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PERFORMANCE OF ADVANCE LINES OF AROMATIC RICE UNDER DIFFERENT TRANSPLANTING DATES

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শেরেবাংলা কৃষি বিশ্ববিদ্যালয় গন্থাগার
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Chairman
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CERTIFICATE

This is to certify that the thesis entitled, "**PERFORMANCE OF ADVANCE LINES OF AROMATIC RICE UNDER DIFFERENT TRANSPLANTING DATES**" Submitted to the Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE** in **AGRONOMY** embodies the result of a piece of bona fide research work carried out by **IFTEKHER AHMED**, Registration No. **25078/00401** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by him.

Dated : 27.6.07
Place : Dhaka Bangladesh

(Prof. Dr. A.K.M. Ruhul Amin)
Supervisor

Dedicated to

My

Beloved Parents

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The Author

PERFORMANCE OF ADVANCE LINES OFAROMATIC RICE UNDER DIFFERENT TRANSPLANTING DATES

ABSTRACT

A field experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University (SAU), Dhaka during the *Aman* season in July to November 2005, with a view to study the performance of newly developed Suvash promising lines under different transplanting date along with one modern variety. The experiment consist two levels of treatments viz. A: Four transplanting date: 15 July, 1 August, 15 August and 1 September, B: Four promising lines/ variety: Subash1, Subash2, Subash5, and inbred variety BRRI dhan38. The experiment was laid out in split plot design with three replications. Experimental result showed that transplanting dates and variety individually had significant effect on the agronomic parameters like plant height, panicle length, total tiller m^{-2}, non-effective tillers m^{-2}, effective tillers m^{-2}, total spikelet panicle^{-1}, filled grains panicle^{-1}, spikalet sterility (%), grain yield (t ha^{-1}), straw yield (t ha^{-1}) and biological yield (t ha^{-1}). The result revealed that 1 August transplanting gave the highest grain yield (4.03 t ha^{-1}) which was at per with 15 July transplanting (3.88 t ha^{-1}). Among the varieties Subash1 gave the highest yield (3.95 t ha^{-1}) but that was at per with those of Suvash2 (3.81 t ha^{-1}) and inbreed variety BRRI dhan38 (3.72 t ha^{-1}).The combined effect of date of transplanting and variety had also significant effect on yield and yield characters. Subash1 and BRRI dhan38 planted on 1 August showed highest yield attaining good yield contributing characters.

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LIST OF ACRONYMES

AEZ	Agro-ecological zone
BBS	Bangladesh Bureau of Statistices
N	Nitrogen
S	Sulphur
P_2O_5	Phosphorus Penta Oxide
K_2O	Potassium oxide
SAU	Sher-e- Bangla Agricultural University
HI	Harvest Index
%	Percent
g	gram(s)
kg	kilogram (s)
t ha^{-1}	Tons per hectare
CV %	Percentage of Coefficient of Variance
ppm	Parts per million
mm	Milimeter
cm	Centi- meter
^oC	Degree Celsius
m^2	meter square
NS	Non significant
No.	Number
Var.	Variety
et al	And others
etc	Etcetra
Res.	Research

Chapter I
Introduction

CHAPTER I

INTRODUCTION

Rice (*Oryza sativa* L.) being the worlds most widely consumed grain play an unique role in combating global hunger (IRRI, 2004). It is the dominant food to feed the people of the developing world and in Asia. In Asia more than 90 % of the world's rice is produced and consumed, so it is the homeland of rice cultivation (Hossain and Pingali, 1998). At present, food production has been given the highest priority in the world in meeting the demands of its ever-increasing population. Half of the world's populations choose rice as their food as it alone supplies about 75 % of the calories and 5.5 % of the protein in the average daily diet (BRRI, 2001; Kenmore, 2003 and Bhuiyan *et al.* 2004). Moreover, it provides vitamin and other nutrients for people (BRRI 1997a; Sattar, 1994). Bangladesh is the fourth largest producer and consumer of rice in the world with annual production of 26 million metric tons and area of 11 million hectare (BBS, 2004).

Compared to mid sixties rice production in Bangladesh has almost doubled during the past three decades. But yet we can't export the coarse rice after fulfillment of the demand due to high competition of other quality rice growing countries (Choudhury, 1991). So, breeding strategies should be focused on to produce fine aromatic rice. Thirty- six indigenous aromatic rice accessions in BRRI germplasm pagal, Modhumala, Tulsi, Mohonbhog, Raj bhog, Badshabhog kataribhog and khaskani were evaluated (BRRI, 1993). BRRI released two short bold grain type aromatic rice varieties BR5 and BR 34 in 1976 and in 1997 respetively. BRRI dhan37 and BRRI dhan38 are the modern varieties of aromatic rice, which have been developed by Bangladesh Rice Research Institute (BRRI). Among the aromatic rice Badshabhog, Kataribhog, Kalizira, Tulshimala, Chinigura, BRRI dhan37 and BRRI dhan38 are the most highly valued commodity in Bangladesh agricultural trade market for having small grain and pleasant aroma.

Rice breeder at Bangladesh Rice Research Institute (BRRI) as well as national policy makers has been given emphasis on fine and aromatic rice production. This rice has long been popular in the orient and are now becoming more popular in Middle East, Europe and United States. So, there is a great opportunity to earn foreign currency by exporting aromatic rice, as the consumption area of aromatic rice throughout the world is large and price is also high (Choudhury and Bhuiyan, 1991). Islam *et al.* (1996) observed that the yield of aromatic rice was lower (1.5-2.0 t ha^{-1}) but its higher price and low cost of cultivation generate higher profit margins compared to other varieties grown in the area. Furthermore, consumers in urban areas in our country also prefer fine and aromatic rice. Most of the aromatic rice germplasm available in our country are low yielding, photoperiod sensitive and grown during *Aman* season in the rainfed condition (Begum *et al.* 1993). Some of these have good quality in respect of fineness, aroma and protein content (Kaul *et al.* 1982). Therefore, attention should be given for breeding of high yielding quality aromatic rice varieties.

(Kaul *et al.* 1982). Therefore, attention should be given for breeding of high yielding quality aromatic rice varieties.

Most of the aromatic rice varieties in Bangladesh are traditional type, photoperiod sensitive and are grown during *Aman* season in the rain fed condition. A study (Islam *et al.* 1996) revealed that 12.49% of the study area was cultivated by aromatic rice varieties. Another study (Baque *et al.*, 1997) revealed that among the aromatic rice varieties, Chinigura is the predominant one that covers more than 70% farms in the northern districts of Naogaon and Dinajpur. In these districts, 30% of rice lands were covered by aromatic rice varieties are Kalijira (Predominant in Mymensingh) and Kataribhog (Predominant in Dinajpur).

Traditional basmati varieties are tall growing and highly photosensitive. All the aromatic rice traits are genetically governed and inherited, their expression under natural condition is very much dependent on environment, soil and management practices. Farmer's sown seed in the bed and than transfer to field. Delayed transplanting resulted in poor vegetative growth as well as yield. Planting date of a crop is an important factor for obtaining higher yields (Bhuiyan, 1992). However, Seeding and transplanting time can be influenced directly or indirectly, by weather condition during land and seedbed preparation, method of seeding or transplanting, irrigation facilities, times of maturity of rice in relation to the date of seeding or transplanting. Singh *et al.*, (1997) described some factors which adversely affects aroma such as, hot weather during flowering and development, nitrogenous fertilizer particularly urea, poor soil, transplanting date, heavy soil, delayed harvesting after maturity and mechanical dehulling Late transplanting of photoperiod-sensitive *Aman* rice does not produce flower due to higher day length. Narayanaswamy *et al.*, (1982) reported that early transplanting of *Aman* rice in 1 July produced the higher grain yield 2.6 t ha^{-1} than other dates 15 July and 1 August. Rice planted in mid July gave the highest grain yield and with the advancement of planting dates yield decreased.

However, appropriate planting date is required for higher yields with better quality of this rice. So the above circumstances, the objectives of the study are as follows-

1. To select the optimum planting time of transplanted aromatic rice
2. To evaluate the yield performance of transplanted aromatic rice
3. To study the effective interaction between varieties and planting time on the yield and yield contributing characters of aromatic rice.

Chapter II

Review of literature

CHAPTER 2

REVIEW OF LITERATURE

The performance of the fine rice is determined by the interactions of genetic potential with its environment to which it is grown (BRRI, 1990). The genetic potential (yield) depends on cultural practices. The cultural practices such as transplanting of rice in optimum time and the use of good varieties have considerable role on the growth and yield of rice. A number of experiments have been conducted in Bangladesh and also elsewhere in the world with these aspects to evaluate the performance of transplant *Aman* rice. In this chapter, an attempt has been made to review some of the remarkable findings of various researches at home and abroad related to the optimum time and variety on the performance of some transplant *Aman* rice varieties.

2.1 Effect of date of transplanting

In Bangladesh, BRRI (2001) evaluated that most of the fine rice varieties are grown in the *Aman* season. However, fine rice varieties can also be grown in *Boro* season with the manipulation of planting date and the application of water.

Singh *et al.* (1997) conducted experiment and showed that the rice seedlings planted early or late influence the growth and yield due to change in the climatic conditions. Thus, the growth and grain yields of rice depended on the genetic potentials of cultivars, environmental conditions and management practices.

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Ghosh and Ganguly (1994) observed in a trial that modern variety in late planting caused reduction of grain yield, while, early planting of traditional variety failed to increase grain yield due to premature lodging of the crop prior to flowering .

From an experiment Islam *et al.* (1999b) showed that agronomic characters such as plant height, panicle $hill^{-1}$ and panicle length were significantly affected by planting dates.

Gangwar and Sharma (1997) observed that the different rice varieties (Aromatic and non aromatic) transplanted in different dates significantly influenced the grain yield and aroma content of rice. To exploit the full yield potential of traditional aromatic rice varieties, it is necessary to determine their optimum planting time in each season in a specific location.

Joseph and Havanagi (1987) reported that consideration of planting time of rice was the most important to obtain higher yield. The early or late planting of rice in the *Aman* season influences the growth and yield due to change in the climatic condition.

Zaman (1980) revealed that transplanting time in *Aman* season was very important to control the vegetative phase of a variety. In other words, early transplanting beyond the optimum enhanced excessive vegetative growth and late planting shortening the vegetative phase.

In a report BRRI (2001) stated that under favorable condition transplant Aman rice performed best when planted between mid July and the end of August.

Alam (1998) observed that traditional rice sometimes transplanting continued up to the end of September.

BRRI (1999 and 2001) conducted an experiment to find out the best time of transplanting for *Aman* season. Under favorable condition, the optimum time of planting of modern *Aman* rice as recommended by BRRI is July to 15 August.

BRRI (2001) reported that most of the fine rice varieties produced the higher grain yields planted in early September.

Islam *et al.* (1999b) observed that the grain yield of transplanting *Aman* rice decreased gradually with the delay of planting dates beyond August, because low temperature increase sterility in late planted rice.

Dhiman *et al.* (1997) showed that when transplanting became late the crop was attacked by insect or disease severely.

Miah *et al.* (1990) and Islam *et al.* (1999b) reported that transplanting time influences the vegetative phase of a variety in *Aman* season.. Rice seedling when planted late, it will get short period for its vegetative growth and thus its yield decreased.

BRRI (1994) reported that the planting of *Aman* rice in September decreased grain yield and rate of yield reduction increased with the delaying of planting time. On the contrary, yield reduction was higher in weekly photoperiod sensitive varieties compared to strongly photoperiod sensitive rice.

BRRI (2003a) reported that drastically yield reduction was observed when transplanting was done after mid September.

From the result of an experiment, BRRI (1990) reported that the grain yield of photoperiod sensitive varieties decreased as the transplanting delayed beyond September at Gazipur area of Bangladesh. The rate of grain yield reduction was higher in the Northern regions compared to southern part of Bangladesh.

Subbian *et al*. (1995) reported that the highest grain yield was recorded at 15 July transplanting which was significantly superior to both 30 June and 30 July planting in India. Crop transplanting 30 June experienced more number of cloudy days during panicle initiation and flowering stages and there by had adverse effect on fertilization. This was reflected through number of grains panicle^{-1}, which were significantly less than those under 15 July transplanting. However, late planted crop gave less number of tillers and panicles, consequently reduced grain yield.

In India, Gohain and Saikia, (1996) observed that scented rice varieties planting in mid July (20 July) gave yield maximum grain yield and thereafter the yield was declined with delay in planting. The reduction of yield was about 50% when planting was delayed from 20 July to September.

Babu (1987) and AICRIP (1992) reported that the yield and quantity of scanted rice was achieved by planting the crop at the optimum time at any specific location, which may vary from variety to variety.

Paliwal *et al*. (1996) observed that scented rice planting in early July gave the highest grain yield compared to mid August planting in India. The normal time of transplanting of scanted rice is July to august but often it delayed due to late onset of the monsoon rains resulting low yield.

Dinesh *et al.* (1997) observed that basmati rice planted from July to September responded differently. Delayed planting (August) significantly decreased grain and straw yields of rice in India.

Krishnan and Nayak (1998) conducted an experiment and observed that transplanting during 15-25 July gave the highest grain yield, while delay in transplanting up to 4^{th} August reduced grain yield by 38.9%. Rice planted in mid July gave the highest grain yield and with the advancement of planting dates yield decreased.

Haque (1997) reported that delayed transplanting led to increase in vegetative growth index, where as duration of vegetative growth based on number of days until heading decreased. Changed in growth duration to various stages due to delayed transplanting were more pronounced for flowering and 80% panicle ripe indicating that these stages could be optimal for studying the response of rice plant to delayed transplanting. It is better to transplanting *Aman* rice such a way that, the reproductive phase takes place in good weather with declining temperature and high solar radiation for grain filling.

Krishnan and Nayak (1998) stated that pollen grains were dessicated by high temperature was significantly reduced by delayed transplanting.

Yoshida (1981) reported that the flowering response to photoperiod sensitive varieties was markedly affected by the changes in day length. Rice growing in short day is sensitive to photoperiod thus long day can prevent or considerably delay flowering. However, photoperiod of most varieties is about 9-10 hours.

Ali *et al.* (1991) observed that during wet season early or delay transplanting adversely affected milling recovery and cooking quality of scented Basmati rice.

BRRI (1988) reported that three photosensitive varieties viz. BR4, BR10 and BR11 transplanted on 2 and 18 September and showed that the grain yield was reduced in all the varieties in 18 september transplanting compared to September 2 transplanting.

Alim etal. (1986) reported that transplanting of Aman rice after 15 July decreasing grain yield. The critical transplanting date for transplanting date for transplant Aman rice was 8 September. They further stated that the grain drastically reduced after 8 September planting.

Islam (1986) stated that the time between July 15 and August 15 was the best time for transplanting of high yield varieties of transplanting aman rice specially for photosensitive cultivers.

Chandra and Manna (1988) reported that the day length of the vegetative phase determines the growth and ultimate grain yield. It has been found that the vegetative phase shorter by delayed planting and ultimately decreases the yield.

2.2 Effect of variety

Alam, (1998) observed that most of the indigenous cultivated *Aman* rices are photosensitive while the modern genotypes are insensitive to highly sensitive to photoperiod.

Ahmed *et al.* (1998) worked in Bangladesh during *Aman* season when natural disaster like flood and cyclone were more prevalent, when crop was planted late, the photosensitive varieties were reported to play a major role for boosting yield of rice.

In Bangladesh, BRRI (2000a) reported that from different varieties (Basmati 406 (4508), Kataribhog, BRRI dhan34 and Basmati) plant height differed significantly among the varieties. Result revealed that the tallest plant (126 cm) was recorded from Basmati 406 and the shortest one (115 cm) was observed due to Kataribhog.

BRRI (1998b) reported that highest plant height was obtained from Kataribhog (153 cm) followed by Khaskani (143 cm), BR4384-2B-2-2-4 (130 cm), BR4384-2B-2-2-6 (125 cm) and BR4384-2B-2-2-2HR3 (125 cm) lines.

Alam *et al.* (1996) conducted an experiment to evaluate the performance of different rice varieties. Among the varieties, Kalijira produced the tallest plant, which was followed by Pajam.

From the results of an experiment, BRRI (1995) showed that the average plant height of BRRI dhan30, BR22 and BR23 were 120, 125 and 120 cm, respectively. In another study, BRRI (1995) again revealed that the average plant height of BR3, BR7, and BRRI dhan29 were 95, 125 and 95 cm respectively.

Hossain and Alim (1991) reported that the growth characters like plant height, number of total tillers/ hill and the number of grains/ panicle differed significantly among BR3, BR14 and Pajam varieties in *Boro* season.

Islam (1995) observed with four cultivars viz. BR10, BR11, BR22 and BR23 that the highest number of non bearing tillers $hill^{-1}$ was produced by cultivar BR11 and the lowest number was produced by the cultivar BR10.

BRRI (1991) reported that the number of effective tillers/ hill was produced by transplant *Aman* rice varieties which ranged from 7-14. Number of effective tillers/ hill significantly differed among the varieties.

BRRI (1997) stated that in local varieties namely, Haloi, Tilockachari, Nizersail and Latishail, the number of effective tillers $hill^{-1}$ were 9.7, 9.3, 10.8 and 9.0, respectively.

Chowdhury *et al.* (1993) observed that BR23 showed superior performance over Pajam in respect of number of productive tillers $hill^{-1}$.

BRRI (1991) reported that the number of total tillers $hill^{-1}$ differed significantly among BR3, BR11, BR14, Pajam and Zagali varieties in *Boro* season.

Islam (1995) in a study with four cultivars viz. BR10, BR11, BR22 and BR23 found that the highest number of non bearing tillers $hill^{-1}$ was produced by cultivar BR11 and the lowest number was produced by the cultivar BR10.

Idris and Matin (1990) conducted an experiment and found that panicle length differed among the varieties and it was greater in IR 20 than that of any of the indigenous and high yielding varieties. They further reported that total number of tillers $hill^{-1}$ was identical among the tested varieties.

Babiker (1986) reported that panicle length of rice cv. Gazi 171 and Gazi 180 differed significantly among the varieties.

Chowdhury *et al.* (1993) observed that the variety Pajam produced significantly higher number of total spikelets as well as unfilled spikelets panicle^{-1} than that of BR23.

BRRI (1994) conducted an experiment to observe the performance of BR14, Pajam, BR5 and Tulsimala. They observed that Tulsimala produced the highest number of spikelets panicle^{-1} and BR14 produced the lowest number of spikelets panicle^{-1}.

Kamal *et al.* (1988) reported that produced the number of grains panicle^{-1} in BR3, IR 20 and Pajam were 107.6, 123.0 and 170.9 respectively.

BRRI (1998a) reported that the 1000- grain weight of Kuicha Binni, Leda Binni, Chanda Binni, Dudh Methi, Maraka Binni, Nizershail and one high yielding variety BR 25 were 24, 22, 25, 20, 23, 18 and 17 g, respectively.

BRRI (1998b) found that 1000-grain weight of some aromatic rice varieties ranged from 12 to 20 g and it differed significantly from variety to variety. It was also reported that three advanced lines BR4384-2B-2-2-4, BR4384-2B-2-2-6 and BR4384-2B-2-2-HR3 and two local varieties namely Kataribhog and Khaskani showed 1000-grain weight values of 20, 16.5, 16.2, 15 and 12 g, respectively.

In a report BRRI (1991) stated that weight of 1000-grain of Haloi, Tilockachari, Nizershail and Latishail were 26.5, 27.7, 19.6 and 25.0 g respectively.

Chabder and Jitendra (1996) conducted an experiment and reported that the average productivity of aromatic rice is very low

In an experiment BRRI (2000a) observed the performance of three advanced lines BR438-2B-2-2-2-4, BR4384-2B-2-2-6 and BR4284-2B-2-2-HR3 along with two standard checks and seven local checks in 11 locations. Kataribhog and Khaskani were used as standard check and Chinking, Basmati, Kalijira, Philippine Katari, Chinigura, Chiniatop and Bashful as local checks.From the results it was reported that in Sonagazi and Bogra sadar, the yield performances of advanced lines were excellent with more than 4.0 t/ ha grain yield. About 30% higher yield was obtained from the advanced lines over the checks.

BAU (1998) conducted a field trial with seven hybrids and one modern variety of rice during *Aman* season. It was found that the hybrid variety 93024 gave the highest grain yield (7.58 t/ ha) followed by Alok 6201 (7.33 t/ ha) and the check one (BR22) gave the lowest yield (4.75 t/ ha).

BRRI (1995) evaluated the varietals performance of BR4, BR10, BR11, BR22, BR23, and BR25 including two local checks Challisha and Nizershail. The results indicated that BR4, BR10, BR11, Challisha and Nizershail produced yields of 4.38, 3.12, 3.12, 3.12 and 2.70 t ha^{-1} respectively while BRRI (1995b) in another trial observed that BR25 out yielded over BR22 and Nizershail. Farmer preferred BR25 for its finer grain and straw qualities.

BRRI (1994) found from the result of an experiment that BR14 produced the highest yield (3.75 t ha^{-1}) followed by Pajam and Tulshimala while BR5 produced the lowest yield (2.61 t ha^{-1}).

Rao *et al.* (1993) found that the highest grain yield was obtained in the wet seasons by local variety Badshabhog (3.21 t ha^{-1}) than the other ones (cv. Kastui, Ranbir, Basmati and IET 8579) and mean yields varied from 2.22 - 2.58 t ha^{-1}.

Alim *et al.* (1962) tested five fine rice cultivars namely, Badshabhog, Basmati, Hatishail, Gobindhabhog and Radhunipagal for five years and found that Basmati showed the best performance followed by Gobindhabhog and Badshabhog. They also reported that Badshabhog and Hatishail yielded 2.6 and 2.69 t ha^{-1}, respectively.

Islam and Islam (2004) reported that grain yield of aromatic rice varieties was low but its high price and low cost of cultivation generates high profit compared to other varieties grown in the Northern region of Bangladesh.

Chapter III

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

The study was carried out at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka during the *Aman* season of 2005 with aromatic rice genotypes. This chapter deals with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recording and analysis etc.

3.1 Site description

The experiment was conducted in Sher-e-Bangla Agricultural University farm, Dhaka, under the AEZ-28 (Modhupur tract) during *Aman* season, 2005.

3.2 Climate

The area under experiment was situated under subtropical zone. During Aman season in general there was sufficient rainfall for growing the crop. However, some times crop suffered from inadequate rainwater and then irrigation was applied. On the other hand, the temperature increased in the *Aman* season and gradually decreased with the advance of time during *Rabi* season (October- March). The bright sunshine hours were comparatively lower in the *Aman* season. Thus the climatic factors were agreeable to grow the quality aromatic rice. Climatic data is presented in Appendix I.

3.3 Soil

The soil of the experimental farm belongs to the general soil type (Shallow red brown trrace Soil). The land was above flood level. Soil samples from 0-15 cm depth were collected from experimental field. The analysis was done at Soil Resources and Development Institute (SRDI), Dhaka. The physio-chemical properties of the soil are presented in Appendix II.

3.4 Genotypes used

The tested rice genotypes has given by Prof. Dr. Sarwar Hossain, Genetics and Plant Breeding department of SAU and other collected from BRRI, Gazipur for screening the promising genotypes. Genotypes were transplanted in different dates in the same season to find out the optimum time of planting and to select suitable genotypes. Finally, potential genotypes were selected from the tested genotypes based on the yield performance.

3.5 Raising Seedling

The seedlings of different genotypes were raised in the separate seedbed in traditional way with initial seed soaking in water for 24 hours and incubated for a period until radical came out. No fertilizer was applied in seedbed. Sprouted seeds were sown in beds by broadcast method. Nursery beds were irrigated as and when necessary.

3.6 Land preparation

The experimental land was prepared with the help of power tiller by three successive ploughing and cross-ploughing followed by laddering. The experimental field was puddled by stagnant water. Weeds and crop residues of previous crop were removed from the field. The experimental area was laid out according to the design of the experiment. The unit plot was leveled before transplanting.

3.7 Fertilizer management

At the time of first ploughing cowdung was applied at the rate of 10 t ha^{-1}. The experimental area was fertilized with 120, 80, 80, 20, and 5 kg ha^{-1} N, P_2O_5 K_2O, S and Zn applied in the from of urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate, respectively. The full amounts of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation as a basal dose. Urea was applied in three installments. The first one – fourth (25%) of urea was top dressed after seedling recovery, 50 % at 15 days after first top dressing, rest 25% at the time panicle initiation.

3.8 Experiment treatments

Treatments included in the experiment were as fallows:

A. Transplanting date-4

i) 15 July (T_1)

ii) 1 August (T_2)

iii) 15 August (T_3)

iv) 1 September (T_4)

B. Variety/Lines-4

i) Subash1 (V_1)

ii) Subash2 (V_2)

iii) Subash5 (V_3)

iv) BRRI dhan38 (V_4)

3.9 Experimental Design

The unit plots were arranged in a split plot design. The experiment was replicated thrice.

Each planting date was placed in main plots and variety in the sub plots. The unit plot size was 4m ×2.5 m.

3.10 Date of Transplanting

Thirty days old seedlings using 1 seedling per hill were transplanted with a spacing of 25cm ×15cm on 15 July, 1 August, 15 August and 1 September, 2005.

3.11 Intercultural operations

3.11.1 Gap filling

Gap filling was done after one week of transplanting using the seedling from the same source.

3.11.2 Weeding

Two hand weedings were done at 20 DAT and second weeding at 30 DAT to keep the crop weed free.

3.11.3 Application of irrigation water

Irrigation was applied during transplanting and crop establishment period. The field was saturated with 1-2 cm water and water level was increased with the advance of growth stages. However, at maturity no standing water was allowed.

3.11.4 Plant protection measures

Crop was infested with rice bug with some extent in early transplanting which was controlled by Diazinon @ 2 ml/Liter of water. Crop was protected from birds and rats during the grain filling period. Field trap and fostoxin bait were used to control rat.

3.11.5 Harvesting and post harvest operation

Crop was harvested at maturity when 80% grains were matured. Harvesting was done in different dates due to the variation of planting dates and variation of life cycle of rice genotypes (10 October, 27 October, 16 November and 27 November, 2005). Five hills were randomly select from middle portion of each plot for different agronomic data collection and hills of three m^2 areas were separately harvested and bundled, properly tagged and then brought to the threshing floor for recording grain and straw yield. Threshing was done by using pedal thresher. The grains were cleaned and sun dried to moisture content of 14%. Straw was also sun dried properly.

3.12 Recording of data

The followings data were recorded at harvest.

A. Plant characters

i. Plant height at harvest (cm)

ii. Panicle length (cm)

iii. Total tiller m^{-2} (no.)

iv. Non-effective tillers m^{-2} (no.)

v. Rachis branch $panicle^{-1}$ (no.)

vi. Total spikelet $panicle^{-1}$ (no.)

vii. Sterility (%)

B. Yield attributes

i. Effective tillers m^{-2} (no.)

ii. Filled grains $panicle^{-1}$ (no.)

iii. Weight of 1000-grain (g)

iv. Grain yield (t ha^{-1})

v. Straw yield (t ha^{-1})

vi. Biological yield (t ha^{-1})

vii. Harvest index (%)

3.13 Detailed procedures of data recording

A brief outline of the data recording procedure is given below

A. Plant characters

Plant height (cm)

Plant height was measured at harvest. The height of the plant was determined by measuring the distance from the soil surface to the tip of panicle.

Panicle length (cm)

Measurement of panicle length was taken from basal node of the rachis to apex of each panicle.

Total tiller $hill^{-1}$

Number of tillers $hill^{-1}$ were counted at harvest from the 5 sample hills and finally averaged as their tiller number.

Non-effective tillers $hill^{-1}$

The panicle which not able to reached in a productive stage.

Rachis $panicle^{-1}$ (no.)

Number of rachis was counted of each panicle after harvest.

Total spikelet panicle^{-1} (no.)

Total grains refers to the grains consist of panicle. The number of filled grains panicle^{-1} plus the number of unfilled grains panicle^{-1} gave the total number of grain panicle^{-1}.

Sterility (%)

Percentage of sterility was calculate by using following formula,

$$\% \text{ Sterility} = \frac{\text{Unfilled grains}}{\text{Filled grain + Unfilled grain}} \times 100$$

B. Yield attributes

Effective tillers hill^{-1} (no.)

The panicles which had at least one grain was considered as effective tillers.

Filled grains panicles^{-1}(no.)

Filled grain was considered to be if any kernel was present there. The number of total filled grains present on each panicle was recorded.

1000 grain weight (g)

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

Grain yield (t ha^{-1})

Grain yield was determined from the central 3 meters area of each plot and expressed as t ha^{-1} in 14% moisture basis. Grain moisture content was measured by suing a digital moisture tester.

Straw yield (t ha^{-1})

Straw yield was determined from the central 3 meter area of each plot after separating of grains. The samples were oven dried to a constant weight and finally converted to t ha^{-1}.

Biological yield (t ha^{-1})

Biological yield was determined by adding grain yield and straw yield.

Harvest index (%)

The harvest index was calculated by the formula,

$$\% \text{ Harvest index} = \frac{\text{Grain yield}}{\text{Grain yield} + \text{Straw yield}} \times 100$$

3.14 Statistical analysis of the data

Statistical analysis was done by using MSTAT program. The mean differences among the treatments were compared by LSD at 5% level of significance.

Chapter IV

Results and Discussion

CHAPTER 4

RESULTS AND DISCUSSION

Result recorded from the present study regarding the effect of transplanting date and variety and their interaction on yield and yield contributing characters have been presented and discussed in this chapter.

4.1 Plant characters

4.1.1 Plant height at harvest

4.1.1.1 Effect of date of transplanting

Plant height showed a decreasing trend with the delayed transplanting starting from 15 July to 1 September (Table 1). The tallest plant (111.5 cm) was observed in the plots where crops transplanted on 15 July. The shortest plant (90.91 cm) was observed from 1 September transplanting.

Table 1. Effect of date of transplanting on plant height of aromatic rice

Date of transplanting	Plant height (cm)
15 July	111.50
1 August	107.50
15 August	93.14
1 September	90.91
LSD (0.05)	8.25
CV (%)	5.19

The result agreed with Majos and Pave (1980) who reported that plant height reduced with delayed transplanting might be due to the premature flowering because of strong photoperiod sensitiveness of the variety which forced the plants to switch from vegetative stage to the reproductive stage. The inducement of flowering by the shortening day length influences their ripening period. So, they are date fixed as regarded maturity date, though their growing period can be optimized by earlier sowing.

4.1.1.2 Effect of aromatic rice varieties on plant height

The result revealed that BRRI dhan38 produced the highest plant height (113.60 cm) and the lowest plant height (96.03 cm) was recorded from the variety of Subash5 (Table 2). The plant height recorded from Subash2 and Subash1 were 96.89cm and 96.55 cm respectively. Plant heights of three promising lines were significantly similar. The result agreed with BRRI (1995) that plant height of three varieties in *Aman* season ranged from 95 cm - 125 cm.

Table 2. Effect of aromatic rice varieties on plant height

Variety/Lines	Plant height (cm)
Subash1	96.55
Subash2	96.89
Subash5	96.03
BRRI dhan38	113.60
LSD (0.05)	4.11
CV (%)	5.19

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4.1.1.3 Interaction effect of transplanting date and aromatic rice varieties regarding plant height

The result showed that the best combination between date of transplanting and variety was 15 July transplanting with BRRI dhan38 (134.5 cm) and the second best combination was obtained from 1 August transplanting with BRRI dhan38 (110.1

cm). The lowest plant height (86.34 cm) was obtained from the interaction between 1 September transplanting with Subash5 (Table 3).

Table 3. Interaction effect of date of transplanting and aromatic rice varieties on plant height

Transplanting date × Variety		Plant height (cm)
15 July	× Subash1	107.10
	× Subash2	104.00
	× Subash5	100.20
	× BRRI dhan38	134.50
1 August	× Subash1	103.30
	× Subash2	108.20
	× Subash5	108.40
	× BRRI dhan38	110.10
15 August	× Subash1	88.14
	× Subash2	88.02
	× Subash5	89.12
	× BRRI dhan38	107.30
1 September	× Subash1	87.67
	× Subash2	87.29
	× Subash5	86.34
	× BRRIdhan38	102.30
LSD (0.05)		8.81
CV (%)		5.19

4.1.2 Panicle Length

4.1.2.1 Effect of date of transplanting on panicle length of aromatic rice

The panicle length was significantly influenced by date of transplanting (Table 4). The table showed that panicle length reduced gradually with the delayed transplanting from 15 July to 1 September.

Table 4. Effect of date of transplanting on panicle length in aromatic rice

Date of transplanting	Panicle length (cm)
15 July	28.37
1 August	27.12
15 August	26.23
1 September	25.66
LSD (0.05)	0.70
CV (%)	2.31

The maximum panicle length (28.37 cm) was recorded in 15 July transplanting followed by 1 August transplanting (27.12 cm). The result also revealed that the lowest panicle length (25.66 cm) was produced from in the where crops transplanted on 1 September. The result corroborates with the findings of Islam *et al*.(1999b) who reported that planting dates affects the panicle length significantly.

4.1.2.2 Effect of aromatic rice varieties on panicle length

The result revealed that panicle length differed from variety to variety (Table 5). Maximum panicle length (27.69 cm) was recorded from BRRI dhan38.

Table 5. Effect of aromatic rice varieties on Panicle length

Variety/Lines	Panicle length (cm)
Subash1	26.31
Subash2	26.74
Subash5	26.65
BRRI dhan38	27.69
LSD (0.05)	0.52
CV (%)	2.31

The lowest panicle length was obtained from Subash1 (26.31 cm) which was similar with Subash2 and Subash5.The result was supported by Idris and Matin (1990) who reported that panicle length differed among varieties.

4.1.2.3 Interaction effect between transplanting date and variety on panicle length

The interaction of transplanting date and variety showed a significant variation in producing panicle length (Table 6).

Table 6. Interaction effect between date of transplanting and aromatic rice variety on panicle length

Transplanting date × Variety		Panicle length (cm)
15 July	× Subash1	26.74
	× Subash2	27.44
	× Subash5	27.22
	× BRRI dhan38	32.09
1 August	× Subash1	27.24
	× Subash2	27.22
	× Subash5	27.49
	× BRRI dhan38	26.53
15 August	× Subash1	25.96
	× Subash2	26.25
	× Subash5	26.22
	× BRRI dhan38	26.19
1 September	× Subash1	25.30
	× Subash2	26.03
	× Subash5	25.38
	× BRRI dhan38	25.94
LSD (0.05)		1.04
CV (%)		2.31

Among the interactions 15 July transplanting × BRRI dhan38 showed the highest (32.09 cm) panicle length and the lowest (25.30 cm) was recorded from 1 September × subash1 transplanting interaction, which was statically similar with 15 August × Subash1transplanting, 15 August × Subash2 transplanting, 1 September × BRRI dhan38 transplanting, 1 September × Subash2 transplanting, 1 September × Subash5 transplanting and 1 September × BRRI dhan38 transplanting.

4.1.3 Total tiller m^{-2}

4.1.3.1 Effect of date of transplanting on total tillers of aromatic rice

Total tiller m^{-2} exerted significant variations due to date of transplanting (Table 7). Early transplanting (15 July) showed the highest number of tiller m^{-2} (188.6) and the tiller number reduced gradually with the transplanting delayed. The lowest number of tiller m^{-2} (180.0) was obtained from 1 September transplanting. The result agreed with Islam (1990 b) who reported that planting date affects tiller hill^{-1}.

Table 7. Effect of date of transplanting on total tiller m^{-2} in aromatic rice

Date of transplanting	Total tiller m^{-2} (no.)
15 July	188.6
1 August	186.9
15 August	181.2
1 September	180.0
LSD (0.05)	5.38
CV (%)	5.40

4.1.3.2 Effect of aromatic rice varieties on total tillers m^{-2}

Total tiller m^{-2} number varied significantly from variety to variety (Table 8).

Table 8. Effect of aromatic rice varieties on total tiller m^{-2}

Variety/Lines	Total tiller m^{-2} (no.)
Subash1	188.4
Subash2	186.0
Subash5	172.0
BRRI dhan38	190.7
LSD (0.05)	8.39
CV (%)	5.40

BRRI dhan38 produced higher tiller (190.7) followed by two promising lines Subash1 (188.4) and Subash2 (186.0). Subash5 gave significantly lowest number of tiller m^{-2} (172.0). The result corroborates with the findings of BRRI (1991) that the number of total tiller differed significantly among the varieties.

4.1.3.3 Interaction effect between transplanting date and aromatic rice varieties on total tiller m^{-2}

Interaction between dates of transplanting with variety had significant effect on total tiller m^{-2} (Table 9).

Table 9. Interaction effect between dates of transplanting and aromatic rice varieties on total tiller m^{-2}

Transplanting date × Variety		Total tiller m^{-2} (no.)
15 July	× Subash1	187.3
	× Subash2	190.4
	× Subash5	180.4
	× BRRI dhan38	196.3
1 August	× Subash1	192.5
	× Subash2	184.3
	× Subash5	170.9
	× BRRI dhan38	199.9
15 August	× Subash1	187.1
	× Subash2	183.7
	× Subash5	170.1
	× BRRI dhan38	184.1
1 September	× Subash1	186.5
	× Subash2	185.0
	× Subash5	165.6
	× BRRI dhan38	182.6
LSD (0.05)		17.48
CV (%)		5.40

Among the interactions 1 August × BRRI dhan38 transplanting showed the highest number (199.9) tillers m^{-2} which was at per with 15 July × BRRI dhan38, 1August × Subash1 interaction. The 1 September transplanting × Subash5 interaction showed minimum total tiller m^{-2} (165.6). But as visually seen, transplanting at early dates (15 July and 1 August) with any combination produced higher tillers m^{-2} (170.9 -199.9) than late transplanting date 15 August and 1 September (165.6-187.1).

4.1.4. Rachis branch panicle^{-1}

4.1.4.1 Effect of date of transplanting on rachis branch panicle^{-1}

The result revealed that maximum number of rachis branch was recorded from 1 August transplanting (13.95) at per with 15 July transplanting. (Table 10). The Lowest number of rachis was obtained from 1 September transplanting (11.93) which were statistically similar with the preceding transplanting date (15 August).

Table 10. Effect of date of transplanting on rachis branch panicle $^{-1}$

Date of transplanting	Rachis branch panicle $^{-1}$ (no.)
15 July	13.13
1 August	13.95
15 August	12.07
1 September	11.93
LSD (0.05)	0.875
CV (%)	3.33

4.1.4.2 Effect of aromatic rice varieties on rachis branch panicle^{-1}

Effect of variety did not show significant variation on the production of rachis branch number panicle^{-1} in rice (Table 11). Numerically the highest rachis panicle^{-1} (13.89) was found in BRRI dhan38 and the lowest in Subash5 (12.28).

Table 11. Effect aromatic rice varieties on rachis branch panicle^{-1}

Variety/Lines	Rachis branch panicle^{-1} (no.)
Subash1	12.53
Subash2	12.38
Subash5	12.28
BRRI dhan38	13.89
LSD (0.05)	NS
CV (%)	3.33

4.1.4.3 Interaction effect between transplanting date and variety on rachis branch panicle^{-1}

Interaction effect of transplanting date and variety was significant in producing number of rachis panicle^{-1} (Table 12).

Table 12. Interaction effect between date of transplanting and aromatic rice varieties on rachis branch panicle^{-1}

Transplanting date× Variety		Rachis panicle^{-1} (no.)
15 July	× Subash1	12.83
	× Subash2	12.40
	× Subash5	12.80
	× BRRI dhan38	14.50
1 August	× Subash1	14.29
	× Subash2	13.99
	× Subash5	13.19
	× BRRI dhan38	14.35
15 August	× Subash1	11.74
	× Subash2	11.67
	× Subash5	11.39
	× BRRI dhan38	13.47
1 September	× Subash1	11.28
	× Subash2	11.45
	× Subash5	11.76
	× BRRI dhan38	13.23
LSD (0.05)		0.717
CV (%)		3.33

The highest number of rachis branch panicle^{-1} (14.50) was found in the interaction of 15 July transplanting × BRRI dhan38 which was similar with the interaction of 1 August × Subash1 (14.29), 1 August × Subash2 (13.99) and 1 September × BRRI dhan38 (14.35). However, the lowest rachis branch panicle^{-1} (11.28) was found in the interaction of 1 September × Subash1.

4.1.5 Non-effective tillers m^{-2}

4.1.5.1 Effect of date of transplanting on producing non effective tiller m^{-2}

Transplanting date exerted significant variation in producing non effective tillers m^{-2}

(Table 13). 1st August transplanting showed the lowest number (23.42) of non-effective tillers m^{-2}. After that the number of non effective tillers m^{-2} showed increasing trend with the delayed transplantings and the highest number (33.83) was attained with the last date of transplanting (1 September). The table indicated that first two transplanting dates showed similar number of non-effective tillers m^{-2}. The result agreed with the findings of Davidson (1964) and Bremner (1969) who reported that late transplanting increases non effective tillers.

Table 13. Effect date of transplanting on non-effective tillers m^{-2} in aromatic rice

Date of transplanting	Non-effective tillers m^{-2} (no.)
15 July	24.25
1 August	23.42
15 August	30.08
1 September	33.83
LSD (0.05)	2.34
CV (%)	10.76

4.1.5.2 Effect of aromatic rice varieties on non-effective tillers m^{-2}

Non effective tillers m^{-2} not affected significantly due to varieties (Table 14).But visually Subash1 showed the highest (28.83) number of non-effective tillers m^{-2} which was higher than other tested Subash lines. BRRI dhan38 produced the lowest number of non-effective tillers m^{-2} (27.0).

Table 14. Effect of aromatic rice varieties on non-effective tillers $m-^{2}$

Variety/Lines	Non-effective tillers m^{-2} (no.)
Subash1	28.83
Subash2	27.08
Subash5	28.67
BRRI dhan38	27.00
LSD (0.05)	NS
CV (%)	10.76

4.1.5.3 Interaction effect between transplanting date and variety on non effective tillers m^{-2}

Interaction table showed significant variations among transplanting date and variety (Table 15).

Table 15. Interaction effect between date of transplanting and aromatic rice varieties on non-effective tillers m^{-2}

Transplanting date × Variety		Non-effective tillers m^{-2} (no.)
15 July	× Subash1	23.33
	× Subash2	23.67
	× Subash5	28.00
	× BRRI dhan38	23.33
1 August	× Subash1	24.02
	× Subash2	23.87
	× Subash5	24.02
	× BRRI dhan38	23.03
15 August	× Subash1	32.06
	× Subash2	30.01
	× Subash5	30.35
	× BRRI dhan38	28.33
1 September	× Subash1	36.02
	× Subash2	33.33
	× Subash5	32.67
	× BRRI dhan38	33.33
LSD (0.05)		5.06
CV (%)		10.76

Interaction table of transplanting date and variety showed that the lowest number of non- effective tiller m^{-2} was produced by 15 July and 1 August transplanting with BRRI dhan38 (23.33) and the higher non-effective tiller m^{-2} (36.02) was recorded from 1 September transplanting with Subash1. However, the result revealed that in general, late transplanting showed higher level of non-effective tillers than earlier transplanting with all the varieties.

4.1.6 Total spikelet panicle^{-1}

4.1.6.1 Effect of date of transplanting on total spiketel

Transplanting date influenced the production of total spikelet panicle^{-1} significantly (Table 16). The table showed that total spikelet panicle^{-1} slightly increased from 15 July to 1 August transplanting after that the number of total spikelet reduced gradually and the lowest value (147.3) reaches at 1 September transplanting. The result revealed that the early transplanting produced the highest number of grains panicle^{-1} than delayed transplantings. The result was supported by Islam *et al.* (1999b) who observed that grain number decreased with delayed transplanting beyond August.

Table 16. Effect of date of transplanting on total spikelet panicle^{-1}

Date of transplanting	Total spikelet panicle^{-1} (no.)
15 July	162.6
1 August	165.1
15 August	155.1
1 September	147.3
LSD (0.05)	9.06
CV (%)	7.54

4.1.6.2 Effect of aromatic rice varieties on total spikelet panicle^{-1}

The production of total spikelet panicle^{-1} not affect significantly due to varieties (Table 17). The result showed that BRRI dhan38 produced the highest number (160.6) of spikelet panicle^{-1} than other three advanced promising lines (Subash1, Subash2 and Subash5). But producing of total spikelet panicle^{-1} by three advanced promising lines and inbred variety does not differ significantly. The result was confirmed by Kamal *etal.* (1988) in that the number of grains panicle^{-1} differed among the varieties.

Table 17. Effect aromatic rice varieties total spikelet panicle^{-1}

Variety/Lines	Total spikelet panicle^{-1} (no.)
Subash1	159.4
Subash2	158.2
Subash5	152.0
BRRI dhan38	160.6
LSD (0.05)	NS
CV (%)	7.54

4.1.6.3 Interaction effect of date of transplanting and aromatic rice varieties on total spikelet panicle^{-1}

The interaction of transplanting date and variety exerted significant variation in respect of total spikelet panicle^{-1} (Table 18).

Table 18. Interaction effect between date of transplanting and aromatic rice varieties on total spikalet panicle^{-1}

Transplanting date × Variety		Total spikelet panicle^{-1} (no.)
15 July	× Subash1	160.0
	× Subash2	163.9
	× Subash5	157.9
	× BRRI dhan38	168.6
1 August	× Subash1	166.8
	× Subash2	165.8
	× Subash5	156.1
	× BRRI dhan38	171.9
15 August	× Subash1	159.6
	× Subash2	155.3
	× Subash5	150.0
	× BRRI dhan38	155.7
1 September	× Subash1	151.3
	× Subash2	147.8
	× Subash5	144.2
	× BRRI dhan38	146.0
LSD (0.05)		20.02
CV (%)		7.54

The highest number of spikelet panicle^{-1} (171.9) was observed in 1 August × BRRI dhan38 interaction which was at per 15 July × BRRI dhan38 interaction (168.6). The lowest total spikelet panicle^{-1} (144.2) was found with the interaction of 1 September × Subash5 combination. It can be inferred from the table that in general, all varieties showed decreasing trend for producing total spikelet panicle^{-1} gradually delayed transplanting.

4.1.7 Spikelet sterility (%)

4.1.7.1 Effect of date of transplanting on spikelet sterility

Percent of sterility was significantly influenced by the date of transplanting (Table 19). The maximum spikelet sterility (10.06%) was recorded on 1 September transplanting.

Table 19. Effect date of transplanting on spikelet sterility (%)

Date of transplanting	Spikelet sterility (%)
15 July	7.39
1 August	6.27
15 August	9.38
1 September	10.06
LSD (0.05)	0.43
CV (%)	7.99

The minimum spikelet sterility (6.27%) was obtained on 1 August transplanting. Transplanting on 15 August produced the second highest sterility (9.38%).The result revealed that date of transplanting beyond 1 August increased percent of spikelet sterility gradually up to 1 September. The result supported by Subbain *et al.* (1995) who reported that panicle initiation and flowering in delayed planting adversely affects on fertilization.

4.1.7.2 Effect of aromatic rice varieties on spikelet sterility (%)

Spikelet Sterility (%) varied significantly due to varieties (Table 20). In general, Subash varieties showed higher level of spikelet sterility (9.41-9.45%) than inbred variety BRRI dhan38 (4.85). Subash5 showed the highest level of sterility (9.45%) which was at per Subash1 (9.41%) and Subash2 (9.43%). Significantly lowest level of sterility (4.85%) was observed in BRRI dhan38.

Table20. Effect of aromatic rice varieties on spikelet sterility

Variety/Lines	Spikelet sterility (%)
Suvash1	9.41
Suvash2	9.43
Suvash5	9.45
BRRI dhan38	4.85
LSD (0.05)	0.55
CV (%)	7.99

4.1.7.3 Interaction between date of transplanting and aromatic rice varieties on spikelet sterility

Spikelet Sterility (%) varied significantly due to interaction of transplanting date and variety (Table 21). In general, irrespective of varieties late transplanting showed the higher percentage of sterility than earlier transplantings. The highest percentage of spikelet sterility (12.13 %) was found in 1 September × Subash1. The lowest Spikelet sterility (4.46 %) was observed in the interaction of 1 September × BRRI dhan38. Lower percentage of sterility was found in earlier two transplanting date (4.46-8.19) compared to delayed two transplanting date (4.82-12.13) due to delayed transplanting faces low temperature.

Table 21. Interaction effect between date of transplanting and aromatic rice varieties on spikelet sterility .

Transplanting date× Variety		Spikelet sterility (%)
15 July	× Subash1	8.19
	× Subash2	8.03
	× Subash5	8.02
	× BRRI dhan38	5.33
1 August	× Subash1	6.52
	× Subash2	7.46
	× Subash5	6.66
	× BRRI dhan38	4.46
15 August	× Subash1	10.81
	× Subash2	10.33
	× Subash5	11.60
	× BRRI dhan38	4.80
1 September	× Subash1	12.13
	× Subash2	11.93
	× Subash5	11.53
	× BRRI dhan38	4.82
LSD (0.05)		1.12
CV (%)		7.78

4.2 Yield attributes

4.2.1 Effective tillers m^{-2}

4.2.1.1 Effect of date of transplanting on effective tillers on aromatic rice

Effective tillers m^{-2} was significantly affected by the date of transplanting (Table 22). The maximum effective tillers m^{-2} (164.02) recorded from 1 August transplanting which was at per 15 July transplanting (163.0) and the lowest effective tillers m^{-2} (146.72) was recorded from 1 September transplanting. The result revealed that early transplanting showed the highest number of effective tillers m^{-2} than delayed transplanting. These might be due to delayed transplanted crops get shorter period for their vegetative growth compared with earlier transplanted crops. Plant that have short growth duration do not enough have time to produce enough tillers while the plant that have long growth duration produced optimum number of tillers. The result agreed with Subbain *et al.* (1995) who reported that late planted crop gave less number of tillers and panicles.

Table 22. Effect of date of transplanting on number of effective tillers m^{-2}

Date of transplanting	Effective tillers m^{-2} (no.)
15 July	163.0
1 August	164.02
15 August	151.03
1 September	146.72
LSD (0.05)	3.50
CV (%)	6.15

4.2.1.2 Effect of aromatic rice varieties on effective tillers m^{-2}

The production of tillers number m^{-2} was significantly influenced by the variety at harvest (Table 23).

Table 23. Effect of aromatic rice varieties on effective tillers m^{-2}

Variety/Lines	Effective tillers m^{-2} (no.)
Suvash1	157.9
Suvash2	157.2
Suvash5	145.2
BRRI dhan38	164.5
LSD (0.05)	8.10
CV (%)	6.15

BRRI dhan38 produced the highest number of effective tillers m^{-2} (164.5) and the lowest was recorded from Subash5 (145.2). The production of tillers m^{-2} in Subash1 and Subash2 was statistically similar. The differences in tillers number among the varieties might be due to the difference of genetic make up of the varieties. BRRI (1991) reported similar views that the number of effective tillers differed among different varieties.

4.2.1.3 Interaction effect between date of transplanting and aromatic rice varieties on effective tillers m^{-2}

The interaction of transplanting date and variety exerted significant variation in respect of number of effective tillers m^{-2} (Table 24)

Table 24. Interaction effect between date of transplanting and variety on of effective tillers m^{-2}

Transplanting date × Variety		Effective tillers m^{-2} (no.)
15 July	× Subash1	162.0
	× Subash2	164.7
	× Subash5	152.4
	× BRRI dhan38	172.9
1 August	× Subash1	163.9
	× Subash2	161.7
	× Subash5	153.6
	× BRRI dhan38	176.9
15 August	× Subash1	155.1
	× Subash2	153.7
	× Subash5	139.6
	× BRRI dhan38	155.7
1 September	× Subash1	150.5
	× Subash2	148.8
	× Subash5	135.3
	× BRRI dhan38	152.3
LSD (0.05)		16.20
CV (%)		6.70

Among the different interaction combinations 1 August × BRRI dhan38 gave the highest number of effective tillers m^{-2} (176.9) than others. The lowest tillers m^{-2} (135.3) was found in 1 September × Subash5 interaction combination. Effective tiller number showed decreasing trend from early to late transplanting time in all combination.

4.2.2 Filled grains panicle^{-1}

4.2.2.1 Effect of date of transplanting on filled grains panicle^{-1}

Date of transplanting had significant effect on filled grains panicle^{-1}(Table 25). The highest number of filled grains panicle^{-1} was produced in 1 August transplanting (155.5) which was at per 15 July transplanting (151.8). The lowest number of filled grains panicle^{-1} (133.4) was produced by 1 September transplanting. The early transplanting showed higher filled grains than delayed ones due to higher dry matter accumulation by the early planted crop at panicle initiation and subsequent flowering stage. This result is in agreed with the findings of Om *et al.* (1993) who reported that delayed of transplanting decreased the grains panicle^{-1}.

Table 25. Effect of date of transplanting on filled grains panicle^{-1}

Date of transplanting	Filled grains panicle^{-1} (no.)
15 July	151.8
1 August	155.5
15 August	142.0
1 September	133.4
LSD (0.05)	8.119
CV (%)	7.45

4.2.2.2 Effect of aromatic rice varieties on filled grains panicle^{-1}

There exists a significant difference among the varieties in respect of filled grains panicle^{-1} (Table 26). The result showed that BRRI dhan38 produced the highest number of filled grains panicle^{-1} (153.2) than the promising Subash lines. Among the promising advanced line Subash1 produced the highest filled grains (145.9) than Subash2 (144.6) and Subash5 (139.1) but there were no significant difference in the three promising lines.

Table 26. Effect of aromatic rice varieties on filled grains panicle^{-1}

Variety/Lines	Filled grains panicle^{-1} (no.)
Suvash1	145.9
Suvash2	144.6
Suvash5	139.1
BRRI dhan38	153.2
LSD (0.05)	9.14
CV (%)	7.45

4.2.2.3 Interaction effect between date of transplanting and aromatic rice varieties on filled grains panicle^{-1}

Filled grains panicle^{-1} affected significantly by the interaction of transplanting date and variety (Table 27). The highest filled grains panicle^{-1} was produced by the interaction between 1 August × BRRI dhan38 (165.4) followed by 15 July × BRRI dhan38 (161.3). The lowest filled grains panicle^{-1} was produced from 1 September × Subash5 (129.4). In general BRRI dhan38 produced higher filled grains panicle^{-1} (165 to 137) than other three Subash line (157 to 129) in all interactions with date of transplanting.

Table 27. Interaction effect between date of transplanting and variety on number of filled grain panicle^{-1}

Transplanting date× Variety		Filled grains panicle^{-1} (no.)
15 July	× Subash1	147.9
	× Subash2	151.7
	× Subash5	146.1
	× BRRI dhan38	161.3
1 August	× Subash1	156.5
	× Subash2	153.8
	× Subash5	146.3
	× BRRI dhan38	165.4
15 August	× Subash1	144.1
	× Subash2	140.7
	× Subash5	134.4
	× BRRI dhan38	148.9
1 September	× Subash1	135.0
	× Subash2	132.1
	× Subash5	129.4
	× BRRI dhan38	137.1
LSD (0.05)		18.30
CV (%)		7.45

4.2.3 Weight of 1000 grain (g)

4.2.3.1 Effect of date of transplanting on 1000 grain weight on aromatic rice

Weight of thousand seed showed not significant variation due to transplanting

Table 28. Effect of date of transplanting on weight of thousand seed

Date of transplanting	Weight of 1000 seed (g)
15 July	17.79
1 August	17.94
15 August	17.78
1 September	17.76
LSD (0.05)	NS
CV (%)	2.86

(Table 28). Numerically 1 August transplanting showed highest weight of thousand seed (17.94) followed by 15 July transplanting (17.79). Last date of transplanting (1 September) showed the lowest weight of thousand seed (17.76).

4.2.3.2 Effect of aromatic rice varieties on 1000 grain weight

Thousand grains weight significantly affected by variety (Table.29).The highest weight of 1000 seed (18.27) was recorded from Subash2 followed by Subash1 (17.98) and Subash5 (17.94). The inbred variety BRRI dhan38 produced the lowest weight of 1000 grain (17.08) that was 6.51 % lower than the highest one. The result is agreed with the findings of BRRI (1998 b) that thousand grain weight of some aromatic rice varieties ranged from 12 to 20 g and it differed significantly from variety to variety.

Table 29. Effect of aromatic rice varieties on weight of 1000 seed

Variety/ Lines	Weight of thousand seed (g)
Subash1	17.98
Subash2	18.27
Subash5	17.94
BRRI dhan38	17.08
LSD (0.05)	0.29
CV (%)	2.86

4.2.3.3 Interaction effect between date of transplanting and aromatic rice varieties on weight of thousand seed

Interaction of transplanting date and variety showed significant variation in respect of weight of thousand seed (Table 30). Among the interactions the highest weight of thousand seed (18.52) was observed in 1 August × Subash2 and the lowest thousand weight (17.10) was found in 1 September × BRRI dhan38 interaction.

Table 30. Interaction effect between date of transplanting and aromatic rice varieties on weight of 1000 seed

Transplanting date × Variety		Weight of 1000 seed (g)
15 July	× Subash1	17.65
	× Subash2	18.44
	× Subash5	17.96
	× BRRI dhan38	17.13
1 August	× Subash1	18.04
	× Subash2	18.52
	× Subash5	18.19
	× BRRI dhan38	17.03
15 August	× Subash1	18.23
	× Subash2	18.05
	× Subash5	17.77
	× BRRI dhan38	17.08
1 September	× Subash1	18.02
	× Subash2	18.09
	× Subash5	17.84
	× BRRI dhan38	17.10
LSD (0.05)		0.519
CV (%)		1.69

4.2.4 Grain yield

4.2.4.1 Effect of date of transplanting on grain yield of aromatic rice

Date of transplanting exerted significant effect on seed yield (Table 31).

The highest grain yield was recorded from 1 August (4.03 t ha^{-1}) which was statistically similar with 15 July transplanting (3.88 t ha^{-1}) The highest grain yield in 1 August transplanting may be attributed to higher number of effect tiller m^{-2}, filled grains $panicle^{-1}$ and thousand seed weight than other dates. After 1 August transplanting, the grain yield reduced gradually with the delayed transplanting and the lowest yield (3.38 t ha^{-1}) was found in 1 September transplanting. The result revealed that the 1 August transplanting out yielded over 1 September, 15 August and 15 July transplanting by 0.65, 0.45 and 0.15 t ha^{-1}, respectively. The result corroborates with the findings of Ali *et al.* (1995) who stated that delayed transplanting reduces grain yield of aromatic rice in *Aman* season.

Table 31. Effect of date of transplanting on yield of rice

Date of transplanting	Grain yield (t ha^{-1})
15 July	3.88
1 August	4.03
15 August	3.58
1 September	3.38
LSD (0.05)	0.252
CV (%)	10.08

4.2.4.2 Effect of aromatic rice varieties on grain yield

Grain yield exerted significant variations among the tested varieties (Table 32). Significantly the highest grain yield (3.95 t ha^{-1}) was recorded in Subash1 followed by the Subash2 (3.81t ha^{-1}) and inbred variety BRRI dhan38 (3.72 t ha^{-1}). The lowest grain yield (3.40 t ha^{-1}) was found in Subash5. Two Subash varieties (Subash1 and Subash2) showed statistically similar grain yield. However, Subash1 out yielded over Subash5, Subash2 and BRRI dhan38 by 0.55, 0.14 and 0.23 t ha^{-1} respectively. The higher grain yield in Subash1 may be due to its higher number of tillers m^{-2}, filled grains $panicle^{-1}$ and weight of thousand grains than other varieties. The result is corroborates with the findings of Chabder and Jitender (1996) who reported that the average productivity of aromatic rice is very low.

Table 32. Effect of aromatic rice varieties on grain yield

Variety/Lines	Grain yield ($t\ ha^{-1}$)
Subash1	3.95
Subash2	3.81
Subash5	3.40
BRRI dhan38	3.72
LSD (0.05)	0.314
CV (%)	10.08

4.2.4.3 Interaction effect of transplanting date and aromatic rice varieties on grain yield

Interaction of transplanting date and variety showed significant variations in respect of grain yield (Table 33).

Table 33. Interaction effect between date of transplanting and aromatic rice varieties on grain yield

Transplanting date× Variety		Grain yield ($t\ ha^{-1}$)
15 July	× Subash1	3.88
	× Subash2	4.03
	× Subash5	3.56
	× BRRI dhan38	4.11
1 August	× Subash1	4.15
	× Subash2	4.04
	× Subash5	3.75
	× BRRI dhan38	4.15
15 August	× Subash1	3.86
	× Subash2	3.68
	× Subash5	3.25
	× BRRI dhan38	3.43
1 September	× Subash1	3.91
	× Subash2	3.50
	× Subash5	3.13
	× BRRI dhan38	3.00
LSD (0.05)		0.632
CV (%)		10.08

In general, 1August × BRRI dhan38 and 1 August × Subash1 transplanting interaction produced the highest yield (4.15 t ha^{-1}) which was at per 15 July × BRRI dhan38 transplanting (4.11 t $ha^{-1)}$. On the other hand, Subash1 and Subash2 showed better performance with all three transplanting dates than Subash5. However, the lowest grain yield (3.00 t ha^{-1}) recorded from 1 September × BRRI dhan38 interaction treatment. Yield decreases more rapidly in BRRI dhan38 from early transplanting date to late transplanting date than other tested lines.

4.2.5 Straw yield

4.2.5.1 Effect of transplanting date on straw yield

Straw yield was significantly influenced by date of transplanting (Table 34). The highest straw yield (5.74 t ha $^{-1}$) was recorded on 15 July transplanted crops and 1 September transplanting crop produced the lowest straw yield (4.66 t ha^{-1}). The crop transplanted on 15 July gave maximum plant height and number of tillers m^{-2} which intern helped to produce higher straw yield.

Table 34. Effect of date of transplanting on straw yield

Date of transplanting	Straw yield (t ha^{-1})
15 July	5.74
1 August	5.69
15 August	4.86
1 September	4.66
LSD (0.05)	0.144
CV (%)	4.81

On the other hand, the reduction in plant height and numer of tiller m^{-2} due to delayed transplanting were perhaps responsible for the reduction of straw yield in 1 September transplanting. The result confirmatory with the findings of Dinesh *et al.*

(1997) who observed delayed planting significantly decreased grain and straw yield of rice.

4.2.5.2 Effect of aromatic rice varieties on straw yield

Straw yield varied significantly among the varieties (Table 35). The highest straw yield (5.53 t ha $^{-1}$) was recorded in BRRI dhan38, which was statistically similar with Subash1 (5.41 t ha^{-1}) because of its profuse vegetative growth and highest tiller number than other varieties. The lowest straw yield was obtained from Subash5 (4.77 t ha^{-1}).

Table 35. Effect of aromatic rice varieties on straw yield

Variety/Lines	Straw yield (t ha^{-1})
Subash1	5.41
Subash2	5.25
Subash5	4.77
BRRI dhan38	5.53
LSD (0.05)	0.21
CV (%)	4.81

4.2.5.3 Interaction effect of transplanting date and aromatic rice varieties on straw yield

Interaction of transplanting date and variety affects the straw yield significantly (Table 36). In general, irrespective of transplanting dates BRRI dhan38 produced higher straw yield (6.58 - 4.62 t ha^{-1}) than other interactions (5.86 - 4.43 t ha^{-1}). The highest straw yield was observed in the interaction of 15 July × BRRI dhan38 (6.58t ha^{-1}) and the lowest was found in 1 September × Subash5 interaction (4.43 t ha^{-1}). Straw yield was highest in first two dates due to profuse vegetative growth.

Table 36. Interaction effect between date of transplanting and aromatic rice varieties on straw yield

Transplanting date × variety		Straw yield (t ha^{-1})
15 July	× Subash1	5.86
	× Subash2	5.49
	× Subash5	5.03
	× BRRI dhan38	6.58
1 August	× Subash1	5.67
	× Subash2	5.82
	× Subash5	5.13
	× BRRI dhan38	6.15
15 August	× Subash1	5.28
	× Subash2	4.92
	× Subash5	4.49
	× BRRI dhan38	4.77
1 September	× Subash1	4.83
	× Subash2	4.77
	× Subash5	4.43
	× BRRI dhan38	4.62
LSD (0.05)		0.423
CV (%)		4.81

4.2.6 Biological yield

4.2.6.1 Effect of date of transplanting on biological yield of aromatic rice

The date of transplanting was found highly significant in case of biological yield (Table 37). The highest biological yield (9.74 t ha^{-1}) was produced in 1 August transplanting and the lowest (8.01 t ha^{-1}) was obtained with 1 September transplanted crops. Biological yield slightly increased from 15 July to 1 August transplanting, after 1 August transplanting the biological yield decreased gradually with the delayed transplanting and the lowest (8.01 t ha^{-1}) was found in the last date of transplanting. The first two transplanting date showed statistically similar and significantly higher biological yield than delayed transplantings which may be attributed the higher straw and grain yield. Zaman (1980) expressed similar views that late transplanting reduced biological yield of rice.

Table 37. Effect of date of transplanting on biological yield of aromatic rice

Date of ransplanting	Biological yield ($t\ ha^{-1}$)
15 July	9.63
1 August	9.74
15 August	8.46
1 September	8.01
LSD (0.05)	0.273
CV (%)	6.06

4.2.6.2 Effect of aromatic rice varieties on biological yield

Biological yield exerted significant variation among the varieties (Table 38). Like grain and straw yield Subash1 and BRRI dhan38 maintained its superiority by producing higher biological yield (9.29 and 9.27 $t\ ha^{-1}$) over the promising lines of Subash2 (9.06) which was statistically similar. However, subash5 showed the lowest biological yield (8.20 $t\ ha^{-1}$).

Table 38. Effect of aromatic rice varieties on biological yield

Variety/ Lines	Biological yield ($t\ ha^{-1}$)
Subash1	9.29
Subash2	9.06
Subash5	8.20
BRRI dhan38	9.27
LSD (0. 05)	0.456
CV (%)	6.06

4.2.6.3 Interaction effect between transplanting date and aromatic rice varieties on biological yield

Biological yield significantly influenced by the interaction of transplanting date and variety (Table 39). The trend of biological yield similar as observed in grain yield and straw yield i.e. early transplanting showed the highest biological yield than late transplanting.

Table 39. Interaction effect between date of transplanting and aromatic rice varieties on biological yield

Transplanting date× variety		Biological yield ($t\ ha^{-1}$)
15 July	× Subash1	9.75
	× Subash2	9.53
	× Subash5	8.52
	× BRRI dhan38	10.70
1 August	× Subash1	9.85
	× Subash2	9.86
	× Subash5	8.88
	× BRRI dhan38	10.35
15 August	× Subash1	9.15
	× Subash2	8.60
	× Subash5	7.74
	× BRRI dhan38	8.30
1 September	× Subash1	8.41
	× Subash2	8.27
	× Subash5	7.63
	× BRRI dhan38	7.72
LSD (0.05)		0.913
CV (%)		6.06

However, the highest biological yield (10.70 $t\ ha^{-1}$) was found in the interaction of 15 July × BRRI dhan38 which was statistically similar with 1 August × BRRI dhan38 (10.35) and the lowest (7.63 $t\ ha^{-1}$) was observed in 1 September × Subash5 interaction treatment.

4.2.7 Harvest index (%)

4.2.7.1 Effect of date of transplanting on harvest index on aromatic rice

Harvest index was significantly affected by date of transplanting (Table 40). 15 July transplanting showed the lowest harvest index (40.69) and 15 August showed the highest harvest index (42.35) which was statistically similar 1 August(41.70) and 1 September (41.73).

Table 40. Effect of date of transplanting on harvest index of aromatic rice

Date of transplanting	Harvest index (%)
15 July	40.69
1 August	41.70
15 August	42.35
1 September	41.73
LSD (0.05)	1.113
CV (%)	5. 56

4.2.7.2 Effect of aromatic rice varieties on harvest index

Harvest index showed significant variation among the varieties (Table 41). Subash2 showed the highest harvest index (42.05) which was at per with Subash1 (42.01)and Subash5 (41.73). BRRI dhan38 produced the lowest harvest index (40.64).

Table 41. Effect of aromatic rice varieties on harvest index

Variety	Harvest index (%)
Subash1	42.01
Subash2	42.05
Subash5	41.73
BRRI dhan38	40.64
LSD (0.05)	0.896
CV (%)	5.56

4.2.7.3 Interaction effect between date of transplanting and varieties on harvest index

Harvest index had significant effect in combination with date of transplanting and variety. From interaction table 15 August × Subash2 produced the highest harvest index (42.74) and 1 September × BRRI dhan38 produced the lowest harvest index (40.15)

Table 42. Interaction effect between date of transplanting and varieties on harvest index

Transplanting date× variety		Harvest index (%)
15 July	× Subash1	41.12
	× Subash2	42.28
	× Subash5	40.91
	× BRRI dhan38	38.46
1 August	× Subash1	42.09
	× Subash2	40.88
	× Subash5	42.19
	× BRRI dhan38	42.62
15 August	× Subash1	42.26
	× Subash2	42.74
	× Subash5	41.93
	× BRRI dhan38	42.45
1 September	× Subash1	42.56
	× Subash2	42.31
	× Subash5	41.90
	× BRRI dhan38	40.15
LSD (0.05)		1.79
CV (%)		5.56

Chapter V

Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

The field experiment was conducted at the Agronomy field laboratory of Sher-e-Bangla Agricultural University (SAU), Dhaka during the *Aman* season in July to November 2005 with a view to find out the influences of date of transplanting on yield and newly developed subash promising lines yield performance in respect of our modern variety. The experiment consists two level of treatment viz. A. Four transplanting date: 15 July, 1 August, 15 August and 1 September, B. Four Variety / Promising lines: Subash1, Subash2, Subash5, and inbred variety BRRI dhan38. The experiment was laid out in split plot design with three replications. The unit plot size was 4 × 2.5 m. The land was fertilized with 120, 80, 80, 20 and 5 kg ha^{-1} N, P_2O_5, K_2O, S and Zn. The total amount fertilizers except urea were applied in the field during final land preparation. The urea was applied in three equal splits. Thirty days old seedlings were transplanted in the plots with row to row and plant to plant spacing of 25 ×15cm. All intercultural operation were given as when required.

Results of the experiment showed that plant height, panicle length and rachis number were significantly affected by transplanting dates. Numerical values of these characters were the highest for early transplanting (15 July and 1 August) and the lowest for 1 September transplanting. Variety had significant effect on those crop characters and the highest values obtained from BRRI dhan38. Interaction between transplanting date and variety significantly affects in plant height and panicle length. The highest values of these characters were observed in early transplanting with all varieties and the lowest was recorded from delayed transplanting.

Total and non-effective tillers m^{-2} were also affected significantly by the transplanting dates. The highest total tiller m^{-2} was obtained from 15 July and lowest from 1 September transplanting. The highest number of non-effective tillers m^{-2} produce in 1 September transplanting. BRRI dhan38 produce the highest number of total tiller m^{-2} while Subash5 produced the lowest. The lowest number of non-effective tillers m^{-2} was produced by BRRI dhan38. Production of total tillers m^{-2} was the highest in early transplanting dates (ranged 170.9-199.9) than delayed transplanting dates (ranged 165.5-187.1) with decreasing trends. In non-effective tillers m^{-2}, where as early transplanting produced the lowest number of non–effective tillers m^{-2} than delayed transplanting with all interactions.

In case of effective tiller m^{-2}, 1 August transplanting produced the highest number of effective tillers m^{-2} while 1 September produced the lowest number of effective tillers m^{-2}. BRRI dhan38 produced the highest effective tillers than other tested lines. First August transplanting × BRRI dhan38 produced the highest effective tillers (176.9) and 1 September transplanting × BRRI dhan38 produced the lower number effective tillers m^{-2} (152.3). Similar trends were observed in all other interactions.

Maximum total spikelet penical^{-1} was found in 1 August transplanting and minimum was found in 1 September transplanting but maximum percentages of sterile spikelet was found in 1 September transplanting and minimum was recorded in 1 August transplanting. The Highest number of total spikelet panicle^{-1} and lowest percentage of sterility was obtained from BRRI dhan38. Subash5 produce the lowest number of total spikelet panicle^{-1} and highest sterility (%).Percentages of sterility was also showed similar trend as non-effective tillers where delayed transplanting produced the highest spikelet sterility (%) than early transplanting with all interactions.

The highest number of filled grains panicle^{-1} was produced in 1 August transplanting and the lowest obtained from 1 September transplanting. BRRI dhan38 produce the highest filled grains panicle^{-1} while Subash5 produced the lowest filled grains panicle^{-1}. Number of filled grains panicle^{-1} also showed decreasing trends from early transplanting (146.1-165.4) than delayed transplanting (129.4-148.9).

1000 seed weight was not affected by date of transplanting but lowest 1000 grain weight was found in BRRI dhan38.

Grain yield was highest in 1 August transplanting (4.03 t ha^{-1}) followed by 15 July transplanting and lowest grain yield (3.38 t ha^{-1}) was observed in 1 September transplanting. Subash1 produced the highest grain yield (3.95 t ha^{-1}) followed by Subash2 (3.81) and BRRI dhan38 (3.72 t ha^{-1}) and the lowest grain yield (3.40 t ha $^{-1}$) recorded from Subash5. The result showed that interaction of 1August × Subash1 and 1 August × BRRI dhan38 gave the highest grain yield

($4.15\ t\ ha^{-1}$) followed by 15 July transplanting with the BRRI dhan38 ($4.11\ t\ ha^{-1}$) and the lowest grain yield ($3.00\ t\ ha^{-1}$) was observed from 1 September × BRRI dhan38 interaction treatment. Among the advance lines 1 August × Subash2 ($4.04\ t\ ha^{-1}$) also showed good performance.

Straw yield was the highest in 15 July transplanting and highest biological yield produced when crop transplanted on 1 August and the lowest recorded from 1 September transplanting. BRRI dhan38 produced the highest straw yield but Subash1 produced the highest biological yield followed by BRRI dhan38. Harvest Index was also significantly affected by transplanting date and variety. Crop transplanted on 15 August showed the highest harvest index and among the varieties Subash2 was the best one inrespect of harvest index. Straw yield and biological yield was the highest in 15 July transplanting × BRRI dhan38 and it decreases with delayed planting with all interactions. Harvest index was the highest in 15 August ×Subash2 interaction.

Based on the result of the present study, the conclusion may be drawn as

- Crop transplanted on 1 August produced the highest grain yield ($4.03\ t\ ha^{-1}$) but delayed transplanting (1 September) producing lowest grain yield ($3.44\ t\ ha^{-1}$).
- Among the tested variety/lines, Subash1 produced the highest grain yield ($3.95\ t\ ha^{-1}$) which was at per with Subash2 ($3.81\ t\ ha^{-1}$).
- 1August × Subash1 and 1 August × BRRI dahn38 produced the highest grain yield ($4.15\ t\ ha^{-1}$) followed by15 July × BRRI dhan38 ($4.04\ t\ ha^{-1}$) interaction. Transplanting all the varieties on 1 August showed significantly higher yields and yields was decreased with delayed transplanting in all combination.

Chapter VI

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Chapter VII
Appendices

APPENDECS

Appendix I. Monthly record of air temperature, rainfall, and relative humidity during the period from July – December, 2005

Month	RH (%)	Temperature (°c)		Rain fall (mm)
		Maximum	Minimum	
April	66.5	34.4	24.1	91
May	74.60	33.2	24.2	298
June	78.60	33.4	26.8	260
July	80.78	31.1	26.1	542
August	83.22	32.0	26.7	361
September	81.71	31.7	26.0	514
October	88.42	30.6	23.3	413
November	73.90	29.0	19.8	03
December	62.79	27.0	15.7	00

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

Appendix II: Characteristics of experimental soil was 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. Physio-chemical properties of the initial soil

Characteristics	Value
Partical size analysis	
% Sand	26
% Silt	45
% Clay	29
Textural class	Silty- clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100g soil)	0.10
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

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