Reprint **ISSN 1923-7766 (Web Version)**

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 12 **Issue: 2** **September 2022**

Int. J. Expt. Agric. 12(2): 9-20 (September 2022)

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An International Scientific Research Publisher

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ISSN-1923-7766 (Online)
Int. J. Expt. Agric. 12(2):9-20(September 2022)

PERFORMANCE OF SOME HYV RICE IN AMAN SEASON AT AEZ1

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Accepted for publication on 25 August 2022

ABSTRACT

Mohammad F, Bahadur MM, Chowdhury AKMMB (2022) Performance of some HYV rice in aman season at AEZ 1. *Int. J. Expt. Agric*. 12(2), 9-20.

As an agro-based country, it is essential to adopt more steps for increasing the production level of rice in Bangladesh. Variety is the most significant factor that plays a crucial role in yield of different crops including rice. A field experiment was conducted at the experimental field of Crop Physiology and Ecology during June to December 2018, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh to know the comparative study on morphological, phenological and yield attributes of some Aman rice varieties. Binadhan-7, BRRI dhan56, BRRI dhan62, BRRI dhan71 and BRRI dhan72 were imposed in 20 plots. Different varieties showed significant variation due to booting, heading, anthesis, leaf dry matter, stem dry matter, leaf area hill^{-1}, crop growth rate and net assimilation rate, leaf area index, number of leaves hill^{-1} and plant height, number of total tillers hill^{-1}, productive tillers hill^{-1}, panicle length, grains panicle^{-1}, fertile grains panicle^{-1}, sterile grains panicle^{-1}, test weight, grain yield, straw yield and biological yield. The highest time require for booting (61.75 days), heading (67.12 days), anthesis (71.75 days), leaf dry matter (13.14 g), stem dry matter (15.45 g), leaf area hill^{-1}, crop growth rate (18.14 gm^{-2}d^{-1}) and net assimilation rate (8.93 gm^{-2}d^{-1}), leaf area index, number of leaves hill^{-1}, number of leaves hill^{-1} (48.75), number of total tillers hill^{-1} (22.3), productive tillers hill^{-1} (19.3), panicle length (33.17 cm), grains panicle^{-1} (203.25), fertile grains panicle^{-1} (192.2), test weight (28.10 g) grain yield (6.29 tha^{-1}), straw yield (7.42 tha^{-1}), biological yield (13.71 tha^{-1}) and minimum sterile grains panicle^{-1} (10.05) were produced by BRRI dhan72 among studied five elite Aman varieties.

Key words: *performance, HYV rice, aman season, yield and yield contributing characteristics*

INTRODUCTION

Rice (*Oryza sativa* L.*)* is one of the most important food grains produced and consumed all over the world. It is a grain plant belonging to the family Poaceae and genus *Oryza* with chromosome no. = 24. Global rice demand was 439 million tonnes in 2010 and is expected to rise to 496 million tonnes in 2020 and further increase to 553 million tonnes in 2035 (FAO 2017). Agriculture is the predominant profession by the most of the people of our country. The intensive rice (*Oryza sativa* L.) cultivation governs the agriculture of our country. Rice is the staple food crop in Bangladesh and the cropping pattern of the country is predominately rice-based. Bangladesh is the 4th largest rice producing country of the world (BBS 2012). The population of Bangladesh may become 30 million over the next 20 years due to increase by two million every year. Therefore, about 27.26 million tons of rice for the year of 2020 require for livelihood of our country (BRRI 2011). About 77 per cent of cropped area of Bangladesh is used for rice production, with annual production of 33.83 million ton from 11.41 million ha of land which contributes about 19.60 per cent of the country's GDP (BBS 2013). About 35.06 million metric tons of rice was produced 11.3 million hectares of land in Bangladesh (AIS 2017). The increase rate of population and decreasing rate of agricultural land are 1.42 and 1%, respectively (BBS 2010). The cultivation of modern varieties and management are the two important approaches to get higher yield. The increase in dry mass is the growth as mentioned by Physiologist. The higher dry matter production and ultimate grain weight as facilitated by quantitative and qualitative changes is termed as growth (Tanaka 1980). The yield of rice progressively dependent on the different growth parameters, i.e. leaf area index, dry matter production and its partitioning, tillering, etc. (Shams 2002). Higher grain yield of rice are the reflection of leaf area index, leaf area duration (LAD), CGR, NAR and RGR (Thakur and Patel, 1998).

The diverse ecosystem like irrigated, rainfed and deep water conditions are the growing place of rice in three distinct overlapping seasons namely aus, aman and boro.

Among these three seasons, the monsoon rice, transplanted aman covers the largest area (50.58% of total rice area) and average yield of aman rice is 3.33 tha^{-1} (BBS 2010). The horizontal expansion of rice area in Bangladesh is impossible due to limited land resources with population explosion. So the only avenue left is to increase production of rice by vertical means i.e. management practices. Rice productions largely depend on the ability to integrate a better crop management for the different varieties into the existing cultivation systems (Mikkelsen *et al.* 1995 and Liza *et al*. 2014). The genetic factor which contributes a lot in producing yield and yield components of a particular crop is called variety. The yield and yield components of crops directly depend on the variety and neighboring growing environments. The yield and ancillary characteristics of rice greatly varied in different varieties (Chodury and Bhuian, 1991 and Miah *et al.*1989).

Farmers are generally used HYV and MV of rice developed by BRRI instead of using the local indigenous low yielding rice varieties with a view to obtaining 20% to 30% more yield unit^{-1} land area (Shahjahan 2007 and El-Hadidi *et al*. 2016). So, rice research is predominantly conducted to develop modern high yielding varieties in Bangladesh as well as in the world. After the introduction of high yielding varieties research interest shifted from local varieties to modern varieties of rice and thus the local varieties, the indigenous resources remained neglected.

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There are large reserves of local rice cultivars in Bangladesh (Amin *et al.* 2006 and Vennila 2007). Mustafi *et al.* (1993) justified the cultivation of modern aman varieties by the poor farmers. Comparable higher grain yields were obtained than some traditional wet season varieties (Talukdar1998) and Ichikawa *et al.* (1996). However, more studies on their morphological, phenological and physiological characteristics are essential. The growth duration of modern varieties are less than HYV (135-150 days) in Aman season in Bangladesh, while high daily yield in hybrid rice was due to its short duration of 120-130 days as mentioned by Julfiquar *et al.* (1998) and Zhang *et al*. (1998). Crop duration can be reduced by 20-40 days by introducing short duration hybrid rice.

However, some of the newly introduced HYV rice isBinadhan-7, BRRI dhan56, BRRI dhan57, BRRI dhan62, BRRI dhan71 and BRRI dhan72. So, it is prime need to evaluate their comparative performances in Aman season at specific agro-ecological conditions like AEZ 1. Under these circumstances, the study was undertaken with objectives to observe the growth, phenophase, yield attributes and yield of different HYV of rice during Aman season and to identify the best rice varieties among five HYV in Aman season for AEZ 1.

MATERIALS AND METHODS

Details of the methodology of the study followed during the research period are presented in this chapter.

Location and duration

The experiment was conducted at the research farm of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during June to August 2018. The experimental site is situated under the Dinajpur and located at 25º39′ N latitude and 88º41′ E longitude with an elevation of 37.58 meter above the sea level. It was situated in AEZ 1.

Soil and climate

The soil (Ranisankail Series) is sandy loam under the Order Inceptisol. The experimental site is situated in the sub-tropical region characterized by heavy rainfall during the months from May to September and scantly rainfall in the rest of the year. Details of the soil characteristics of the experimental site is presented in Table 1 and details of the meteorological data in respect to temperature, rainfall and relative humidity during the growing period of the experimental site are presented in the Table 2.

Table 1. Characteristics of soil of the experimental site

General characters	**Description**	
Location	Research field of Crop Physiology and Ecology, HSTU, Dinajpur.	
AEZ	Old Himalayan Piedmont Plain (AEZ-1)	
General Soil type	Non-Calcareous Brown Floodplain Soil	
Parent material	Piedmont alluvium	
Soil series	Ranishankail	
Drainage	Moderately well drained	
Flood level	Above flood level	
Topography	High land	
Physical characteristics	**Value**	
Bulk density (g cm-3)	0.86-1.07	
Sand (2-0.02 mm)	60.0	
Silt (0.02-0.002 mm)	27.0	
Clay (< 0.002 mm)	13.0	
Textural class	Sandy loam	
Chemical characteristics	**Content**	**Interpretation**
pH	5.40-5.50	Moderately acidic
Organic carbon (%)	0.69	Low
Organic matter (%)	1.19	Low
CEC (meq/100g soil)	5.60	Low
Total N (%)	0.07	Very low
Available P (ppm)	16.75	Medium
Exchangeable K (meq/100g soil)	0.17	Medium low

Table 2. Weather data for growing season of aman rice, August to December, 2018

Month	**Relative humidity (%)**	**Temperature**		**Total rainfall (mm)**
		Minimum (°C)	**Maximum (°C)**	
August	78.23	23.34	32.29	17.93
September	80.13	26.17	33.59	14.80
October	70	13.20	28.10	5.20
November	81	16.10	30.0	0.00
December	85	12.10	26.4	7.00

Brief description of cultivars used

Varieties	Releasing year	Plant height (cm)	Life span (days)	Grain size	Major traits
Binadhan-7	2007	95	110-120	Thin	BPH tolerant
BRRI dhan56	2011	115	105-110	Thick	Drought tolerant
BRRI dhan62	2013	98	100	Thin	Medium drought tolerant and contains Zinc
BRRI dhan71	2014	107-108	114-117	Medium thick	Medium drought tolerant
BRRI dhan72	2014	116	125-130	Thick	Zinc enriched

Collection of seed

The seeds ofBinadhan-7, BRRI dhan56, BRRI dhan62, BRRI dhan71 and BRRI dhan72 were collected from Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh and Rice Research Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Bangladesh.

Growing of seedlings

Seeds were soaked in water and staged for 24 h by putting gunny bag on the seeds for quick sprouting. Sprouted seeds were sown in the wet nursery bed and were taken required care up to 30 days. Before sprouting and sowing in the nursery bed, seeds of the concerned variety were treated with a popular fungicide, Provax-200 WP, which contains Carboxin and Thiram (marketed by Hossain Enterprise Bangladesh Ltd., Associated with Chemtura Corp., USA).

Details of the experiment

The experiment comprising of five rice varieties were laid out in Randomized Complete Block Design (Single factor) with four replications.

There were five treatments such as

V_1- Binadhan-7, V_2- BRRI dhan56, V_3- BRRI dhan62, V_4- BRRI dhan71, andV_5- BRRI dhan72 with four replications.

Land preparation and field operations

The experimental plot was prepared by cross harrowing of the land followed by cross ploughing with cultivator. Each ploughing was followed by planking in order to pulverize the soil, weeds, root stubbles and other crop residues were removed and the field was leveled and puddled under transplanting. The field was prepared by single ploughing without puddling and the seeds are directly sown into the field by the help of tyne under broadcasting method. There were 20 plots and unit plot size was 2.0 mx2.5 m. Spacing was maintained as 25 cm x 15 cm with 25 days old seedlings.

Fertilizer application

The land was fertilized as per treatment specifications. Well decomposed cowdung was applied on 27 July, 2018, 10 days before transplanting. Full dose of TSP, MOP and gypsum were applied one day before transplanting. Nitrogen from urea was applied per treatments in three equal splits. The first split of urea was applied as top dressing after 20 days of transplanting. The second split of urea was applied with Zinc sulphate and Boron after 35 days of transplanting and the third split of urea was applied after 55 days of transplanting.

Plant protection measures

During the experimentation same treatment were applied at all plots for fungal diseases controlled by applying Dithane M-45 @ 2.0 kg ha^{-1} and Eminent Pro @ 790 mL ha^{-1} after 30 days and 50 days of transplanting. Some insect pest like steem borer, grass hopper and rice bug were controlled by spraying Ultima plus 40 WG @ 75 g ha^{-1}, Fyfanon 57 EC @ 988 mL ha^{-1} 30 days and 50 days of transplanting.

Harvesting

When more than 90% of grains matured fully, free from greenish tint and plants turned yellowish color with dryness, crop was harvested in first week of August with the help of sickle. The net plot size 2.0 m x 2.5 m was marked by two rows on both sides of length of breadth of the plot. After sun drying, the produce grain of individual plot was bundled and weighed for total biological yield.

Details of observations recorded

Crop growth parameters

Tiller number

The tiller number (m^{-2}) was counted at 30 DAT, 45 DAT, 60 DAT, 75 DAT and at harvest from randomly five selected tillers per hill. The final value was computed and expressed in terms of mean value of four observations by completing the sum of the four observations.

Number of leaves/hill

Total numbers of leaves were counted in five marked hills of each plot at 30, 45 and 75 DAT growth stages. Then mean was computed.

Physiological parameters

Stem and leaf dry matter hill^{-1}

Root, stem and leaf dry matter hill^{-1} were recorded at 30 DAT, 45 DAT, 60 DAT, 75 DAT and at harvest from five 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.

Total dry matter hill^{-1}

Total dry matter hill^{-1} was recorded at 30 DAT, 45 DAT, 60 DAT, 75 DAT and at harvest by adding stem dry matter and leaves dry matters hill^{-1}.

Leaf area index

Leaf area index (LAI) was measured at the time of 30, 45, 60, 75 and at harvest. Data were recorded as the average of 03 hills selected at random the inner rows of each plots. The final data calculated as per the formula given

$$\text{LAI} = \frac{\text{A}}{\text{P}}$$

Where,

LAI = Leaf area index, A = Leaf area and P = Ground area

Crop growth rate (CGR)

Increase of plant material per unit of time per unit of land area at 50-60 days.

$$\text{CGR} = \frac{1}{\text{A}} \times \frac{\text{W} - \text{W}}{\text{T} - \text{T}} \text{g } m$$

Relative growth rate (RGR)

Increase of plant material per unit of material present per unit of time at 50-60 days.

$$\text{RGR} = \frac{\text{L W} - \text{L W}}{\text{T} - \text{T}} \text{mg } g$$

Net assimilation rate (NAR)

Increase of plant material per unit of leaf area per unit of time at 50-60 days

$$\text{NAR} = \frac{(W_2 - W_1)}{(t_2 - t_1)} \text{ X } \frac{(\text{Ln } LA_2 - \text{Ln } LA_1)}{(LA_2 - LA_1)}$$

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

Phenological Parameters

Data on phenological parameters of rice such as days to booting, days to heading and days to anthesis.

Yield attributes and yield studies

Plant height

Height (cm) of the five tagged plants from five hills was measured from base of the plant to tip of the tallest leaf in each plot at different stages of growth. Thereafter, average height per plant was worked out for each plot.

Productive tillers hill^{-1}

The panicles which had at least one grain was considered as productive tillers. The number of productive tillers of 5 hills was recorded and expressed as effective tillers number m^{-2}.

Number of non-productive tillers hill^{-1}

The panicles which had no grain were recorded as non-productive tillers.

Panicle length

Randomly selected ten panicles were tagged and the length was measured (cm) from the neck node to the tip of the upper most panicle and average length was recorded.

Fertile grains panicle^{-1}

The filled grain per panicles were randomly selected from tagged plants of ten panicles from each plot were counted and averaged.

Sterile grains panicle^{-1}

The spikelets lacked any food material inside were considered as sterile spikelets and such spikelets present on each panicle was counted.

Test weight (g)

One thousand cleaned dried seeds were counted randomly from each sample and weighed by using a digital electric balance at the stage the grain retained 14% moisture and the mean weight were expressed in gram.

Grain yield (t ha^{-1})

Grain yield was determined from the net plot area of each plot and expressed as t ha^{-1} and adjusted with 12% moisture basis. Grain moisture content was measured by using a digital moisture tester.

Straw yield (t ha^{-1})

Straw yield was determined from the net plot area of each plot. After separating of grains, the sub-samples were oven dried to a constant weight and finally converted into t ha^{-1}.

Harvest index

It denotes the ratio of economic yield (grain yield) to biological yield and was calculated with following formula (Gardner *et al*. 1985).

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

Statistical analysis

Data collected during this study were statistically analyzed using MSTAT statistical package of Michigan State University, USA. Duncan's multiple range test (DMRT) at a 5% probability level was used to test differences among mean values (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

This chapter contains results of the experiment and the follow up discussion. Results obtained from the present study regarding growth, yield and phenological responses of five elite *Aman* rice varieties have been presented and discussed below:

Rice varieties in relation to phenological parameters

Booting stage (days)

Booting stage significantly affected due to variety to variety. BRRI dhan72 takes the maximum days (61.75 days) for booting while the minimum days (38.63 days) requires for in BRRI dhan62 which is statistically identical with rest varieties (Table 3).

Heading stage (days)

Different variety significantly influenced the booting stage of rice (Table 3). The highest time (67.12 days) require for the booting of rice plant in BRRI dhan72which is statistically similar with BRRI dhan71 and the rest of the varieties needed more or less similar time for heading(Table 3).

Anthesis date (days)

Anthesis in rice significantly influenced by Aman rice genotypes (Table 3). BRRI dhan72 and BRRI dhan62 takes the maximum (71.75 days) and minimum (48.5 days) and time, respectively for the anthesis among all genotypes.

Table 3. Effect of different Aman rice varieties on phenological characters of rice

Variety	Booting date (days)	Heading date(days)	Anthesis date(days)
Binadhan-7	45.43b	46.08b	48.5
BRRI dhan56	41.05b	47.23b	50.31
BRRI dhan62	38.63b	43.87b	47.67
BRRI dhan71	45.31b	50.91ab	57.31
BRRI dhan72	61.75a	67.12a	71.75
LSD	9.51	17.11	14.25
Level of significance	**	**	**
CV(%)	9.57	16.36	12.02

The values with same letters(s) in a column are not significantly different as per DMRT

Rice varieties in relation to physiological parameters

Leaves dry weight (g)

Leaves dry matter in rice at different stages progressively varied due to varietal effect (Table 4). The highest leaves dry matter (13.14 g) was found in BRRI dhan72 which is statistically similar with BRRI dhan56 and Binadhan-7 whereas the minimum (9.84 days) was recorded by BRRI dhan62 at harvesting among all of the rice genotypes (Table 4). At 30 DAT, the highest leaves dry weight (2.78 g) was recorded in BRRI dhan72 and rest varieties produced more or less dry weight. Similar results were observed at all growth stages of rice.

Table 4. Effect of different *Aman* rice varieties on leaves dry weight at several growth stages

Variety	Leaves dry weight (g)				
	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
Binadhan-7	2.19b	6.78	7.98ab	10.17ab	12.14ab
BRRI dhan56	1.97c	5.87	7.23b	9.47ab	11.29ab
BRRI dhan62	1.78d	4.73	6.87b	8.79ab	9.84b
BRRI dhan71	2.01c	6.24	7.89ab	7.91b	10.43b
BRRI dhan72	2.78a	6.73	9.133a	10.98a	13.14a
LSD	0.78		1.56	2.33	2.52
Level of significance	**	NS	*	**	**
CV(%)	4.34	17.93	13.02	11.41	10.28

The values with same letters(s) in a column are not significantly different as per DMRT

Stem dry weight (g)

Different aman variety significantly influenced the stem dry matter in rice (Table 5). BRRI dhan72 produced the highest stem dry weight (9.36 g) which is statistically similar with BRRI dhan71 and Binadhan-7 and rest two varieties produced similar stem dry weight at 45 DAT. All HYV studied in this experiment produced the non-significant variation in case of stem dry weight at 60 and 75DAT. At harvesting as well as all growth stages, BRRI dhan72 and BRRI dhan54 produced the highest (15.45 g) and lowest (11.97 g) stem dry matter, respectively among all genotypes.

Table 5. Effect of different Aman rice varieties on stem dry weight at several growth stages

Variety	Stem dry weight (g)				
	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
Binadhan-7	3.168b	8.78a	10.13	12.37	14.37ab
BRRI dhan56	2.918c	7.98ab	9.45	11.87	13.43ab
BRRI dhan62	2.483d	6.77b	8.97	10.95	11.97b
BRRI dhan71	3.01c	8.57a	9.935	11.01	12.41b
BRRI dhan72	3.528a	9.36a	11.24	13.45	15.45a
LSD	0.102	1.37			2.52
Level of significance	**	**	NS	NS	**
CV(%)	2.11	7.65	12.10	11.14	9.25

The values with same letters(s) in a column are not significantly different as per DMRT

Total dry matter (g)

Data pertaining to dry matter production by the plants of rice varieties at successive growth stages are given through graphically illustration by the Fig.1. It is obvious from the data that in correspondingly increased with the advancement of growth stages up to the maturity stage in all the varieties. The rapid rate of increase in dry matter production was obtained in between 60 to 75 DAT. The dry matter production was very low at 30 DAT. BRRI dhan72 produced higher amount of total dry matter and the lowest was obtained by BRRI dhan62 in all successive growth stages among all varieties.

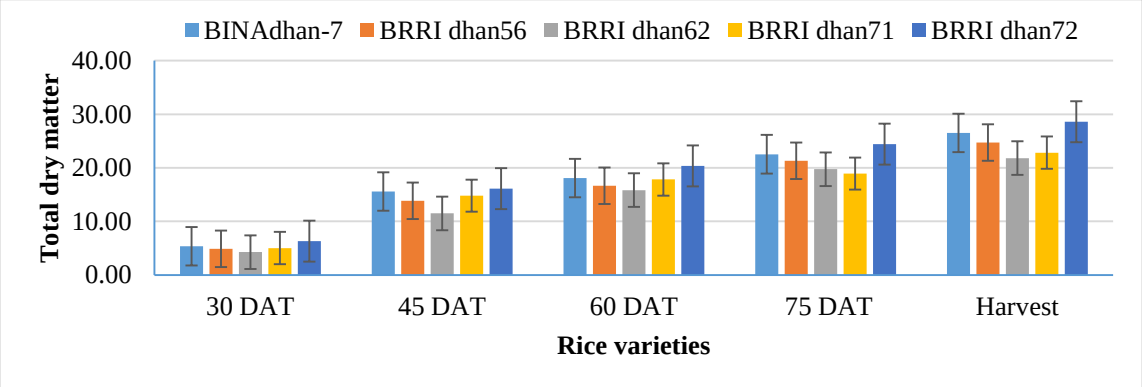

Fig. 1. Total dry matter content as influenced by aman rice varieties at different successive stages

Leaf area index (LAI)

Data pertaining to LAI of different rice varieties at different successive growth stages are given in Table 5. It is clear from the data that LAI significantly increased in all varieties at different successive growth (Fig. 2). At 60 DAT, BRRI dhan72 and BRRI dhan62 led to record maximum and minimum values of LAI, respectively among all varieties. During every sampling the highest LAI was recorded by BRRI dhan72, Binadhan-7, BRRI dhan71, BRRI dhan56 and BRRI dhan62. Similar results were found in same varieties in all successive growth stages. Generally, with the advancement of the plant age and varieties greatly varied the LAI in most of the field crops (Dutta and Mondal, 1998).

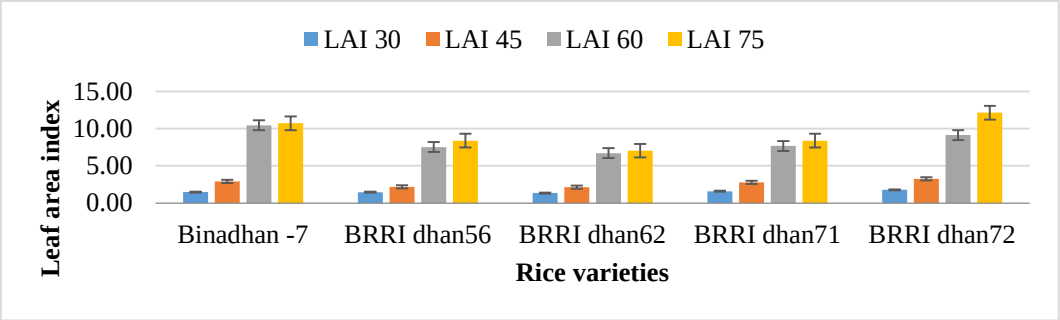

Fig. 2. Effect of Aman rice varieties on leaf area index at different successive stages

Crop growth rate ($gm^{-2}d^{-1}$)

Crop growth rate (CGR) of rice significantly influenced by different varieties at 50-60 days is given in (Table 6). BRRI dhan72 produced the highest CGR (18.14 $gm^{-2}d^{-1}$) which was statistically similar with BRRI dhan71 (17.40 $gm^{-2}d^{-1}$) and Binadhan-7 (17.39 $gm^{-2}d^{-1}$) while the minimum was recorded by BRRI dhan62 (12.87 $gm^{-2}d^{-1}$) among all rice varieties. Difference of CGR at different varieties might attribute to the different LAI. (Fig. 2). So, the CGR increased along with increases in LAI. This result is in agreement with the finding of Yang *et al*. (2011).

Relative growth rate ($mgg^{-1}d^{-1}$)

It is evident that different rice varieties showed different RGR and it is non-significant (Table 6). The highest (72.10 $mgg^{-1}d^{-1}$) and lowest RGR (62.66 $mgg^{-1}d^{-1}$) RGR were found in BRRI dhan72 and BRRI dhan62, respectively among all genotypes

Net assimilation rate ($gm^{-2}d^{-1}$)

Net assimilation rate (NAR) of rice significantly varied due the different varieties (Table 6). The highest NAR was recorded in BRRI dhan72 (8.93$gm^{-2}d^{-1}$) which is statistically identical with Binadhan-7(8.69 $gm^{-2}d^{-1}$) and BRRI dhan56 (8.20g $m^{-2}d^{-1}$) while the lowest NAR value was observed in BRRI dhan62 (7.12 $gm^{-2}d^{-1}$). It is evident The NAR values significantly differed between the varieties at early growth stage (0-30 DAT), but they did not differ significantly during advanced growth stages This result is agreed with result of Hoque (2004) who reported that high yielding rice had greater NAR than the low yielding ones.

Table 6. Physiological parameters as influenced by aman rice varieties

Variety	Crop Growth Rate ($gm^{-2}d^{-1)}$	Relative Growth Rate ($mgg^{-1}d^{-1}$)	Net Assimilation Rate ($gm^{-2}d^{-1}$)
Binadhan-7	17.39a	70.74	8.69a
BRRI dhan56	15.93ab	69.28	8.20ab
BRRI dhan62	12.87b	62.66	7.12b
BRRI dhan71	17.40a	66.18	7.50ab
BRRI dhan72	18.14a	72.10	8.93a
LSD	4.01		1.35
Level of significance	**	NS	*
CV(%)	11.39	9.64	10.83

The values with same letters(s) in a column are not significantly different as per DMRT

Rice varieties in relation to morphological and yield contributing parameters

Plant height (cm)

Different rice varieties at various stages significantly varied the plant height (Table 7). The smallest plant height (109.75 cm) and tallest plant height (125.51 cm) was obtained from BRRI dhan62 and BRRI dhan72, respectively at harvesting as well as among all growth stages. The differences of genetic makeup might be varied the plant height. Sarkar *et al.* (2016) observed variation in plant height due to varietal differences. Similar results were reported by Shamsuddin *et al*. (1988) and Kabir *et al.* (2004).

Table 7. Effect of different *Aman* rice varieties on plant height at several growth stages

Varieties	Plant height (cm)				
	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
Binadhan-7	55.16bc	73.25ab	84.09ab	98.81ab	117.15ab
BRRI dhan56	58.03b	65.03bc	73.15ab	93.37bc	109.75bc
BRRI dhan62	45.39c	52.25d	68.67b	84.59c	103.61c
BRRI dhan71	54.75bc	58.75cd	81.12ab	96.34ab	114.43ab
BRRI dhan72	70.06a	80.09a	88.34a	105.32a	125.51a
LSD	11.69	11.46	16.05	9.92	12.25
Level of significance	**	**	**	**	**
CV(%)	9.57	8.06	9.43	4.83	4.99

The values with same letters(s) in a column are not significantly different as per DMRT

Leaves hill^{-1}

In case of leaves hill^{-1} in rice significantly varied by varietal effect (Table 8). BRRI dhan72 always produced higher amount of leaves hill^{-1}which is statistically identical with Binadhan-7 and BRRI dhan71 and BRRI dhan62 at 30, 45, 60, 75 DAT as well as up to harvesting among all genotypes.

Table 8. Effect of different Aman rice varieties on number of leaves hill^{-1}at several growth stages

Varieties	Number of leaves hill^{-1}				
	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
Binadhan-7	59.09b	48.78b	40.31b	34.43b	31.32bc
BRRI dhan56	52.23bc	46.34b	41.26b	36.01b	34.13b
BRRI dhan62	48.09bc	42.32b	38.09b	32.98b	28.25bc
BRRI dhan71	45.03c	42.75b	34.06b	28.8b	25.45c
BRRI dhan72	80.27a	71.08a	63.56a	56.43a	48.75a
LSD	11.95	10.83	7.94	7.89	7.78
Level of significance	**	**	**	**	**
CV(%)	9.74	10.04	8.36	9.89	10.78

The values with same letters(s) in a column are not significantly different as per DMRT

Number of tillers hill^{-1}

Table 9. showed that number of total tillers hill^{-1} was significantly (P≤0.01) influenced by the rice varieties. Among all genotypes, BRRI dhan72 and BRRI dhan62 produced the maximum (22.3) and minimum number of tillers hill^{-1} (12.3), respectively. BRRI dhan56 and BRRI dhan71 produced the medium tillers per hill^{-1}. This confirms the report of Sawant *et al.* (1986), who reported that variable effect variety on the number of effective tillers hill^{-1}. The same result was reported by Schnier *et al.* (1990). With the decrease of tillers hill^{-1}, yield also decease considerably (Hoque 2004).

Number of productive tillers hill^{-1}

The number of productive tiller (tillers which bears panicle) rather than the total number of tillers greatly influenced the productivity of rice plant (Table 9). BRRI dhan72 produced the maximum number of effective tillers hill^{-1} (19.3) while the minimum (8.3) was recorded in BRRI dhan 62 among all varieties. These results are well corroborated with the findings of (Yang *el al*. 2011; Munshi 2005).

Non-productive tillers hill^{-1}

Non-productive tillers hill^{-1} showed the insignificant (P≤0.05) variation due to the variation of rice varieties. Numerically the highest number of non-effective tillers hill^{-1} (4.00) was obtained from BRRI dhan62 and BRRI dhan62. The lowest (2.9) number of non- effective tillers hill^{-1} was found in BRRI dhan72. This result is in line with findings of Sarkar *et al.* (2016), opined the highest number of effective tillers hill^{-1} with different rice genotypes.

Panicle length (cm)

The effect of rice genotypes on panicle length was significant (P≤0.01) (Table 9). BRRI dhan44 produced the longest panicle (33.17 cm) which is statistically identical with BRRI dhan71 while the smallest (25.53 cm) was found in BRRI dhan62 among all of the varieties. The variation might be due to the genetic variation of variety. These results are in agreement with the findings of Mahamud *et al.* (2013) who reported that panicle length was differed due to variety. Higher yield in rice can be achieved from panicle length as mentioned by Salam *et al.* (1990). Ahmed *et al.* (1997) and Idris and Matin (1990).

Number of grains panicle^{-1}

It was evident from table, grains panicle^{-1} was statistically significant (P≤0.01) due to different Aman rice varieties. The grains panicle^{-1} ranged from 156.53 to 202.25. The highest number of grains panicle^{-1} (202.25) was obtained in BRRI dhan72 which is statistically similar with BRRI dhan71, BRRI dhan56 and Binadhan-7 and the lowest no. of grain panicle^{-1} (156.53) was found in BRRI dhan62 among all varieties. This result is in agreement with the result of Duttaand Mondal (1998) who observed that yield was affected by the filled grains panicle^{-1}.

Table 9. Effect of different *Aman* rice varieties on yield components of rice

Varieties	Total tillers hill^{-1}	Productive tillers hill^{-1}	Non-productive tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}
Binadhan-7	20.51a	17.5ab	3.01	26.85b	194.01ab
BRRI dhan56	17.25b	13.2b	4.05	28.45b	185.48b
BRRI dhan62	12.39c	8.3c	4.09	25.53b	156.53c
BRRI dhan71	15.1b	12.2b	2.9	29.72ab	195.03ab
BRRI dhan72	22.38a	19.3a	3.08	33.17a	202.25a
LSD	2.23	1.97		4.30	9.26
Level of signi.	**	**	NS	**	**
CV(%)	5.91	6.47	14.34	6.93	2.30

The values with same letters(s) in a column are not significantly different as per DMRT

Number of fertile grains panicle^{-1}

The number of fertile grains panicle^{-1} was significantly varied due to Aman rice varieties and it was statistically significant (P≤0.05) (Table 10). Among all genotypes, the highest number of fertile grains panicle^{-1} (192.2) was obtained in BRRI dhan72 and lowest number of fertile grain panicle^{-1} (109.9) was found in BRRI dhan41. Other varieties gave intermediate value. Similar trends were reported by Sarkar *et al.* (2016) in Aman rice.

Number of sterile grains panicle^{-1}

Number of sterile grains panicle^{-1}significantly decreased due to rice genotypes (P≤0.01). BRRI dhan62 produced higher no. of sterile grains (47.23) panicle^{-1} and the lowest no. of sterile grains (10.05) panicle^{-1} was found in BRRI dhan72 among all aman rice genotypes (Table 10). Sarkar *et al*. (2016) reported differences in number of sterile grains panicle^{-1} due to varietal character.

Test weight (g)

Test weight of rice was significantly affected by different rice genotypes (Table 10). The test weight of rice significantly varied from 22.43 to 28.10 g. Among all aman rice varieties, the lowest test weight (22.43 g) was observed in BRRI dhan56 whereas BRRI dhan72 produced the highest test weight (28.10 g) among all genotypes. 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. This result is an agreement with the findings of Islam *et al*. (2013) who stated that weight of 1000- grain differed due to the varietal differences.

Grain yield (t ha^{-1})

Experimental analyzed data showed grain yield significantly varied among different varieties (Table 10). BRRI dhan72 produced the maximum grain yield (6.29 tha^{-1}) while the minimum grain yield (3.73 tha^{-1}) observed in and BRRI dhan62. This higher yield is due to due the availability of nutrient to the plants. It is might be due to maximum fertile tiller per hill and productive spikelets per spike. This finding is in conformity with that of Jewel *et al*. (2016) who reported that yield progressively influenced by varietal effect. This result confirms with the finding of Tyeb*et al*. (2013) who reported that grain yield greatly varied due to different genotypes.

Straw yield(t ha^{-1})

The data depicted that straw yield (t ha^{-1}) significantly varied due to varietal effect (Table 10). Among all rice genotypes, BRRI dhan72 and BRRI dhan62 produced the maximum and minimum straw yield, respectively. Tyeb *et al*. (2013) who reported different genotypes produced different straw yield.

Table 10. Yield and yield components of rice as influenced by different Aman rice varieties

Varieties	Fertile grains panicle^{-1}	Sterile grains panicle^{-1}	Test weight(g)	Grain yield (tha^{-1})	Straw yield (tha^{-1})
Binadhan-7	173b	21.01c	25.15ab	4.67bc	5.14b
BRRI dhan56	150.4c	35.08b	22.43b	4.89bc	5.53b
BRRI dhan62	109.3d	47.23a	23.53b	3.73c	4.09c
BRRI dhan71	179b	16.03d	24.31ab	5.51ab	6.5a
BRRI dhan72	192.2a	10.05e	28.10a	6.29a	7.42a
LSD	8.38	4.17	3.98	1.31	0.97
Level of significance	**	**	**	**	**
CV(%)	2.40	7.47	7.49	12.02	7.80

The values with same letters(s) in a column are not significantly different as per DMRT

Biological yield (tha^{-1})

Different genotypes of rice positively influenced the biological yield (Table 11)**.** The lowest (7.82) and highest biological yield (13.71 tha^{-1}) was obtained from BRRI dhan62 and BRRI dhan72, respectively. Munshi (2005) and Chowdhury *et al*. (1995) reported that grain yield was positively correlated with biological yield in rice

Harvest index (%)

Analysis of variance data on harvest index was non-significant due to varietal effect. The highest harvest index (48.07%) was recorded in BRRI dhan62 and the lowest harvest index (46.02%) was recorded in BRRI dhan72 (Table 11).

Table 11. Effect of different *aman* rice varieties on straw yield and grain yield

Varieties	Biological yield (tha^{-1})	Harvest index (%)
Binadhan-7	9.81c	47.62
BRRI dhan56	10.42bc	47.552
BRRI dhan62	7.82d	48.068
BRRI dhan71	12.01ab	46.303
BRRI dhan72	13.71a	46.023
LSD	1.82	
Level of significance	**	NS
CV(%)	7.82	7.26

The values with same letters(s) in a column are not significantly different as per DMRT

CONCLUSION

In conclusion, from the data pertaining to the different varieties, the phenological characters of Aman rice varieties booting stage, heading date and anthesis progressively influenced by varietal effect. The maximum and minimum time required for booting, heading and anthesis were observed in BRRI dhan72 and BRRI dhan62 respectively, among five studied elite Aman varieties. Different Aman varieties showed significant variation in physiological characters of rice. BRRI dhan72 produced the highest leaf dry matter (13.14 g), stem dry matter (15.45 g), leaf area hill^{-1}, Crop Growth Rate (18.14 gm^{-2}d^{-1}) and Net Assimilation Rate (8.93 gm^{-2}d^{-1}), Leaf Area Index while the lowest time was recorded by BRRI dhan62 at harvesting as well as different growth stages among all varieties. Morphological characters (*i.e* number of leaves hill^{-1} and plant height) and yield contributing characters like number of total tillers hill^{-1}, productive tillers hill^{-1}, panicle length, grains panicle^{-1}, fertile grains panicle^{-1}, sterile grains panicle^{-1}, test weight, grain yield, straw yield and biological yields were significantly influenced by different varieties. The plant height (125 cm), number of leaves hill^{-1}(48.75), number of total tillers hill^{-1}(22.3), productive tillers hill^{-1}(19.3), panicle length (33.17 cm), grains panicle^{-1} (203.25), fertile grains panicle^{-1}(192.2), test weight(28.10 g), grain yield (6.29 tha^{-1}), straw yield (7.42 tha^{-1}), biological yield (13.71 tha^{-1}) and minimum sterile grains panicle^{-1}(10.05) were produced by BRRI dhan72 among studied five elite Aman varieties. From the overall results it may be concluded that BRRI dhan72 and BRRI dhan62 are the superior and inferior variety based on phenological characters of Aman rice *viz.* booting stage, heading date and anthesis among studied varieties, BRRI dhan72 had higher morphological attributes among all HYV rice as well as higher yield and yield contributing characters were obtained by BRRI dhan72 among all studied aman rice varieties. From the finding of this study, the following recommendation can be made with a view to obtaining maximum productivity as well as national economic benefits, BRRI dhan72 can be advised to adopt in Aman season. For wider acceptability, the same experiment should be repeated at different Agro-ecological zones of the country.

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