EFFECTS OF DIFFERENT AGED SEEDLINGS AND TRANSPLANTING DATES ON THE GROWTH, YIELD AND NUTRIENT CONTENTS OF LATE AMAN RICE CULTIVARS

By

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Registration No. : 05-01671

A Thesis

Submitted to the Department of Agricultural Chemistry
Sher-e-Bangla Agricultural University, Dhaka
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE (M.S.)
IN
AGRICULTURAL CHEMISTRY

Semester: July-December, 2013

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CERTIFICATE

This is to certify that the thesis entitled "EFFECTS OF DIFFERENT AGED SEEDLINGS AND TRANSPLANTING DATES ON THE GROWTH, YIELD AND NUTRIENT CONTENTS OF LATE AMAN RICE CULTIVARS" submitted to the DEPARTMENT OF AGRICULTURAL CHEMISTRY, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE (M.S.) in AGRICULTURAL CHEMISTRY, embodies the results of a piece of bona fide research work carried out by GHULAM SAROWAR, Registration. No. 05-01671, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

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

Dated:

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Dedicated to

My

Beloved Parents

ACKNOWLEDGEMENTS

All praises are due to Almighty Allah, the Great, Gracious and Merciful, Whose blessings enabled the author to complete this research work successfully.

The author likes to express his deepest sense of gratitude to his respected supervisor ***Professor Dr. Md. Abdur Razzaque****, Chairman, Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh, for his scholastic guidance, support, encouragement and invaluable suggestions and constructive criticism throughout the study period and gratuitous labor in conducting and successfully completing the research work and in the preparation of the manuscript writing.*

The author also expresses his gratefulness to respected co-supervisor, ***Dr. Sheikh Shawkat Zamil****, Assistant Professor, Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, helpful comments and constant inspiration, inestimatable help, valuable suggestions throughout the research work and in preparation of the thesis.*

The author expresses heartfelt thanks to all the teachers of the Department of Agricultural Chemistry, SAU, for their valuable suggestions and instructions.

The author is also grateful to all his seniors and friends for their help, encouragement and moral support towards the completion of the degree.

Last but not least, the author expresses his heartfelt gratitude and indebtedness to his beloved father and mother and elder brother for their inspiration, encouragement and blessings that enabled him to complete this research work.

The Author

ABSTRACT

The field experiment was conducted to study the effect of 4 transplanting dates (15, 22, 29 September and 06 October) and 4 different aged seedlings (4, 5, 6 and 7 weeks aged seedlings) on the growth, yield and nutrient content of two late T. Aman rice Bina-sail and BR22 cultivars during July to December, 2013. The two factorial experiment was laid out in a RCBD design with three replications. The cultivars BR22 and Bina-sail showed non-significant variation in case of growth and yield parameters at different aged seedlings and transplanted dates except plant height, panicle length and filled grain panicle^{-1}, where Bina-sail gave significantly higher results than BR22. In case of N, P and K contents in shoot and 1000-grain weight & grain yield, BR22 cultivar gave significantly higher results than Bina-sail. Different aged seedlings and transplanting dates had significant effects on growth & yield parameters and also on N, P and K contents in shoot of late T. Aman rice except total tillers hill^{-1}, panicle length and spikelets panicle^{-1}. The highest plant height, effective tillers hill^{-1}, panicle length, spikelet and filled grain number panicle^{-1}, 1000-grain weight and grain yield were found in 4 weeks aged seedlings transplanted on 15 September. On the other hand, 7 weeks aged seedlings transplanted on 06 October showed the lowest results in all cases except non-effective tillers hill^{-1} and unfilled grains panicle^{-1} where the highest results were recorded in 7 weeks aged seedlings transplanted on 06 October and the lowest values were found in 4 weeks aged seedlings transplanted on 15 September. N, P and K contents in shoots of late T. Aman rice significantly decreased in old seedlings with later dates of transplantation in case of both BR22 and Bina-sail cultivars. The plant height, filled and unfilled grains panicle^{-1}, 1000-grain weight and grain yield differed significantly due to the interaction effect of different aged seedlings and planting dates of late T. aman rice cultivars. The highest plant height and filled grains panicle^{-1} were obtained from Bina-sail which was planted on 15 September with 4 weeks old seedlings except unfilled grain panicle^{-1} where it was the lowest result. But the highest grain yield and 1000-grain weight were found in BR22 transplanted on 15 September with 4 weeks old seedlings.

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LIST OF ABBREVIATIONS

%	=	Per cent
@	=	At the rate
°C	=	Degree Celcius
AEZ	=	Agro Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
cv.	=	Cultivar (s)
DMRT	=	Duncan's Multiple Range Test
et al.	=	And Others
FAO	=	Food and Agriculture Organization
g	=	Gram
IRRI	=	International Rice Research Institute
LSD	=	Least Significant Difference
SAU	=	Sher-e-Bangla Agricultural University
t/ha	=	Tonne per Hectare
RCBD	=	Randomized Complete Block Design
DAT	=	Days After Transplanting

CHAPTER 1

INTRODUCTION

Rice is the staple food crop over half of the world's population and the most important food grain in the diets of billions of people of Asia, Africa and Latin America. Sub Saharan Africa produced about 21.6 million tons of rice in 2006 and accounted for 32% of rice import in the global international market to meet its demand because of the result of population growth (about 4% per annum) and the increased consumer preference in favor of rice in urban area (Atera *et al.*, 2011). In many Asian countries including Bangladesh rice provides food security where it is the principal food for 60% of the population (Dunand and Dilly, 1982). It is the main source of calories of almost 40% of the world population (Alam, 1988). The demand of rice would increase by 25% by 2025 to keep pace with population growth (Krishna *et al.*, 1994). It is predominantly an Asian crop; 95% of it is being produced and consumed in the South and South East Asian countries. It plays an absolutely dominant role in Bangladesh agriculture covering 75% of the total cropped area (BBS, 2009). The total area and production of rice in Bangladesh are 11.35 million hectares and 31.978 million tons, respectively (BBS, 2010).

The second largest part of the total production of rice comes of Aman rice after Boro. Bangladesh earns about 31.6% of her gross domestic product (GDP) from agriculture (BBS, 2008) in which rice is the main crop. Agriculture in Bangladesh is characterized by intensive crop production with rice based cropping systems. Rice is also the principal commodity of trade in our internal agricultural business.

The average yield of rice in our country is around 2.45 t ha^{-1} which is less than the world average (3.1 t ha^{-1}) and frustratingly below the highest yield recorded (9.65 t ha^{-1}) in Australia (FAO, 2008).

Horizontal expansion of rice area in Bangladesh is not possible due to limited land resources, as land availability for crop production has been declining day by day because of population pressure and rapid urbanization. So, the only avenue left is to increase the production of rice through increasing crop intensity. Although the soil and climate of Bangladesh are favorable for rice cultivation throughout the year but per hectare yield of this crop is much below the potential yield level. The reasons are manifolds, some are varietals, some are technological and some are ecological. Modern high yielding varieties require higher price of seeds, fertilizers, irrigation and pesticides. Farmers of the country are poor, so they can not always afford their costs. Hence, special attention should be given for increasing the yield per unit area by applying improved management practices. On the contrary, every year thousands of hectares of lands are bared and remain uncultivated due to different reasons, we can increase our rice production by utilizing these lands. But flash flood in Aman season is one of the main reasons for remaining rice fields uncultivated. These lands become water free in the late season of the Aman. In this aspect late variety of Aman rice and re-transplanting of rice seedling can help the farmers of Bangladesh.

In Bangladesh, when the photosensitive Aman rice varieties are transplanted in the late season during September-October, their sensitivity to flower in the months of October-December mostly depends on the planting dates. The phenological events of photosensitive varieties depend on the particular air temperature. BRRI (1989) and Yoshida (1981) reported that rice plants require a particular temperature for its phenological affairs such as panicle initiation, flowering, panicle exertion from flag leaf sheath and maturity and these are much influenced by the planting dates during transplanting (T) Aman season. Deviation from the optimum planting time may cause incomplete and irregular panicle exertion, increased spikelet sterility (Mangor, 1984). The optimum planting time of T. Aman rice is in August. But sometimes transplanting is delayed due to various causes such as rainfall, flood and socioeconomic factors. This late planting exposes the reproductive phases as well as phonological events of crop in an unfavourable temperature regime thereby causing high spikelet sterility and poor growth of the plant (BRRI, 1989). Halappa *et al.* (1974) reported that the performance of rice is greatly influenced by the date of transplanting due to the effect of cold hazard and incidence of biotic stress. Faria and Folegatt (1962) reported that grain yield was high for sowing in October (5.4 - 6.0 t ha^{-1}) and lower for sowing in December (1.6 - 4.8 t ha^{-1}) due to the low temperature at grain formation stages, mostly for the late cultivar. However, information regarding the effect of late planting in Aman rice is not adequate and re-transplanting is a newer idea in which rice seedling is uprooted from the seedbed and transplanted in another flood free land with 3-4 cm soil and under the soil layer a polyethylene sheet is provided for arrestation of root growth towards lower soil.

Variety is the key component to produce higher yield of rice depending upon their differences in genotypic characters, input requirements and response, growth process and off course the prevailing environmental conditions during the growing season. The growth process of rice plants under a given agro-climatic condition differs with variety.

Keeping these views in mind, the present study was designed and conducted with the following objectives:

i) To select the late T. Aman rice variety for cultivation at late Aman season

ii) To determine a suitable aged seedlings and date of transplanting for the highest yield of aman rice, and

iii) To analyze the nutrient content of rice plant as affected by different aged seedlings and late transplanting dates.

CHAPTER 2

REVIEW OF LITERATURE

Growth and development of rice plants are greatly influenced by the environmental factors i.e. air, day length or photoperiod, temperature etc., variety used and agronomic practices like transplanting time, spacing, number of seedlings, depth of planting, fertilizer management etc. Among the factors, which are responsible for the yield of rice, late transplanting of Aman rice is one of them. Cultivar plays an important role in rice production by affecting the growth, yield and yield components of rice. Research works related to effect of variety and late transplanting on the growth, yield and yield components of Aman rice have been reviewed in this chapter.

2.1 Effect of variety

Variety itself is the genetic factor which contributes a lot in improving yield and yield components. Different scientists reported on the effect of rice varieties on grain yields. Some available information and literature related to the effect of variety on the yield and yield contributing characters of rice are furnished here.

An experiment was carried out by Alam *et al.* (2012) at Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi during the kharif season to study the effect of variety, spacing and number of seedlings $hill^{-1}$ on the yield potentials of transplant aman rice. The experiment consisted of three high yielding varieties viz. BRRI dhan32, BRRI dhan33 and BR11, four levels of spacing viz. 10 cm × 25 cm, 15 cm × 25 cm, 20 cm × 25 cm and 25 cm × 25 cm and four levels of number of seedlings $hill^{-1}$ viz. 2 seedlings $hill^{-1}$, 3 seedlings $hill^{-1}$, 4 seedlings $hill^{-1}$ and 5 seedlings $hill^{-1}$. A split-split plot design was used with three replications assigning the variety on the main plot, spacing to the sub-plots and number of seedlings $hill^{-1}$ to the sub-sub plots. Variety had significant effects on almost all the yield component characters and yield. Among the varieties BRRI dhan33 gave significantly the tallest plant (113.17 cm), which is statistically identical with BR11 (111.25 cm). The highest number of total tillers $hill^{-1}$ (12.23) was produced by BR11 and the lowest number of total tillers $hill^{-1}$ (10.17) was produced by BRRI dhan32. All the yield components characters (tillers $hill^{-1}$, effective tillers $hill^{-1}$, panicle length, weight of 1000-grain and grain yield) except number of fertile spikelets $panicle^{-1}$ were highest in case of variety BR11 and hence it produced the highest grain yield (5.92 t ha^{-1}).

A study was undertaken to evaluate the growth performance and grain quality of six aromatic rice varieties BRRI dhan34, BRRI dhan38, Kalizira, Chiniatop, Kataribhog and Basmati grown under rainfed conditions by Ashrafuzzaman *et al.* (2009). They found that Kalizira was the tallest (107.90 cm) of all the studied varieties. It had shown no significant difference with BRRI dhan38 (107.80 cm) and BRRI dhan34 (106.70 cm). BRRI dhan34 showed the highest number of panicles per hill (11.67) followed by Kalizira (11.33).The rice varieties differed significantly ($P<0.05$) with respect to leaf chlorophyll content, plant height, internode length, thousand grain weight and grain and straw yields. Varieties differed in morphological and yield and yield contributing traits. Thousand grain weight and grain yield both were highest in BRRI dhan38. Basmati required shorter days to maturity and Kalizira longest days to maturity.

A field experiment was conducted by Roy *et al.* (2014) to evaluate the growth, yield and yield attributing characteristics of 12 indigenous *Boro* rice varieties collected from South-Western regions of Bangladesh namely; Nayon moni, Tere bale, Bere ratna, Ashan boro, Kajol lata, Koijore, Kali boro, Bapoy, Latai balam, Choite boro, GS one and Sylhety boro. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. Parameters on, growth parameter *viz.* plant height and number of tillers $hill^{-1}$ (at different days after transplanting); yield contributing characters such as effective tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, filled grains $panicle^{-1}$, thousand grain weight, grain yield, straw yield, biological yield and harvest index were recorded. The plant height and number of tillers $hill^{-1}$ at different days after transplanting varied significantly among the varieties up to harvest. At harvest, the tallest plant (123.80 cm) was recorded in Bapoy and the shortest (81.13 cm) was found in GS one. The maximum number of tillers $hill^{-1}$ (46.00) was observed in Sylhety boro and the minimum (19.80) in Bere ratna. All of the parameters of yield and yield contributing characters differed significantly at 1% level except grain yield, biological yield and harvest index. The maximum number of effective tillers hill^{-1} (43.87) was recorded in the variety Sylhety boro while Bere ratna produced the lowest effective tillers hill^{-1} (17.73). The highest (110.57) and the lowest (42.13) number of filled grains panicle^{-1} was observed in the variety Koijore and Sylhety boro, respectively. Thousand grain weight was the highest (26.35 g) in Kali boro and the lowest (17.83 g) in GS one. Grain did not differ significantly among the varieties but numerically the highest grain yield (5.01 t ha^{-1}) was found in the variety Koijore and the lowest in GS one (3.17 t ha^{-1}).

Number of panicles was the result of the number of tillers produced and the proportion of effective tillers, which survived to produce panicle (Hossain *et al.*, 2008).

Hossain and Alam (1991) found that the plant height in modern *Boro* rice varieties of BR3, BR11 and Pajam were 90.4, 94.5, 81.3 and 90.7 cm, respectively.

Bhuiya (2000) reported that plant height varied variety to variety *viz.* Binasail, Binadhan 4 and Binadhan 19 with different plant spacing *viz.* 20 cm x 10 cm, 20 cm x 15 cm and 20 cm x 20 cm.

Sultana (2008) observed that number total of tillers hill^{-1} was not significantly affected by variety. Apparently more number (11.07) of total tillers was produced by the variety BR14 than BR26 (10.90).

Idris and Matin (1990) reported that number of total tillers hill^{-1} was identical among the varieties studied.

BRRI (2006) studied the performance of BR14, Pajam, BR5 and Tulsimala and reported that Tulsimala produced the highest number of filled grains panicle^{-1} and BR14 produced the lowest number of filled grains panicle^{-1}.

BRRI (2004) reported that the filled grains panicle^{-1} of different modern varieties were 95-100 in BR3, 125 in BR4, 120-130 in BR22 and 110-120 in BR23 when they were cultivated in transplant *Aus* season. They reported that three modern upland rice varieties namely, BR20, BR21 and BR24 were suitable for high rainfall belts of Bangladesh. Under proper management, the grain yield was 3.5 ton for BR 20, 3.0 ton for BR21 and 3.5 ton for BR24 ha^{-1}. They also reported that grain yields of the modern rice varieties in *Aus* season under transplant condition ranged from 4.0-4.5 t ha^{-1} for BR3, 5.5 - 6.5 t ha^{-1} for BR4, 2.5-5.5 t ha^{-1} for BR23 and 4.0-4.5 t ha^{-1} for IR20.

Kamal *et al.* (1988) carried an experiment with BR3, IR20, and Pajam and found that number of grains panicle^{-1} were 107.6, 123.0, and 170.9, respectively for the three varieties.

Takita (2009) reported that Nerica rice has erect panicles even after maturity which can favor high canopy photosynthesis with less light interception by these panicles than droopy panicles.

Jesy (2007) observed that weight of 1000-grains was not significantly affected by variety. Apparently BRRI dhan4l produced the higher weight of 1000-grains (23.42 g) than BRRI dhan40 (23.39 g).

Hasanuzzaman *et al.* (2009) in a study found that the length of panicle in late transplanted Aman rice ranged from 23.59 to 21.30 cm.

Refey *et al.* (1989) reported that weight of 1000-grains differed among the cultivars studied.

RARC (2011) conducted an experiment where rice cv. NERICA L19 and ROK10 and subjected to four different herbicides at different rates with different active ingredients, there NERICA L19 was high yielding and weed competitive.

Hossan (2005) observed that grain yield was significantly differed due to variety. It was evident from the result that BRRI dhan4l produced the higher grain yield (5.02 t ha^{-1}) than BRRI dhan31.

Hossain and Alam (1991) reported that the grain yield of six modern varieties of *Boro* rice namely BR3, BR11, BR14, IR8, Pajam and BR16 differed significantly in a varietal trail at haor area were 4.59, 5.3, 5.73, 4.86, 3.75 and 4.64 t ha^{-1}. They also studied farmers production technology in haor area and found that the grain yield of modern varieties of *Boro* rice were 2.12, 2.18, 3.17, 2.27 and 3.05 t ha^{-1} respectively with BR14, BR11, BR9, IR 8 and BR3.

Miah *et al.* (1993) reported that plant height differed significantly among BR 3, BR 11, BR 22, Nizershail, Pajam, and Badshabhog varieties in Aman season (Jul-Dec). Tiller number varied widely among the varieties and the number of tillers/plant at the maximum tiller number stage ranged between 14.3 and 39.5 in 1995 and 12.2 and 34.6 in 1996.

2.2 Effect of late transplanting

BRRI (1989) and Yoshida (1981) reported that rice plants require a particular temperature for its phenological affairs such as panicle initiation, flowering, panicle exertion from flag leaf sheath and maturity and these are much influenced by the planting dates during T. Aman season.

BRRI (1989) further reported that the optimum planting time of T. Aman rice is in August. But sometimes transplanting is delayed due to various physical and socioeconomic factors. This late planting exposes the reproductive phases as well as phonological events of crop in an unfavorable temperature regime thereby causing high spikelet sterility and poor growth of the plant.

Faria and Folegatt (1962) reported that grain yield was high for sowing in October (5.4 to 6.0 t/ha) and lower for sowing in December (1.6 to 4.8 t ha^{-1}) due to the low temperature at seed filling stages, mostly for the late cultivar.

Mangor (1984) reported that deviation from the optimum planting time may cause incomplete vegetative stage and irregular panicle exertion.

Pal *et al.* (2002) conducted an experiment to find out the effect of method of planting (row and haphazard) and five hill arrangements [1 (25 x 12 cm^2), 2 (25 x 6 cm^2), 3 (25 x 4 cm^2), 4 (25 x 3 cm^2) and 5 (25 x 2.4 cm^2)] on the yield of late transplanted Aman rice (cv. BR23) grown under different planting dates (1^{st} , 15^{th} and 30^{th} Sept.). Yield components namely number of effective tillers m^{-2}, number of grains and that of total spikelets $panicle^{-1}$, weight of 1000 grains were notably decreased with the delay in transplanting which in turn resulted in the decreased grain yield. The grain yield gradually decreased from 1^{st} September transplanting onwards and became the lowest when the crop was transplanted on 30^{th} September.

Biswas and Salokhe (2001) in their experiments in Bangkok clay soil tried to investigate the influence of planting date, tiller separation and plant density on the yield and yield attributes of parent and clone plants of two transplanted rice varieties. The 15 July transplanting of mother crop and collected vegetative tillers and re-transplanting on 15 August showed significantly high grain yield (3·8 t ha^{-1}). The photoperiod-insensitive variety RD23 gave higher yield (3·8 t ha^{-1}) than the photoperiod-sensitive variety KDML105 (3·0 t ha^{-1}). Tiller separation upto 4 tillers/hill did not adversely affect the mother crop. Vegetative tillers transplanted with 2–4 tillers/hill gave a similar yield as the mother crop in both the seasons. Vegetative tillers gave a higher yield than nursery seedlings transplanted on the same date. The yield components, *i.e.* weight of 1000 grains, grains/panicle and percent filled grains, showed better responses with early transplanting of KDML105 in the mother crop and vegetative tillers except for panicle number and panicle length of vegetative tillers with RD23. The results suggest that in some flood-prone lowlands, where the transplanted crop is damaged by natural hazards, vegetative propagation using tillers separated (maximum 4/hill) from the previously established transplanted crop is beneficial for higher productivity.

A field experiment was conducted during kharif season of 2010 and 2011 by Pramanik and Bera (2013) to investigate the optimization of nitrogen levels under different age of seedlings transplanted on growth, chlorophyll content, yield and economics of hybrid rice. Fifteen treatment combinations consisted of three levels of seedlings age (10, 20 and 30 days) and five levels of nitrogen viz. N_0, N_{50}, N_{100}, N_{150} and N_{200} kg ha^{-1}. Seedlings age had marked effect on all the growth, chlorophyll content and yield attributing traits. Transplanting of 10 days seedlings showed significantly highest grain yield of 5575 and 5946 kg ha^{-1} in 2010 and 2011, respectively. The percentage of grain yields an increase of 10.7 and 21.3 per cent in first year and 10.6 and 21 per cent in second year over 20 and 30 days seedlings respectively.

Shimizu and Kumo (1967) reported a wide range of abnormal spikelets, all of which were induced under the low temperature treatments at the young panicle primordial differentiation stage.

2.3 Interaction effect of variety and late transplanting

Nahar *et al.* (2009) in a field experiment during the Aman (monsoon) season of 2008 studied the effect of low temperature stress influenced by date of transplanting on yield attributes and yields of two rice varieties. The experiment consisted of two varieties (BRRI dhan46 and BRRI dhan31) and 4 transplanting dates (01, 10, 20 and 30 September, 2008). BRRI dhan46 had significantly higher values of yield attributes (effective tillers $hill^{-1}$, panicles $hill^{-1}$, panicle length, spikelets $panicle^{-1}$, filled grains $panicle^{-1}$ and 1000-grain weight) and yields than the BRRI dhan31 in late transplanted conditions. There were significant reductions in yield attributes and yields after delayed transplanting. Spikelet sterility was increased by late transplanting due to low temperature at panicle emergence stage. Yield reduction of BRRI dhan46 due to late transplanting at 10 September, 20

September and 30 September were 4.44, 8.88 and 15.55%, respectively compared to 01 September transplanting. In case of BRRI dhan31 the reduction was more significant which were 6.12, 20.48 and 36.73%, respectively.

An experiment was carried out by Amin and Haque (2009) at the field laboratory of the Department of Agronomy, Bangladesh Agricultural University, Mymensingh in July to December 2001. Two indigenous varieties, viz.: Kalizira and Tulshimala, and two improved varieties, viz.: BRRI dhan38 and BRRI dhan37, with four different aged seedlings, viz.: 15, 25, 35, and 45 days old, were transplanted on the same day maintaining 25 cm x 15 cm spacing. The highest plant height was observed in BRRI dhan37 followed by Tulshimala and Kalizira among 35-day old seedlings at 60 days after transplanting (DAT). But during harvest, 35-day old Kalizira seedling gave the highest plant height. BRRI dhan38 and BRRI dhan37 seedlings, both 35 days old, produced the highest number of tiller $hill^{-1}$ at all DATs except 15 DAT. But during harvest, only BRRI dhan38 with 35-day old seedling gave the best result. The highest LAI (Leaf Area Index) was found in BRRI dhan38's 35-day old seedling at 45, 60, and 75 DAT. However, at 15 DAT, BRRI dhan37's 45-day old seedling showed the highest value of LAI. Kalizira's 45-day old seedling gave the lowest LAI at 75 DAT which was statistically similar to Tulshimala with 15 days old seedling. The highest grain yield (4.30 t ha^{-1}) was found in BRRI dhan38's 35-day old seedling, followed by BRRI dhan37's with the same age of seedling (4.00 t ha^{-1}). The study also revealed that the overall performance (growth, yield, and yield contributing characters) of indigenous varieties were better with 35 days old seedlings.

From the above reviews it is cleared that variety and late transplanting have profound influence on the yield and yield contributing characters of aman rice. Thus there may have enough scope investigating the effect of variety and transplanting date in favor of yield improvement of aman rice cv. Binasail.

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted at the experiment field of the farm of Sher-e-Bangla Agricultural University during the period from July to December 2013. This chapter deals with a brief description of the site, land preparation, intercultural operations, data recording and procedure of statistical analysis.

3.1. Location and site

The experimental field is located at the Sher-e-Bangla Agricultural University (SAU), Dhaka-1207. The experimental area belongs to Modhupur Tract (Agro-Ecological Zone 28). The land area was situated at 23°41' N latitude and 90°22' E longitude at an altitude of 8.6 meter above the sea level.

3.2 Planting material

The two rice cultivars Bina sail and BR 22 were selected for this experiment. The varieties are Transplant Late Aman type.

3.3 Experimental treatment and design

The treatments included in the experiment are two factorials.

Design: RCBD with two factorials

Factor 1: Rice varities 2 (V_1: BR 22 and V_2: Bina-sail)

Factor 2: Transplanting dates and ages of seedlings: 4

T_1 : 15 September (Transplanting of 4 weeks aged seedlings)

T_2 : 22 September (Transplanting of 5 weeks aged seedlings)

T_3 : 29 September (Transplanting of 6 weeks aged seedlings)

T_4 : 06 October (Transplanting of 7 weeks aged seedlings)

Treatment combination = 3 x 4 = 12

Replication: 3

3.4 Raising of seedlings

Seeds of BR 22 and Bina sail rice cultivars were collected from BRRI (Bangladesh Rice Research Institute), Gazipur and BINA (Bangladesh Institute of Nuclear Agriculture), Mymensingh. Seedlings were raised at the wet seed beds in SAU farm. Seeds were sprouted by soaking for 72 hours. The sprouted seeds were sown uniformly in the well-prepared seed bed in 18 th August, 2013.

3.5 Land preparation

The experimental field was opened with a power tiller plough and later on, the land was ploughed and cross-ploughed three times by country plough followed by laddering to obtain the desirable tilth. The corners of the land were spaded. All kinds of weeds and stubbles were removed from the field and the land was made ready. Whole experimental land was divided into sub plots. Finally basal doses of Phosphorus, Potassium and Sulfur fertilizers were applied in sub plots and the plots were made ready by thorough spading and leveling before transplantation.

3.6 Fertilizer application

At the time of first ploughing cow dung at the rate of 1 t ha^{-1} was applied. The plots were fertilized with 85, 60, 50 and 16 kg ha^{-1} urea, triple super phosphate (TSP), muriate of potash (MoP) and gypsum, respectively (BINA, 1987). All the fertilizers were incorporated with the soil of main plot one day before transplanting except urea. The prilled urea was applied in three splits in equal ratios after planting the seedlings.

3.7 Uprooting and transplanting of seedlings

Four, 5, 6 and 7 weeks old seedlings of two rice cultivars were uprooted from the seed beds carefully and transplanted at the experimental fields according to T_1, T_2, T_3, and T_4 treatments with row to row distance 25 cm and hill to hill distance 15 cm. The 3 seedlings per hill were maintained.

3.8 Intercultural operations

The following intercultural operations were done for ensuring the normal growth of the crop.

Weed control

During plant growth stage hand weeding was done according to needs.

Irrigation

Irrigation water was applied keeping a standing water of about 2-3 cm during the whole growing period.

Plant protection measure

During the growing period, some plants were infested by rice stem borer (*Scirpophaga incertulus*) which was successfully controlled by applying Diazinon 60 EC @ 20 ml per 10 L of water for spraying. No prominent infestation of insect-pests and diseases were observed in the field.

3.9 Harvest and post harvest operation

The crop was harvested after the grains attained maturity. The grains were threshed, cleaned and sun dried to record grain yield/plot.

3.10 Sampling and data collection

Data collections from the experiment on different growth stages were done under the following heads as per experimental requirements.

3.10.1 Plant height

The heights of the pre-selected 10 hills were taken by measuring the distance from base of the plant to the tip of the flag leaf after heading. The collected data were finally averaged.

3.10.2 Number of effective, non-effective and total tillers $hill^{-1}$

Number of effective and non-effective tillers were counted from 10 pre-selected hills after harvesting and finally averaged. The total tillers were counted by the summation of effective and non-effective tillers $hill^{-1}$.

3.10.3 Number of filled, unfilled grains and spikelets $panicle^{-1}$

Number of filled grains and unfilled grains were counted from 10 panicles at each plot. Lack of any food materials inside the spikelets were denoted as unfilled grains. The total numbers of spikelets were counted by the summation of filled and un-filled grains $panicle^{-1}$.

3.10.4 1000-grain weight

One thousand grains were randomly collected from each plot and were sun dried and weighed by an electronic balance.

3.10.5 Grain yield

Four square meter (m^2) area (each plot) were harvested. The grains were threshed, cleaned, dried and then weighed in kg. Thereafter it was converted as ton per hectare ($t\ ha^{-1}$).

3.10.6 Analyses of plant samples for determining N, P and K

The harvested rice plants were immediately separated into shoot and panicle. Rice shoot samples were analyzed for estimation of N, P and K constituents through acid digestion techniques by macro-Kjeldahl digestion system (Thomas *et al.*, 1967 and Jackson, 1973).

Procedure

For acid digestion, oven-dried ground plant shoot tissues (0.5 g) and 15 mL of concentrated sulphuric acid and 2 mL H_2O_2 or 15 mL di-acid (HNO_3 & $HClO_4$) mixture (Jackson, 1973) were taken in a digestion flask and left to stand for over-night and then transferred to a digestion block and continued heating at 100°C. The temperature was increased to 200°C gradually to prevent frothing and left to digest until yellowish color of the solution turned to whitish color. Then the digestion flasks were removed from the heating source and allowed to cool to room temperature. About 40 mL of distilled water was carefully added to the digestion flasks and the contents filtered through Whatman no. 40 filter paper into a 100 mL volumetric flasks and the volume was made up to the mark with distilled water. The samples were stored at room temperature in clearly marked containers.

Total N was measured by distillation flow titration. Total P was measured by a Spectrophotometer according to Jackson (1973). Content of K ions were determined by flame emission spectrophotometer.

3.11 Statistical Analysis

The data were compiled and tabulated in proper form and were subjected to statistical analysis. Analysis of variance was done following the computer package MSTAT-C program developed by Russel (1986). The mean differences among the treatments were adjusted by Duncan's Multiple Range Test at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER 4

RESULTS AND DISCUSSION

This chapter comprises of presentation and discussion of the results obtained from the study to evaluate the effect of 4 different transplanting dates (15, 22, 29 September and 06 October) and 4 different aged seedlings (4, 5, 6 and 7 weeks aged seedlings) on the growth, yield and N, P, K nutrients content of two late T. aman rice Bina sail and BR 22 cultivars. Effects of different treatments on growth, yield and nutrient content are presented as follows:

4.1 Plant height

The varietal effect on plant height of T. aman rice showed significant variation (Table 1). The tallest plant (139.02 cm) was obtained from variety Bina-sail while the variety BR 22 gave the shortest plant (104.67 cm). This difference might be due to genetical. Alam *et al.* (2012) carried out an experiment using 3 rice varieties viz. BRRI dhan32, BRRI dhan33 and BR11 where BRRI dhan33 gave higher plant height. Ashrafuzzaman *et al.* (2009) found that among six aromatic Aman rice varieties; Kalizira was the tallest (107.90 cm).

It was observed from the results presented in Fig. 1 that the different aged seedlings and transplanting dates have significant influence on plant height. The tallest plant (124.80 cm) was obtained from T_1 (4 weeks aged seedlings transplanted on 15th September) which was statistically similar with T_2 (5 weeks aged seedlings transplanted on 22

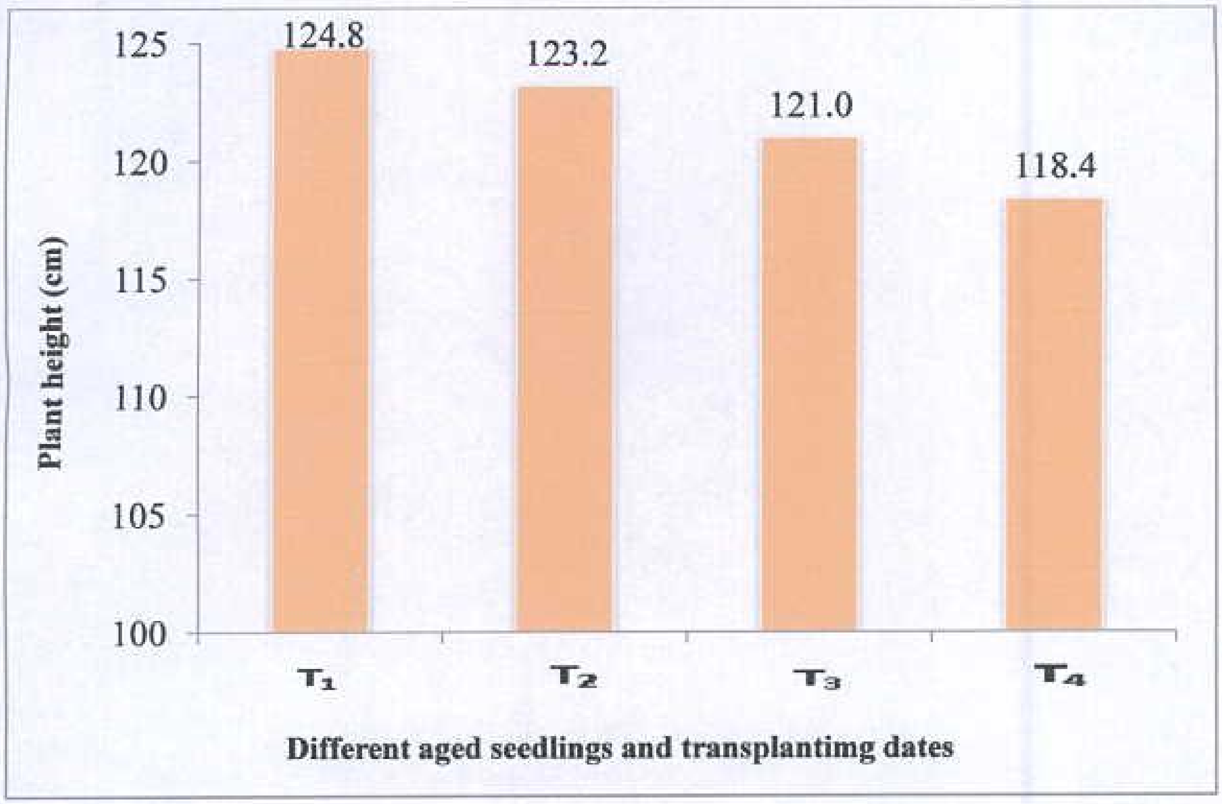
September). On the other hand, 7 weeks aged seedlings transplanted on 06 October (T_4) produced the shortest one (118.40 cm) (Appendix 1).

The results presented in Table 2 showed that plant height differed significantly due to the interaction effect of varieties and different aged seedlings & different planting dates of Late T. aman tice cultivars. The tallest plant (140.60 cm) was obtained from Bina-sail variety and 4 weeks aged seedlings transplanted on 15 September (V_2T_1) which was statistically similar with V_2T_2, V_2T_3 and V_2T_4. On the other hand, V_1T_4 (BR 22 and 7 weeks aged seedlings transplanted on 06 October) produced the shortest one (98.33 cm).

Table 1. The varietal effect on plant height and total tiller number of T. aman rice

Variety	Plant height (cm)	Total tiller hill^{-1}
BR22 (V_1)	104.67	13.17
Bina-sail (V_2)	139.02	13.17
Significant level	**	NS
SE	0.69	-
CV (%)	1.96	7.71

** → Significant at 1% level of probability; NS → Non-significant



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

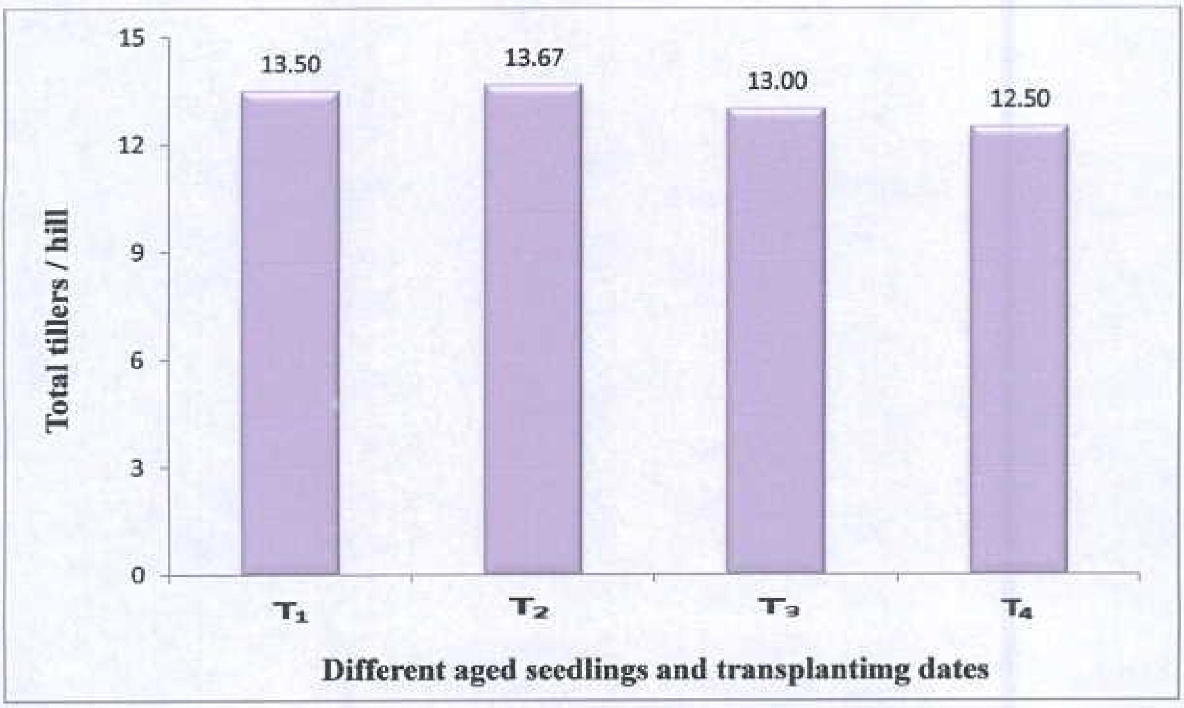
T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 1. The effect of different aged seedlings and transplanting dates on plant height (mean of two rice cultivars)

BRRI (1989) reported that the optimum planting time of T. aman rice is in August. But sometimes transplanting was delayed due to various physical and socioeconomic factors. This late planting exposed the vegetative and reproductive phases as well as phonological events of crop in an un-favourable temperature regime thereby causing high spikelet sterility and poor growth of the plant.

4.2 Number of total tillers $hill^{-1}$

Number of total tillers $hill^{-1}$ of late T. aman rice plant was not significantly affected by different T. aman rice cultivars (Table 1) and also by different aged seedlings & transplanting dates (Fig. 2). In fact, both the varieties gave same number of total tiller. But the highest number of total tillers $hill^{-1}$ (13.67) was obtained from T_2 (5 weeks aged seedlings transplanted on 22 September) while 7 weeks aged seedlings transplanted on 06 October (T_4) gave the lowest result (12.50) (Appendix 1).



T_1 : 4 weeks aged seedlings transplanted on 15 September
T_2 : 5 weeks aged seedlings transplanted on 22 September
T_3 : 6 weeks aged seedlings transplanted on 29 September
T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 2. The effect of different aged seedlings and transplanting dates on number of total tillers $hill^{-1}$ (mean of two rice cultivars)

Table 2. The interaction effect of varieties and different aged seedlings planting dates on plant height and tiller number of T. aman rice

Variety	Planting date	Plant height (cm)	Total tiller $hill^{-1}$
BR22 (V_1)	15/9/13 (T_1)	108.90 b	13.33
	22/9/13 (T_2)	107.20 bc	13.67
	29/9/13 (T_3)	103.60 c	13.00
	06/10/13 (T_4)	98.93 d	12.67
Bina-sail (V_2)	15/9/13 (T_1)	140.60 a	13.67
	22/9/13 (T_2)	139.20 a	13.67
	29/9/13 (T_3)	138.30 a	13.00
	06/10/13 (T_4)	137.90 a	12.33
Significant level		*	NS
$LSD_{(0.05)}$		4.18	-
CV (%)		1.96	7.71

* → Significant at 5% level of probability; NS → Non-significant

These results are similar with the findings of Sultana (2008) observed that number total of tillers $hill^{-1}$ was not significantly affected by variety. Idris and Matin (1990) also reported that number of total tillers $hill^{-1}$ was identical among the varieties studied. But the results are in contrary with Alam *et al.* (2012) who found that highest number of total tillers $hill^{-1}$ (12.23) was produced by BR11 and the lowest number of total tillers $hill^{-1}$ (10.17) was produced by BRRI dhan32 among three varieties. Roy *et al.* (2014) found that, number of tillers $hill^{-1}$ at different days after transplanting varied significantly among the varieties up to harvest where maximum number of tillers hill^{-1} (46.00) was observed in Sylhety boro and minimum (19.80) in Bere ratna. Miah *et al.* (1993) reported that tiller number varied widely among the varieties and the number of tillers/plant at the maximum tiller number stage ranged between 14.3 and 39.5 in 1995 and 12.2 and 34.6 in 1996. Amin and Haque (2009) found that BRRI dhan38 and BRRI dhan37 seedlings, both 35 days old, produced the highest number of tiller hill^{-1} at all DATs except 15 DAT.

4.3 Number of effective tillers hill^{-1}

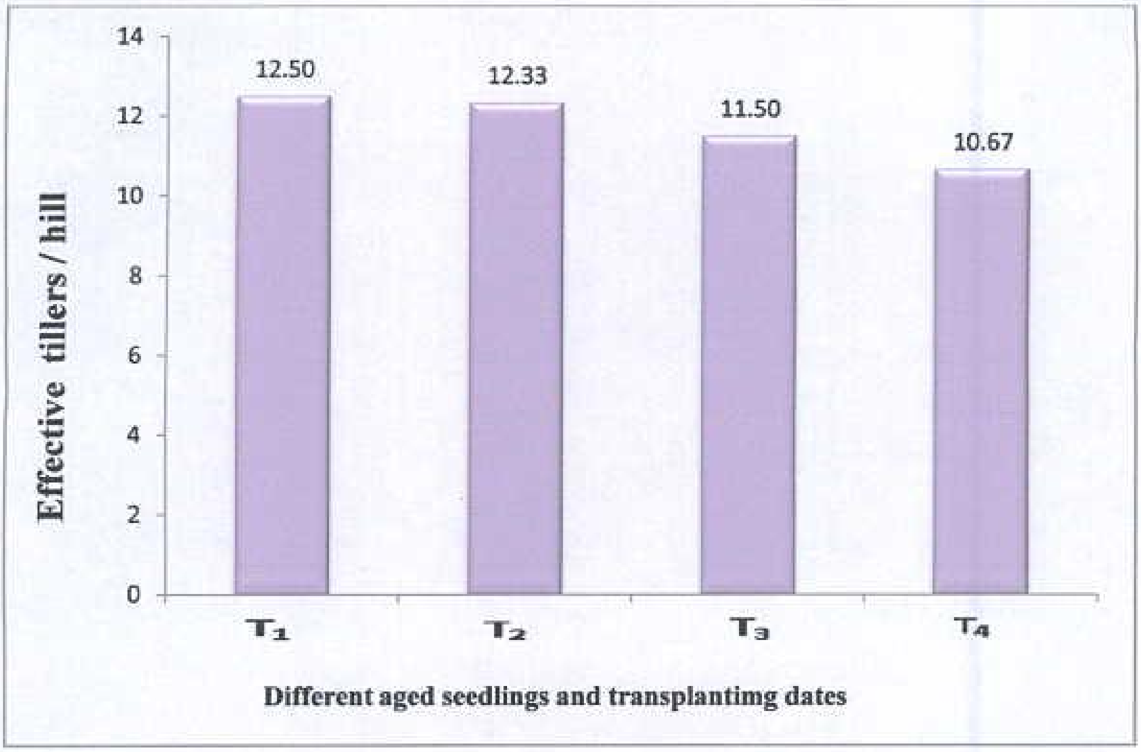
The effective tillers hill^{-1} did not significantly differ due to the varietal effect (Table 3). Though comparatively higher number of effective tiller hill^{-1} was recorded in Bina-sail (11.92). These results not match with the findings of Roy *et al.* (2014) who reported that effective tillers hill^{-1} differed among the varieties.

There was significant influence on the number of effective tillers hill^{-1} shown by different aged seedlings and transplanting dates (Fig.3). The highest number (12.50) of effective tillers hill^{-1} was obtained from T_1 (4 weeks aged seedlings transplanted on 15 September) which was statistically identical with T_2 (5 weeks aged seedlings transplanted on 22 September) while 7 weeks aged seedlings transplanted on 06 October (T_4) gave the lowest number of effective tillers (10.67) hill^{-1} (Appendix 1). Pal *et al.* (2002) conducted an experiment to find out the yield of late transplanted Aman rice (cv. BR23) grown under different planting dates (1st, 15th and 30th Sept.). They found that yield components namely number of effective tillers m^{-2}, number of grains and that of total spikelets panicle^{-1}, weight of 1000 grains were notably decreased with the delay in transplanting which in turn resulted in the decreased grain yield. The grain yield gradually decreased from 1st September transplanting onwards and became the lowest when the crop was transplanted on 30th September.

Table 3. The varietal effect on number of effective and non-effective tiller $hill^{-1}$ and panicle length of T. aman rice

Variety	Effective tillers $hill^{-1}$	Non-effective tillers $hill^{-1}$	Panicle length (cm)
BR22 (V_1)	11.58	1.50	22.38
Bina-sail (V_2)	11.92	1.25	24.48
Significant level	NS	NS	**
SE	-	-	0.49
CV (%)	9.89	31.24	7.21

** → Significant at 1% level of probability; NS → Non-significant



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 3. The effect of different aged seedlings and transplanting dates on number of effective tillers hill^{-1} (mean of two rice cultivars)

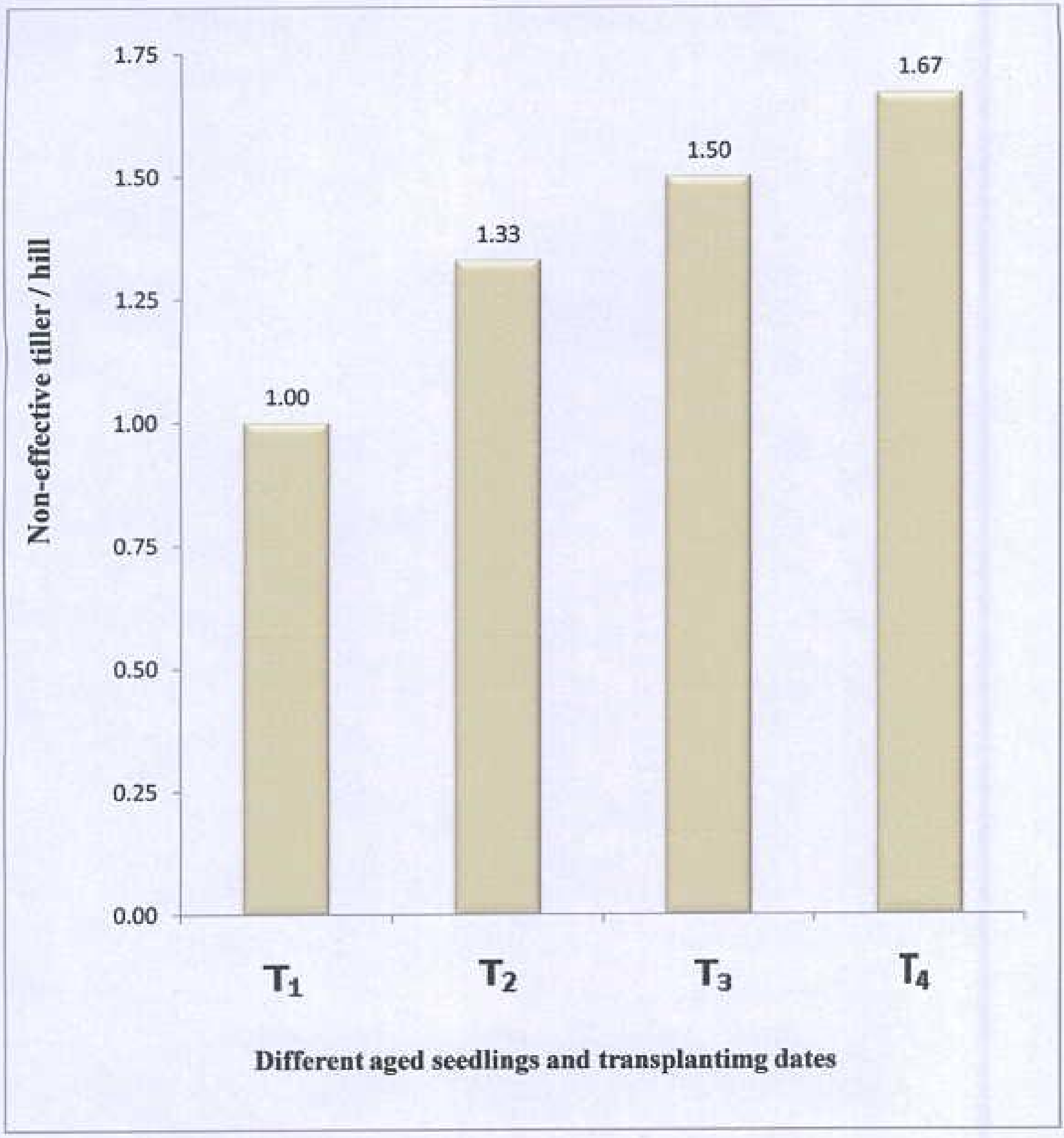
Interaction effect of varieties and different aged seedlings & transplanting dates did not show significant influence on the number of effective tillers hill^{-1} (Table 4). The highest number of effective tillers (12.67) hill^{-1} was found from variety Bina-sail transplanting at 15 and 22 September of 4 and 5 weeks aged seedlings (V_2T_1 and V_2T_2). On the other hand, 7 weeks aged seedlings transplanted on 06 October (T_4) of both the varieties gave the lowest number of effective tillers hill^{-1} (10.67). The result is similar to that of Nahar *et al.* (2009) who reported that BRRI dhan46 had significantly higher effective tillers hill^{-1} than the BRRI dhan31 in late transplanted conditions.

4.4 Number of non-effective tillers hill^{-1}

The main effect of varieties on the number of non-effective tillers hill^{-1} was non-significant (Table 3). Though comparatively higher number of non-effective tiller hill^{-1} was recorded in BR22 (1.50).

Different aged seedlings and transplanting dates had significant influence on number of non-effective tillers hill^{-1} (Fig. 4). The highest number of non-effective tillers hill^{-1} (1.67) was obtained from T_4 (7 weeks aged seedlings transplanted on 06 October) while the lowest number of non-effective tillers hill^{-1} was obtained from T_1 (4 weeks aged seedlings transplanted on 15 September) (Appendix 1).

There was no significant variation found in number of non-effective tillers hill^{-1} due to the interaction effect of varieties and different aged seedlings & transplanting dates (Table 4). The present study was similar to the study of Mangor (1984) who reported that deviation from the optimum planting time may cause incomplete vegetative stage and irregular panicle exertion.



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 4. The effect of different aged seedlings and transplanting dates on number of non-effective tillers hill^{-1} (mean of two rice cultivars)

Table 4. The interaction effect of varieties and different aged seedlings planting dates on number of effective tillers hill^{-1}, non-effective tillers hill^{-1} and panicle length of T. aman rice

Variety	Planting date	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)
BR22 (V_1)	15/9/13 (T_1)	12.33	1.00	22.57
	22/9/13 (T_2)	12.00	1.67	22.50
	29/9/13 (T_3)	11.33	1.67	22.27
	06/10/13 (T_4)	10.67	1.67	22.17
Bina-sail (V_2)	15/9/13 (T_1)	12.67	1.00	25.50
	22/9/13 (T_2)	12.67	1.00	25.03
	29/9/13 (T_3)	11.67	1.33	24.43
	06/10/13 (T_4)	10.67	1.67	22.93
Significant level		NS	NS	NS
$LSD_{(0.05)}$		-	-	-
CV (%)		9.89	31.24	7.21

* → Significant at 5% level of probability; NS → Non-significant

4.5 Panicle length

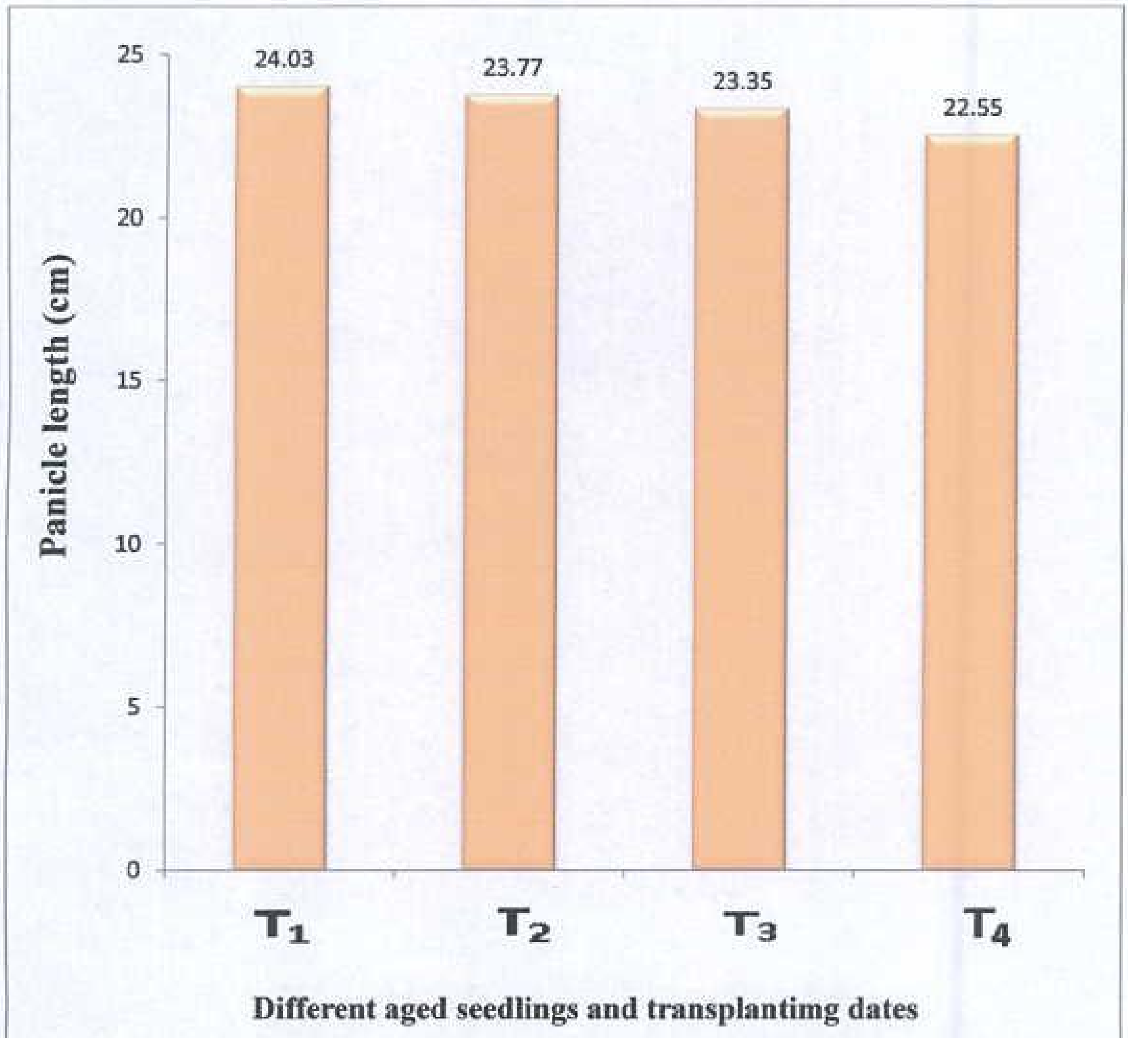
There significant variatin was found due to the main effect of two varietes on the panicle length of late T. aman rice (Table 3). The highest length of panicle (24.48 cm) was obtained from variety Bina-sail while the shortest panicle (22.38 cm) found in variety BR

22. It may be due to genetic character. Alam *et al.* (2012) found that BR11 have higher panicle length than BRRI dhan32 and BRRI dhan33.

But no significant influence was observed on panicle length due to the effect of different aged seedlings and transplanting dates (Fig. 5). The highest length of panicle (24.03 cm) was obtained from T_1 (4 weeks aged seedlings transplanted on 15 September). On the other hand, 7 weeks aged seedlings transplanted on 06 October (T_4) gave the lowest result (22.55 cm) (Appendix 1).

The panicle length did not significantly differ due to the interaction effect of vatieties and different aged seedlings and transplanting dates (Table 4). But the longest panicle (25.50 cm) was found from V_2T_1 (Bina-sail and 4 weeks aged seedlings transplanted on 15 September) and the shortest (22.17 cm) panicle was recorded in V_1T_4.

Hasanuzzaman *et al.* (2009) in a study found that the length of panicle in late transplanted Aman rice ranged from 23.59 to 21.30 cm which matched with the present study. Yoshida (1981) reported that rice plants required a particular temperature for its phenological affairs such as panicle initiation, flowering, panicle exertion from flag leaf sheath and maturity and these are much influenced by the planting dates during T. aman season.



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 5. The effect of different aged seedlings and transplanting dates on panicle length (mean of two rice cultivars)

4.6 Number of spikelet

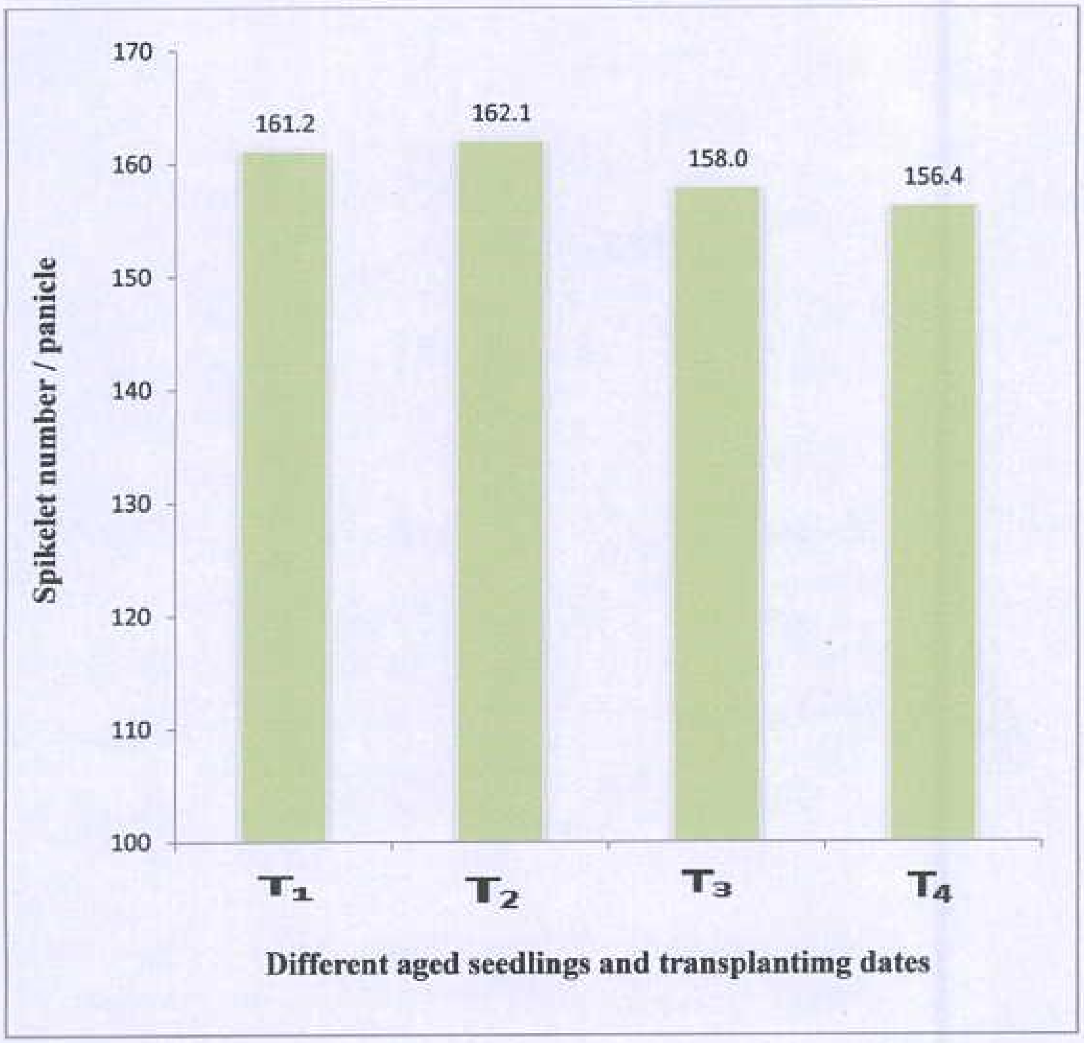
The number of spikelet panicle^{-1} of late T. aman rice did not significantly affect by the two rice cultivars (Table 5). But the highest number of spikelet (161.75) panicle^{-1} was recorded from the variety Bina-sail (V_2) and the variety BR 22 (V_1) gave the lowest spikelet (157.09) panicle^{-1}.

Table 5. The varietal effect on spikelet, filled grain and unfilled grain panicle^{-1} of T. aman rice

Variety	Spikelet panicle^{-1}	Filled grain panicle^{-1}	Un-filled grain panicle^{-1}
BR 22 (V_1)	157.09	134.68 b	22.42
Bina-sail (V_2)	161.75	139.67 a	22.08
Significant level	NS	**	NS
Se	-	0.92	-
CV (%)	3.47	2.31	16.10

** → Significant at 1% level of probability; NS → Non-significant

The number of spikelet panicle^{-1} did not differ significantly due to the different aged seedlings and transplanting dates (Appendix 2). The highest number of spikelet (162.10) panicle^{-1} was obtained from T_2 (5 weeks aged seedlings transplanted on 22 September) and the lowest (156.40) was recorded from T_4 (7 weeks aged seedlings transplanted on 06 October) (Fig. 6).



T_1 : 4 weeks aged seedlings transplanted on 15 September
T_2 : 5 weeks aged seedlings transplanted on 22 September
T_3 : 6 weeks aged seedlings transplanted on 29 September
T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 6. The effect of different aged seedlings and transplanting dates on number of spikelet panicle^{-1} (mean of two rice cultivars)

It was revealed from the results presented in Table 6 that the interaction effect of varieties and different aged seedlings and transplanting dates have non-significant on the number of spikelet panicle^{-1}. But the highest number of spikelet (166.80) panicle^{-1} was recorded from V_2T_2 while the lowest (155.90) was recorded from V_1T_4.

Table 6. The interaction effect of varieties and different aged seedlings planting dates on spikelet, filled grain and unfilled grain panicle^{-1} of T. aman rice

Variety	Planting date	Spikelet panicle^{-1}	Filled grain panicle^{-1}	Un-filled grain panicle^{-1}
BR22 (V_1)	15/9/13 (T_1)	157.90	137.90 b	20.00 ab
	22/9/13 (T_2)	157.30	137.00 b	20.33 ab
	29/9/13 (T_3)	157.20	134.90 bc	22.33 ab
	06/10/13(T_4)	155.90	128.90 c	27.00 a
Bina-sail (V_2)	15/9/13 (T_1)	164.50	146.90 a	17.67 b
	22/9/13 (T_2)	166.80	144.50 a	22.33 ab
	29/9/13 (T_3)	158.70	134.70 bc	24.00 ab
	06/10/13(T_4)	156.90	132.60 bc	24.33 ab
Significant level		NS	*	*
$LSD_{(0.05)}$		-	5.56	6.27
CV (%)		3.47	2.31	16.10

* → Significant at 5% level of probability; NS → Non-significant

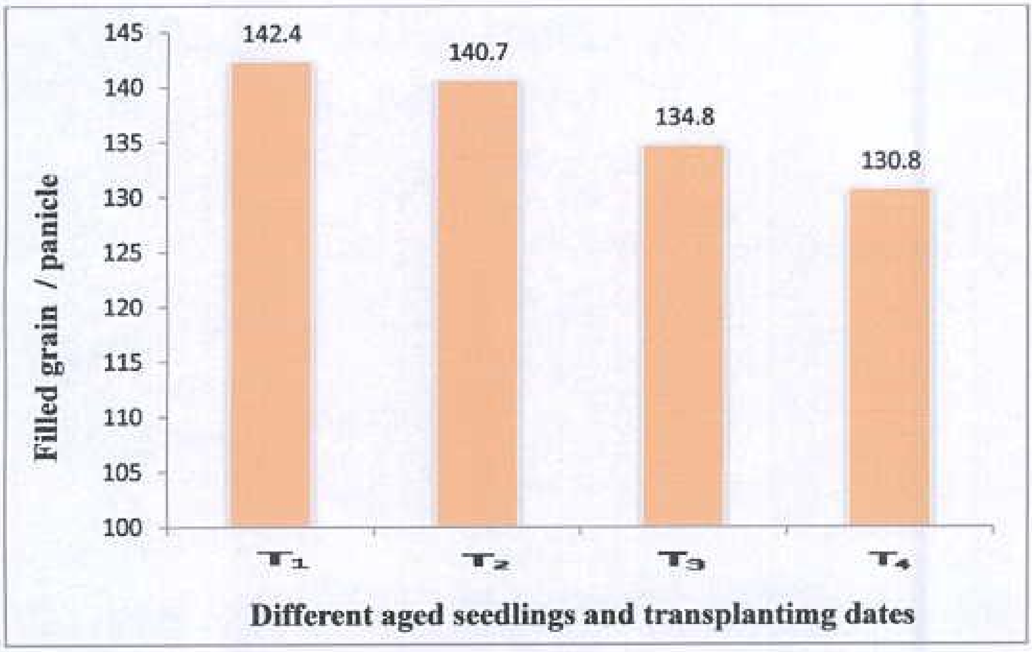
Pal *et al.* (2002) conducted an experiment to find out the yield of late transplanted Aman rice (cv. BR23) grown under different planting dates (1st, 15th and 30th Sept.). They found that yield components namely number of effective tillers m^{-2}, number of grains and that of total spikelets $panicle^{-1}$, weight of 1000 grains were notably decreased with the delay in transplanting which in turn resulted in the decreased grain yield. The grain yield gradually decreased from 1st September transplanting onwards and became the lowest when the crop was transplanted on 30th September.

4.7 Number of filled grain

A significant variation was observed due to the varietal effect on the number of filled grain $panicle^{-1}$ (Table 5). Maximum number of filled grains (139.67) $panicle^{-1}$ was recorded from the variety Bina-sail while the variety BR22 gave the lowest (134.68) filled grain $panicle^{-1}$. BRRI (2006) studied the performance of BR14, Pajam, BR5 and Tulsimala and reported that Tulsimala produced the highest number of filled grains $panicle^{-1}$ and BR14 produced the lowest number of filled grains $panicle^{-1}$.

The significant influence was recorded due to different aged seedlings and transplanting dates on the number of filled grain $panicle^{-1}$ (Fig. 7). The highest number of filled grain (142.40) $panicle^{-1}$ was obtained from T_1 (4 weeks aged seedlings transplanted on 15 September) which was statistically similar with T_2. On the other hand, the lowest (130.80) filled grain was recorded from T_4 (7 weeks aged seedlings transplanted on 06 October) (Appendix 2).

It was revealed from the results presented in Table 6 that the interaction effect of varieties and different aged seedlings & transplanting dates have significant influence on the number of filled grain panicle^{-1}. The highest number of filled grain (146.90) panicle^{-1} was recorded from V_2T_1 which was statistically similar with V_2T_2. The lowest (128.90) filled grain was recorded from V_1T_4 (BR 22 and 7 weeks old seedlings transplanted on 06 October).



T_1 : 4 weeks aged seedlings transplanted on 15 September
T_2 : 5 weeks aged seedlings transplanted on 22 September
T_3 : 6 weeks aged seedlings transplanted on 29 September
T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 7. The effect of different aged seedlings and transplanting dates on number of filled grain panicle^{-1} (mean of two rice cultivars)

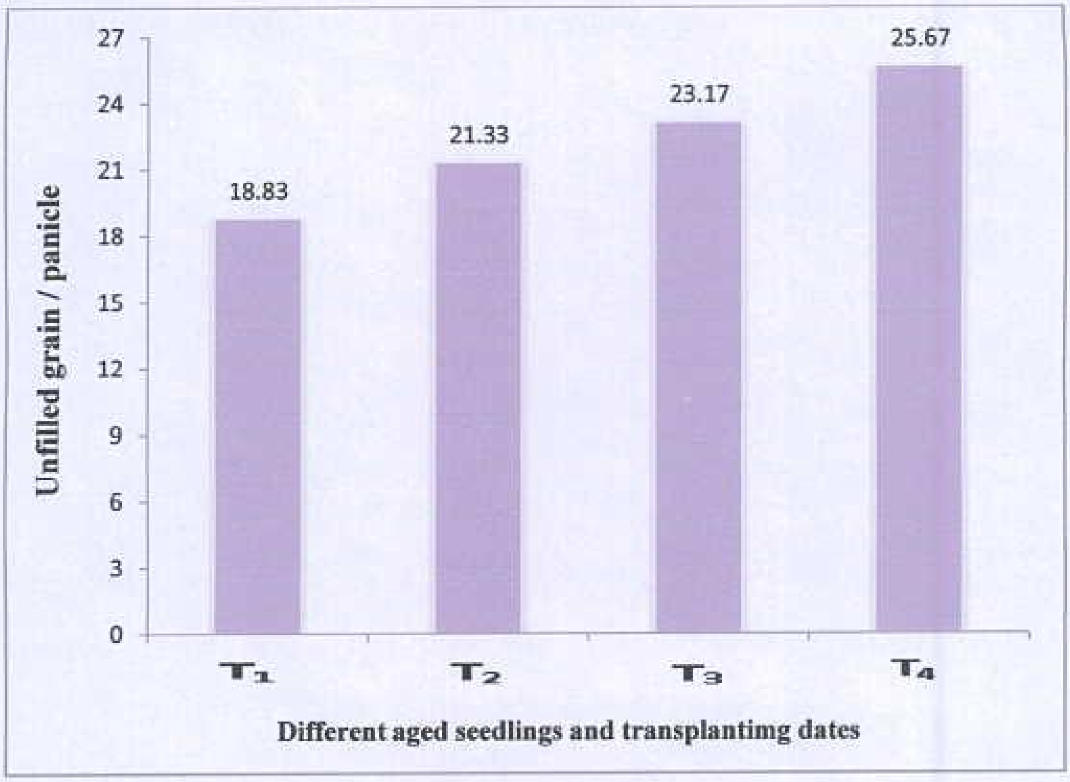
4.8 Number of unfilled grain

No significant difference was observed in case of number of unfilled grain panicle^{-1} among the two Aman rice cultivars BR 22 and Bona-sail (Table 5).

Different aged seedlings and transplanting dates have significant influence on the number of sterile or unfilled grain panicle^{-1} (Fig. 8). From T_4 (7 weeks aged seedlings transplanted on 06 October), the highest number of unfilled grain (25.67) panicle^{-1} was obtained whereas the lowest (18.83) was recorded from T_1 (4 weeks aged seedlings transplanted on 15 September) (Appendix 2).

The interaction effect of varieties and different aged seedlings & transplanting dates show significant influenced on the unfilled grain panicle^{-1} (Table 6). The highest number of unfilled grain (27.00) panicle^{-1} was obtained from V_1T_4 whereas the lowest (17.67) number of unfilled grain panicle^{-1} was recorded from V_2T_1.

Shimizu and Kumo (1967) reported a wide range of abnormal spikelets, all of which were induced under the low temperature treatments at the young panicle primordial differentiation stage. As the temperature in Bangladesh is lower in December it induced in increased sterile grain.



T_1 : 4 weeks aged seedlings transplanted on 15 September
T_2 : 5 weeks aged seedlings transplanted on 22 September
T_3 : 6 weeks aged seedlings transplanted on 29 September
T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 8. The effect of different aged seedlings and transplanting dates on number of unfilled grain panicle^{-1} (mean of two rice cultivars)

4.9 1000-grain weight

There was a significant variation observed due varietal effect of BR 22 and Bina-sail on the 1000-grain weight (Table 7). The highest weight (18.62 g) of 1000-grain was recorded from the variety BR 22 while the variety Bina-sail gave the lowest weight (17.58 g) of 1000-grain. Alam *et al.* (2012) found that BR11 have higher 1000-grain weight than BRRI dhan32 and BRRI dhan33.

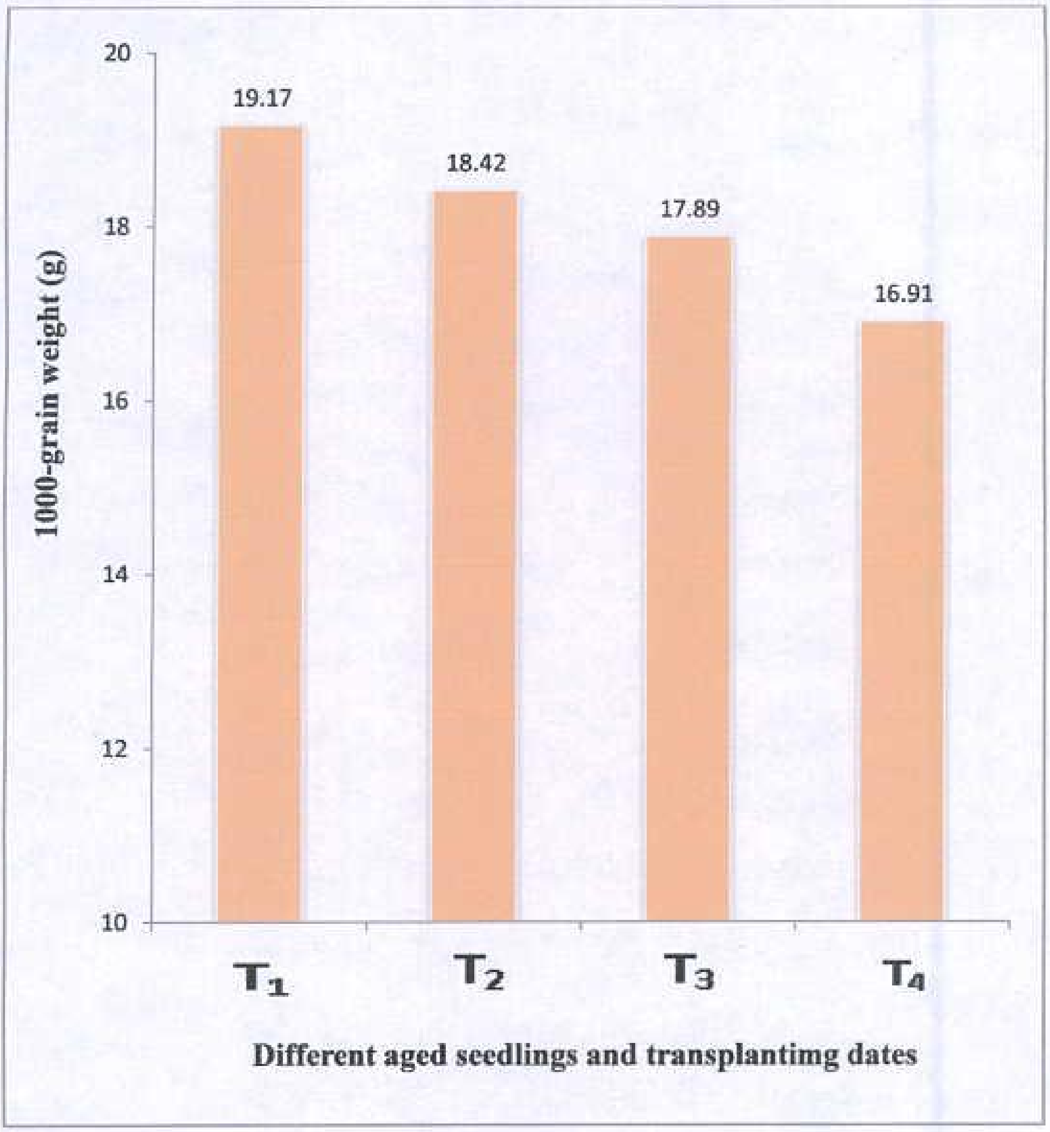
Table 7. The varietal effect on 1000-grain weight and grain yield of T. aman rice

Variety	1000-grain weight (g)	Yield (t ha^{-1})
BR 22 (V_1)	18.62	3.562
Bina-sail (V_2)	17.58	2.964
Significant level	**	**
Se	0.08	0.05
CV (%)	1.48	4.99

** → Significant at 1% level of probability;

The 1000-grain weight of late aman rice significantly influenced by different aged seedlings and transplanting dates (Fig. 9). The highest 1000-grain weight (19.17 g) was recorded from T_1 (4 weeks old seedlings transplanted on 15 September). On the other hand, 7 weeks old seedlings transplanted on 06 October (T_4) showed the lowest result (16.91 g) (Appendix 2).

The 1000-grain weight of late aman rice significantly influenced by the interaction effect of varieties and different aged seedlings & transplanting dates (Table 8). The highest 1000-grain weight (19.99 g) was recorded from V_1T_1 (BR 22 and 4 weeks aged seedlings transplanted on 15 September). On the other hand, V_2T_4 (Bina-sail and 7 weeks old seedlings transplanted on 06 October) showed the lowest result (16.63 g).



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 9. The effect of different aged seedlings and transplanting dates on 1000-grain weight (mean of two rice cultivars)

Table 8. The interaction effect of varieties and different aged seedlings planting dates on 1000-grain weight and grain yield of T. aman rice

Variety	Planting date	1000-grain weight (g)	Yield (t ha^{-1})
BR22 (V_1)	15/9/13 (T_1)	19.99 a	4.060 a
	22/9/13 (T_2)	18.90 b	3.868 a
	29/9/13 (T_3)	18.39 c	3.469 b
	06/10/13 (T_4)	17.20 d	2.850 d
Bina-sail (V_2)	15/9/13 (T_1)	18.36 c	3.255 bc
	22/9/13 (T_2)	17.94 c	3.001 cd
	29/9/13 (T_3)	17.39 d	2.894 d
	06/10/13 (T_4)	16.63 e	2.705 d
Significant level		*	*
$LSD_{(0.05)}$		0.47	0.282
CV (%)		1.48	4.99

* → Significant at 5% level of probability;

Pal *et al.* (2002) conducted an experiment to find out the yield of late transplanted Aman rice (cv. BR23) grown under different planting dates (1^{st}, 15^{th} and 30^{th} Sept.). They found that yield components namely number of effective tillers m^{-2}, number of grains and that of total spikelets $panicle^{-1}$, weight of 1000 grains were notably decreased with the delay in transplanting which in turn resulted in the decreased grain yield. The grain yield gradually decreased from 1st September transplanting onwards and became the lowest when the crop was transplanted on 30th September.

4.10 Grain yield

The grain yield (t ha^{-1}) of late T. aman rice significantly differed due to the varietal effect of two Aman rice cultivars BR22 and Bina-sail (Table 7). The highest grain yield (3.562 t ha^{-1}) was recorded from the variety BR22 (V_1) while the variety Bina-sail gave the lowest grain yield (2.964 t ha^{-1}). Alam *et al.* (2012) found that the yield components (tillers $hill^{-1}$, effective tillers $hill^{-1}$, panicle length, weight of 1000-grain and grain yield) except number of fertile spikelets $panicle^{-1}$ were highest in case of variety BR11 and hence it produced the highest grain yield (5.92 t ha^{-1}) than BRRI dhan32 and BRRI dhan33.

The different aged seedlings and transplanting dates have significant influence on grain yield (Fig. 10). The highest grain yield (3.658 t ha^{-1}) was obtained from T_1 (4 weeks old seedlings transplanted on 15 September) and the lowest result (2.777 t ha^{-1}) was recorded from T_4 (7 weeks old seedlings transplanted on 06 October) (Appendix 2).

From Table 8, it is clear that the interaction effect of varieties and different aged seedlings & transplanting dates have significant effect on grain yield of Late T. aman rice. The highest grain yield (4.060 t ha^{-1}) was obtained from V_1T_1 (BR 22 and 4 weeks old seedlings transplanted on 15 September) which was statistically identical with V_1T_2 while the lowest result (2.705 t ha^{-1}) was recorded from V_2T_4 (Bina-sail and 7 weeks old seedlings transplanted on 06 October) which was statistically identical with V_1T_4 and V_2T_3.

T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 10. The effect of different aged seedlings and transplanting dates on grain yield (mean of two rice cultivars)

Nahar *et al.* (2009) found that grain yield decreased significantly with the delay of transplanting date. BRRI (1989) also reported similar results. Faria and Folegatt (1962) reported that grain yield was high for sowing in October (5.4 to 6.0 t ha^{-1}) and lower for sowing in December (1.6 to 4.8 t ha^{-1}) due to the low temperature at seed filling stages, mostly for the late cultivar.

4.11 Chemical Composition

4.11.1 Nitrogen content in shoot

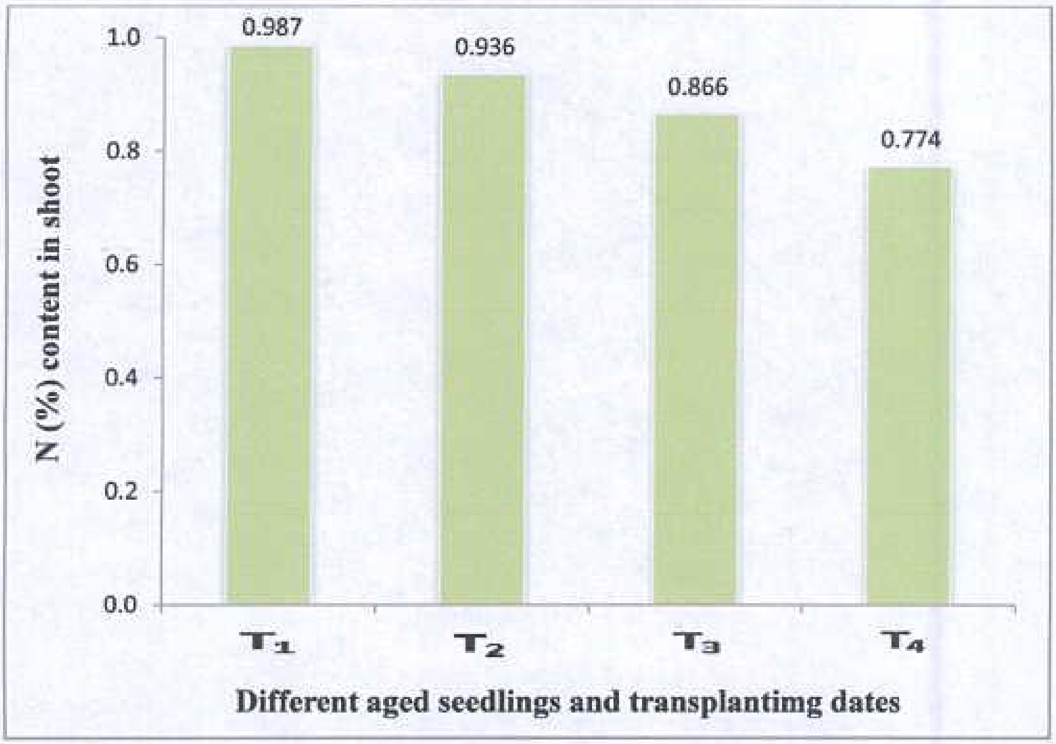
Nitrogen content (%) in shoot of rice showed a statistically significant difference due to the varietal effect of BR 22 and Bina-sail (Table 9). In shoot, the highest N content (1.018 %) was found in variety BR 22 (V_1) and the variety Bina-sail contained the lowest amount (0.764 %) of N.

Table 9. The varietal effects on nitrogen, phosphorus and potassium contents in shoots of T. aman rice

Variety	N (%)	P (%)	K (%)
BR 22 (V_1)	1.018 a	0.260 a	1.743 a
Bina-sail (V_2)	0.764 b	0.241 b	1.320 b
Significant level	**	**	**
SE	0.020	0.003	0.012
CV (%)	7.90	3.89	2.75

** → Significant at 1% level of probability

It was observed from the results presented in Fig. 11 and Appendix 3 that, different aged seedlings and transplanting dates have significant effect on N content in shoot of late T. aman rice. The highest N content (0.987 %) in shoot was observed from T_1 (4 weeks old seedlings transplanted on 15 September) while 7 wweks old seedlings transplanted on 06 October (T_4) gave the lowest result (0.774 %).



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 11. The effect of different aged seedlings and transplanting dates on N content in straw (mean of two rice cultivars)

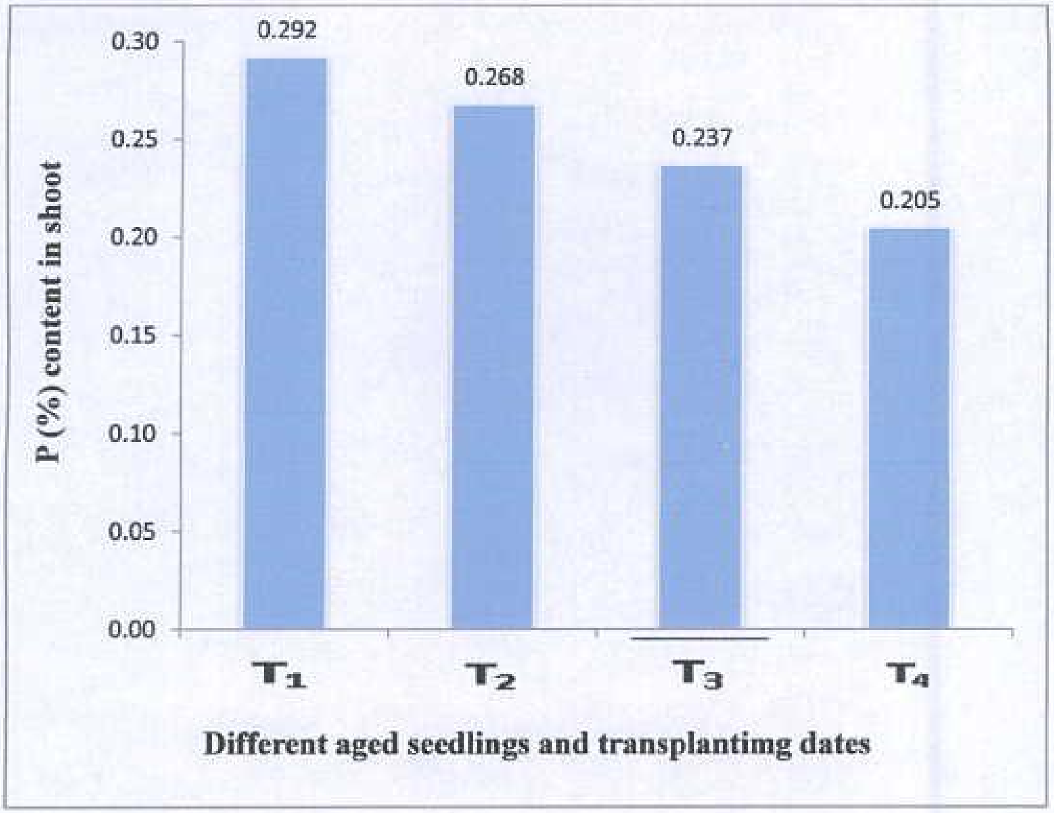
N content in shoot of aman rice varied significantly due to the interaction effect of varieties and different aged seedlings and transplanting dates (Table 10). The highest N content in shoot (1.092 %) was observed in V_1T_1 (BR 22 and 4 weeks old seedlings transplanted on 15 September) while the lowest result (0.626 %) was recorded in V_2T_4 (Bina-sail and 7 weeks old seedlings transplanted on 06 October).

4.11.2 Phosphorus content in shoot

A significant variation was observed due to the varietal effect on P content in shoot of Aman rice (Table 9). In shoot, the highest P content (0.260 %) was observed in V_1 (BR 22) while Bina-sail (V_2) contained 0.241 % P.

The P content in shoot varied significantly due to the effect of different aged seedlings and transplanting dates (Fig. 12). Maximum P content (0.292 %) in straw was recorded maximum in T_1 (4 weeks old seedlings transplanted on 15 September) and minimum (0.205 %) in T_4 (7 weeks old seedlings transplanted on 06 October) (Appendix 3).

From Table 10, it is clear that interaction effect of varieties and different aged seedlings & transplanting dates have significant effect on P content in shoot. The highest P content (0.295 %) was observed in shoot of Aman rice from V_1T_1 which was statistical identical with V_2T_1 and V_1T_2 while the V_2T_4 gave the lowest result (0.204 %) which was statistical similar with V_1T_4 and V_2T_3.



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

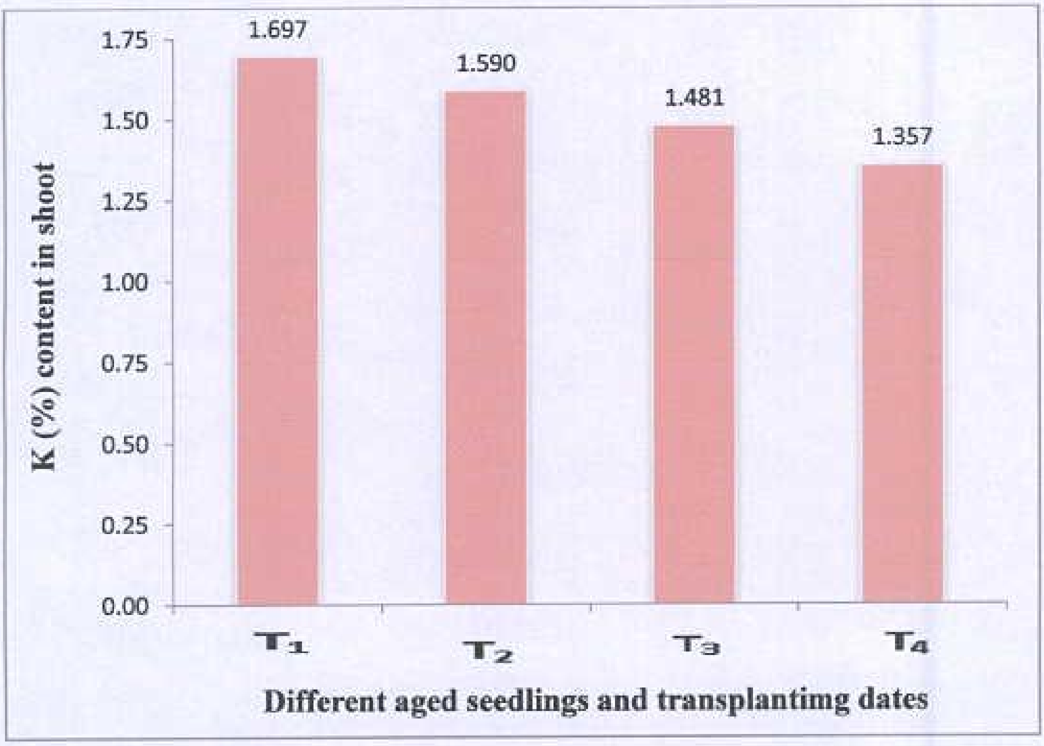
T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 12. The effect of different aged seedlings and transplanting dates on P content in straw (mean of two rice cultivars)

4.11.3 K content in shoot

Potassium content (%) in shoot of Aman rice differed significantly due to the effect of varieties BR 22 and Bina-sail (Table 9). The highest K content (1.743 %) was found in shoot of BR 22 and the lowest content (1.320 %) of K in shoot of Bina-sail.

The K content in shoot of late T. aman rice showed a significant difference due to the effect of different aged seedlings and transplanting dates (Fig. 13). The highest K content (1.697 %) in straw was observed from T_1 (4 weeks old seedlings transplanted on 15 September) followed by T_2, T_3 and T_4 (Appendix 3).



T_1 : 4 weeks aged seedlings transplanted on 15 September

T_2 : 5 weeks aged seedlings transplanted on 22 September

T_3 : 6 weeks aged seedlings transplanted on 29 September

T_4 : 7 weeks aged seedlings transplanted on 06 October

Figure 13. The effect of different aged seedlings and transplanting dates on K content in straw (mean of two rice cultivars)

K content (%) in shoot of late T. aman rice varied significantly due to the interaction effect of varieties and different aged seedlings & transplanting dates (Table 10). The highest K content (1.902 %) in shoot was observed from V_1T_1 while the V_2T_4 gave the lowest content (1.140 %) of K in shoot.

Table 10. The interaction effect of varieties and different aged seedlings planting dates on nitrogen, phosphorus and potassium content in shoots of T. aman rice

Variety	Planting date	N (%)	P (%)	K (%)
BR22 (V_1)	15/9/13 (T_1)	1.092 a	0.295 a	1.902 a
	22/9/13 (T_2)	1.062 a	0.283 a	1.788 b
	29/9/13 (T_3)	0.995 ab	0.256 b	1.708 c
	06/10/13 (T_4)	0.922 bc	0.205 c	1.575 d
Bina-sail (V_2)	15/9/13 (T_1)	0.882 bc	0.288 a	1.493 e
	22/9/13 (T_2)	0.810 cd	0.254 b	1.392 f
	29/9/13 (T_3)	0.736 de	0.218 c	1.254 g
	06/10/13 (T_4)	0.626 e	0.204 c	1.140 h
Significant level		*	*	*
$LSD_{(0.05)}$		0.124	0.018	0.078
CV (%)		7.90	3.89	2.75

** → Significant at 1% level of probability

The N, P and K contents in straw/ shoot of two late T. aman rice cultivars significantly decreased with increasing the time transplanting date. These results confirmed the opinion of Ahmed (2009). It might be due to low contents of N, P and K in the soil of seed beds. So, some part of the N, P and K fertilizers should be added in the soil of seed beds in the period of growing the seedlings.

Chapter 5

SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from August to December, 2013 to find out the effect of two late T. Aman rice cultivars (BR22 and Bina-sail) on the growth, yield and nutrient contents of different aged seedlings transplanted on different dates. The two factorials experiment was laid out in a RCBD design with three replications.

The effect of the cultivars BR22 and Bina-sail showed non-significant variation in case of growth and yield parameters at different aged seedlings and transplanted dates except plant height, panicle length and filled grain panicle^{-1}, where Bina-sail gave significantly higher results than BR22. In case of nutrient N, P& K content and 1000-grain weight & grain yield, BR22 cultivar gave significantly higher results than Bina-sail.

The effect of different aged seedlings and transplanting dates on growth & yield parameters and N, P & K nutrients content in shoot of late T. Aman rice varied significantly in all parameters except total tillers hill^{-1}, panicle length and spikelets panicle^{-1}. The highest results of the growth and yield parameters of late Aman rice were found in T_1 (4 weeks old seedlings transplanted on 15 September) and T_2 (5 weeks old seedlings transplanted on 22 September) except non-effective tillers hill^{-1}

and unfilled grains panicle^{-1} where the highest results were recorded in T_4 (7 weeks old seedlings transplanted on 7 October). On the other hand, the last transplanting *i.e.* 06 October with 7 weeks old seedlings (T_4) showed the lowest results in all cases except non-effective tillers hill^{-1} and unfilled grains panicle^{-1} where the lowest results were recorded in T_1 (4 weeks old seedlings transplanted on 15 Setember). For N, P and K contents in shoots of late aman rice significantly differed due to the effect of different planting dates with different aged seedlings where the highest results were recorded in T_1 followed by T_2 & T_3; and the lowest result was obtained from T_4.

The total tillers, effective and non-effective tillers hill^{-1}, panicle length and spikelet panicle^{-1} did not differ significantly due to the interaction effect of different aged seedlings transplanted on different dates and two late aman rice cultivars BR22 & Bina-sail. But plant height, filled and unfilled grains panicle^{-1} grain yield and 1000-grain weight differed significantly due to the interaction effect of different aged seedlings transplanted on different dates and two late aman rice cultivars. The tallest plant and the highest filled grains panicle^{-1} were obtained from V_2T_1 (Bina-sail and 4 weeks old seedlings transplanted on 15 September). On the other hand, V_1T_4 (BR22 and 7 weeks old seedlings transplanted on 06 October) produced the shortest ones. The highest number of non-effective tillers hill^{-1} was found in BR22 variety and transplanted on 06 October with 7 weeks old seedlings. The highest 1000-grain weight and grain yield were found in V_1T_1 (BR22 variety and 4 weeks old seedlings transplanted on 15 September) which were lowest in V_2T_4 (Bina-sail variety and 7 weeks old seedlings transplanted on 06 October). The nutrient N, P and K contents in shoot decreased with later dates of transplantation with old seedlings in both the cultivars.

It appeared from the above results that different aged seedlings and transplanting dates have significant effect on growth, yield and nutrient (N, P & K) contents of T. aman rice BR22 and Bina-sail. With delay in transplanting, the yield of T. Aman rice BR22 and Bina-sail reduced but still it was possible to get some sort of economic return by escaping the late flood.

The following recommendations may be made based on the results-

- In flood prone areas, it may be possible to get some yield by late transplanting of 7 weeks old seedlings of late T. aman rice BR22 and Bina-sail.
- Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performance.

REFERENCES

Ahmed, M. 2009. Study of different retransplanting dates on yield and nutrient content of late Aman rice (BR 22). M.S Thesis, Dept. of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka 1207.

Alam, A.B.M.M. 1988. Performance of local and modern varieties of *Boro* rice under irrigated condition. *In:* Research Activities, 1986-87. Farming System Research and Development Program, BAU, Mymensingh. p 710.

Alam, MS; Baki, MA; Sultana, MS; Ali, KJ; and Islam, MS. 2012. Effect of variety, spacing and number of seedlings per hill on the yield potentials of transplant aman rice. International Journal of Agronomy and Agricultural Research . 2 (12) : 10-15.

Ashrafuzzaman, M., M.R. Islam, M.R. Ismail, S.M. Shahidullah and M.M. Hanafi, 2009. Evaluation of six aromatic rice varieties for yield and yield contributing characters. *Int. J. Agric. Biol.* 11: 616–620.

Atera, E.A., Onyango, J.C., Azuma, T., Asanuma, S. and Itoh, K. (2011). Field evaluation of selected NERICA rice cultivars in Western Kenya. African J. Agric. Res. 6(1): 60-66.

BBS (Bangladesh Bureau of Statistics). 2009. Monthly Statistical Bulletin of Bangladesh. Bangladesh. October, 2007. Statistics Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh. Dhaka. p. 57.

BBS (Bangladesh Bureau of Statistics). 2010. Monthly Statistical Bulletin of Bangladesh. October, 2006. Statistics Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh. Dhaka. p. 47.

BBS (Bangladesh Bureau of Statistics), 2008. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh. pp. 16-18.

Bhuiya, A.K.M.A. 2000. Effect of variety and spacing on the performance of transplant aman rice. M.S Thesis. Agronomy Dept. Bangladesh Agril. Univ., Mymensingh. pp. 43-45.

BINA (Bangladesh Institute of Nuclear Agriculture). 1987. A *Book Let* of developed variety of transplanted Aman rice BINA-Sail. Post Box No. 4, Mymensingh.

Biswas, P. K. and V. M. Salokhe. 2001. Effects of planting date, intensity of tiller separation and plant density on the yield of transplanted rice. J. Agric. Sci, 137(3) : 279-287.

BRRI (Bangladesh Rice Research Institute). 1989. Annual internal review for 1988. Plant Physiology Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh, pp: 59.

BRRI (Bangladesh Rice Research Institute). 2004. *Adhunic Dhaner Chash* Pub. No. 5. Bangladesh Rice Res. Inst. Joydebpur, Gazipur. pp. 140-158.

BRRI (Bangladesh Rice Research Institute). 2006. Annual Report for 2004 Joydebpur, Gazipur, Bangladesh. pp.8, 320.

Dunand, R. and Dilly, R. 1982. Rice growth analysis. In: 74th Ann. Prog. Rep. Rice Exp. Sta. pp. 159-172.

FAO (Food and Agriculture Organization). 2008. Working parts on the economics of fertilizer use. Intl. Fen. Corres. 23(1): 7-10.

Faria, R.T. de and V.M. Folegatt.1962. Nutrient absorption by rice root planting dates and water regimes on two upland rice under submersed conditions. J. Sci. Soil Manure, Jpn., e Ambiental. 5(1): 43-48.

Gomez, K. A. and A. A. Gomez. 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons. New York, Brisbance. Singapore. pp. 139-240.

Halappa, G., T.A. Khan, N. Mahadevappa, and M.N. Venkataraman.1974. Optimum time of planting for high yielding varieties of paddy in kharif season of tank fed tracts of Karnataka. Mysore J. Agric. Sci., 8: 488-492.

Hasanuzzaman M., K. Nahar, M.M. Alam, M.Z. Hossain and M. R. Islam. 2009. Response of transplanted rice to different application methods of urea fertilizer. *International Journal of Sustainable Agriculture*. 1 (1): 01-05.

Hossain, M.B., M.O. Islam and M. Hasanuzzaman, 2008. Influence of different nitrogen levels on the performance of four aromatic rice varieties. *Int. J. Agric. Biol.,* 10: 693–696.

Hossain, S.M.A and Alam, A.B.M.N. 1991. Productivity of cropping pattern of participating farmers. *In:* Fact Searching and Intervention in two FSRDP Sites, Activities. 1890-90. Farming System Research and Development Programme, BAU, Mymensingh. pp. 41-44.

Hossan, M.D. 2005. Effect of variety and spacing on the growth and yield of transplant Aman rice.M.S. Thesis. Agronomy Dept. Bangladesh Agril. Univ., Mymensingh. pp. 54.

Idris, M. and Matin, M.A. 1990. Response of four exotic strains of Aman rice to urea. Bangladesh J. Agril. Sci. 17(2): 271-275.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice-Hall of India, Pvt. Ltd.. pp. 326-338.

Jesy, A.J. 2007. Effect of variety and spacing on the performance of transplant Aman rice. M.S. Thesis. Agronomy Dept. Bangladesh Agril. Univ., Mymensingh. p. 27.

Kamal, A.M.A., Azam, M.A. and Islam, M.A. 1988. Effect of cultivars and NPK combination on the yield contributing characters of rice. Bangladesh J. Agril. Sci. 15(1): 105-110.

Amin, A.K.M.K. and Haque, M.A. 2009. Seedling age influence rice (*Oryza sativa* L.) performance. Philippine Journal of Science. 138 (2): 219-226.

Krishna, R., Natarajan, S. and Planiswamy, C. 1994. Effect of spacing, Azolla and levels of nitrogen on rice. Madras Agric. J. 81(9): 514-515.

Mangor, N.P. 1984. A cropping pattern model for rainfed lowland rice in Bangladesh. M. Ag. Thesis. Faculty of. Agriculture, The University of Sydney, Sydney N.S.W., Australia, pp: 3-38.

Miah M.A.B., M.M. Alam, M.Z. Hossain and M. R. Islam. 1993. Morpho-physiological Studies of Some Rice Cultivars. MS in Crop Botany. Department of Crop Botany. Bangladesh Agricultural University. Mymensingh, Bangladesh: p 111.

Nahar, K., M.H. Zaman, and R.R. Majumder. 2009. Effect of low temperature stress transplanted Aman rice varieties mediated by different transplanting dates. Academic Journal of Plant Sciences 2(3):132-138.

Pal, R. K., M. A.Taleb and M. B. Hossain. 2002. Effect of planting method and hill arrangement on the yield and yield components of late transplanted aman rice grown under different planting dates. Pakistan Journal of Biological Sciences. 5(1): 1232-1236.

Pramanik, K. and Bera, A. K. 2013. Effect of seedling age and nitrogen fertilizer on growth, chlorophyll content, yield and economics of hybrid rice (*Oryza sativa* L.). International Journal of Agronomy and Plant Production. 4:3489-3499.

RARC (2011). Rokupr Agricultural Research Centre, Annual work programme review conference. Freetown, Sierra Leone.

Refey, A., Khan P.A. and Srivastava, V.C. 1989. Effect of nitrogen on growth, yield and nutrition uptake of upland rice. Indian J. Agron. 34(2): 133-135.

Roy SK, Ali MY, Jahan MS, Saha UK, Ahmad-Hamdani MS, Hasan MM, and Alam MA. 2014. Evaluation of growth and yield attributing characteristics of indigenous Boro rice varieties. *Life Sci J.* 11(4):122-126.

Russel, D.F. 1986. MSTAT-C Package Programme. Dept. of Crop and Soil Science, Michigan State University, USA.

Shimizu, M. and K. Kumo. 1967. Some cyto-histological observations on the morphogenetically abnormal rice spikelets caused by a low temperature. Proc. Crop Sci. Soc. Japan., 36: 489-502.

Sultana, M. 2008. Effect of variety, method of planting and weeding on the yield and yield components of transplant *Aus* rice. M.S. Thesis. Agronomy Dept. Bangladesh Agril. Univ., Mymensingh. p. 28.

Takita, T. 2009. Yield and canopy structure of a super high yielding rice variety recently developed. Nogyo Gijutsu 64: 136-139.

Thomas, R.L., R.W. Sheard and J.R. Moyer. 1967. Comparison of conventional and automated procedures for nitrogen, phosphorus and potassium analysis of plant material using a single digestion. Agron. J. 59: 240-243.

Yoshida, S.. 1981. Fundamentals of rice crop science. International Rice Research Institute, Los Banos Laguna, Philippines. p: 267.

APPENDICES

Appendix 1. The effect of different aged seedlings and transplanting dates on plant height, tiller number and panicle length of T. aman rice

Different aged seedling planting date	Plant height (cm)	Total tiller $hill^{-1}$	Effective tiller $hill^{-1}$	Non-effective tiller $hill^{-1}$	Panicle length (cm)
T_1	124.80 a	13.50	12.50 a	1.00 b	24.03
T_2	123.20 ab	13.67	12.33 a	1.33 ab	23.77
T_3	121.00 bc	13.00	11.50 ab	1.50 ab	23.35
T_4	118.40 c	12.50	10.67 b	1.67 a	22.55
Significant level	**	NS	*	*	NS
$LSD_{(0.05)}$	2.96	-	1.44	0.53	-
CV (%)	1.96	7.71	9.89	31.24	7.21

**→ Significant at 1% level of probability, *→ Significant at 5% level of probability

NS → Non-significant

Appendix 2. The effect of different aged seedlings and transplanting dates on spikelet, filled grain, unfilled grain, 1000-grain weight and grain yield of T. aman rice

Different aged seedling planting date	Spikelet $panicle^{-1}$	Filled grain $panicle^{-1}$	Un-filled grain $panicle^{-1}$	1000-grain weight (g)	Yield (t/ha)
T_1	161.20	142.40 a	18.83 b	19.17 a	3.658 a
T_2	162.10	140.70 a	21.33 ab	18.42 b	3.434 b
T_3	158.00	134.80 b	23.17 ab	17.89 c	3.182 c
T_4	156.40	130.80 c	25.67 a	16.91 d	2.777 d
Significant level	NS	**	*	**	**
$LSD_{(0.05)}$	-	3.93	4.43	0.33	0.199
CV (%)	3.47	2.31	16.10	1.48	4.99

**→ Significant at 1% level of probability, *→ Significant at 5% level of probability

NS → Non-significant

Appendix 3. The effect of different aged seedlings and transplanting dates on nitrogen, phosphorus and potassium content in shoots of T. aman rice

Different aged seedling planting date	N (%)	P (%)	K (%)
T_1	0.987 a	0.292 a	1.697 a
T_2	0.936 ab	0.268 b	1.590 b
T_3	0.866 b	0.237 c	1.481 c
T_4	0.774 c	0.205 d	1.357 d
Significant level	**	**	**
$LSD_{(0.05)}$	0.088	0.012	0.055
CV (%)	7.90	3.89	2.75

**→ Significant at 1% level of probability, *→ Significant at 5% level of probability

NS → Non-significant