increasing yield potential in irrigated rice: breaking the yield barrier. Rice research for food security and poverty alleviation – proceeding of the International Rice Research Conference.

Hosain M. T *et al*. (2014). Performance of Hybrid Rice (*Oryza sativa* l.) Varieties at Different Transplanting Dates in Aus Season.M. S Thesis Dept. Agric. Bot., Shere-Bangla Agric. Univ., Dhaka.

Mondal, M.M.A., Islam, A.F.M.S. and Siddique, M. A. (2001). Performance of 17 modern transplant *Aman* cultivar in the north region of Bangladesh. *Bangladesh J. Crop. Sci.*, **16**:23-29.

Munshi, R.U. (2005). A comparative morpho-physiologial study between two local and two modern rice cultivars. M.S. Thesis, Dept. Crop Botany, Bangladesh Agric. Univ., Mymensingh.

Panda *et al*. (1971). Performance of hybrid and composite varieties of maize under Sambalpur condition. *Indian J. Agron.* 45 (5):47-49.

Paranhos, J.T., Marchezan, E. and Dutta, L.M.C. (1997) Morphological parameters of three irrigated rice cultivars. *Int. Rice Res. News l.* 17 (5):9.

Salam, M. A., Khorshed, A. and Chowdhury. S.I. (1990): Morpho-physiological aspects of Binasail for its improved yield potential over the parent Nizersail. *Bangladesh J. Nuclear Agric*. 5(5):15-21.

Song, Z.P., Lu, B. R., Wang, B. and Chen, J. K. (2009). Fitness estimation through performance comparison of F_1 hybrids with their parental species *Oryza rufipogon* and *O. sativa*. *Ann. Bot.* **93**(3): 311–316.

Yang, F., Wang, X.L., Ma, J.Y. and Ling, F.L. (2010). A comparative analysis of yield component factors of two rice varieties JND3 and JND13. *J. Jilin Agril. Univ.***23**(4): 21–24