MORPHO-PHYSIOLOGICAL STUDY OF DIFFERENT LOCAL AND HYV RICE VARIETIES DURING *Aman* SEASON

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MORPHO-PHYSIOLOGICAL STUDY OF DIFFERENT LOCAL AND HYV RICE VARIETIES DURING *Aman* SEASON

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CERTIFICATE

This is to certify that the thesis entitled ***"Morpho-physiological study of different local and HYV rice varieties during Aman season"****submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of* ***Master of Science*** *in the department of* ***Agricultural Botany****, embodies the result of a piece of bonafide research work carried out by****Rumana Ahmed****, Registration No. 11-04600under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated: June, 2017

Place: Dhaka, Bangladesh

.....
(Prof. Dr. Nasima Akhter)
Supervisor


Dedicated To
My Beloved Parents

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ABSTRACT

An experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period from July 2017 -December 2017**,** to study the morpho-physiological study of different local and HYV rice varieties during *aman* season and to identify the important vegetative, reproductive and yield characteristics which might contribute in higher yield. Ten rice varieties were used as treatments. Among the varieties, seven were local (Buta, Dudkat, Bindipakri, Chinisagar, Sunashail, Kartik jhul and Ranjay) and three were HYV varieties (BRRI dhan51, BRRI dhan52 and BRRI dhan70). The experiment was laid out in a Randomized complete Block Design (RCBD) with four replications. Data on different growth parameters, physiological parameters and yield with yield contributing characters were recorded. The collected data were statistically analyzed for evaluation of the treatment effect. Results signified that the highest number of total tillers hill^{-1}, dry weight hill^{-1}, crop growth rate , absolute grain growth rate, flag leaf dry weight, SPAD value of flag leaf at anthesis stage and grain filling stage, number of effective tiller, number of ineffective tiller ,panicle length, number of filled grains panicle^{-1}, number of grains plant^{-1}, weight of grains plant^{-1}, grain yield (3.78 t ha^{-1}), straw yield (6.88 t ha^{-1}), biological yield (10.66 t ha^{-1}) and harvest index (35.46%) were recorded from the variety, V_8 (BRRI dhan51). The lowest number of effective tiller, number of filled grains panicle^{-1}, number of grains plant^{-1}, grain yield (0.57 t ha^{-1}), straw yield (1.83 t ha^{-1}), biological yield (2.40 t ha^{-1}) and lowest harvest index (23.75%) were observed from the variety, V_2 (Dudkat). Among the local varieties V_3 (Bindipakri) performed better for its higher number of leaves plant^{-1},crop growth rate, absolute grain growth rate, number of effective tillers, panicle length, number of filled grains panicle^{-1}, number of grains plant $^{-1}$, weight of grains plant^{-1} (33.36) and grain yield (2.05 t ha^{-1}).

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ABBREVIATIONS AND ACRONYMS

%	=	Percent
AEZ	=	Agro ecological zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
Ca	=	Calcium
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
e.g.	=	exempli gratia (L), for example
et al.,	=	And others
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram (s)
GM	=	Geometric mean
i.e.	=	id est (L), that is
K	=	Potassium
Kg	=	Kilogram (s)
L	=	Litre
LSD	=	Least Significant Difference
M.S.	=	Master of Science
m^2	=	Square meter
mg	=	Miligram
ml	=	Mililitre
NaOH	=	Sodium hydroxide
No.	=	Number
^oC	=	Degree Celsius
P	=	Phosphorus
SAU	=	Sher-e-Bangla Agricultural University
USA	=	United States of America
var.	=	Variety
WHO	=	World Health Organization
HYV	=	High Yielding Variety
µg	=	Microgram

CHAPTER I

INTRODUCTION

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INTRODUCTION

Rice (*Oryza sativa*) belongs to the family Gramineae, is the staple food for at least 62.8% of total planet inhabitants and it contributes on an average 20% of apparent caloric intake of the world population and 30% of population in Asian countries. This caloric contribution varies from 29.5% for China to 72.0% for Bangladesh (Calpe and Prakash, 2007). Around 90% of rice is grown and consumed in south and southeast Asia, the highly populated area (Catling, 1992). It is the staple food for more than two billion people in Asia (Hien *et al*., 2006). Bangladesh ranks 4th in both area and production and 6th in the production of per hectare yield of rice in the world.

Rice is the staple food of about 160 million people of Bangladesh. The population of Bangladesh will increase to 173 million in 2020 which is 31 percent higher than the present level (FAO, 1998). Population growth demands a continuous increase in rice production in Bangladesh. Production of rice has to be increased by at least 60% to meet up food requirement of the increasing population by the year 2020 (Masum, 2009). As it is not possible to have horizontal expansion of rice area, rice yield per unit area should be increased to meet this ever-increasing demand of food in the country. The current level of annual rice production of around 545 million tons could be increased to about 700 million tons to feed an additional 650 million rice eaters by 2025 using less land indeed the great challenge in Asia (Dawe, 2003). Rice is extensively grown in Bangladesh in the three seasons namely, *Aus*, *Aman* and *Boro* which covers total 80% of the total cultivable area of the country (AIS, 2011). Among these cropping seasons transplanted *aman* is most important and occupied about 46% of the rice cultivated land in 2009-10. The rest 41, 9 and 4 percent of the land is occupied by *Boro*, *Aus* and sown *Aman* respectively. Area covered by *Aus* is 10.50 lac hectare and production 23 lac

metric ton, area covered by *Aman* is 56 lac hectare and production 131 lac metric ton, lastly area covered by *Boro* is 48 lac hectare and production 192 lac matric ton (BBS, 2016). *Aman* season, however, available information regarding the yield and yield contribution characters, both morpho-physiological characteristics of HYV rice varieties are meager in Bangladesh. That is why, it is a prime need to conduct more research work to find out and develop sustainable technologies regarding HYV 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 and high yielding rice was due to its short duration of 120-130 days. Therefore, it is postulated that if HYV rice is introduced, crop duration can be reduced by 20-40 days. In the year 2010, among the *aman* rice varieties high yielding modern varieties covered 66.63% and yield was 2.49 t ha^{-1} and local varities covered 24.97% and yield was 1.58 t ha^{-1} (BBS, 2010). It is the farmers who have gradually replaced the local indigenous low yielding rice varities by high yielding ones and modern varities of rice developed by Bangladesh Rice Research Institute (BRRI) only because of getting 20 to 30% more yield unit land area (Shahjahan, 2007).

Two types of rice cultivars are cultivated in Bangladesh viz. traditional (local) and modern (high yielding) varieties. Though the soil and climate of our country is quite suitable for the production of rice, still it is facing many problems of which the poor yielding inherent capability of our local varieties is the most important one. Poor plant type, such as tall plant, long and droopy leaves, weak culms, susceptible to lodging etc. are the main causes of the low yield of local varieties. On the other hand, modern varieties possess short and stout culms with dark green, thick and erect leaves and do not lodge.

Variety plays an important role for successful crop production. Significant variation was found due to varietal difference on yield of rice. HYV and hybrid

rice varieties have 15-30% yield advantage over local inbred (Julfiquar *et al*., 2009; Abou Khalifa, 2009). Our indigenous cultivars were given less attention and their morphological characters and yielding ability were not studied well. We should find out the special vegetative and reproductive characters of different local aman rice varieties. For the development of our high yielding rice varieties our indigenous rice cultivars may play a vital role as parent material because they are most adaptive to our environment. If it becomes possible to incorporate some important characteristics of local rice in HYV rice then the production of HYV can be increased in a great extend. That is why it is necessary to study the vegetative and reproductive characteristics of different local and HYV varieties.

Considering the above facts the present study was undertaken with the following objectives:

i) To study the important morpho-physiological characteristics of local and HYV *aman* rice.
ii) To identify the important vegetative characteristics of the tested varieties.
iii) To identify important reproductive and yield characteristics of the tested varieties.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Rice yield varies due to varietal differences. So, varieties are the most important factor needed to be considered in rice cultivation. Some of the important and informative works and research findings related to different rice varieties done at home and abroad have been reviewed under the following headings:

2.1 Effect of variety

2.1.1 Growth parameters

Sarker *et al.* (2013) conducted an experiment to study morphological, yield and yield contributing characters of four *Boro* rice varieties of which three were local *viz*., Bashful, Poshursail and Gosi; while another one was a high yielding variety (HYV) BRRI dhan28. The BRRI dhan28 were significantly superior among the cultivars studied. The BRRI dhan28 was shorter in plant height, having more tillering capacity, higher leaf number which in turn showed superior growth character and yielded more than those of the local cultivars. The HYV BRRI dhan28 produced higher number of grains panicle^{-1} and bolder grains resulted in higher grain yield over the local cultivars. Further, BRRI dhan28 had more total dry mass than those of local varieties. The BRRI dhan28 produced higher grain yield (7.41 t ha^{-1}) than Bashful, Poshurshail and Gosi, respectively. Among the local rice cultivars, Gosi showed the higher yielding ability than Bashful and Poshursail.

Sarkar *et al*. (2014) conducted an experiment to study the yield and quality of aromatic fine rice as affected by variety and nutrient management. The

experiment comprised three aromatic fine rice varieties *viz*. BRRI dhan34, BRRI dhan37 and BRRI dhan38. The tallest plant (142.7 cm), the highest number of effective tillers hill^{-1} (10.02), number of grains panicle^{-1} (152.3), panicle length (22.71cm), 1000-grain weight (15.55g) and grain yield (3.71 t ha^{-1}) were recorded in BRRI dhan34.

Anwar and Begum (2010) reported that time of tiller separation of rice significantly influenced plant height, total number of tiller hill^{-1}, number of bearing tillers and panicle length but grain and straw yields were unaffected. Therefore, Sonarbangla-1 appeared to be tolerant to tiller separation and separation should be done between 20 to 40 DAT without hampering grain yield.

Islam *et al*. (2009) conducted a pot experiments with Hybrid variety Sonarbangla-1 and inbred modern variety BRRI dhan31 and BRRI hybrid dhan-l to compare the growth and yield behavior of hybrid and inbred rice varieties under controlled condition. BRRI dhan3l had about 10-15% higher plant height, very similar tillers/plant, 15-25% higher leaf area at all days after transplanting (DAT) compared to Sonarbangla-1. Sonarbangla-1 had about 40% higher dry matter production at 25 DAT but had very similar dry matter production at 50 and 75 DAT, 4-11% higher rooting depth at all DATs, about 22% higher root dry weight at 25 DAT, but 5-10% lower root dry weight at 50 and 75 DAT compared to BRRI dhan31. The photosynthetic rate was higher (20 µ mol m^{-2} sec^{-1}) in BRRI dhan3l at 35 DAT (maximum tillering stage) but at 65 DAT, Sonarbangla-l had higher photosynthetic rate of 19.5 µ mol m^{-2} sec^{-1}. BRRI dhan3l had higher panicles plant^{-1} than Sonarbangla-1, but Sonarbangla-1 had higher number of grains panicle^{-1}, 1000-grain weight and grain yield than BRRI dhan31.

Ahmed *et al.* (2007) conducted a field experiment to study the influence of cultivation methods on inbred and hybrid rice in *Boro* season. The experiment

consisted of two levels of treatment *viz*. variety and cultivation method. Interaction of variety and cultivation method revealed that nursery seedlings of the inbred variety produced the highest grain yield (8.88t ha^{-1}) and sprouted seeds broadcast of the inbred variety gave the lowest grain yield (6.35 t ha^{-1}).

Myung (2005) worked with four different panicle types of rice varieties and observed that the primary rachis branches (PRBs) $panicle^{-1}$ and grains were more on Sindongjinbyeo and Iksan467 varieties, but secondary rachis branches (SRBs) were fewer than in Dongjin1 and Saegyehwa varieties.

Akbar (2004) reported that variety, seedling age and their interaction exerted significant influence on almost all the crop characters. Among the varieties, BRRI dhan41 performed the best in respect of number of bearing tillers $hill^{-1}$, panicle length, total spikelet's $panicle^{-1}$ and number of grains $panicle^{-1}$. BRRI dhan41 also produced the maximum grain and straw yields. Sonarbangla-1 ranked first in respect of total tillers $hill^{-1}$ and 1000-grain weight but produced highest number of non-bearing tillers $hill^{-1}$ and sterile spikelet's $panicle^{-1}$. Grain, straw and biological yields were found highest in the combination of BRRI dhan41 with 15 day-old seedlings.

Anwar and Begum (2004) reported that time of tiller separation of rice significantly influenced plant height, total number of tiller $hill^{-1}$, number of bearing tillers and panicle length but grain and straw yields were unaffected. Therefore, Sonarbangla-1 appeared to be tolerant to tiller separation and separation should be done between 20 to 40 DAT without hampering grain yield.

Chen-Liang *et al*. (2000) showed that the cross between Peiai 64s and the new plant type lines had strong heterosis for filled grains $plant^{-1}$, number of spikes $plant^{-1}$ and grain weight $plant^{-1}$, but heterosis for spike fertility was low.

Om *et al.* (1999) conducted a field experiment with four varieties (3 hybrids: ORI 161, PMS 2A, PMS 10A and I inbred variety HKR 126) during rainy season and observed that hybrid ORI 161 exhibited superiority to other varieties in grain yield and straw yield.

Julfiquar *et al.* (1998) reported that BRRI evaluated 23 hybrids along with three standard checks during *Boro* season 1994-95 as preliminary yield trial at Gazipur and it was reported that five hybrids (IR58025A/IR54056, IR54883, PMS8A/IR46R) out yielded the check varieties (BR14 and BR16) with significant yield difference. They also reported that thirteen rice hybrids were evaluated in three locations of BADC farm during *Boro* season of 1995-96. Two hybrids out yielded the check variety of same duration by more than 1 t ha^{-1}.

BRRI (1995) conducted three experiments to find out the performance of different rice varieties. Results of the first experiment indicated that BR4, BR10, BR11, Challish and Nizersail produced grain yield of 4.38, 3.12, 3.12, 3.12 and 2.70 t ha^{-1}, respectively. Challish cultivar flowered earlier than all other varieties. BR22 and BR23 showed poor performance. Second experiment with rice cv. BR10, BR22, BR23 and Rajasail at three locations in *aman* season. It was found that BR23 yielded the highest (5.17 t ha^{-1}), and Rajasail yielded the lowest (3.63 t ha^{-1}). Growth duration of BR22, BR23 and Rajasail were more or less similar (152-155 days). Third experiment with BR22, BR23, BR25 and Nizersail during *aman*season at three locations-Godagari, Noahata, and Putia where BR25 yielded the highest and farmer preferred it due to its fine grain and desirable straw qualities.

BRRI (1994) also reported that among the four varieties *viz.* BRRI dhan14, Pajam, BRRI dhan5 and Tulsimala, BRRI dhan14 produced the highest tillers $hill^{-1}$ and

the lowest number of spikelet panicle^{-1} respectively. They also observed that the finer the grain size, the higher was the number of spikelet panicle^{-1}.

Mallick (1994) carried out a pot experiment at the Institute of Postgraduate Studies in Agriculture (IPSA), Salna, Gazipur during the wet season, 1993 to evaluate the varietal differences in panicle characteristics, spikelet ripening, and special distribution of filled and unfilled spikelets within a panicle as influenced by tiller removal and double transplanting. The two varieties- Nizersail and BR22 representing old and modern rice were taken as variables. Removal of tillers from the mother shoot and double transplanting increased panicle formation by about 10% in both the varieties. Tiller removal increased grain yield panicle^{-1} by 27% in Nizersail and 21% in BR22. Double transplanting increased the number of spikelet's panicle^{-1} in both the varieties. Tiller removal also increased spikelets but not as much as was in the double transplanted rice.

Haque *et al.* (2013) conducted an experiment to evaluate some physiological traits and yield of three hybrid rice varieties (BRRI hybrid dhan2, Heera 2, and Tia) in comparison to BRRI dhan48 in Aus season. Compared to BRRI dhan 48, hybrid varieties accumulated greater shoot dry matter at anthesis, higher flag leaf chlorophyll at 2, 9, 16 and 23 days after flowering (DAF), flag leaf photosynthetic rate at 2 DAF and longer panicles. Heera 2 and BRRI hybrid dhan 2 maintained significantly higher chlorophyll a, b ratio over Tia and BRRI dhan 48 at 2, 9, 16 and 23 DAF in their flag leaf. Shoot reserve remobilization to grain exhibited higher degree of sensitivity to rising of minimum temperature in the studied hybrids compared to the inbred. Inefficient photosynthetic activities of flag leaf and poor shoot reserve translocation to grain resulted poor grain filling percentage in the test hybrids. Consequently the studied hybrids showed significantly lower grain yield (36.7%) as compared to inbred BRRI dhan48, irrespective of planting date in *Aus* season.

Murshida *et al*. (2017) conducted an experiment with three varieties (cv. BRRI dhan28, BRRI dhan29 and Binadhan-14) and four water management systems to examine the effect of variety and water management system on the growth and yield performance of boro rice. At 100 DAT, the highest plant height, maximum number of tillers hill^{-1}, dry matter of shoot hill^{-1} and dry matter of root hill^{-1} were obtained from BRRI dhan29 and the lowest values were found in Binadhan-14. Variety had significant effect on all the crop characters under study except 1000-grain weight. The highest grain yield was obtained from BRRI dhan29 and the lowest value was recorded from Binadhan-14.

Chamely *et al*. (2015) conducted an experiment with three varieties *viz*., BRRI dhan28 (V_1), BRRI dhan29 (V_2) and BRRI dhan45 (V_3); and five rates of nitrogen *viz*., control (N_0), 50 kg (N_1), 100 kg (N_2), 150 kg (N_3) and 200 kg (N_4) N ha^{-1} to study the effect of variety and rate of nitrogen on the performance of Boro rice. The growth analysis results indicate that the tallest plant (80.88 cm) and the highest number of total tillers hill^{-1} (13.80) were observed in BRRI dhan29 at 70 DATs and the highest total dry matter (66.41 g m^{-2}) was observed in BRRI dhan45. The shortest plant (78.15 cm) and the lowest number of tillers hill^{-1} (12.41) were recorded from BRRI dhan45 and the lowest dry matter (61.24 g) was observed in BRRI dhan29. The harvest data reveal that variety had significant effect on total tillers hill^{-1}, effective tillers hill^{-1}, non-effective tillers hill^{-1}, panicle length, grain yield, straw yield and harvest index. The highest grain yield (4.84 t ha^{-1}) was recorded from BRRI dhan29.

Abou-Khalif (2009) conducted an experiment for physiological evaluation of some hybrid rice varieties in different sowing dates. Four hybrid rice H_1, H_2, GZ 6522 and GZ 6903 were used. Results indicated that H1 hybrid rice variety surpassed other varieties for number of tillers m^{-2}, chlorophyll content, leaf area

index, sink capacity, number of grains panicle^{-1}, panicle length (cm), 1000-grain weight (g), number of panicles m^{-1}, panicle weight (g) and grain yield (ton ha^{-1}).

Amin *et al.* (2006) conducted a field experiment to find out the influence of variable doses of N fertilizer on growth, tillering and yield of three traditional rice varieties *(viz.* Jharapajam, Lalmota, Bansful Chikon) was compared with that of a modern variety (*viz.* KK-4) and reported that traditional varieties accumulated higher amount of vegetative dry matter than the modern variety.

Murthy *et al.* (2004) conducted an experiment with six varieties of rice genotypes Mangala, Madhu, J-13, Sattari, CR 666-16 and Mukti and observed that Mukti (5268 kg ha^{-1}) out yielded the other genotypes and recorded the maximum number of filled grains and had lower spikelet sterility (25.85%) compared to the others.

Biswas and Salokhe (2002) conducted an experiment in a Bangkok clay soil to investigate the influence of N rate, light intensity, tiller separation, and plant density on the yield and yield attributes of parent and clone plants of transplanted rice. Application of 75 kg N and 120 kg N ha^{-1} resulted in similar yields. The 50% reduction of light intensity reduced grain yield to 43.5% compared with normal light intensity. Separation of more than 4 tillers hill^{-1}had an adverse effect on the mother crop. Nitrogen fertilizer had no influence on grain weight, per cent filled grains, and panicle size of the mother crop, but increased N produced a higher number of tillers. Reduction of light intensity and higher tiller separation adversely affected grain weight and panicle number. Variation of N rate and light intensity of the mother crop had no influence on grain yield, grain weight, and panicle number of clonal tillers transplanted with 75 kg N ha^{-1} and with normal light intensity.

2.1.2 Yield parameters

Yuni Widyastuti *et al.* (2015) conducted a study with twenty-four experimental hybrid rice varieties. The results showed that grains yields were affected by locations, seasons, and genotypes. The genotypes × locations × seasons interaction effect was significant; therefore, the best hybrid was different for each location and season. A7/PK36 hybrid has the best performance in Batang during the dry season, while A7/PK40 and A7/PK32 are the best hybrids in the rainy season. In Sukamandi, nine hybrids were identified as better yielder than that of the check cultivar in the dry season, but not so in the rainy season.

Jisan *et al*. (2014) carried out an experiment to examine the yield performance of some transplant *aman* rice varieties as influenced by different levels of nitrogen. The experiment consisted of four varieties *viz*. BRRI dhan49, BRRI dhan52, BRRI dhan56, BRRI dhan57. Among the varieties, BRRI dhan52 produced the tallest plant (117.20 cm), highest number of effective tillers hill^{-1} (11.28), grains panicle^{-1} (121.5) and 1000-grain weight (23.65 g) whereas the lowest values of these parameters were produced by BRRI dhan57. Highest grain yield (5.69 t ha^{-1}) was obtained from BRRI dhan52 followed by BRRI dhan49 (5.15 t ha^{-1}) and the lowest one (4.25 t ha^{-1}) was obtained from BRRI dhan57.

Obaidullah *et al*. (2009) conducted a field experiment to study the growth and yield of inbred and hybrid rice with clonal tillers different of age. They found highest grain yield (5.10 t ha^{-1}) from the clonal tiller of 25 days old and the lowest grain yield (4.31 t ha^{-1}) from 40 days old clonal tillers. Irrespective of variety 25 to 35 days old clonal tiller showed superior performance. Hybrid variety transplanted with 25 days old clonal tiller gave significantly higher grain yield.

Ashrafuzzaman *et al.* (2008) conducted a field experiment to study the growth and yield of inbred and hybrid rice with tiller separation at different growth periods.

The experiment was conducted with two levels of treatments *viz.* (a) Variety: BRRI dhan32 and Sonarbangla-1; and (b) tiller separation days: 20, 25, 30, 35 and 40 days after mother plant transplantation. Maximum filled grains panicle^{-1} (144.28) was observed from the tiller separation at 20 DAT. Total and effective tillers hill^{-1}was affected by tiller separation beyond 30 DAT. Delayed tiller separation extended the flowering and maturity duration. Therefore, it was concluded that earlier tiller separation (20-30 DAT) resulted higher grain yield in hybrid variety but no such variations was observed in inbred variety.

Wang *et al.* (2006) studied the effects of plant density on the yield and yield components of hybrids and conventional cultivars of rice. Compared with conventional cultivars, the hybrids had larger panicles, heavier seeds, resulting in an average yield increase of 7.27%.

Chowdhury *et al*. (2005) conducted an experiment to study their effect on the yield and yield components of rice varieties BR23 and Pajam with 2, 4 and 6 seedlings hill^{-1} during the *aman* season. They reported that the cv. BR23 showed superior performance over Pajam in respect of yield and yield contributing characters i.e. number of productive tillers hill^{-1}, length of panicle, l000-grain weight, grain yield and straw yield. On the other hand, the cultivar Pajam produced significantly the tallest plant, total number of grains panicle^{-1}, number of filled grains panicle^{-1} and number of unfilled grains panicle^{-1}.

Sumit *et al.* (2004) worked with newly released four commercial rice hybrids (DRRH 1, PHB 71, Pro-Agro 6201, KHR 2, ADTHR 1, UPHR 1010 and Pant Sankar dhan1) and two high yielding cultivars (HYV) as controls (Pant dhan 4 and Pant dhan 12) and reported that KHR 2 gave the best yield (7.0 t/ha) among them.

Dongarwar *et al.* (2003) comprised an experiment to investigate the response of hybrid rice KJTRH-1 in comparison with 2 traditional cultivars, Jaya and Swarna,

to 4 fertilizer rates, i.e. 100:50:50, 75:37.5:37.5, 125:62.5:62.5 and 150:75:75 kg NPK ha^{-1} and reported that KJTRH-1 produced significantly higher yield (49.24 q ha^{-1}) than Jaya (39.64 q ha^{-1}) and Swarna (46.06 q ha^{-1}).

Siddiquee *et al.* (2002) conducted a study to evaluate the difference between hybrid and inbred rice in respect of their growth duration, yield and quality in *Boro* season, 1999. Among the varieties, Aalok 6201 had the highest grain yield followed by BRRI dhan29 and IR68877H but statistically they were similar. BRRI dhan28 had the lowest grain yield, which was statistically similar to Loknath503. BRRI dhan28 and the tested hybrid rice had lower growth duration than BRRI dhan29. Milling out turn varied from 67 to 70% among the tested varieties. Loknath 503 had the lowest milling out turn (70%) and, BRRI dhan28 and BRRI dhan29 had the highest milling out turn (70%) for unparboiled but parboiled rice the highest milling out turn(73%) were found in BRRI dhan28 and IR68877H . All tested hybrid rice were medium bold, whereas BRRI dhan29 and BRRI dhan28 were medium slender and long slender, respectively in both parboiled and unparboiled condition. Among the varieties, amylose content (%) was higher in BRRI dhan29 and protein content (%) was higher in IR68877H for both under parboiled and unparboiled condition.

Rahman *et al.* (2002) carried out an experiment with 4 varieties of transplant *aman* rice *viz.,* BR1l, BR22, BR23 and Tuishimala and 6 structural arrangement of rows *viz.,* 25 cm + 25 cm, 30 cm + 20 cm, 35 cm + 1 5 cm, 40 cm + 10 cm) 45 cm + 05 cm and haphazard planting at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. Thousand grains weight and grain yield were highest in BR23 and these were lowest in Tulshirnaia.

Obulamma *et al.* (2002) performed an experiment with hybrid rice DRRHI and APHR-2 at Andhra Pradesh, India. The treatments were 4 spacing (15x10, 2U x10,

15x15 and 20cm x15 cm) and 3 seedling densities (1, 2 and 3 seedlings hill^{-1}). APHR-2 was found to produce higher yield than DRRH-l.

Bhowmick and Nayak (2000) conducted an experiment with two hybrids (CNHR2 and CNHR3) and two high yielding varieties (IR36 and IR64) of rice and five levels of nitrogenous fertilizers. They observed that CNHR2 produced more number of productive tillers (413.4 m^{-}) and filled grains panicle^{-1} (111.0) than other varieties, whereas IR36 gave the highest 1000- grain weight (21.07 g) and number of panicles m^{-} than other tested varieties. In a trial, varietal differences in harvest index and yield examined using 60 Japanese varieties and 20 high yielding varieties bred in Asian countries. It was reported that harvest index varied from 36.8% to 53.4%. Mean values of harvest index were 43.5% in the Japanese group and 48.8% in high yielding group. Yield ranged from 22.6 g plant^{-1} to 40.0 g plant^{-1}.

The mean value of yield in Japanese group was 22.8 g plant^{-1}, and that in the high yielding group was 34.1 g plant^{-1}. They also reported that a positive correlation was found between harvest index and yield in the high yielding group (Cui *et al.,* 2000).

Patel (2000) studied that the varietal performance of Kranti and IR36. He observed that Kranti produced significantly higher grain and straw yield than IR36. The mean yield increased with Kranti over IR36 was 7.1 and 10.0% for grain and straw, respectively.

Molla (2001) reported that Pro-Agro6201 (hybrid) had a significant higher yield than IET4786 (HYV), due to more mature panicles m^{-2}, higher number of filled grains panicle^{-1} and greater seed weight.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during the period from July 2017 to December 2017. This chapter deals with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recording and their analysis.

3.1 Site description

The experiment was conducted at the Sher-e-Bangla Agricultural University research field, Dhaka, under the Agro-ecological zone of Modhupur Tract, AEZ-28. The land area is situated at 23°41' N latitude and 90°22' E longitude at an altitude of 8.6 meter above sea level. The experimental site is shown in the AEZ Map of Bangladesh in Appendix I.

3.2 Climate

The experimental area is under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (October-March). The weather data during the study period of the experimental site is shown in Appendix II.

3.3 Soil

The farm belongs to the general soil type, shallow red brown terrace soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. The experimental area was flat having available irrigation and drainage system. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples

from 0-15 cm depths were collected from experimental field. The analyses were done by Soil Resources and Development Institute (SRDI), Dhaka. The physicochemical properties of the soil are presented in Appendix III.

3.4 Treatments

Single factor experiment was conducted and 10 *aman* rice varieties were considered as the treatment for the present study. The respected varieties were as follows:

(i) V_1 = Buta
(ii) V_2 = Dudkat
(iii) V_3 = Bindipakri
(iv) V_4 = Chinisagar
(v) V_5 = Sunashail
(vi) V_6 = Kartik jhul
(vii) V_7 = Ranjay
(viii) V_8 = BRRI dhan51
(ix) V_9 = BRRI dhan52
(x) V_{10} = BRRI dhan70

3.5 Plant materials and collection of seeds

Seven local rice varieties *viz.* Buta, Dudkat, Bindipakri, Chinisagar, Sunashail , Kartik jhul, Ranjay and three HYV varieties *viz.* BRRI dhan51, BRRI dhan52 and BRRI dhan70 were used as plant materials for the present study. The seeds of local and HYV varieties were collected from BRRI, Joydebpur, Gazipur, Bangladesh.

3.6 Seed sprouting

Healthy seeds were kept in water bucket for 24 hours and then it was kept tightly in gunny bags. The seeds started sprouting after 48 hours and were sown after 72 hours.

3.7 Preparation of nursery bed and seed sowing

As per BRRI recommendation, seedbed was prepared with 1m wide adding nutrients as per the requirements of soil. Seeds were sown in the seed bed on July, 2017in order to transplant the seedlings in the main field.

3.8 Preparation of experimental land

The plot selected for the experiment was opened in the first week of July 2017 with a power tiller, and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubble were removed, and finally obtained a desirable field for transplanting of the seedlings.

3.9 Fertilizer application

The following doses of fertilizer were applied for cultivation of crop as recommended by BRRI, 2016.

Fertilizer	**Recommended doses (kg ha^{-1})**
Urea	150
TSP	100
MP	100
Zinc sulphate	10
Gypsum	60
Borax	10

The fertilizers N, P, K, S, Zn and B in the form of urea, TSP, MP, gypsum, zinc sulphate and borax, respectively were applied. The entire amount of TSP, MP, gypsum, zinc sulphate and borax were applied during the final preparation of land. Mixture of cowdung and compost was applied at the rate of 10 t ha^{-1} during 15 days before transplanting. Urea was applied in three equal installments at seedling establishment, tillering and before panicle initiation.

3.10 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications (block). Each block was first divided into 10 sub plots where varieties of rice were assigned. Thus the total number of unit plots was 10×4=40. The size of the unit plot was 3m × 2m. The distance maintained between two unit plots was 0.5m and that between blocks was 1m. The treatments (varieties) were randomly assigned to the plots within each block.

3.11 Uprooting of seedlings

The nursery bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted on August 5, 2017 without causing much mechanical injury to the roots.

3.12 Transplanting of seedlings in the field

The seedlings were transplanted in the main field on August 5, 2017 with a spacing 15 cm from hill to hill and 20 cm from row to row.

3.13 Intercultural operations

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the rice seedlings.

3.13.1 Irrigation and drainage

Flood irrigation was given to maintain a constant level of standing water upto 3 cm at the early stages to enhance tillering and 4-5cm in the later stage to discourage late tillering. The field was finally dried out at 15 days before harvesting.

3.13.2 Gap filling

Gap filling was done for all of the plots at 10 days after transplanting (DAT) by planting same aged seedlings.

3.13.3 Weeding

The crop was infested with some common weeds, which were controlled by uprooting and remove them three times from the field during the period of experiment. Weeding was done after 15, 32 and 52 days of transplanting.

3.14 Plant protection

There were some incidence of insects specially grasshopper, stem borer, rice ear cutting caterpillar, thrips and rice bug which was controlled by spraying Curatter 5 G and Sumithion. Brown spot of rice was controlled by spraying Tilt.

3.15 Harvesting, threshing and cleaning

The rice plant was harvested depending upon the maturity of the plant and harvesting was done manually from each plot. The harvested crop of each plot was bundled separately, properly tagged and brought to threshing floor. Enough care was taken for harvesting, threshing and also cleaning of rice seed. Fresh weight of grain and straw were recorded plot wise. The grains were cleaned and finally the weight was adjusted to a moisture content of 12%. The straw was sun dried and the yields of grain and straw $plot^{-1}$ were recorded and converted to t ha^{-1}.

3.16 General observation of the experimental field

The field was observed time to time to detect visual difference among the treatments and any kind of infestation by weeds, insects and diseases so that considerable losses by pest was minimized.

3.17 Recording of data

The following data were recorded during the study period:

3.17.1 Growth characters

1. Plant height (cm)
2. Number of leaves plant^{-1}
3. Number of total tillers plant^{-1}
4. Dry weight plant^{-1} (g)
5. Crop growth rate
6. Absolute grain growth rate

3.17.2 Morphological parameters

1. Days to first anthesis
2. Flag leaf area (cm^2)
3. Flag leaf dry weight (g)
4. Total life duration
5. SPAD reading of flag leaf

3.17.3 Yield contributing parameters

1. Number of effective tillers plant^{-1}
2. Number of ineffective tillers plant^{-1}
3. Panicle length (cm)
4. Number of filled grains panicle^{-1}
5. Number of unfilled grains panicle^{-1}
6. Number of grains plant^{-1}

7. Weight of grains plant^{-1}
8. 1000 grains weight (g)

3.17.4 Yield parameters

1. Grain yield (t ha^{-1})
2. Straw yield (t ha^{-1})
3. Biological yield (t ha^{-1})
4. Harvest index (%)

3.18 Procedures of recording data

A brief outline of the data recording procedure is given below:

3.18.1 Plant height

The height of plant was recorded in centimeter (cm) at the time of 25, 50, 75 DAT and at harvest. Data were recorded as the average of same 5 plants pre-selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of the plant.

3.18.2 Number of leaves plant^{-1}

Number of leaves plant^{-1} was counted from the average of same 5 plants pre-selected at random from the inner rows of each plot.

3.18.3 Number of total tillers plant^{-1}

Total tillers which had at least one leaf visible were counted. It includes both productive and unproductive tillers. It was counted from the average of same 5 plants pre-selected at random from the inner rows of each plot.

3.18.4 Dry weight plant^{-1}

Dry matter plant^{-1} was recorded at 25, 50, 75 DAT and at harvest from 5 randomly selected plant of each plot from inner rows leaving the boarder row. Collected

plant were oven dried at 70°C for 72 hours then transferred into desiecator and allowed to cool down at room temperature, then final weight was taken.

3.18.5 Crop growth rate

CGR is the rate of dry matter production per unit of ground area per unit of and was worked out by the following formula,

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{1}{A} \text{ g cm}^{-2} \text{ day}^{-1}$$

Where,

W_1 = dry weight of the plant at time t_1
W_2 = dry weight of the plant at time t_2
A = land area covered by the plant in cm^2
t_2 and t_1 = time interval in days

3.18.6 Absolute grain growth rate (AGGR)

During anthesis, different main panicles were tagged; some were sampled and packed in separate brown paper packet as per treatment. Then the packets were kept in oven at 70ºC for 72 hrs. The tagged panicles were collected after 10 days interval from anthesis to maturity. Then the panicles were packed and oven dried at the same procedure. After drying 20 grains were randomly collected from each panicles and the weight of one grain was calculated. The absolute grain growth rate (AGGR) was calculated using the following formula according to Hasan (2009). The average values were taken from each treatment for analysis.

$$\text{AGGR (mg/grain/day)} = \frac{(W_2 - W_1)}{(t_2 - t_1)}$$

Where,

W 1 = Grain dry weight at initial time
W 2 = Grain dry weight at final time
T 1 = Initial time
T 2 = Final time

3.18.7 Days to first anthesis

From randomly select 10 plants, days to first anthesis was recorded by keen observation and the mean value was counted.

3.18.8Flag leaf area (cm^2)

Flag leaf area was calculated by multiplying length and breadth of the leaf from 10 selected plants and the mean values were recorded

3.18.9Flag leaf dry weight (g)

Flag leaf weight was measured from 10 selected plants and the mean values were recorded

3.18.10SPAD value of flag leaf

Flag leaf SPAD value was recorded at anthesis stage and grain filling stage.

3.18.11 Number of effective tillers $plant^{-1}$

The total number of effective tillers $plant^{-1}$ was counted from 5 selected plants at harvest and average value was recorded.

3.18.12 Panicle length (cm)

The length of the panicle was measured with a meter scale from 10 selected panicles and the average value was recorded.

3.18.13 Number of filled grains $panicle^{-1}$

The total number of filled grains was collected randomly from selected 5 plants of a plot and then average number of filled grains $panicle^{-1}$ was recorded.

3.18.14 Number of unfilled grains panicle^{-1}

The total number of unfilled grains was collected randomly from selected 5 plants of a plot and then average number of unfilled grains panicle^{-1} was recorded.

3.18.15 Weight of 1000 grain (g)

One thousand cleaned dried grains were counted randomly from each plot and weighed by using a digital electric balance when the grains retained 12% moisture and the mean weight was expressed in gram.

3.18.16 Grain yield

Grain yield was determined from the central 1 m^2 area of each plot and expressed as t ha^{-1} on 12% moisture basis. Grain moisture content was measured by using a digital moisture tester.

3.18.17 Straw yield

Straw yield was determined from the central 1 m^2 area of each plot, after separating the grains. The sub-samples were oven dried to a constant weight and finally converted to t ha^{-1}.

3.18.18 Biological yield

Biological yield was determined using the following formula

Biological yield = Grain yield +Straw yield

3.18.19 Harvest index (%)

It denotes the ratio of grain yield to biological yield and was calculated with the following formula.

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

3.19 Statistical analysis

The data were analyzed in Randomized Complete Block Design and the means were separated by DMRT at 5% level of significance using the statistical computer package program MSTAT-C (Russell, 1986).

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted aimed to a morpho-physiological study of different local and HYV rice varieties during *aman* season. The results obtained from the study have been presented, discussed and compared in this chapter through different tables, figures and appendices. The results have been presented and discussed and possible interpretation has been given under the following headings.

4.1 Growth parameters

4.1.1 Plant height

Plant height of different *aman* rice varieties differed significantly among the local and HYV rice varieties (Fig. 1 and Appendix IV). Plant height increased progressively with the advancement of time and growth stages.

At 25 DAT, the tallest (59.63 cm) plant was obtained from V_5 followed by V_1 and the shortest (36.68 cm) plant was obtained from V_8 which is statistically similar with V_9.

At 50 DAT, the tallest (99.27 cm) plant was obtained from V_5 followed by V_6 which is statistically similar with V_4 and the shortest (66.09 cm) plant was obtained from V_8 followed by V_9.

At 75 DAT, the highest (134.20cm) plant height was achieved from V_5 followed by V_2 statistically similar with V_6 and the shortest (85.37cm) plant was recorded in V_8.

At the time of final harvest, V_5 had the highest plant height (146.1cm) which is statistically similar with V_6 and V_7, followed by V_2 and the shortest (92.6cm) was in V_8. The local varieties had the higher plant height than HYV varieties. Similar results on plant height were also observed by Sarker *et al.* (2013), Anwar and Begum (2010) and Islam *et al*. (2009).

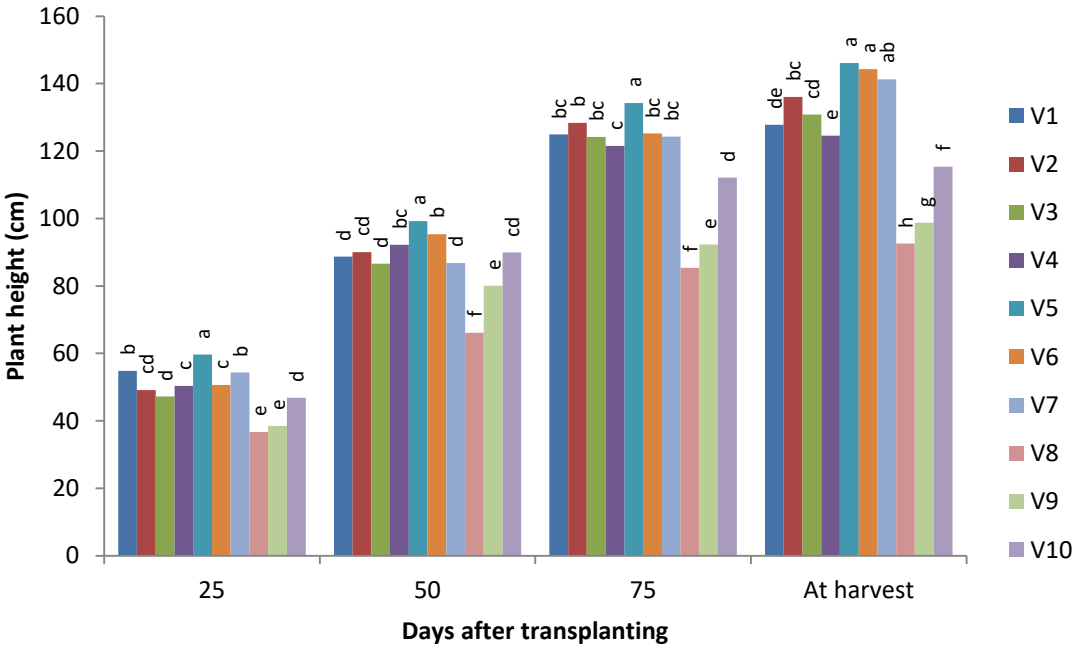

Fig. 1. Plant height of different *aman* rice varieties at various days after transplanting (DAT) and at final harvest. Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan51, V_9 = BRRI dhan52, V_{10} = BRRI dhan70

4.1.2 Number of leaves plant^{-1}

Significant difference on total number of leavesplant^{-1} in the rice varieties was observed from 25 DAT, 50 DAT, 75 DAT and at harvest (Table 1 &Appendix V). The total number of leaves was continued to increase up to 75 DAT and thereafter declined.

For 25 DAT, among the varieties tested, the highest (25.67) number of leaves plant^{-1} was recorded in $V_3$and V_7which was significantly higher than any other variety; which was followed by V_1 and V_6. The varieties V_2 and V_9 produced statistically similar number of leaves as V_1 and V_6. The lowest (13.67) number of leaves plant^{-1} was recorder in V_4 which was significantly lower than any other variety.

For 50 DAT, the highest (62.00) number of leaves plant^{-1} was recorded in V_3 which was significantly higher than any other variety followed by V_9. The varieties V_1 and V_{10} produced statistically similar number of leaves as V_9. The lowest (37.67) number of leaves plant^{-1} was recorder in V_4 which was significantly lower than any other variety.

For 75 DAT, the highest (68.67) number of leaves plant^{-1} was recorded in V_3 which was significantly higher than any other variety followed by V_9 which was statistically similar with V_{10} and V_2. The lowest (40.33) number of leaves plant^{-1} was recorder in V_4 which was significantly lower than any other variety.

At final harvest, the highest (59.67) number of leaves plant^{-1} was recorded in V_3 which was significantly higher than any other variety followed by V_2. The lowest (35.67) number of leaves plant^{-1} was recorder in V_4 which was significantly lower than any other variety.

From the above study it was found that, V_3 (Bindipakri) produced the highest number of leaves plant^{-1} and V_4 (Chinisagar) produced the lowest number of

leaves plant^{-1}. The number of leaves plant^{-1} was higher in local varieties than HYV varieties. Haque *et al.* (2013), Sarker *et al.* (2013) and Abou-Khalif (2009) also found similar on number of leaves plant^{-1}.

Table 1. Number of leaves plant^{-1} of *aman* rice varieties at various days after transplanting (DAT) and at final harvest.

Variety	Number of leaves plant^{-1}			
	25 DAT	**50 DAT**	**75 DAT**	**At harvest**
V_1	21.67 b	48.00 bc	51.00 cd	48.00 cd
V_2	21.33 b	45.00 cd	56.00 bc	53.00 b
V_3	25.67 a	62.00 a	68.67 a	59.67 a
V_4	13.67 d	37.67 f	40.33 e	35.67 g
V_5	18.00 c	44.67 d	48.67 d	43.33 f
V_6	21.67 b	40.33 ef	51.00 cd	49.33 c
V_7	25.67 a	43.00 de	48.00 d	45.00 ef
V_8	17.67 c	42.00 de	46.33 d	50.33 c
V_9	19.00 bc	51.00 b	58.00 b	45.00 ef
V_{10}	17.00 c	49.67 b	56.67 bc	46.67 de
$LSD_{0.05}$	**2.90**	**3.14**	**5.57**	**2.36**
CV (%)	**6.94**	**8.66**	**10.71**	**10.50**

Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan51, V_9 = BRRI dhan52, V_{10} = BRRI dhan70

4.1.3 Number of total tillers plant^{-1}

Significant variation was found on number of number of total tillers plant^{-1} at different growth stages affected by different rice varieties (Table2 and Appendix VI).

At 25 DAT, the highest (7.00) number of tillers plant^{-1} was produced by V_8 which was statistically similar with V_2 that was significantly different from the rest of the variety. The lowest (4.00) number of tillers plant^{-1} was found in V_1 which was statistically similar with V_7 and V_{10}.

At 50 DAT, the maximum (14.00) number of tillers plant^{-1} was produced by V_8 which was significantly different from the rest of the variety that was followed by V_2. The lowest (7.00) number of tillers plant^{-1} was found in V_1 which was statistically similar with V_3 and V_5.

At 75 DAT, the highest (16.67) number of tillers plant^{-1} was found inV_8 which was statistically similar with V_9 and significantly different from the rest of the variety that was followed by V_5 and V_7. The lowest (11.00) number of tillers plant^{-1} was found in V_1 which was statistically identical with and statistically similar with V_2, V_3 and V_{10}.

At harvest, the maximum (21.50) number of tillers plant^{-1} was produced by V_8 that was significantly different from the rest of the variety; which was followed by V_{10} that was statistically similar with. The lowest (12.75) number of tillers plant^{-1} was found in V_1 which was statistically similar with V_2 followed by V_3 and V_5.

From the above study it was found that the highest number of tillers plant^{-1} was in V_8 ((BRRI dhan51) and the lowest number of tillers plant^{-1} was in V_1 (Buta). The results obtained from the present study was similar with the findings of Islam *et al*. (2009), Obaidullah *et al*. (2009), Ashrafuzzaman *et al.* (2008), Chowdhury *et al*. (2005) and Akbar (2004).

Table 2. Number of total tillers plant^{-1} of *aman* rice varieties at various days after transplanting (DAT) and at final harvest.

Variety	Number of total tillers plant^{-1}			
	25 DAT	**50 DAT**	**75 DAT**	**At harvest**
V_1	4.00 d	7.00 d	11.00 c	12.75 f
V_2	6.67 ab	10.30 b	12.00 bc	13.00 ef
V_3	5.33 c	7.67 cd	11.67 bc	14.00 de
V_4	5.67 bc	9.33 b	12.67 b	14.50 cd
V_5	5.60 c	7.33 d	13.00 b	14.00 de
V_6	5.50 c	9.00 bc	11.00 c	15.50 c
V_7	5.00 cd	9.67 b	13.00 b	15.25 c
V_8	7.00 a	14.00 a	16.67 a	21.50 a
V_9	5.70 c	9.00 bc	15.67 a	18.25 b
V_{10}	4.67 cd	9.00 bc	12.00 bc	19.00 b
$LSD_{0.05}$	**0.97**	**1.37**	**1.39**	**1.10**
CV (%)	**4.88**	**7.30**	**8.84**	**6.21**

Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan51, V_9 = BRRI dhan52, V_{10} = BRRI dhan70

4.1.4 Dry weight plant^{-1}

Remarkable variation was identified in terms of dry weight plant^{-1} at different growth stages influenced by different rice varieties (Fig. 2 and Appendix VII). It was noted that the highest (19.64, 41.53 and 64.97 g at 50, 75 DAT and at harvest respectively) dry weight plant^{-1} was obtained from the treatment, V_8 (BRRI dhan51) which was significantly different from all other varieties followed by V_9 (BRRI dhan52) and V_{10} (BRRI dhan70) at the time of harvest. The lowest (12.83, 18.66 and 39.62 g at 50, 75 DAT and at harvest respectively) dry weight plant^{-1} was obtained from the variety, V_2 (Dudkat) which was which was statistically similar with V_1 (Buta) at the time of harvest. Among the local varieties the highest dry weight plant^{-1} was observed from V_5 at 75 DAT and at harvest. Dry weight plant^{-1} was recorded higher in HYV varieties than local varieties, this might be due to higher tiller number and grain yield in HYV varieties. Chamely *et al*. (2015), Sarker *et al.* (2013) and Haque *et al.* (2013) also found similar results with the present study.

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

Crop growth rate (CGR) of different *aman* rice varieties differed significantly among the local and HYV rice varieties (Fig. 3 and appendix VII). The HYV rice V_8 showed the highest (2.92) CGR which is statistically similar with V_9 and V_{10}. In contrast, the lowest (0.78) CGR was observed in local rice V_2. Among the local varieties the highest CGR was observed from V_5 which was statistically similar with V_3. Though the plant height was higher in local varieties than HYV varieties but the CGR was recorded higher in HYV varieties. This might be due to higher tiller number in HYV varieties. These results are consistent with the result of Miah et al. (1996) and Piranhas et al. (1997) who reported that varietal differences of CGR were significant at different growth stage.

4.1.6 Absolute grain growth rate (g plant^{-1}d^{-1})

Absolute grain growth rate of different *aman* rice varieties differed significantly among the local and hybrid rice varieties (Fig. 4 and Appendix VII). The HYV rice V_8 showed the highest (1.28) AGGR value which is statistically similar with V_9 followed by V_{10}. In contrast, the lowest (0.25) AGGR was observed in local rice V_4 which is statistically similar withV_2. Among the local varieties, highest (0.81) AGGR was found in V_3 which was statistically similar with V_5. Higher grain growth helps to give better yield. Almost similar result was also observed by Sallauddin (2012) and in this experiment. The result of the present study are in agreement with the result of Sarkar (2014), who stated that the higher AGGR was existed during the vegetative stage and declined rapidly near maturity.

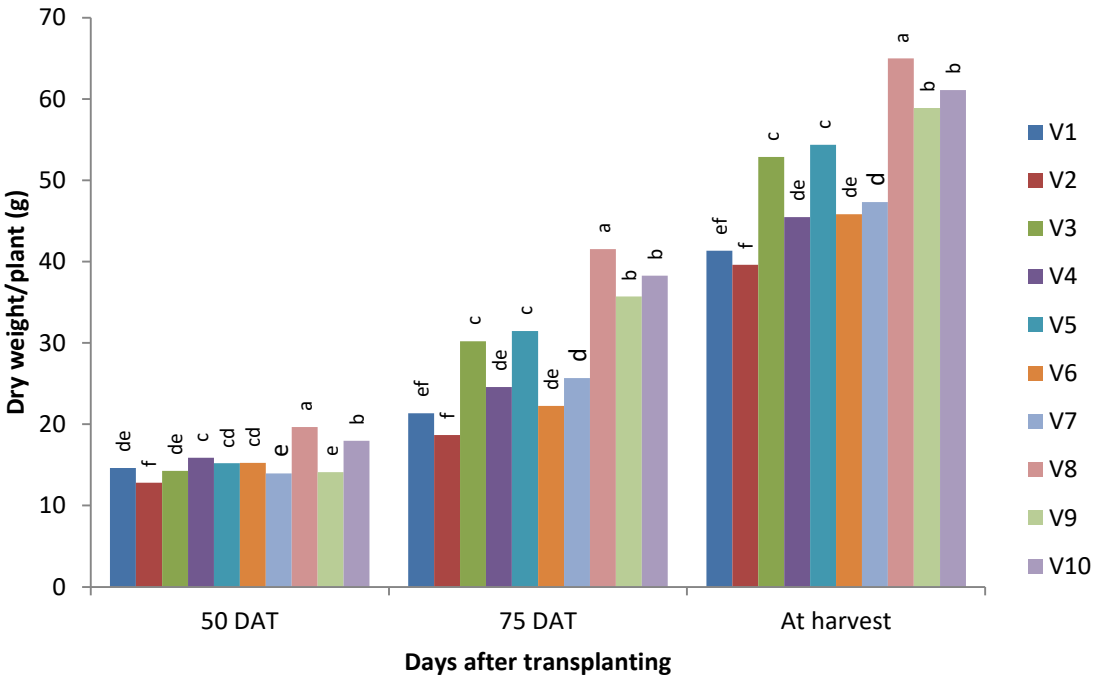

Fig. 2. Dry weight plant^{-1} of *aman* rice varieties at various days after transplanting (DAT) and at final harvest. Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan51, V_9 = BRRI dhan52, V_{10} = BRRI dhan70

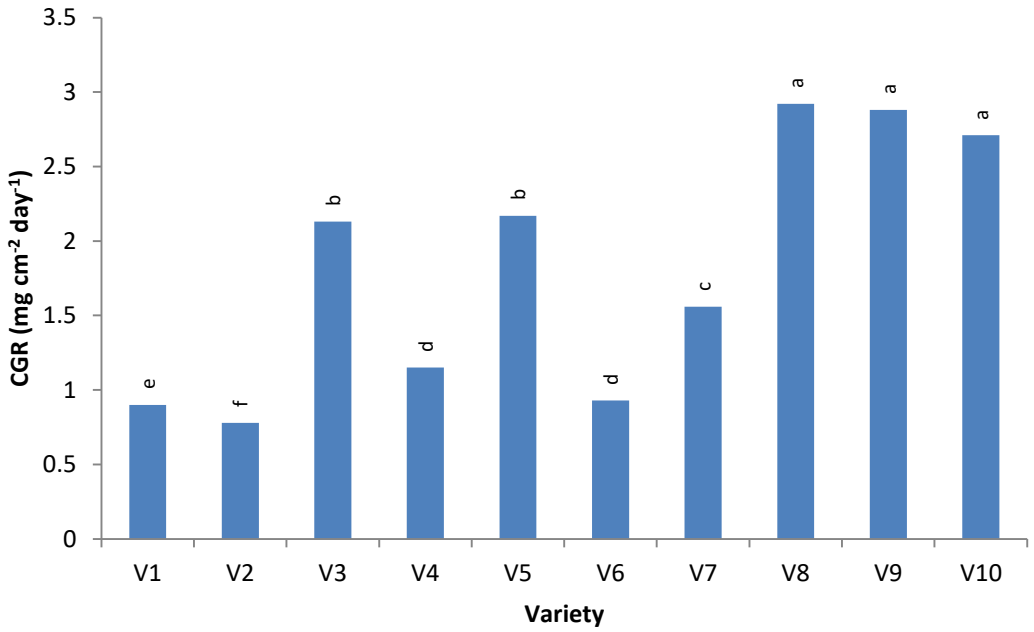

Fig. 3.Crop growth rate of different *aman* rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan51, V_9 = BRRI dhan52, V_{10} = BRRI dhan70

4.2 Morpho-physiological parameters

4.2.1 Days to anthesis

Days to first anthesis was significantly varied due to different varieties of rice (Table 3 and Appendix VIII). It was found that the highest (84.00) days to anthesis was observed from the variety, V_7 (Ranjay) which was significantly different from all other varieties followed by V_1 (Buta), V_4 (Chinisagar) and V_3 (Bindipakri) and V_5 (Sunashail). The lowest (60.00) days to anthesis was observed from the variety, V_{10} (BRRI dhan70) followed by V_2 (Dudkat), V_6 (Kartik jhul), V_8 (BRRI dhan51) and V_9 (BRRI dhan52). Haque *et al.* (2013) also found similar results with the present study.

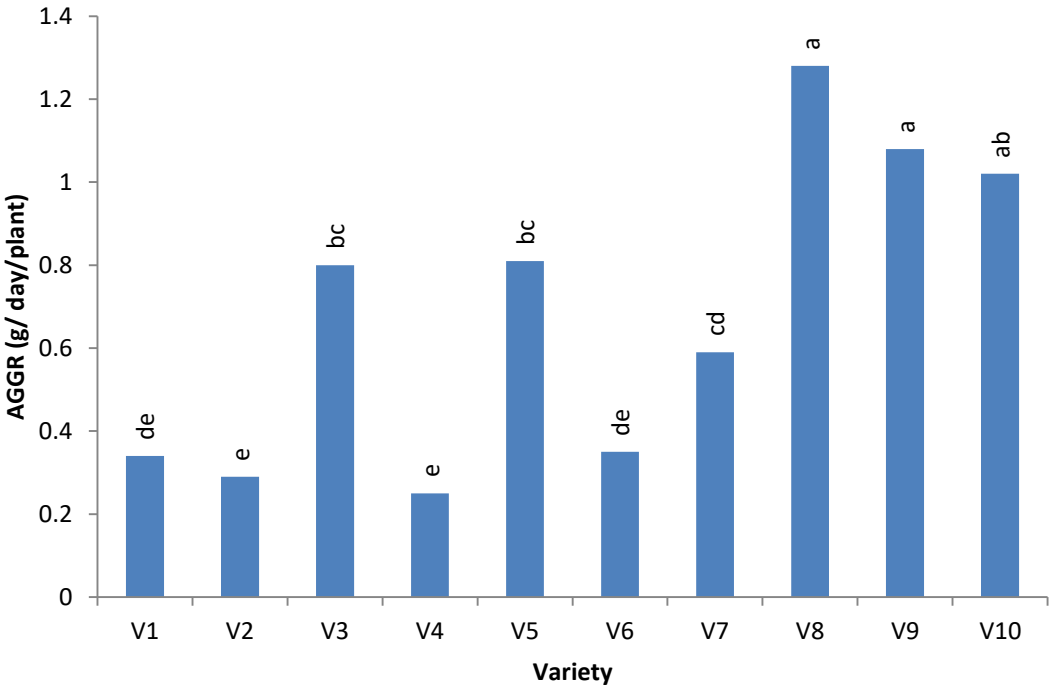

Fig. 4.Absolute grain growth rate of different *aman* rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan 51, V_9 = BRRI dhan 52, V_{10} = BRRI dhan 70

4.2.2 Flag leaf area (cm^2)

Flag leaf area was significantly influenced by different varieties of rice (Table 3 and Appendix VIII). Results revealed that the highest (53.20 cm^2) flag leaf area was observed from the variety, V_1 (Buta) which was statistically identical with V_4 (Chinisagar) where the lowest (27.28 cm^2) flag leaf area was observed from the variety, V_8 (BRRI dhan51) which was statistically similar with V_7 (Ranjay). The results obtained from the present study were similar with the findings of Haque *et al.* (2013).

4.2.3 Flag leaf dry weight (g)

Flag leaf weight was significantly varied due to different varieties of rice (Table3 and Appendix VIII). It was noted that the highest (0.27 g) flag leaf dry weight was observed from the variety, V_8 (BRRI dhan51) which was statistically similar with V_9 (BRRI dhan52) and V_{10} (BRRI dhan70) where the lowest (0.11 g) flag leaf dry weight was observed from the variety, V_4 (Chinisagar) followed by V_2 (Dudkat), V_3 (Bindipakri), V_6 (Kartik jhul) and V_7 (Ranjay). Though flag leaf area was higher in local varieties than HYV varieties but flag leaf weight was higher in HYV varieties. This might be due to the thickness of leaf of HYV varieties. Haque *et al.* (2013) also found similar result with the present study.

4.2.4 Total life duration

Significant influence was observed on total life duration of *aman* rice influenced by different varieties (Table 3). Results showed that variety, V_8 and V_9 showed highest (144) life duration where the lowest (130) life duration was found from varieties of V_2 and V_{10}. Similar results were also observed by Julfiquar *et al.* (1998) , BRRI (1995) and Siddiquee *et al.* (2002).

Table 3. Morphological parameters of different *aman* rice varieties.

Variety	Days to first anthesis	Flag leaf area (cm^2)	Flag leaf weight (g)	Total life duration
V_1	77.00 b	53.20 a	0.20 c	140 b
V_2	65.00 c	38.05 d	0.17 d	130 c
V_3	77.00 b	43.10 c	0.16 d	140 b
V_4	77.00 b	52.25 a	0.11 e	140 b
V_5	77.00 b	48.60 b	0.23 b	140 b
V_6	65.00 c	41.10 cd	0.16 d	140 b
V_7	84.00 a	29.88 ef	0.15 d	140 b
V_8	64.00 c	27.28 f	0.27 a	144 a
V_9	65.00 c	32.89 e	0.26 ab	144 a
V_{10}	60.00 d	48.49 b	0.25 ab	130 c
$LSD_{0.05}$	**3.39**	**3.49**	**0.03**	**2.15**
CV (%)	**7.69**	**11.52**	**3.52**	**5.11**

Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan 51, V_9 = BRRI dhan 52, V_{10} = BRRI dhan 70

4.2.5 SPAD value of flag leaf at anthesis stage and grain filling stage

SPAD value of flag leaf at anthesis stage and grain filling stage showed significant variation affected by different varieties of rice (Fig. 5 and Appendix IX). It was observed that the highest (64.87 and 49.77 respectively) SPAD value of flag leaf at anthesis stage and grain filling stage was found from the variety, V_8 (BRRI dhan51) followed by V_9 (BRRI dhan52) where the lowest (36.70 and 31.90 respectively) SPAD value of flag leaf at anthesis stage and grain filling stage was found from the variety, V_4 (Chinisagar) .Among the local varieties at anthesis stage the highest SPAD value was observed from V_6 (Kartik jhul) and at grain

filling stage the highest SPAD value was observed from V_2 (Dudkat).The result on SPAD value under the present study was in agreement with the findings of Haque *et al.* (2013).

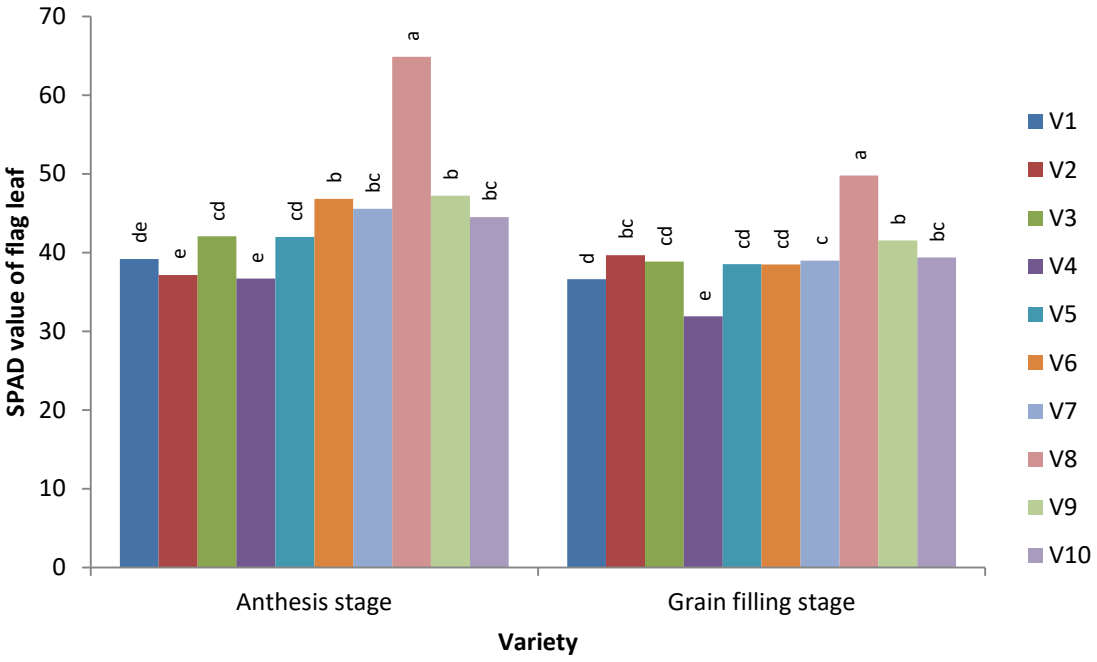

Fig. 5. SPAD value of flag leaf of different *aman* rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan 51, V_9 = BRRI dhan 52, V_{10} = BRRI dhan 70

4.3 Yield contributing parameters

4.3.1 Number of effective tillers plant^{-1}

Different varieties of rice showed significant variation on number of effective tillers (Table 4 and Appendix IX). Results showed that the highest (18.50) number of effective tillers was observed from the variety, V_8 (BRRI dhan51) which was significantly different from the rest of the variety; that was followed by V_9 (BRRI dhan52) and V_{10} (BRRI dhan70). The lowest (7.50) number of effective tiller was observed from the variety, V_2 (Dudkat) which was close to the variety, V_7 (Ranjay) and V_1 (Buta). Among the local varieties the highest (13.00) number of effective tillers plant^{-1} was observed in V_3. Result further revealed that HYV rice produced greater number of effective tillers plant^{-1} than local rice varieties. Similar results were also observed by Ashrafuzzaman *et al.* (2008), Chamely *et al*. (2015) and Jisan *et al*. (2014).

4.3.2 Number of ineffective tillers plant^{-1}

Different varieties of rice showed significant variation on number of ineffective tillers (Table 4 and Appendix IX). The maximum (5.50) number of ineffective tillers plant^{-1} was observed from V_2 which was significantly higher than any other variety, followed by V_7 and the minimum number of ineffective tillers plant^{-1} was observed from V_3 (1.00).

4.3.3Panicle length (cm)

Different varieties of *aman* rice showed significant variation on panicle length (Table 4 and Appendix IX). It was observed that the highest (27.68 cm) panicle length was observed from the variety, V_8 (BRRI dhan51) which was statistically similar with V_{10} (BRRI dhan70) followed by V_9 (BRRI dhan52). The lowest (21.65 cm) panicle length was observed from the variety, V_4 (Chinisagar) followed by V_2 (Dudkat) and V_7 (Ranjay). Among the local variety the highest

(25.78) panicle length was observed from V_3 (Bindipakri). Sarkar *et al*. (2014), Anwar and Begum (2010) and Abou-Khalif (2009) also found similar results with the present study.

4.3.4Number of filled grains panicle^{-1}

Different varieties of *aman* rice showed significant variation on number of filled grains panicle^{-1} (Fig. 6 and Appendix IX). The highest (144.0) number of filled grains panicle^{-1} was observed from the variety, V_8 (BRRI dhan51) followed by the variety, V_9 (BRRI dhan52) and V_3 (Bindipakri) where the lowest (61.00) number of filled grains panicle^{-1} was observed from the variety, V_2 (Dudkat). Among the local variety the highest number of filled grains panicle^{-1} was observed from V_3 (Bindipakri). Similar results were also observed by Ashrafuzzaman *et al.* (2008), Chowdhury *et al*. (2005) and Murthy *et al.* (2004).

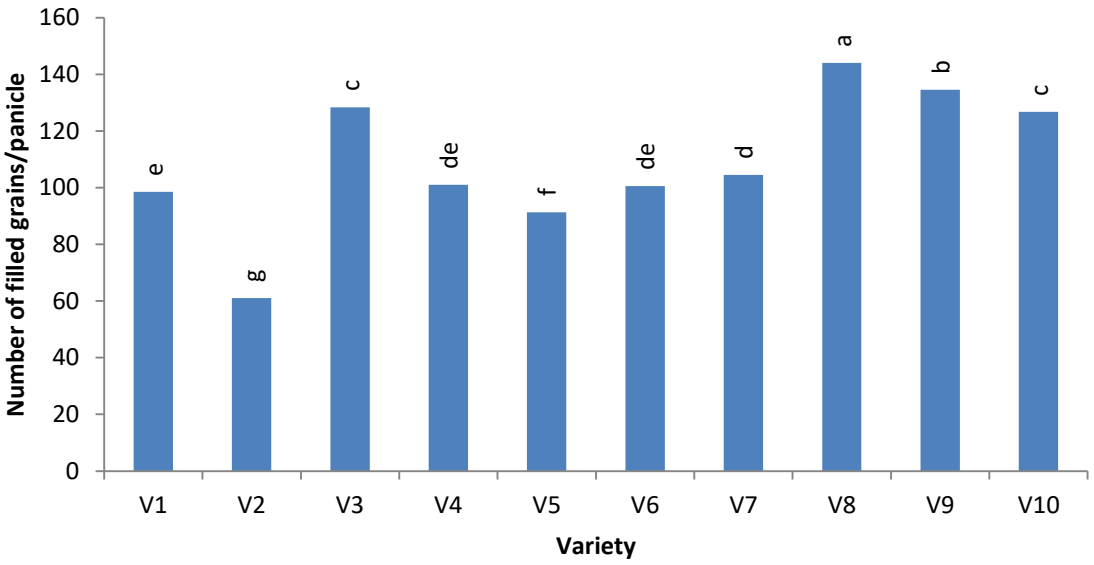

Fig. 6. Number of filled grains panicle^{-1} of different *aman* rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan 51, V_9 = BRRI dhan 52, V_{10} = BRRI dhan 70

4.3.5Number of unfilled grains panicle^{-1}

Number of unfilled grains panicle^{-1} was significantly varied due to different varieties of rice (Fig. 7 and Appendix IX). It was observed that the highest (29.25) number of unfilled grains panicle^{-1} was observed from the variety, V_3 (Bindipakri) which was significantly higher than any other variety, followed by V_4 (Chinisagar) and V_6 (Kartik jhul). The lowest (11.25) number of unfilled grains panicle^{-1} was observed from the variety, V_1 (Buta) which was statistically same with V_8 (BRRI dhan51) and V_5 (Sunashail). Though the number of filled grains panicle^{-1} was higher in V_3 among the local varieties but unfilled grain was also higher, if we increase the number of filled grains panicle^{-1} in V_3 the harvest index will also increase. Mallick (1994) and Chowdhury *et al*. (2005) also found similar results with the present study.

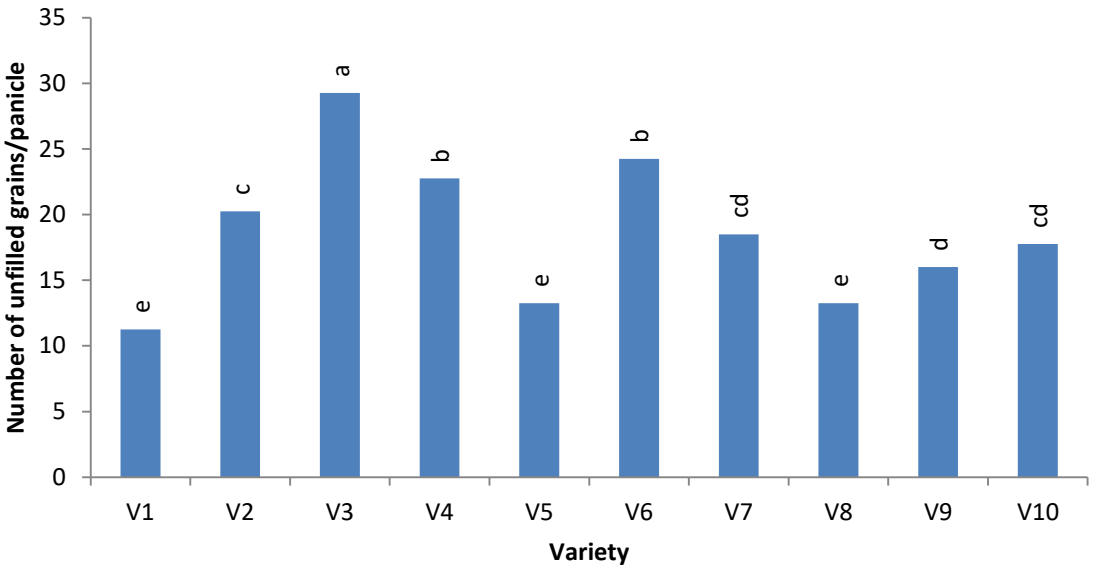

Fig. 7. Number of unfilled grains panicle^{-1} of different *aman* rice varieties. Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan 51, V_9 = BRRI dhan 52, V_{10} = BRRI dhan 70

4.3.6 Number of grains plant^{-1}

Number of grains plant^{-1} of different *aman* rice varieties differed significantly among the local and hybrid rice varieties (Table 4 and Appendix IX). It was observed that the highest (2909.13) number of grains plant^{-1} was observed from the variety, V_8 (BRRI dhan51) which was statistically different from all other test varieties followed by V_9 (BRRI dhan52). The lowest (609.38) number of grains plant^{-1} was observed from the variety, V_2 (Dudkat). Among the local rice varieties, V_3 (Bindipakri) showed the highest (2048) value this might be due to higher panicle length in V_3.

4.3.7 Weight of grains plant^{-1}

Weight of grains plant^{-1}of different *aman* rice varieties differed significantly among the local and hybrid rice varieties (Table 4 and Appendix IX). It was observed that the highest (61.03 g) weight of grains plant^{-1} was observed from the variety, V_8 (BRRI dhan51) which was significantly different from all other varieties tested in the study followed by V_9 (BRRI dhan52) and V_{10} (BRRI dhan70). The lowest (9.51 g) weight of grains plant^{-1} was observed from the variety, V_2 (Dudkat). Among the local rice varieties, V_3 (Bindipakri) showed the highest (33.36) weight of grains plant^{-1}.

4.3.8 1000 grain weight (g)

Different varieties of rice showed significant variation on 1000 grain weight (Table 4 and Appendix IX). It was noted that the highest (23.56 g) 1000 grain weight was observed from the variety, V_{10} (BRRI dhan70) which was statistically similar with V_8 (BRRI dhan51) followed by V_9 (BRRI dhan52), V_5 (Sunashail), V_4 (Chinisagar) and V_1 (Buta). The lowest (18.70 g) 1000 grain weight was observed from the variety, V_7 (Ranjay) which was close to V_3 (Bindipakri) and V_6 (Kartik jhul). Result further revealed that 1000 grain weight of *aman* rice is approximately

same in some local and HYV varieties. Similar results were also observedby Murshida *et al*. (2017), Jisan *et al*. (2014) and Sarkar *et al*. (2014).

Table 4. Yield contributing parameters of different *aman* rice varieties.

Variety	Yield contributing parameters					
	Number of effective tillers	**Number of ineffective tillers**	**Panicle length (cm)**	**Number of grains plant^{-1} (g)**	**Weight of grains plant^{-1} (g)**	**1000 grain weight (g)**
V_1	10.50 e	2.25 c	23.60 de	1152.38 i	21.93 e	21.20 b
V_2	7.50 f	5.50 a	23.33 e	609.38 j	9.54 f	20.85 bc
V_3	13.00 c	1.00 d	25.78 c	2048.15 d	33.36 c	20.00 c
V_4	12.25 cd	2.25 c	21.65 f	1515.94 e	26.60 d	21.50 b
V_5	11.75 d	2.25 c	24.10 d	1227.88 h	23.23 e	21.67 b
V_6	11.25 de	4.24 b	25.43 c	1403.44 f	22.48 e	19.88 c
V_7	10.25 e	5.00 ab	23.15 e	1260.75 g	20.03 e	18.70 d
V_8	18.50 a	3.00 c	27.68 a	2909.13 a	61.03 a	22.91 a
V_9	15.50 b	2.75 c	26.83 b	2332.75 b	45.66 b	21.90 b
V_{10}	14.75 b	4.25 b	27.15 ab	2132.11 c	44.06 b	23.56 a
$LSD_{0.05}$	**1.02**	**1.03**	**0.65**	**6.29**	**2.17**	**0.99**
CV (%)	**6.58**	**4.14**	**8.38**	**11.64**	**8.63**	**7.24**

Values followed by same letter(s) did not differ significantly at 5% level of probability.

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan51, V_9 = BRRI dhan52, V_{10} = BRRI dhan70

4.4 Yield parameters

4.4.1 Grain yield (t ha^{-1})

Different variety of rice had significant influence on grain yield (Table 5 and Appendix X). In was noted that the highest (3.78 t ha^{-1}) grain yield was observed from the variety, V_8 (BRRI dhan51) which was statistically identical with V_8 (BRRI dhan51), V_9 (BRRI dhan52) and V_{10} (BRRI dhan70); followed by V_3 (Bindipakri) and V_7 (Ranjay). The lowest (0.57 t ha^{-1}) grain yield was observed from the variety, V_2 (Dudkat) which was statistically similar with V_6 (Kartik jhul).This result indicated that the HYV rice had remarkable superiority of grain yield over local rice varieties but among the local rice varieties, V_3 (Bindipakri) and V_7 (Ranjay) gave the higher grain yield. The results found from the present study was conformity with the findings of Murshida *et al*. (2017), Chamely *et al*. (2015), Sarker *et al.* (2013), Haque *et al.* (2013) and Islam *et al*. (2009).

4.4.2 Straw yield (t ha^{-1})

Straw yield (t ha^{-1}) was significantly influenced by different varieties of rice (Table 5 and Appendix X). The highest (6.88 t ha^{-1}) Straw yield was observed from the variety, V_8 (BRRI dhan51) which was statistically similar with V_8 (BRRI dhan51) V_9 (BRRI dhan52) and V_{10} (BRRI dhan70). The lowest (1.83 t ha^{-1}) Straw yield was observed from the variety, V_2 (Dudkat) followed by V_6 (Kartik jhul). Chowdhury *et al*. (2005), Akbar (2004) and Anwar and Begum (2004) also found similar results with the present study.

4.4.3 Biological yield (t ha^{-1})

Different variety of rice had significant influence on biological yield (Table 5 and Appendix X). The highest (10.66 t ha^{-1}) biological yield was observed from the variety, V_8 (BRRI dhan51) which was statistically identical with V_8 (BRRI dhan51) V_9 (BRRI dhan52) and V_{10} (BRRI dhan70) where the lowest (2.40 t ha^{-1})

biological yield was observed from the variety, V_2 (Dudkat) followed by V_6 (Kartik jhul). Among the local varieties the maximum biological yield was observed from V_3. As the grain yield of local rice variety was low ultimately biological yield also reduced. That means HYV rice produced more biological yield than local rice varieties. Sallauddin (2012) and Sarkar (2014) reported that hybrid rice varieties produced more biological yield than inbred one.

4.4.4 Harvest index (%)

Harvest index was significantly influenced by different varieties of rice (Table 5 and Appendix X). It was observed that the highest (35.46%) harvest index was observed from the variety, V_8 (BRRI dhan51) which was statistically identical with V_9 (BRRI dhan52) followed by V_{10} (BRRI dhan70). The lowest (34.92%) harvest index was observed from the variety, V_2 (Dudkat) which was statistically identical with V_6 (Kartik jhul); followed by V_4 (Chinisagar) and V_5 (Sunashail). From the results it was observed that among the local rice varieties V_7 (Ranjay) give the highest (29.38%) harvest index. Bhowmick and Nayak (2000), Cui *et al.,* (2000) and Chamely *et al*. (2015) also found similar results with the present study.

Table 5. Yield parameters of different *aman* rice varieties.

Variety	Yield parameters			
	Grain yield (t ha^{-1})	**Stover yield (t ha^{-1})**	**Biological yield (t ha^{-1})**	**Harvest index (%)**
V_1	1.35 c	3.60 d	4.95 d	27.27 d
V_2	0.57 e	1.83 f	2.40 f	23.75 f
V_3	2.05 b	5.65 b	7.70 b	26.62 d
V_4	1.20 cd	3.50 d	4.70 d	25.53 e
V_5	1.16 cd	3.36 d	4.52 d	25.66 e
V_6	0.87 de	2.76 e	3.63 e	23.97 f
V_7	1.93 b	4.64 c	6.57 c	29.38 c
V_8	3.78 a	6.88 a	10.66 a	35.46 a
V_9	3.66 a	6.82 a	10.48 a	34.92 a
V_{10}	3.42 a	6.78 a	10.20 a	33.53 b
$LSD_{0.05}$	**0.40**	**0.46**	**0.56**	**0.95**
CV (%)	**8.80**	**11.25**	**9.38**	**10.23**

Values followed by same letter(s) did not differ significantly at 5% level of probability

V_1 = Buta, V_2 = Dudkat, V_3 = Bindipakri, V_4 = Chinisagar, V_5 = Sunashail, V_6 = Kartik jhul, V_7 = Ranjay, V_8 = BRRI dhan51, V_9 = BRRI dhan52, V_{10} = BRRI dhan70

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period from July 2017 to November, 2017. To study a morpho-physiological study of different local HYV rice varieties during *aman* season. The experiment comprised of single factor (variety). Ten rice varieties were used for the present study. Among the varieties, seven were local (Buta, Dudkat, Bindipakri, Chinisagar, Sunashail, Kartik jhul and Ranjay) and three were three HYV varieties (BRRI dhan51, BRRI dhan52 and BRRI dhan70).The experiment was laid out in a Randomized complete Block Design (RCBD) with four replications. Data on different growth parameters, physiological parameters and yield with yield contributing characters were recorded. The collected data were statistically analyzed for evaluation of the treatment effect.

Significant variation among the varieties was observed regarding different parameters. Results signified that in terms of growth parameters, the highest plant height (59.63, 99.27, 134.20 and 146.10 cm at 25, 50, 75 DAT and at harvest respectively) was obtained from the variety, V_5 (Sunashail) where the highest number of leaves plant $^{-1}$ (25.67, 62.00, 68.67 and 52.67 at 20, 40 DAT and at harvest respectively) was obtained from the variety, V_3 (Bindipakri). Similarly, the highest number of total tillers plant^{-1} (7.00, 14.00, 16.67 and 21.50 at 25, 50, 75 DAT and at harvest respectively), dry weight plant^{-1} (19.64, 41.53 and 64.97 g at 50, 75 DAT and at harvest respectively), CGR (2.92 mg cm^{-2} day^{-}) and AGR at 50-75 DAT (1.28 g day^{-1}plant^{-1}) were found from the variety, V_8 (BRRI Dhan 51). On the other hand, the lowest plant height (36.68, 66.09 and 85.37 cm at 25, 50, 75 DAT and at harvest respectively) and number of total tillers plant^{-1} (14.00, 7.00

and 11.00 at 25, 50, 75 DAT and at harvest respectively) were obtained from the variety, V_1 (Buta) where the lowest dry weight plant^{-1} (12.83,18.66 and 39.62 g at 50, 75 DAT and at harvest respectively) was obtained from the variety, V_2 (Dudkat). Again, the lowest number of leaves plant $^{-1}$ (13.67, 37.67, 40.33 and 28.67 at 25, 50, 75 DAS and at harvest respectively), CGR (0.78 and 1.13 mg cm^{-2} day^{-1}at 50-75 DAT and 75 DAT-at harvest respectively) and AGGR (0.25 g day^{-1}plant^{-1}) were found from V_4 (Chinisagar).

In terms of morpho-physiological parameters, the highest (84.00) days to anthesis was observed from the variety, V_7 (Ranjay) where the highest (53.20 cm^2) flag leaf area was observed from the variety, V_1 (Buta). Again, the highest (0.27 g) flag leaf dry weight and highest SPAD value of flag leaf at anthesis stage and grain filling stage (64.87 and 49.77 respectively) were found from the variety, V_8 (BRRI dhan51). Similarly, the lowest (60.00) days to first anthesis was observed from the variety, V_{10} (BRRI dhan70) and the lowest (27.28 cm^2) flag leaf area was observed from the variety, V_8 (BRRI dhan51) where the lowest (0.11 g) flag leaf weight and lowest SPAD value of flag leaf at anthesis stage and grain filling stage (36.60 and 31.90 respectively) was found from the variety, V_4 (Chinisagar). Highest (144 days) total life duration was found in V_8 and V_9. The lowest (130 days) total life duration was found in V_2 and V_{10}.

Regarding yield and yield contributing parameters, the highest number of effective tiller (18.50), panicle length (27.68 cm), number of filled grains panicle^{-1} (144.0), number of grains plant^{-1} (2909.13) and weight of grains plant^{-1} (61.03 g) were observed from the variety, V_8 (BRRI dhan51) where the highest number of unfilled grains panicle^{-1} (29.25) was observed from the variety, V_3 (Bindipakri) and the highest (23.56 g) 1000 grain weight was observed from the variety, V_{10} (BRRI dhan70). Again, the highest grain yield (3.78 tha^{-1}), stover yield (6.88 tha^{-1}) , biological yield (10.66 t ha^{-1}) and harvest index (35.46%) were recorded from the

variety, V_8 (BRRI dhan51). The lowest panicle length (21.65 cm) was observed from the variety, V_4 (Chinisagar), lowest number of unfilled grains panicle^{-1} (13.25) was observed from the variety, V_8 (BRRI dhan51) and lowest 1000 grain weight (g) (18.70 g) was observed from the variety, V_7 (Ranjay). Similarly, the lowest number of effective tiller (7.50), number of filled grains panicle^{-1} (61.00), grain yield (0.57 t ha^{-1}), straw yield (1.83 t ha^{-1}), biological yield (2.40 t ha^{-1}) and lowest harvest index (34.92%) were observed from the variety, V_2 (Dudkat). Besides above findings, among the local varieties V_3 (Bindipakri) performed better for its high number of leaves plant^{-1} (25.76), number of effective tillers plant^{-1} (13.00), panicle length (25.78 cm), weight of grain plant^{-1} (33.36 g), number of grains plant^{-1} (2048.15) and grain yield (2.05 t ha^{-1}).

Considering the above statement, it can be concluded that-

1. Different morpho-physiological characteristics of ten *aman* rice varieties differed significantly.
2. Among all the rice varieties, the HYV variety V_8 (BRRI dhan51) performed better due to its highest number of total tillers plant^{-1}, crop growth rate, absolute grain growth rate, number of effective tillers plant^{-1}, panicle length, number of grains plant^{-1}, 1000 grain weight, grain yield, biological yield and harvest index.
3. Among the local varieties, V_3 (Bindipakri) showed better performance due to its higher number of leaves plant^{-1}, crop growth rate, absolute grain growth rate, number of filled grains panicle^{-1}, number of effective tillers plant^{-1}, panicle length, number of grains plant^{-1}, weight of grains plant^{-1}, grain yield and biological yield.

From the above findings, it can be concluded that among the HYV the variety V_8 (BRRI dhan51) performed better considering its morpho-physiological and yield characters, compared to other varieties. On the other hand among the local rice

varieties V_3 (Bindipakri) showed better performance considering its morpho-physiological and yield characters, compared to other local varieties.

Further extensive research with more parameters of rice plant is suggested to have more information and more experiments are required with the varieties of my experiment at different locations of Bangladesh for final recommendation.

CHAPTER VI

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

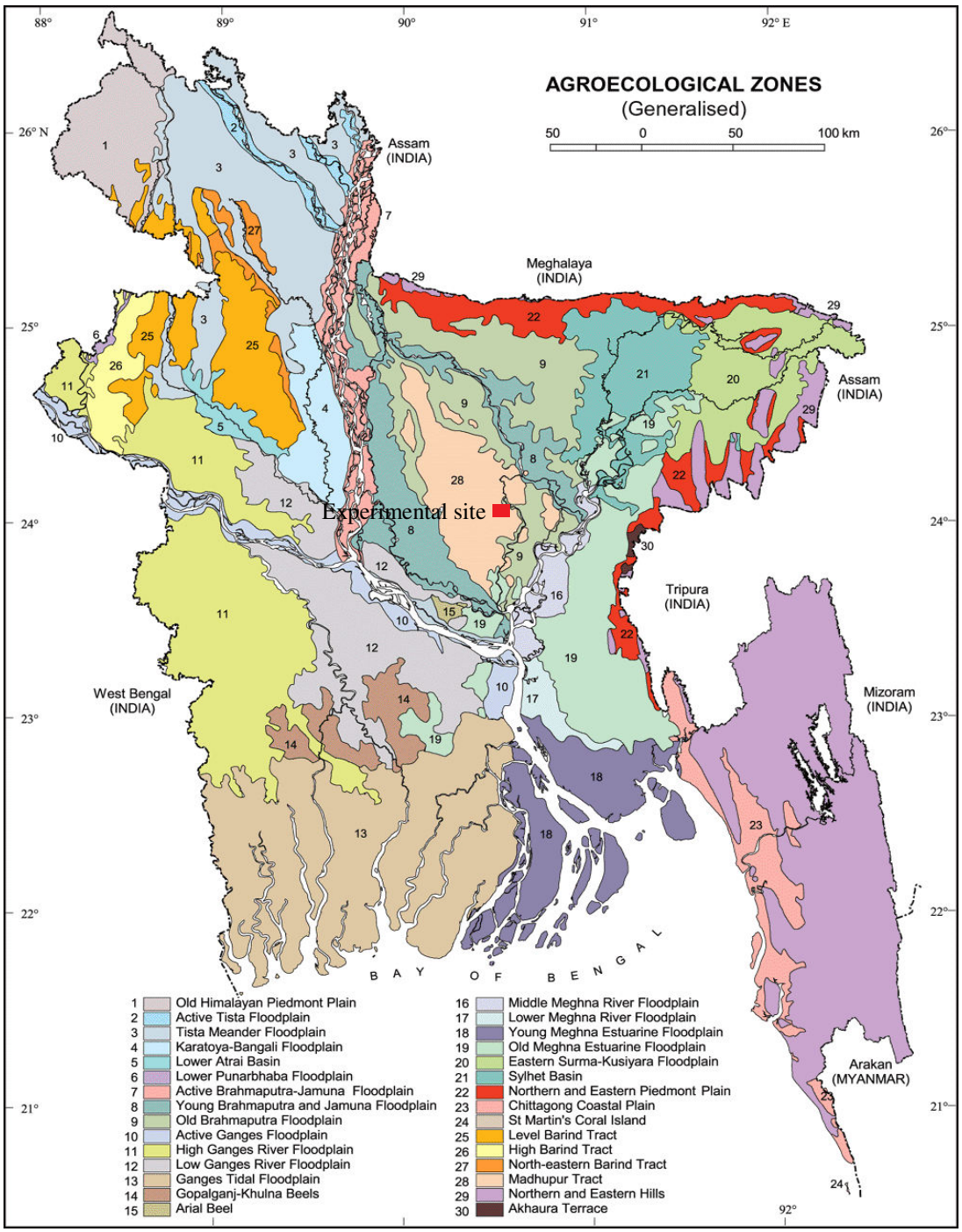

Fig. 8. Experimental site

Appendix II. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from July to October, 2017.

Month	RH (%)	Air temperature (C)			Rainfall (mm)
		Max.	*Min.*	*Mean*	
July	79.60	33.20	25.74	29.47	304.0
August	76.25	31.66	24.40	28.03	152.6
Septembe	71.50	30.8	21.80	26.30	78.52
October	68.48	30.42	16.24	23.33	52.60

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Plant height of different *aman* rice varieties.

Source of variation	Degrees of freedom	Mean square of plant height (cm)			
		25 DAT	50 DAT	75 DAT	At harvest
Replication	3	0.542	1.314	2.056	2.312
Factor A	9	10.322*	17.39*	25.48*	42.32*
Error	27	1.507	2.347	2.448	3.341

Appendix V. Number of leaves plant^{-1}of different *aman* rice varieties.

Source of variation	Degrees of freedom	Mean square of number of leaves plant^{-1}			
		25 DAT	50 DAT	75 DAT	At harvest
Replication	3	0.014	0.156	0.247	0.304
Factor A	9	5.231**	16.347*	38.314*	42.316*
Error	27	0.0142	1.262	1.324	2.052

Appendix VI. Number of tillers plant^{-1}of different *aman* rice varieties.

Source of variation	Degrees of freedom	Mean square of number of total tillers plant^{-1}			
		25 DAT	50 DAT	75 DAT	At harvest
Replication	3	0.021	0.075	0.211	0.375
Factor A	9	5.017**	12.28*	12.017*	17.228*
Error	27	0.226	0.341	0.326	0.412

Appendix VII.Dry weight plant^{-1} and absolute grain growth rate of different *aman* rice varieties.

Source of variation	Degrees of freedom	Mean square of				
		Dry weight plant^{-1} (g)			Growth rate	
		50 DAT	75 DAT	At harvest	CGR	AGGR
Replication	3	0.114	0.337	1.004	0.148	0.228
Factor A	9	6.315**	11.32*	15.54*	7.336**	5.204*
Error	27	0.034	1.026	1.231	0.112	0.017

Appendix VIII. Different morphological parameters of *aman* rice varieties.

Source of variation	Degrees of freedom	Mean square of				
		Days to first anthesis	Flag leaf area (cm^2)	Flag leaf weight (g)	Flag leaf chlorophyll content	
					Anthesis stage	Grain filling stage
Replication	3	0.016	1.013	0.006	1.051	0.036
Factor A	9	7.327*	12.36**	2.434**	11.268**	7.038**
Error	27	0.302	0.507	0.012	0.302	0.204

Appendix IX. Different yield contributing parameters of *aman* rice varieties.

Source of variation	Degrees of freedom	Mean square of yield contributing parameters						
		Number of effective tiller	Panicle length (cm)	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	Number of grains plant^{-1}	Weight of grains plant^{-1}	1000 grain weight (g)
Replication	3	0.12	0.418	0.258	0.304	3.527	0.514	0.114
Factor A	9	10.16*	8.11*	32.27*	9.636*	102.6*	28.63*	16.21*
Error	27	0.402	0.218	3.425	0.503	6.529	1.052	0.247

Appendix X. Different yield parameters of *aman* rice varieties.

Source of variation	Degrees of freedom	Mean square of yield parameters			
		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Replication	3	0.512	1.083	1.125	0.107
Factor A	9	9.863*	11.409*	15.136*	10.239*
Error	27	0.546	1.312	1.228	0.438

Plates

Plate. 1. Sprouted seeds of different *aman* rice varieties.

Plate.2. Pictures of 100 seeds of different *aman* rice varieties.

Plate.3. Transplantation of seedlings in the main field.

Plate.4. Collection of data from experimental field.