EFFECT OF SEEDLING AGE ON THE YIELD OF MODERN VARIETIES OF AROMATIC RICE

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CERTIFICATE

This is to certify that thesis entitled, "Effect of Seedling Age on the Yield of Modern Varieties of Aromatic Rice" 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 Muhammad Anwar Hossain, Registration No. 25213/00338 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.

Dated: 28/12/2006
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Dedicated to
My
Beloved Parents

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ABSTRACT

An experiment was carried out at the Agronomy Field Laboratory, Sher-e-Bangla Agricultural University, Dhaka during the period from July to December, 2006 to study the effect of seedling age on the yield of aromatic varieties. The experiment consisted of two levels of treatments viz. a). variety (BRRI dhan37 and BRRI dhan38) and b). seedling age (15, 20, 25, 30, 35 and 40 days old). The experiment was laid out in a randomized complete block design (Factorial) with three replications. The results revealed that BRRI dhan38 performed the best than BRRI dhan37. The highest grain yield (3.08 t/ ha), number of total tiller/ hill, effective tiller/ hill, 1000-grain weight, harvest index and the longest panicle were attained from BRRI dhan38. Seedling age also significantly influenced all crop characters studied. The results also revealed that 30 days old seedlings showed the best performance than other seedling ages treatment. The highest grain yield (3.3 t/ ha), number of effective tillers/ hill, number of total spikelets/ panicle, grain/ panicle, 1000-grain weight and the longest panicle were obtained from 30 days old seedlings whereas the highest plant height, number of total and non-effective tiller were found in 15 days old seedlings. Combination of BRRI dhan38 with 30 days old seedlings was found to be the best in respect of sterile spikelets/ panicle, 1000-grain weight and grain yield.

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LIST OF ACRONYMS

AEZ	=	Agro- Ecological Zone
BAU	=	Bangladesh Agriculture University
BBS	=	Bangladesh Bureau of Statistics
BINA	=	Bangladesh Institute of Nuclear Agriculture
BRRI	=	Bangladesh Rice Research Institute
0C	=	Degree Centigrade
cm	=	Centimeter
CV%	=	Percentage of coefficient of variance
cv.	=	Cultivar (s)
DAT	=	Days after transplanting
et al.	=	and others (et elli)
etc.	=	Etcetera
g	=	gram (s)
kg	=	Kilogram (s)
kg/ ha	=	Kilogram per hectare
LSD	=	Least Significant Difference
m	=	Meter
MP	=	Muriate of Potash
No.	=	Number
NS	=	Non significance
pH	=	Hydrogen ion concentration.
RCBD	=	Randomized Complete Block Design
RH	=	Relative Humidity
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resource and Development Institute
TSP	=	Triple Super Phosphate
t/ ha	=	Ton per hectare
Viz.	=	Namely
@	=	At the rate of
%	=	Percent

CHAPTER 1

Introduction

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important cereal as it provides more calories than any other cereals. About 40% of the world population consume rice as a major source of calorie (Banik, 1999). Among the major rice growing countries of the world, Bangladesh ranks third in respect of area and fourth in respect of production (BRRI, 2000b). Bangladesh cultivates rice in 10.32 million hectare of land and its average yield is only 2.36 t/ ha (BBS, 2004). Rice provides the staple food of the country and it is cultivated in 76% of the arable land (BBS, 1999). ~~This sector is the most important provider of rural employment (CGIAR, 1999 and IRRI, 1997).~~ It plays a vital role to the economic development of Bangladesh. It contributes about 50% of the total agricultural value added products and engages over 65% of the total agricultural labour force. Besides, the people of this country have to receive their 76% calorie intake and 66% protein intake from rice (BBS, 1996).

Rice is grown in Bangladesh under diverse ecosystems of irrigated, rainfed and deep-water condition in three distinct seasons namely, *aus*, *aman* and *boro* (Rashid, 1994). Out of these, *aman* covers the largest area (about 5.71 million hectare) and the highest production of about 11.25 million metric ton of rice (BBS, 2002).

In Bangladesh, more than four thousand land races of rice are adopted in different parts of this country. Some of these have good quality in respect of fineness, aroma and protein content (Kaul *et al.*, 1982). But the productivity of aromatic rice is very low (Chander and Jitendra, 1996) although it has more demands both internal and external trade

markets. 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. Aromatic rice is used in many ways by the people in the preparation of palatable dishes like *polau, kheer, firny, paish, chira, khoi, biriany, tehary, jarda* etc. It is also sold at higher prices in the market due to its special appeal for aroma and acceptability.

Though rice is the principal food crop but its yield is very low compared to the other rice growing countries of the world. The cultivable area in the country is very limited and there is a little scope to extend the area for production of rice. Actually since 1985, the area under rice cultivation in the country has been continuously declined annually at an average of 0.61% due to urbanization and industrialization (Anwar, 1999). So, vertical means is only the way to increase the rice production. Vertical expansion includes the use of modern production technologies, such as, use of quality seeds, high yielding or hybrid varieties, optimum age of seedlings, adopting appropriate plant protection measures, seedling raising techniques and so on.

Among them seedling age plays a crucial role in obtaining the optimum yields potential of the cultivars because it has a tremendous influence on the plant height, tiller production, panicle length, grain formation, grains/ panicle and other yield contributing characters (Islam and Ahmed, 1981 and BRRI, 1981). The vegetative development of *indica* cultivars is, in general, more affected by age of seedlings than other cultivars (Langfield and Basinski, 1960). Different scientists throughout the world studied extensively the influence of seedling age on growth, yield and yield contributing

characters of rice. Many of them obtained better results from younger and some from older seedlings regarding yield (Alim *et al.*, 1962). Islam (1986) concluded that 25 to 30 day old seedling are the best for transplantation of high yielding varieties of T. *aman* rice especially of photosensitive varieties in Bangladesh. Bangladesh Rice Research Institute (BRRI) also recommended 20 to 30 days old seedlings for transplant *aman* season.

BRRI dhan37 and BRRI dhan38 are the modern varieties of aromatic rice, which have been developed by Bangladesh Rice Research Institute (BRRI). In intensive cropping systems the farmers can not transplant T. *aman* rice with proper ages seedlings due to late harvest of *aus* rice, over flooding condition of cultivable land and lack of proper knowledge regarding the effect of seedling age. Moreover, field performance of aromatic varieties in respect of yield is not good. As a result, farmers are loosing their interest in cultivating aromatic rice. Therefore, there is a vast scope to conduct research activities to evaluate the performance of aromatic rice varieties and to prescribe the suitable variety/varieties and optimum seedling age for cultivation. Some limited research works were performed on these aspects. However, such works on BRRI dhan37 and BRRI dhan38 are scanty. So, present study was conducted with the following objectives:

i. to observe the performance of modern aromatic varieties BRRI dhan37 and BRRI dhan38 under transplanted condition
ii. to find out the optimum age of seedling for maximum yield of transplant aman rice, and
iii. to find out the interaction, if any, between variety and seedling age on the yield and yield components as affected under transplanted condition.

CHAPTER 2

Review of literature

REVIEW OF LITERATURE

Agronomic management is unavoidably necessary for crop production. Among the management practices, the use of good varieties and proper age of seedlings 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 variety and age of seedlings on the performance of some transplant aman rice varieties.

2.1 Effect of variety

2.1.1 Effect on plant characters

2.1.1.1 Plant height

In Bangladesh, BRRI (2000a) evaluated the performance of four varieties viz. Basmati 406(4508), Kataribhog, BRRI dhan34 and Basmati during *aman* season and reported that 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.

Evaluating different hybrid rice lines, Huang *et al.* (1999) observed that a plant height of about 115.8 cm with a culm height of 105.40 cm accompanied by thick and erect v-shaped leaves of deep green colour were found in two lines.

From the results of an experiment, 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.

Om *et al.* (1998) working with hybrid rice cv. ORI 161 and PMS 2A x IR 31802 found taller plants in ORI 161 than PMS 2A x IR 31802.

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. But among others, BR9 produced the highest plant height followed by BR7 and all these were statistically identical with Pajam.

From the results of an experiment, BRRI (1995) showed that the average plant height of BRRI dhan30, BR22, BR23 and Iratom-24 were 120, 125, 120 and 80 cm respectively. In an another study, BRRI (1995) again revealed that the average plants height of BR3, BR7, BRRI dhan29 and Iratom-24 were 95, 125, 95 and 80 cm respectively.

Evaluating the performance of three varieties/advanced lines (Iratom-24, BR14 and BINA 13), BINA (1993) noticed that varieties/advanced lines differed significantly in respect of plant height.

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.

From the results of an experiment, BRRI (1991) showed that plant height differed among the varieties. Shamsuddin *et al.* (1988) also observed that plant height differed significantly among the varieties.

2.1.1.2 Tillering pattern

BRRI (2000a) examined yield performance of three high yielding varieties namely BRRI dhan30, BRRI dhan31, BRRI dhan32 in *aman* season and revealed that effective tillers/ hill of the above mentioned varieties were 7, 8 and 8 respectively.

BINA (1998) while comparing Alok 6201 with Iratom-24, found that number of total tillers/ hill and effective tillers/ hill were maximum in hybrid rice Alok 6201.

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

In a trail, Chowdhury *et al.* (1993) observed that BR23 showed superior performance over Pajam in respect of number of productive tillers/ hill.

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. In local varieties namely, Haloi, Tilockachari, Nizersail and Latishail, number of effective tillers/ hill were 9.7, 9.3, 10.8 and 9.0 respectively (BRRI, 1997).

In a report, BRRI (1991) showed that the number of total tillers/ hill differed significantly among BR3, BR11, BR14, Pajam and Zagali varieties in *boro* season. Hussain *et al.* (1989) while carrying out an experiment with 9 cultivars observed that the number of total tillers/ hill differed among the tested varieties.

Babiker (1986) conducted an experiment with rice cv. Gazi 171 and Gazi 180 and observed that total tillers/ hill were significantly affected by the varieties.

2.1.1.3 Panicle length

In an experiment, BINA (1993) evaluated the performance of four varieties/advanced lines of rice namely, Iratom-24, BR14, BINA 13 and BINA 19. They found that varieties/advanced lines differed significantly in respect of panicle length. It was also reported that each of the varieties BINA 13 and BINA 19 had better physiological characters like CGR, NAR and HI and morphological characters like more grains/ panicle compared to their better parents which contributed to yield improvement in these hybrid lines of rice.

Idris and Matin (1990) conducted an experiment with four rice varieties and found that panicle length differed among the varieties and it was greater in IR 20 than that of any of the indigenous high yielding varieties. They further reported that total number of tillers/ hill was identical among the varieties tested.

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

2.1.1.4 Number of spikelets/ panicle

BRRI (1994) conducted an experiment to see the performance of BR14, Pajam, BR5 and Tulsimala. They observed that Tulsimala produced the highest number of spikelets/ panicle and BR14 produced the lowest number of spikelets/ panicle.

Chowdhury *et al.* (1993) revealed that the variety Pajam produced significantly higher number of total spikelets as well as unfilled spikelets/ panicle than that of BR23.

Devi and Nair (1984) noted that the number of spikelets/ panicle in four drought resistant tall upland rice varieties differed significantly.

2.1.1.5 Number of grains/ panicle

Niu *et al.* (2001) conducted an experiment with three rice varieties viz. Hong 12A/ Tianjin 1244, Hong 21A/ Tianjin 1244 and Hong 264/ Tianjin 1244. Result revealed that grains/ panicle was 186.2, 139.2 and 205.7 respectively.

Kamal *et al.* (1988) reported from the results of an experiment with BR3, IR 20 and Pajam that the number of grains/ panicle was 107.6, 123.0 and 170.9 respectively in the three varieties tested.

BRRI (1994) studied the performance of BR14, Pajam and Tulsimala and reported that Tulsimala produced the highest number of grains/ panicle and BR14 produced the lowest number of grains/ panicle.

Chowdhury *et al.* (1993) found that Pajam produced significantly higher number of grains/ panicle than that of BR23. In an another experiment, Bhowmick and Nayak, (2000) showed that CNHR 2 produced more grains/ panicle (111.0) than any other variety.

Singh and Gangwer (1989) recorded the results of an experiment with four rice cultivars C-14-8, CR-1009, IET-5656 and IET-6314 and found that grains/ panicle was the highest for C-14-8 among the four varieties.

2.1.1.6 Thousand grain weight

Bhowmick and Nayak (2000) studied two hybrids (CNHR2 and CNHR3) and two high yielding varieties (IR 36 and IR 64) of rice. Results showed that IR 36 gave the highest 1000-grain weight (27.7 g) among the four varieties.

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

In an another experiment, BRRI (1998b) found that 1000-grain weight of some aromatic rice varieties ranged from 12 to 20 g and it significantly differed from variety to variety. 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 respectively.

BAU (1998) observed that the modern variety Iratom-24 was found to be better in respect of 1000-grain weight only but other yield components were inferior to hybrid rice Alok 6201.

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

Rafey and Khan (1989) from an experiment with three rice varieties reported that weight of 1000-grain among the varieties differed significantly.

Singh and Gangwer (1989) reported from the results of an experiment with four rice varieties C-14-8, CR-1009, IET-5656 and IET-6314 that weight of 1000-grain was the highest for C-14-8 among the four varieties.

Shamsuddin *et al.* (1988) observed that 1000-grain weight differed significantly among the varieties. They reported that weight of 1000-grain of nine varieties ranged from 21.1 to 31.0 g.

2.1.2 Effect on grain and straw yield

BINA (2001) evaluated the performance of BINA dhan6, a *boro* rice. As compared to other local rice varieties (BRRI dhan29, Tepi and Lakhai) BINA dhan6 performed the best and gave the highest grain yield (4.23 t/ ha) though they possessed much higher straw yield than the modern ones. The yield was attributed the higher panicle/ hill and number of grains/ panicle.

Patel (2000) studied the varietal performance of Kranti and IR36. He observed that Kranti produced significantly higher grain and straw yield than IR36. The increased mean yield of Kranti (10.0%) was due to the production of taller plants, more number of tillers and heavier grain weight as well as stiff straw.

BRRI (2000a) evaluated 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. In Sonagazi and Bogra sadar, the yield performances of advanced lines were excellent with more than 4.0 t/ ha. About 30% higher yield was obtained from the advanced lines over the checks.

Bhowmick and Nayak (2000) found that hybrids gave higher grain and straw yield than HYVs. Rajendra *et al.* (1998) also reported that mean grain yield of hybrid rice cv. Pusa 834 and Pusa HR3 were 3.3 and 5.6 t/ ha respectively.

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).

BINA (1998) conducted a field trial during *boro* rice season of 1997-98. It was found that the hybrid rice Alok 6201 showed 20 - 93% higher grain yield over the modern variety Iratom-24.

BINA (1998) in field trial with seven hybrid rice varieties found that hybrid rice 93024 gave the highest grain yield of 6.04 t/ ha. The lowest grain yield was given by hybrid rice 92017. Alok 6201 gave the grain yield of 5.71 t/ ha.

BRRI (1995) found out the varietal 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 respectively while BRRI (1995b) in another trial observed that BR25 out yielded over BR22 and Nizershail. The farmer preferred BR25 for its finer grain and straw qualities.

Liu Xinhua (1995) conducted a field trial with new indica hybrid rice II-You 92 and found an average yield of 7.5 t/ ha which was 10% higher than that of standard hybrid Shanyou 64.

BRRI (1994) conducted an experiment to see the performance of BR4, Pajam, BR5 and Tulsimala and found that BR14 produced the highest yield (3.75 t/ ha) while BR5 produced the lowest (2.61 t/ ha).

Ali and Murship (1993) conducted an experiment during July to December, 1989 to find out suitable variety for late transplant *aman* rice cv. BR23, BR11 and Kumragoir. They reported that local Kumragoir statistically out yielded than modern varieties (BR23 and BR11).

BINA (1993) evaluated the performance of four varieties/advanced lines of Iratom-24, BR14, BINA13 and BINA19. It was found that grain yield did not differ significantly. Non significant difference in grain yield proved the agronomic potentiality of BINA 19 which produce comparable yield with Iratom-24 and BR14.

Chowdhury *et al.* (1993) conducted an experiment with 2, 4 and 6 seedlings/ hill to study the effect on the yield and yield component of rice cv. BR23 and Pajam during the *aman* season. From the results of the experiment, they reported that the variety BR23 showed superior performances over Pajam in respect of yield and yield contributing characters.

In an another experiment, Rao *et al.* (1993) found that the highest grain yield was given in the wet seasons by local variety Badshabhog (3.21 t/ ha) than the other ones (cv. Kastui, Ranbir, Basmati and IET 8579) mean yields varied from 2.22 - 2.58 t/ ha.

Khan (1991) concluded from a field trail that grain yield was higher in cv. CSRV than BR6. Grain yield of BINA-B and BINA19 were 5.39 and 5.57 t/ ha respectively.

Shamsuddin *et al.* (1988) conducted an experiment at the Agronomy Field Laboratory, BAU, Mymensingh to evaluate the performance of nine modern varieties BR1, BR2, BR3, Purbachi, IR8, BR6, BR7, BR8 and BR9. Maximum grain yield was found in BR1 (5.05 t/ ha) and minimum in Purbachi (2.31 t/ ha). Minimum straw yield was produced by BR7 (7.46 t/ ha) and maximum by Purbachi (12.80 t/ ha).

BRRI (1985) conducted a regional yield trial during *aman* season to find out the performance of modern and local varieties BR4, BR10, Rajashail and Kajalshail and found that BR4 and BR10 were better than Rajashail and Kajalshail. Babikar (1986) from

an another field trial reported that grain yield was significantly influenced by rice varieties.

Miller (1978) found that the grain yield ranged from 5.6 t/ ha to 7.7 t/ ha among the varieties he studied. Kubher and Sonar (1978) reported variable effects of rice varieties on grain yield.

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 respectively.

2.2 Effect of seedling age

2.2.1 Effect on growth attributes

2.2.1.1 Plant height

Akber (2004) conducted an experiment with 10 and 15 days old seedlings. He observed that plant height differed significantly due to different ages of seedlings. Fifteen days old seedlings appeared to be taller at the early stage of the crop growth which lasted up to 45 DAT (Days after transplanting). But after 45 DAT, both 10 and 15 days old seedlings grew faster. At the final harvest, the plant height of both the seedling ages was found to be statistically similar (139.34 cm and 141.09 cm for 10 and 15 days old seedlings respectively).

Haque (2002) stated that the tallest plant height was recorded from 15 days old seedlings, which differed significantly when compared with 25, 35, and 45 days old seedlings. The shortest plant was obtained from 45 days old seedlings.

Hossain (2001) reported that the higher height of the old seedlings in seedbed caused earlier growth in plant height in the main field. But young seedlings grew faster than older ones (35 to 60 days old seedlings).

Rahman (2002) reported that younger seedlings had a tendency to produce the tallest plant than older ones.

Razzaque *et al.* (2000) reported that seedling age had significant effect on plant height. The 30 days old seedlings produced the tallest plants followed by the seedlings of 45 days and 60 days old seedlings which produced shorter plants.

Kim *et al.* (1999) transplanted three rice cultivars namely, Namweonbyeo (early maturing), Hwaseongbyeo (medium maturing) and Dongjinbyeo (medium late maturing) at three different seedling ages to investigate their growth habits. They observed that the 10 days old seedlings showed more vigorous elongation of plants when compared with 35 or 40 days old seedlings. Shi *et al.* (1999) also observed that culm height decreased with increasing transplanting age.

2.2.1.2 Tillering pattern

Akber (2004) reported that number of total tillers/ hill was significantly influenced by the seedling age in all growth stages. From the results of his experiment, he found that younger plants produced higher number of total tillers/ hill up to 45 DAT and then it gradually decreased. At 45 DAT, 15 days old seedlings produced the highest number of total tillers/ hill (34.93) whereas 25 days old seedlings gave the lowest (28.56).

Hossain (2001) stated that the highest number of effective tillers/ hill (11.31 out of 12.29 total tillers/ hill) and the lowest number of non bearing tillers/ hill (0.98 out of 12.29 total tillers/ hill) were produced from 15 days old seedlings.

Kim *et al.* (1999) found that 10 days old seedlings had higher tillering ability but with lower effective tillering rate when compared with 35 or 40 days old seedlings.
Khatun (1995) observed that the tiller production was higher with 30 days old seedlings in transplant *aman* season than others.

Roy and Sattar (1992a) observed that the tillering rate was influenced by seedling age. The absolute tillering rate was more in younger seedlings. When the seedling ages were increased, the tillering rate gradually decreased. They have also stated that within a variety, total number of tillers/ hill decreased when the seedling age was increased.

Mamun and Siddique (1990) carried out a field experiment at BRRI to evaluate growth and yield of rice cv. BR11, BR22, BR23 and Nizershail with the seedlings of 30, 40 and 60 days old. Tiller numbers did not differ significantly with seedling age in BR11 and Nizershail. But the tiller production of BR22 rice was inversely related to seedling age.

Aragones and Wada (1989) reported that transplanting of younger seedlings had a positive influence in increasing the number of total tillers. However, the aged seedlings decreased the number of both total and bearing tillers.

Hossain and Haque (1988) found from a research work that the number of basal tillers/ hill increased with 30 days old seedlings than 60 days old seedlings.

Koshta *et al.* (1987) conducted an experiment with rice cultivars as experimental material using three age of seedlings and found that 20 days old seedlings produced more tillers/ hill as compared to seedling age of 28 and 36 days.

Mandal *et al.* (1984) also observed that the number effective tillers retarded when aged seedlings were transplanted.

Mejos and Pava (1980) in a trail with 10, 20, 30 and 40 days old seedlings of two rice cultivars showed that the number of productive tillers were not affected by the seedling age but differed significantly between cultivars.

Seedling age of rice had a remarkable bearing on its tillering pattern. Singh and Tarat (1978) reported that the highest number of tillers was observed from medium and long duration varieties with 29 days old seedlings. The short duration variety produced lower number of tillers when transplanted with the increased seedling age.

Enyi (1963) observed that the maximum number of tillers was produced by 30 days old seedlings than that of older seedlings. The slow recovery of older seedlings resulted the lower number of tillers as compared to younger ones.

2.2.2 Effect of seedling age on yield contributing characters

2.2.2.1 Number of total and sterile spikelets/ panicle

Khisha (2002) found that the highest number of sterile spikelets/ panicle was obtained from 16 days old seedlings.

Reddy and Narayana (1981) observed that number of total spikelets/ panicle decreased significantly with each 10 days increase in seedling age. Spikelet sterility was 14.0, 9.7 and 8.1% in 20, 30 and 40 days old seedlings respectively.

2.2.2.2 Number of grains/ panicle

Razzaque *et al.* (2000) reported that seedling age showed significant variation in respect of number of grains/ panicle. The highest number of grains was recorded from the lowest seedling age (30 days old) and the lowest number of grains/ panicle was produced by the oldest seedlings (60 days old).

Yoshii *et al.* (1998) reported that transplanting of 10, 15 and 20 days old seedlings showed significant variation in respect of yield components and 20 days old seedlings had the highest number of grains per unit area.

Roy *et al.* (1992b) reported that the number of grains/ panicle slightly decreased with the increased of seedlings age in rice cv. BR14 and IR50. IR50 produced more panicles but less number of grains/ panicle than BR14. The highest number of grains/ panicle was obtained from 28 days old seedlings in case of 60 days old seedlings.

Ashraf *et al.* (1989) conducted an experiment where two varieties of Basmati rice were planted with 30, 45 and 60 days old seedlings. From the results of the experiment, they reported that yield and yield attributes declined significantly with increased seedling age. The yield decline was partly attributable to fewer productive tillers/ hill and fewer spikelets/ panicle. They also observed that 30 days old seedlings gave higher yield followed by 45 and 60 days old seedlings.

Ghosh *et al.* (1960) observed that the yield contributing characters of a variety was influenced to some extent by the age of seedling. Mutry and Sahu (1979) showed that transplanting of older seedling increased the grains/ panicle but decreased the plant height and spikelet sterility.

2.2.2.3 Thousand grain weight

Kamdi *et al.* (1991) reported that grain weight (1000-grain weight) was decreased with aged seedlings used for transplanting. It was concluded from the result of an experiment with 30, 35 and 60 days old seedlings that 30 days old seedlings significantly increased 1000-grain weight. Mori *et al.* (1994) and Mozumder (1997) also found that the seedlings of 15 and 30 days old produced a significant effect on 1000-grain weight.

Mohapatra and Kar (1991) conducted an experiment with 30, 35 and 60 days old seedlings and found that 30 days old seedlings increased 1000-grain weight significantly. Kamdi *et al.* (1991) also reported that 1000-grain weight was decreased when aged seedlings were transplanted.

Raju *et al.* (1989) conducted an experiment with 30, 45 and 60 days old seedlings, which gave the yield of 4.85, 4.40 and 1.19 t/ ha respectively. Number of grains/ panicle and 1000-grain weight was also the highest at 30 days old seedlings.

Reddy and Narayana (1981) observed that number of grains/ panicle, panicle length and weight of 1000-grain decreased significantly with each 10 days increase in seedling age.

Mejos and Pava (1980) in a trail with 10, 20, 30 and 40 days old seedlings of two rice cultivars showed that grains/ panicle, 1000-grain weight and grain yield differed significantly.

2.2.3 Effect of seedling age on grain yield

Khan (2004) reported that grain yield of rice was significantly influenced by age of seedlings. The highest grain yield (5.86 t/ ha) was obtained from 15 days old seedlings. The lowest grain yield (4.42 t/ ha) was recorded from 9 days old seedlings.

From the field study at Kumarganj, Uttar Pradesh, Singh and Singh (1999) reported that irrigated rice cv. Sarjoo-52 transplanted with 3 seedling ages viz. 25, 35 and 45 days old seedlings gave yield of 4.92, 4.64 and 4.22 t/ ha respectively.

Shi *et al.* (1999) carried out an experiment with rice crop and tested 25, 30, 35, 40 and 45 days old seedlings in terms of grain yield. They found that yield was negatively correlated with seedling age at transplanting. Mean yields were 6.7, 6.5, 5.9, 4.7 and 4.5 t/ ha with transplanting 25, 30, 35, 40 and 45 days old seedlings respectively. Yield with 25 or 30 days old seedlings were significantly higher than that with 40 or 45 days old seedlings.

Hundal *et al.* (1999) conducted a research work to observe the effects of various seedling age of rice on yield. They reported that earlier transplanted rice performed better when the seedling age was reduced from 40 to 30 days. Younger seedlings (20 days old) proved better than older (40 days) ones when other variables were kept constant.

Sanbagavalli *et al.* (1999) also observed that 30 days old seedlings of rice cv. ADT38 gave higher yield than 20 or 40 days old seedlings of the same varieties.

Lu *et al.* (1999) in an another experiment with 20, 25, 35, 40, 50 and 55 days old seedlings found that yield decreased with delayed transplanting.

In an experiment, Anita and Dasgupta (1998) used four different ages of seedling (40, 50, 60 and 70 days old) for transplanting. From the results, they observed that early transplanting was highly productive (yield 2.61- 2.99 t/ ha) while delayed transplanting (up to 60 day old) decreased yield (2.28 - 2.52 t/ ha).

Singh and Singh (1998) transplanted 25, 35 and 45 days old seedlings of rice and observed that yield component values and yield decreased with increasing age of seedlings.

Channabasappa *et al.* (1997) conducting an experiment with rice cv. Sonamahsuri and IR-64 reported that the cultivar's yields did not differ significantly but it was the highest with 35 days old seedlings when compared with those of 25, 35 and 45 days old seedlings.

Villela and Junir (1996) in an experiment used 21, 28, 35, 42, 49 and 56 days old seedlings and observed that seedlings older than 28 days caused reduction in grain yield. The best yield was achieved with the use of 28 days old seedlings.

From the results of an experiment, Islam and Ahmed (1981) found that 30 days old seedlings gave significantly the highest grain yield than those of 20 and 40 days old seedlings.

Larrea and Sanchez (1972) reported that the yield of grain decreased with the increasing age of seedling at transplanting and maximum yield was obtained from cv. IR8 when 30 days old seedlings were transplanted.

Seerai (1972) also reported that 25, 30, or 35 days old seedlings of IR8 and Kao Dogmalle105 gave higher yields than 20 or 40 days old seedlings of the same varieties.

BRRI (1967) observed that the seedling aged over 30 days when transplanted in the field recovered more slowly than the younger ones. Particularly when they suffered from stems and roots injuries. The slow recovery resulted in a reduction of grain yield.

Rao (1961) conducted an experiment and found that transplanting of 30 days old seedlings proved to produce higher yield. It was reported that the optimum seedling age was 30 - 40 days which showed higher production in *aman* season (Alim *et al.*, 1962).

2.2.4 Effect of seedling age on straw yield

Rashid *et al.* (1990) reported that 40 days old seedlings gave higher straw yields than 20 and 60 days old seedlings. Whereas Das and Mukherjee (1989) reported that seedling age had no effect on straw yield.

Panikar *et al.* (1981) from an experiment observed that the straw yield significantly increased with 21 days old seedlings than that of 28 or 35 days old seedlings. Similarly Alim *et al.* (1962) found three weeks old seedlings gave the maximum straw yield.

Rao (1976) showed that the straw yield was the highest with younger seedlings (25 days old) than older seedlings (35 and 45 days).

CHAPTER 3

Materials and methods

MATERIALS AND METHODS

Details of different materials used and methodologies followed in the experiment are presented in this chapter.

3.1 Location

The experiment was carried out at the Agronomy Field Laboratory, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from July 11, 2006 to December 04, 2006 to study the effect of seedling age on the yield of two modern varieties of aromatic rice.

3.2 Soil

The soil of the experimental area belonged to the Modhupur tract (AEZ No. 28). It was a medium high land with non-calcarious dark grey soil. The pH value of the soil was 5.6.

3.3 Climate

The experimental area was under the subtropical climate and was characterized by high temperature, high humidity and heavy precipitation with occasional gusty winds during the period from April to September, but scanty rainfall associated with moderately low temperature prevailed during the period from October to March. The detailed meteorological data in respect of air temperature, relative humidity, rainfall and sunshine hour recorded by the Dhaka meteorology centre, Dhaka for the period of experimentation have been presented in Appendix IV.

3.4 Experimental details

3.4.1 Treatment

Two factors were included in the experiment namely, variety and seedling age. The treatments were designated as follows:

Factor A. Rice variety: 2 (Two)

i. BRRI dhan37 (V_1)

ii. BRRI dhan38 (V_2)

Factor B. Seedling age: 6(Six)

i. 15 days old seedling (A_{15})

ii. 20 days old seedling (A_{20})

iii. 25 days old seedling (A_{25})

iv. 30 days old seedling (A_{30})

v. 35 days old seedling (A_{35})

vi. 40 days old seedling (A_{40})

3.4.2 Varietal description

BRRI dhan37

The variety was released by Bangladesh Rice Research Institute (BRRI) in 1998 as transplanting *aman* rice. It was developed from the cross between Basmati and BR 5 (Dulabhog). The genetic line number of the variety was BR4384-2B-2-2-2HR3. Average plant height was 125 cm. The panicle looked attractive due to densely arranged spikelets and spikelets bore small awn. The grain colour, size and scented just like Kataribhog. Its

growth duration was 140 days and average yield was 3.5 t/ ha. It was a photosensitive variety (BRRI, 2000).

BRRI dhan38

The variety was released by Bangladesh Rice Research Institute (BRRI) in 1998. It is recommended for *aman* season. It was a photosensitive variety. It was developed from the cross between Basmati and BR 5 (Dulabhog). The genetic line number of the variety is BR4384-2B-2-2-4. Plant of this variety was stronger than that of Basmati. The panicle looked attractive due to densely arranged spikelets and spikelets bore long sharp awn at the end. The grain and awn of this variety was golden white. It was scented rice. Its grain was elongated and fine. It was moderately resistant to leaf blight diseases (BRRI, 2000).

3.5 Experimental design and layout:

The experiment was laid out in a Randomized Complete Block Design (Factorial) with three replications. Each block was divided into twelve unit plots. Total numbers of unit plots were 36. The net size of unit plot was 10 m^2 (4.0 m x 2.5 m). The distance mentioned between two unit plots was 0.75 m and blocks was 1.5 m. The treatments were allocated randomly.

3.6 Procedure of the experiment

3.6.1 Seedling raising

3.6.1.1 Seed collection

Certified seeds of two modern aromatic rice varieties namely BRRI dhan37 and BRRI dhan38 were collected from Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur.

3.6.1.2 Seed sprouting

Healthy seeds were selected by specific gravity method and immersed in water in a bucket for 24 hours. Then the seeds were taken out of water and spread thickly under gunny bags. The seeds started sprouting after 48 hours and were sown after 72 hours.

3.6.1.3 Preparation of seedling nursery and seed sowing

Seedling nurseries for each variety were prepared by puddling the soil. Sprouted seeds were sown in the wet nursery bed. Weeds were removed and irrigation was given in the seedbed as and when necessary. Seedlings were raised in the same seedbed to obtain the 15, 20, 25, 30, 35 and 40 days old seedlings of two varieties. Seeds were sown in the bed on July 11, 2006.

3.6.2 Land preparation

The experimental field was opened by a tractor driven rotavator 15 days before transplanting. It was then ploughed well to make the soil nearly ready for transplanting. Weeds and stubble were removed and the field was leveled by laddering. The experimental field was then divided into unit plots that were spaded one day before transplanting for incorporating the fertilizers applied as basal. Finally individual plots were prepared before transplantation.

3.6.3 Fertilizer application

The field was fertilized with 220, 80, 120, 55 and 10 kg/ ha urea, TSP, MP, gypsum and zinc sulphate, respectively as per recommendation of BRRI (2000). The whole amounts of TSP, MP, gypsum and zinc sulphate were applied at final land preparation. Urea was top dressed as per specification in three equal splits on 10 day after transplanting (DAT)

at maximum tillering stage on 30 DAT and at panicle initiation stage on 55 DAT (BARC, 1989).

3.6.4 Uprooting seedlings

The nursery beds were made wet by the application of water both in morning and evening on the previous days before uprooting the seedlings. Without causing any mechanical injury to the roots, the seedlings were uprooted and kept on soft mud in shade before they were transplanted.

3.6.5 Transplanting of seedlings

Seedlings of 15, 20, 25, 30, 35 and 40 days old were transplanted on the well puddled experimental plot on July 26, 31, August 5, 10 and 15, 2006 respectively in main field at the rate of 3 seedlings/ hill with 25 cm spacing between the line and 15 cm spacing between the hills.

3.6.6 Intercultural operations

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

3.6.6.1 Gap fillings

Seedlings in some hill died off and those were replaced by the healthy seedlings within seven days of transplanting with the seedlings taken from the same source.

3.6.6.2 Weeding

The experimental plots were weeded three times at 15, 30 and 45 DAT respectively. Shama (*Echinochloa crusgalli*) was the prominent weeds found in the experimental plots

3.6.6.3 Irrigation and drainage

Experimental plot was given flood irrigation to maintain a constant level of standing water up to 6 cm at the early stage to enhance tillering and 10 - 12 cm in later stage to discourage late tillering. A total of seven irrigation was needed throughout the growing season. The field was finally drained out before 15 days of harvest to enhance maturity.

3.6.6.4 Plant protection measures

Plants were infested by rice hispa (*Dicladispa armigera*) and rice stem borer (*Sesamia inferens*) to some extent which was successfully controlled by applying Diazinon @ 10ml/ 10 Liter of water for 5 decimal lands and Ripcord @ 10ml/ 10 Liter of water for 5 decimal lands. It was also infested by stem rot disease caused by *sclaritium oryzae*, a soil born fungus that was controlled by applying Bavistin 50WP. It was also protected from birds at grain filling period. For controlling the birds watching was done properly.

3.6.7 Harvesting and processing

The crop was harvested at full maturation 145 days of transplanting. The crop of individual plot was threshed by hand. Grains were cleaned and sun dried to moisture content of 14%. Straws were sun dried properly. Finally the grain and straw yield/ plot were recorded and converted into t/ ha.

3.7 Data collection

Data had been recorded for measuring growth and yield parameters. For this reason, five hills (excluding border hill) from each plot was selected randomly and tagged for measuring the following characters at 25, 40 and 55 DAT and at harvest 5 hills were selected at random from each unit plot for collecting data on following parameters:

i. Plant height (cm)

ii. Total number of tillers/ hill

iii. Number of effective tillers/ hill

iv. Number of non-effective tillers/ hill

v. Panicle length (cm)

vi. Total number of spikelets/ panicle

vii. Number of sterile spikelets/ panicle

viii. Number of grains/ panicle

ix. Weight of 1000 grains (g)

x. Grain yield (t/ ha)

xi. Straw yield (t/ ha)

xii. Biological yield (t/ ha)

xiii. Harvest index (%)

A brief outline of data collection procedure is given below:

i. Plant height

The height was taken from the base of plants to the tip of the leaf or panicle which was seemed to be on the top and was expressed in cm.

ii. Total number of tiller/ hill

Number of tillers was counted from the selected hills. Tillers that had at least three leaves were considered. At harvest, it included both bearing and non-bearing tillers.

iii. Number of bearing tillers/ hill

The panicle, which had at least one grain, was considered as bearing tiller.

vi. Number of non-bearing tillers/ hill

The panicle that had no grain was considered as non-bearing tiller.

v. Panicle length

Panicle length was recorded from the basal node of the rachis to the apex at each panicle.

vi. Number of total spikelets/ panicle

Number of spikelets both sterile and non-sterile of each panicle was counted.

vii. Number of sterile spikelets/ panicle

Spikelet lacking any food material inside was considered as sterile spikelet and such spikelets present on each panicle were counted.

viii. Number of grains/ panicle

Presence of any food material in the spikelet was considered as grain and total number of grains present on each panicle was counted.

ix. Weight of 1000-grains

One thousand clean dried grains obtained from each plot were counted from the seed lot and weighted by using an electric balance.

x. Grain yield

The grain obtained from each unit plot was threshed from the plants, cleaned, dried and then weighed carefully. The dry weight of grains from the plants of sample hills was converted to record the final yield/ plot. The grain yield was eventually converted to t/ ha.

xi. Straw yield

Straw yield from each unit plot including the straw of five sampled hills dried in the sun and weighed to record the final straw yield and finally converted it to t/ha.

xii. Biological yield

Grain yields together with straw yield were regarded as biological yield. The biological yield was thus calculated with the following formulae:

Biological yield = Grain yield + Straw yield.

xiii. Harvest index

Harvest index is the ratio of economic yield to biological yield and was calculated with the following formulae (Gardner *et al.*, 1985):

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

3.8 Statistical analysis

Data recorded for different parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done following computer package MSTAT programme. Mean differences among the treatments were tested with Least Significant Differences (LSD) at 5% level.

CHAPTER 4

Results and discussion

RESULTS AND DISCUSSION

The experimental results regarding the effect of varieties, age of seedlings and their interaction on the yield and yield components of modern aromatic T. *aman* rice have been presented and discussed in this chapter. The effects of variety and seedling age on growth, yield and yield contributing characters have been shown in Fig. 1 to 18. The interaction effect of variety and seedling age on growth, yield and yield contributing characters have been presented in Table 1 to 6.

4.1 Growth attributes at different sampling dates

Effect of variety and age of seedlings on different vegetative growth parameters, such as plant height and number of tillers/ hill are discussed below.

4.1.1 Plant height (cm)

4.1.1.1 Effect of variety

The growth behaviors of the two rice varieties in terms of plant height differed significantly at all sampling dates (Fig. 1). From the results, it was found that BRRI dhan37 produced taller plants from the early stage of the crop growth to final harvest. At 25 DAT (days after transplanting), BRRI dhan37 produced taller plants (61.05 cm) whereas shorter ones (58.41 cm) were produced by BRRI dhan38. At 40 DAT, BRRI dhan37 produced taller plants (86.70 cm) but shorter ones (85.12 cm) were recorded from BRRI dhan38. At 55 DAT, taller plants (102.69 cm) were found from BRRI dhan37 whereas shorter ones (101.30 cm) were recorded from BRRI dhan38 and at harvest, taller plants (138.63 cm) were produced by BRRI dhan37 but shorter ones (132.40 cm)

were recorded from BRRI dhan38. Although plant height is mostly governed by the genetic make-up of the varieties, the environmental factors also influence it to a great extent. Therefore, the variation in plant heights was probably due to the genetic make-up of the varieties, which was also the fact as reported by BRRI (2000) working on varieties.

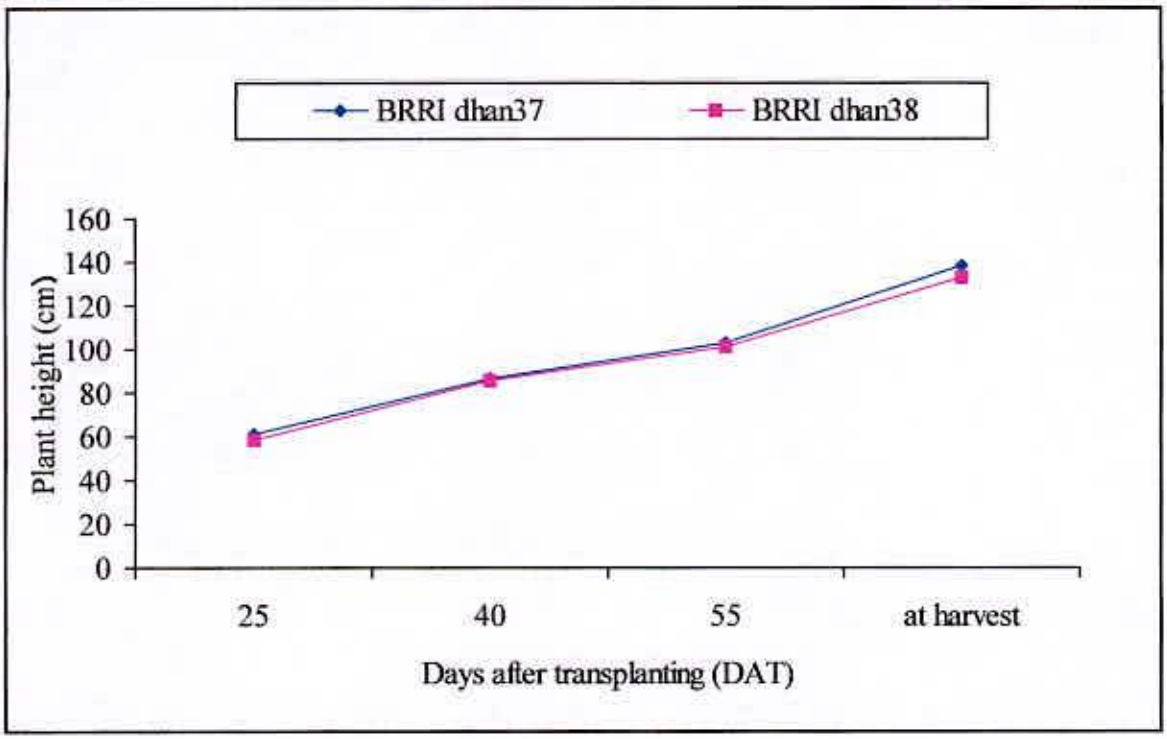

Fig. 1. Effect of variety on the plant height of aromatic rice at different days after transplanting.

4.1.1.2 Effect of seedling age

It was observed that plant height differed significantly due to age of seedlings (Fig. 2). The tallest plants were produced by the 15 days old seedlings at all stages of growth except at 25 DAT and the shortest plants were produced by the 40 days old seedlings at all growth stages except at 25 and 40 DAT. At 25 DAT, the tallest plants (72.81 cm) were produced by the 40 days old seedlings whereas the shortest ones (47.87 cm) were produced by the 15 days old seedlings. Higher height of the old seedlings while in

seedbed probably also caused earlier growth in the main field. At 40 DAT, 15 days old seedlings produced the tallest plants (95.29 cm) whereas the shortest ones (78.23 cm) were observed in 30 days old seedlings. Intermediate plants height (84.49cm) was produced by 40 days old seedlings, which was statistically similar with 35 days old seedlings. At 55 DAT, the tallest plants (109.86 cm) were found in 15 days old seedlings whereas 40 days old seedlings showed the shortest ones (91.07 cm). But 40 days old seedlings produced intermediate plants height (99.86 cm), which was followed by 35 days old seedlings. At harvest, 15 days old seedlings produced the tallest plants (141.89 cm) whereas 40 days old seedlings produced the shortest ones (125.40 cm). It was thus evident that younger seedlings produced the tallest plant and older seedlings produced shorter plant. This result is in agreement with that of Rahman (2002). He reported that the younger seedlings had a tendency to produce the tallest plant than the older ones. Akber (2004) reported plant height differed due to seedling age. He also reported that younger seedling when transplanted produce the tallest plant at the final harvest.

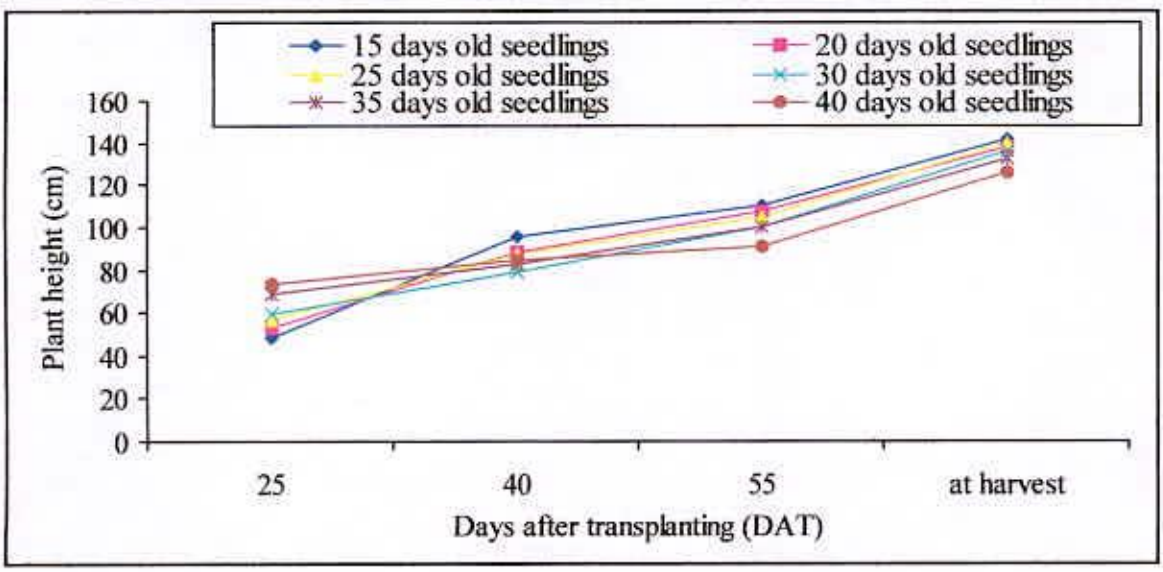

Fig. 2. Effect of seedling age on the plant height of aromatic rice at different days after transplanting.

4.1.1.3 Interaction effect between variety and seedling age

The interaction effect between variety and age of seedling on plant height was significant at all stages of growth except at harvest (Table 1). At 25 DAT, the tallest plants (74.95 cm) were produced from BRRI dhan37 with 40 days old seedlings whereas the shortest ones (46.58 cm) were produced from BRRI dhan38 with 15 days old seedlings. Intermediate plant height was 60.31 cm, which was produced from BRRI dhan38 with 30 days old seedlings. At 40 DAT, the tallest plants (95.52 cm) were produced from BRRI dhan38 with 15 days old seedlings which was statistically similar with BRRI dhan37 with

Table 1. Interaction effect of variety and seedling age of aromatic rice on the plant height at different days after transplanting

Treatment (Variety x seedling age)	*Plant height (cm)*			
	25 DAT	*40 DAT*	*55 DAT*	*At harvest*
$V_1 A_{15}$	49.15	95.07	109.02	145.83
$V_1 A_{20}$	52.87	90.37	108.55	142.00
$V_1 A_{25}$	57.05	88.35	104.23	141.53
$V_1 A_{30}$	58.87	77.95	100.10	140.55
$V_1 A_{35}$	73.38	85.07	99.78	135.53
$V_1 A_{40}$	74.95	83.39	94.48	126.33
$V_2 A_{15}$	46.58	95.52	110.70	134.62
$V_2 A_{20}$	52.87	84.73	105.33	134.13
$V_2 A_{25}$	56.53	86.40	104.87	137.00
$V_2 A_{30}$	60.31	78.51	99.62	132.27
$V_2 A_{35}$	63.53	79.97	99.61	128.55
$V_2 A_{40}$	70.67	85.59	87.67	124.47
LSD (0.05)	1.052	2.978	0.792	NS
CV (%)	11.04	11.05	10.46	7.97

V_1 = BRRI dhan37, V_2 = BRRI dhan38 and A = Age of seedlings, subscripted number after A denotes days after sowing.

15 days old seedlings. The second highest plants (90.37 cm) were produced from BRRI dhan37 with 20 days old seedlings followed by 25 days old seedling. The shortest plants (77.63 cm) were recorded from BRRI dhan37 with 30 days old seedlings which was statistically similar with BRRI dhan38 with 30 and 35 days old seedlings. At 55 DAT, both the tallest (110.70 cm) and the shortest plants (94.48 cm) were produced from BRRI dhan38 with 15 and 40 days old seedlings respectively. The second highest plants (109.02 cm) were produced by BRRI dhan37 with 15 days old seedlings followed by 20 days old seedlings. At harvest, 15 days old seedlings produced tallest plants (145.83 cm) and the shortest plants (124.47 cm) were observed from BRRI dhan38 with 40 days old seedlings. Intermediate plant height (137.00 cm) was produced from BRRI dhan38 with 25 days old seedlings, which was statistically similar with BRRI dhan37 with 35 days old seedlings.

4.1.2 Number of total tillers/ hill

4.1.2.1 Effect of variety

It is evident from Fig. 3 that the number of total tillers/ hill was significantly influenced by variety at all stages of growth up to harvest. At all stages of growth up to harvest, BRRI dhan38 produced significantly higher number of tillers (9.71, 15.72, 14.49 and 8.64 respectively) compared to BRRI dhan37 (9.56, 15.18, 14.44 and 8.24 respectively) but they were statistically similar. In case of both the varieties, total number of tillers/ hill continued to increase up to 40 DAT and thereafter it gradually decreased. This difference in the number of total tillers/ hill could be due to genetic variation between varieties. This fact is in agreement with that of Hussain *et al.* (1989). He observed in an experiment that total tillers/ hill differed among the varieties.

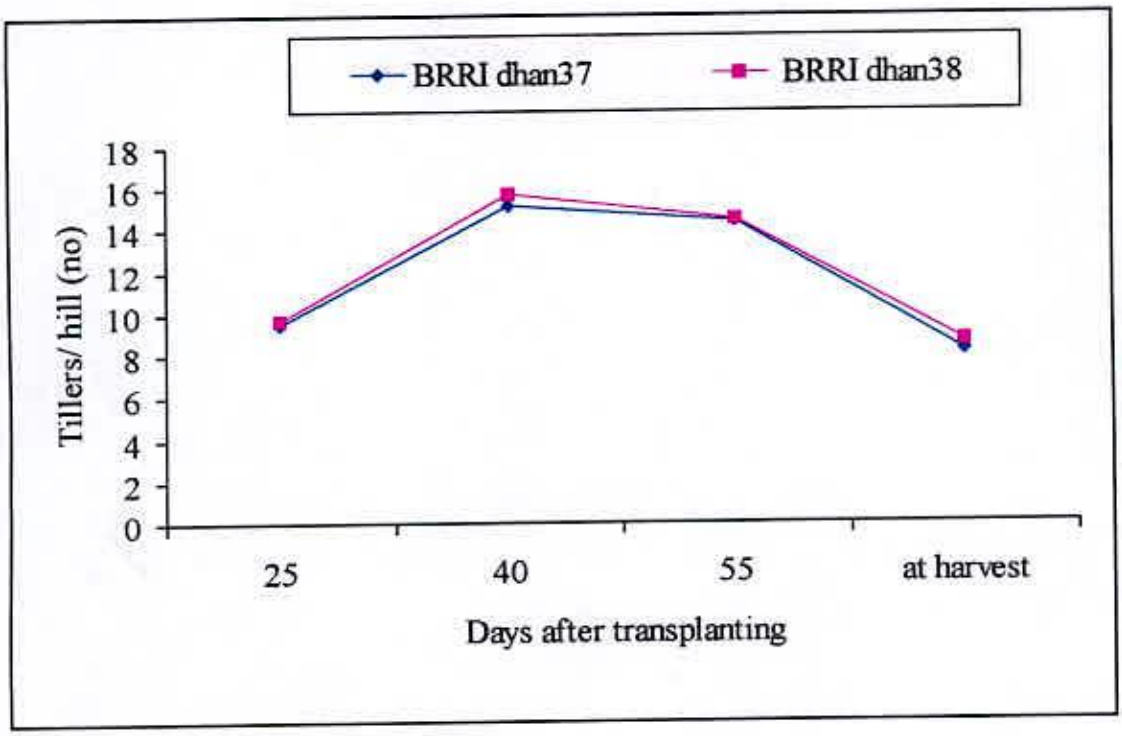

Fig. 3. Effect of variety on the number of total tillers/ hill of aromatic rice at different days after transplanting

4.1.2.2 Effect of seedling age

Number of total tillers/ hill was significantly influenced by age of seedling at all stages of growth (Fig. 4). Fifteen days old seedlings produced the significantly highest number of tillers/ hill (12.73, 20.70, 18.64 and 8.89 respectively) at all stages of growth (25, 40, 55 DAT and at harvest respectively) whereas the lowest one (6.93, 9.78, 11.04 and 7.47 respectively) from 40 days old seedlings. At 25 DAT, intermediate tillers (10.20) were produced from 25 days old seedlings, which was statistically similar with that of 20. At 55 DAT, the maximum tillers (18.77) were statistically similar with that of 20 days. At harvest, the highest tillers (8.89) were produced from 15 days old seedlings which was statistically similar with that of 20, 25 and 30 days. The lowest tillers (7.47) were produced from 40 days old seedlings. In case of all ages of seedlings, total number of tillers/ hill continued to increase up to

40 DAT and thereafter it gradually decreased except 40 days old seedlings. Akber (2004) also found similar trend. From the results, he stated that number of total tillers/ hill was significantly influenced by the seedling age in all growth stages. He also found that younger plants produced higher number of total tillers/ hill up to 45 DAT and then it gradually decreased. The seedlings over 30 days old when transplanted in the field recovered more slowly than the younger ones, particularly when they suffered stems and root injuries. The slow recovery of older seedlings resulted the lower number of total tillers as compared to younger ones. Singh and Tarat (1978) also found similar results.

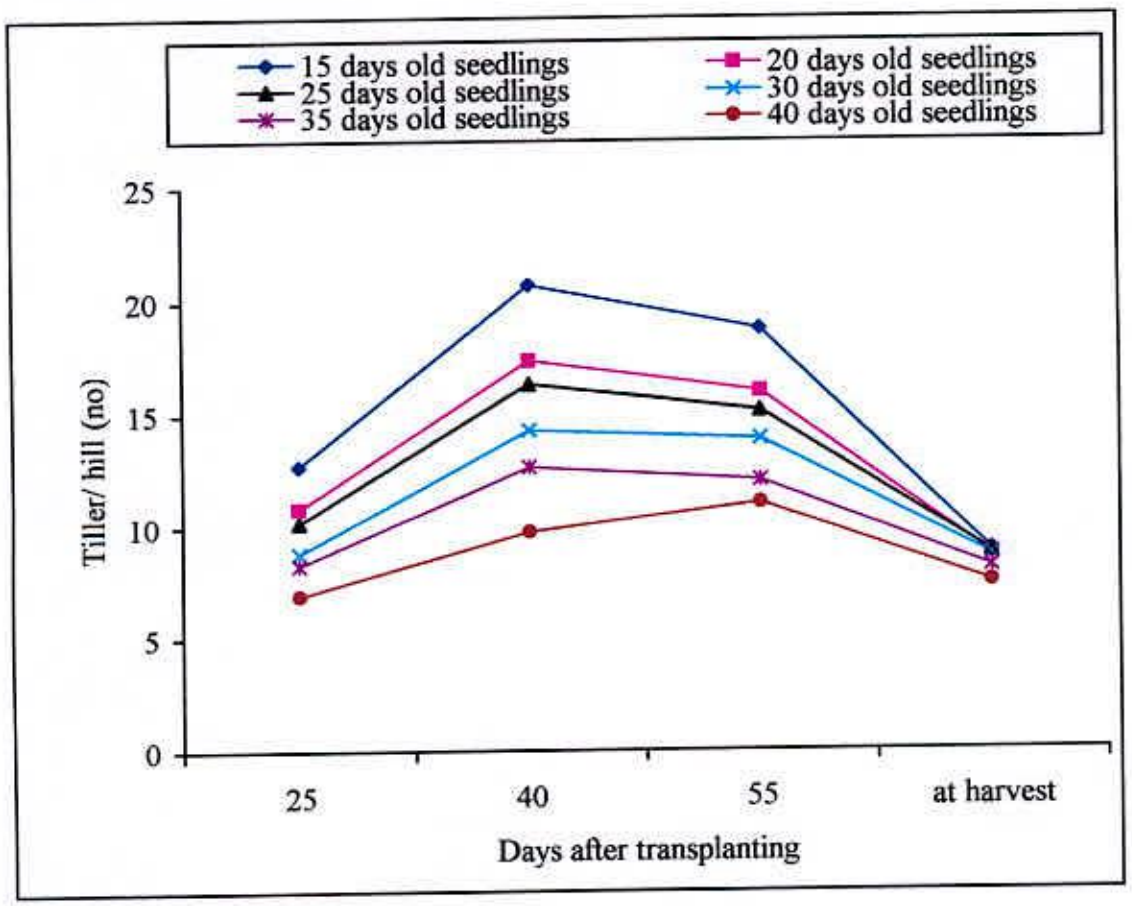

Fig. 4. Effect of seedling age on the number of total tillers/ hill of aromatic rice at different days after transplanting

4.1.1.3 Interaction effect between variety and seedling age

The interaction effect between variety and age of seedlings on number of total tillers/ hill was significant at early stages of growth (25 and 40 DAT) but at later stages (55 DAT and at harvest) was not differed significantly (Table 2). At all stages of growth except 55 DAT, BRRI dhan37 with 40 days old seedlings produced the lowest number of tillers (6.90, 9.51 and 7.07 respectively). At 25 DAT, combination of BRRI dhan38 with 15 days old seedlings produced significantly the highest tillers (12.80) which was statistically similar with that of BRRI dhan37 whereas the lowest ones (6.90) from BRRI dhan37 with 40 days old seedlings also similar with that of BRRI dhan38. At 40 DAT, the highest (20.87) and second highest (20.53) tillers were produced from BRRI dhan37 and BRRI dhan38 respectively with 15 days old seedlings and they are statistically similar. At 55 DAT, the highest tillers (18.90) were produced from BRRI dhan37 with 15 days old seedlings. At harvest, the highest (9.10) and lowest (7.07) was observed from the combination of BRRI dhan38 with 15 and BRRI dhan37 with 40 days old seedlings respectively. Intermediate tillers (8.07) were produced from BRRI dhan38 with 35 days old seedlings.

Table 2. Interaction effect of variety and seedling age of aromatic rice on the number of total tillers/ hill at different days after transplanting

Treatment (Variety x seedling age)	*Total number of tillers/ hill*			
	25 DAT	*40 DAT*	*55 DAT*	*At harvest*
$V_1 A_{15}$	12.65	20.87	18.90	8.67
$V_1 A_{20}$	10.95	18.13	16.57	8.47
$V_1 A_{25}$	10.10	15.60	14.12	8.62
$V_1 A_{30}$	8.50	14.27	13.79	8.42
$V_1 A_{35}$	8.25	12.67	12.02	8.21
$V_1 A_{40}$	6.90	9.51	11.21	7.07
$V_2 A_{15}$	12.80	20.53	18.64	9.10
$V_2 A_{20}$	10.70	16.67	15.43	8.93
$V_2 A_{25}$	10.30	17.07	16.18	9.00
$V_2 A_{30}$	9.15	14.33	14.00	8.87
$V_2 A_{35}$	8.35	12.67	12.09	8.07
$V_2 A_{40}$	6.95	10.05	10.87	7.86
LSD (0.05)	3.02	0.582	NS	NS
CV (%)	10.69	11.41	5.01	5.98

V_1 = BRRI dhan37, V_2 = BRRI dhan38 and A = Age of seedlings, subscripted number after A denotes days after sowing.

4.1.3 Number of effective tillers/ hill

4.1.3.1 Effect of variety

The number of effective tillers/ unit area is one of the yield contributing characters that determines the yield of rice. Higher effective tillers/ hill was reported to produce higher grain yield. In the present experiment, the number of effective tillers/ hill was significantly affected by variety (Fig. 5).Higher number of effective tillers/ hill (7.23) was produced from BRRI dhan38 whereas BRRI dhan37 produced the lowest (6.92).

probable reason for differences in producing the effective tillers/ hill is the genetic make-up of the variety, which is primarily influenced by heredity. Chowdhury *et al.* (1993) and BRRI (1991) also reported that effective tillers/ hill differed significantly due to varieties.

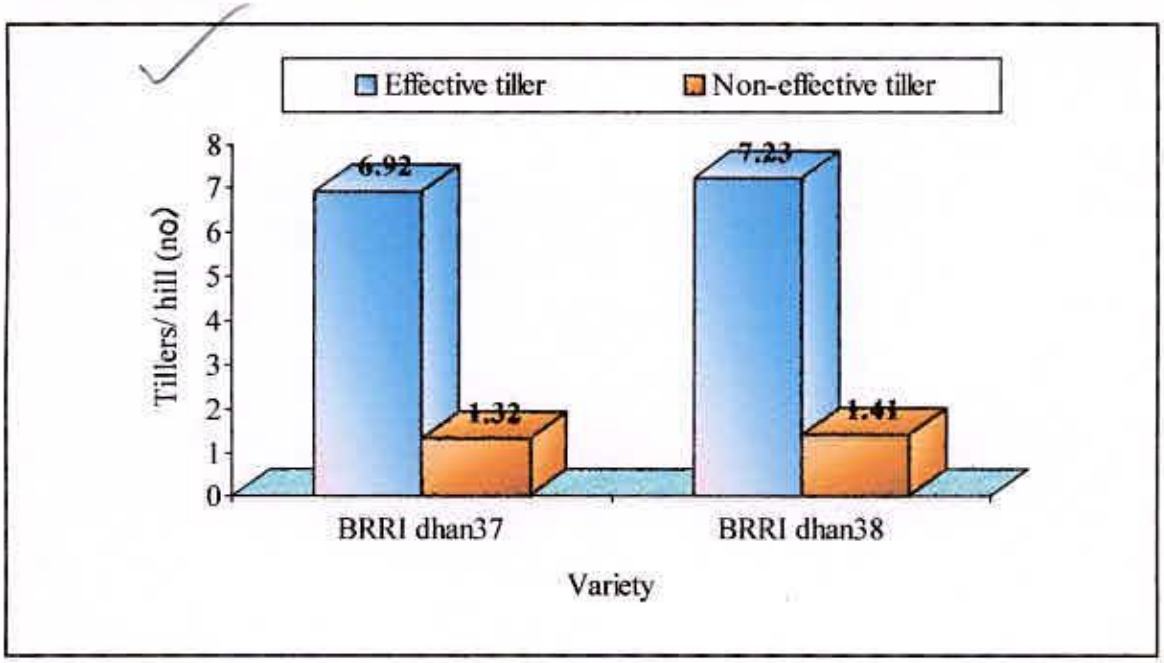

Fig. 5. Effect of variety on the effective (LSD $_{0.05}$ = 0.086) and non-effective tillers/ hill of aromatic rice

4.1.3.2 Effect of seedling age

Seedling age exhibited significant influence on the production of effective tillers/ hill (Fig. 6). Significantly the highest number of effective tillers/ hill (7.80) was produced from 30 days old seedlings which was statistically similar with that of 25 days whereas the lowest ones (6.14) by 40 days old seedlings. Intermediate effective tillers (7.22) were observed in 20 days old seedlings. The slow recovery of older seedlings resulted the lower number of effective tillers as compared to younger ones. The results indicated that too young and too old seedlings were not suitable for T. *aman* rice regarding the

production of effective tillers/ hill. Aragones and Wada (1989) and Mandal *et al.* (1984) also found similar results.

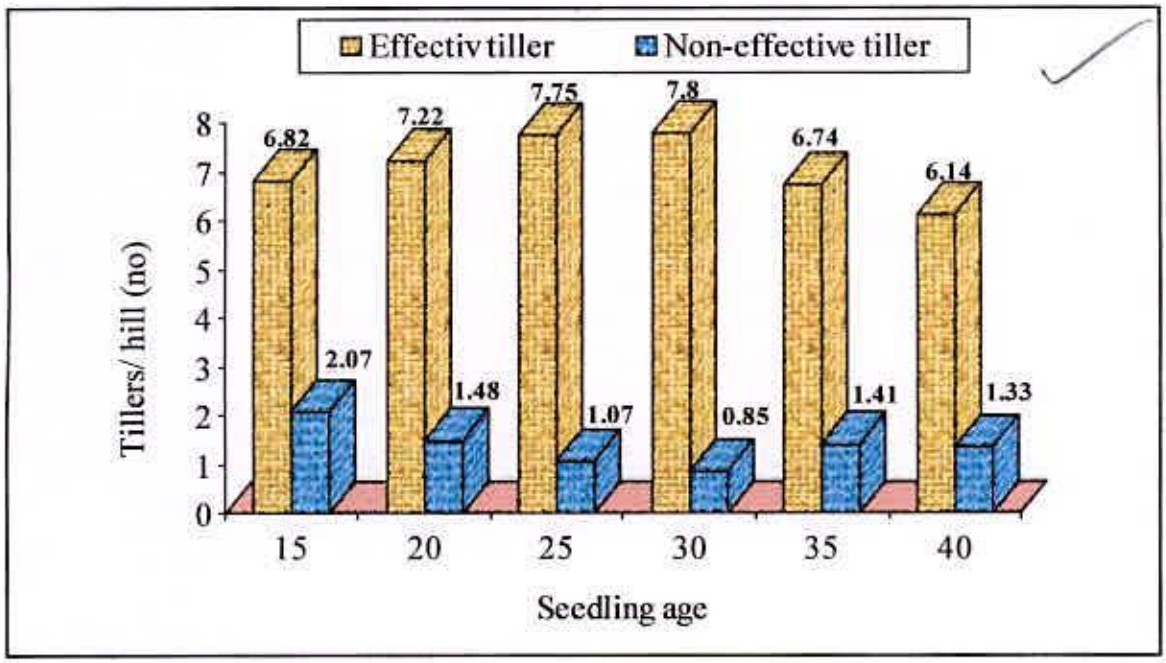

Fig. 6. Effect of seedling age on the effective (LSD $_{0.05}$ = 0.149) and non-effective tillers/ hill (LSD $_{0.05}$ = 0.422) of aromatic rice

4.1.3.3 Interaction effect between variety and seedling age

It was found that interaction between variety and seedling age had not significant effect on number of effective tillers/ hill (Table. 3). However, it was observed that BRRI dhan38 produced the maximum number of effective tillers/ hill (8.00) with 25 days old seedlings but BRRI dhan37 produced the minimum number (5.69) with 40 days old seedlings.

Table 3. Interaction effect of variety and seedling age of aromatic rice on the effective and non-effective tillers

Treatment (Variety x Seedling age)	*Effective tillers/ hill*	*Non-effective tillers/ hill*
$V_1 A_{15}$	6.72	1.95
$V_1 A_{20}$	7.04	1.43
$V_1 A_{25}$	7.49	1.13
$V_1 A_{30}$	7.71	0.71
$V_1 A_{35}$	6.88	1.33
$V_1 A_{40}$	5.69	1.38
$V_2 A_{15}$	6.92	2.18
$V_2 A_{20}$	7.40	1.53
$V_2 A_{25}$	8.00	1.00
$V_2 A_{30}$	7.89	0.98
$V_2 A_{35}$	6.59	1.48
$V_2 A_{40}$	6.59	1.27
LSD(0.05)	NS	NS
CV (%)	11.77	8.30

V_1 = BRRI dhan37, V_2 = BRRI dhan38 and A = Age of seedlings, subscripted number after A denotes days after sowing.

4.1.4 Number of non-effective tillers/ hill

4.1.4.1 Effect of Variety

Result of the present experiment indicated that the number of non-effective tillers/ hill was not significantly affected by the varieties studied (Fig. 5). However, higher number of non-effective tillers/ hill (1.41) was produced in BRRI dhan38 and lower ones (1.32) was produced by BRRI dhan37. Varietal differences regarding non-effective tiller

production might be due to their differences in genetic make-up. BINA (1993) also found that number of non-effective tillers/ hill was not significantly influenced by the varieties, which is in agreement with the present experiment.

4.1.4.2 Effect of seedling age

It was evident from the Fig. 6 that seedling age had significant influence on the production of non-effective tillers/ hill. Significantly highest number of non-effective tillers/ hill (2.07) was produced from 15 days old seedlings and the lowest (0.85) from 30 days old seedlings, which was statistically similar with that of 25 days. The second highest value of non-effective tillers (1.48) was produced from 20 days old seedlings, which was statistically similar with that of 35 and 40 days. Hossain (2001) also noticed a significant effect of seedling age on non-effective tillers/ hill.

4.1.4.3 Interaction effect between variety and seedling age

Interaction effect between variety and seedling age had not significant effect on number of non-effective tillers/ hill (Table 3). However, it was observed that BRRI dhan38 produced the maximum number of non-effective tillers/ hill (2.18) with 15 days old seedlings whereas BRRI dhan37 produced the minimum (0.71) with 30 days old seedlings.

4.2. Yield contributing characters

4.2.1 Panicle length (cm)

4.2.1.1 Effect of variety

Results of the experiment indicated that the panicle length showed significant variation due to variety (Fig. 7). Significantly longer panicle (28.42 cm) was found in BRRI dhan38 whereas shorter (24.81) from BRRI dhan37. BINA (1993) and Idris and Matin (1990) also reported similar findings. This variation as assessed might be mainly due to genetic characteristics of the varieties which is primarily influenced by heredity.

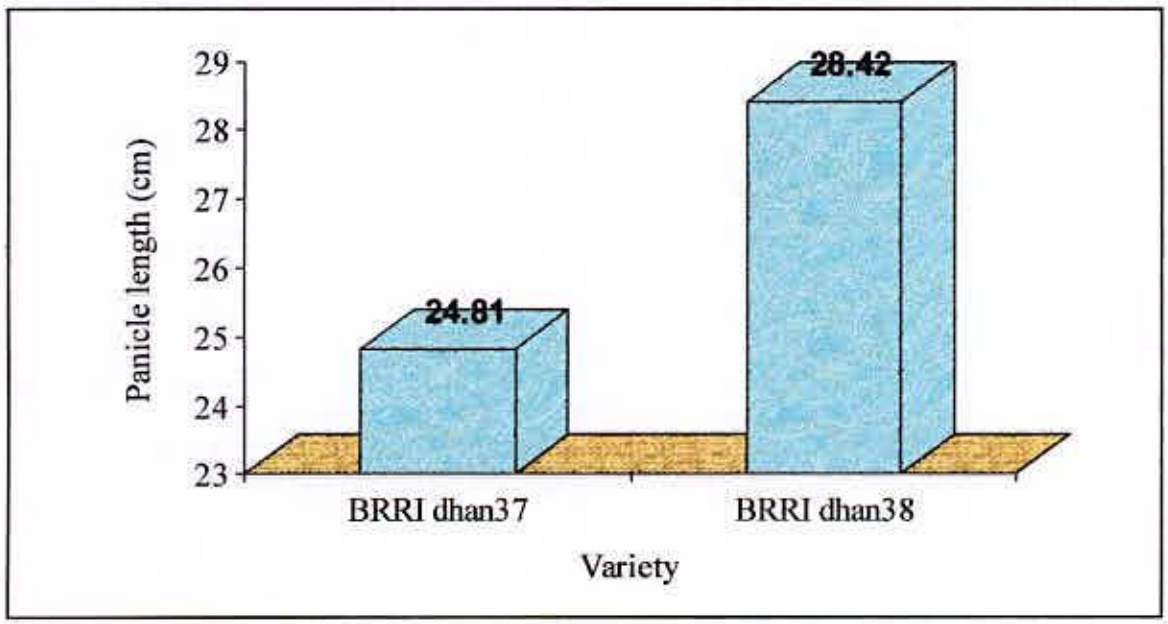

Fig. 7. Effect of variety on the panicle length (LSD $_{0.05}$ = 0.829) of aromatic rice

4.2.1.2 Effect of seedling age

Panicle length was significantly affected by seedling age (Fig. 8). It was found that 30 days old seedlings produced significantly longest panicle (27.97 cm) which was followed by 25 days old seedlings (27.33 cm). On the other hand the shortest panicle (25.42 cm)

was produced when 40 days old seedlings were transplanted and it was statistically similar with that of 35 (25.80). This was probably due to rapid switch over of older seedlings to reproductive phase without having enough vegetative growth. This result is in agreement with that of Reddy and Narayana (1981). They also observed that panicle length decreased significantly with each 10 days increase of seedling age.

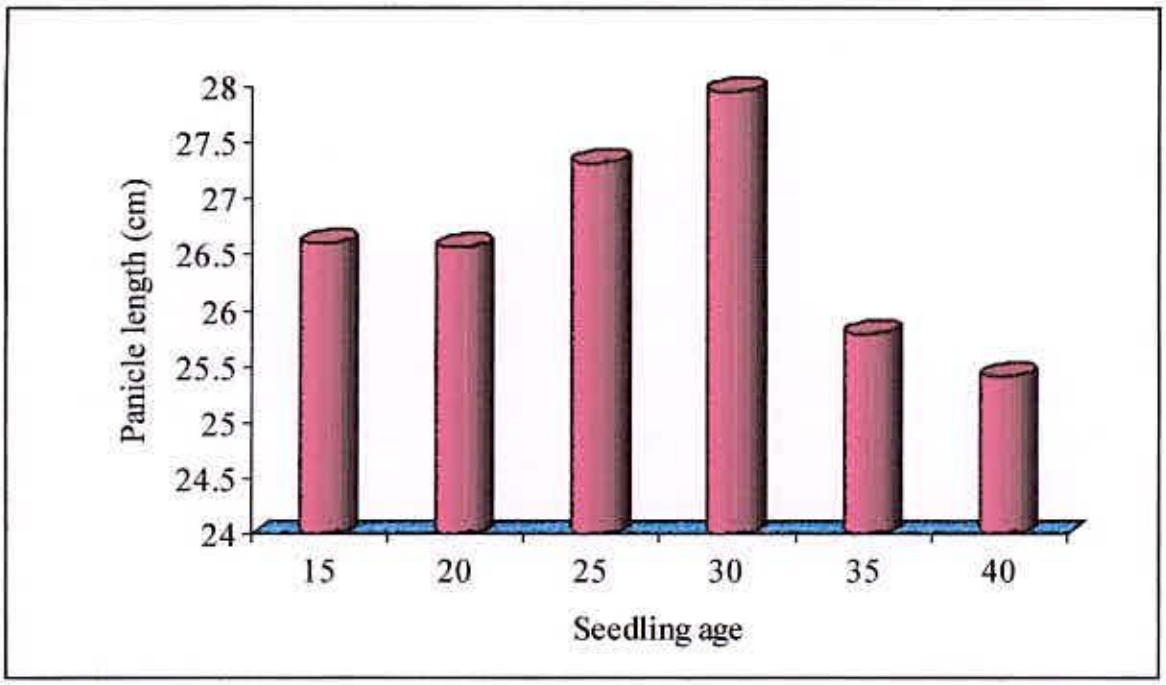

Fig. 8. Effect of seedling age on the panicle length (LSD $_{0.05}$ = 1.436) of aromatic rice

4.2.1.3 Interaction effect between variety and seedling age

Interaction between variety and seedling age on panicle length was not significant (Table 4). However, BRRI dhan38 produced the longest panicle (29.97) in 25 days old seedlings. On the other hand, combination of BRRI dhan37 with 15 days old seedlings produced the shortest panicle (23.75).

4.2.2 Number of total spikelets/ panicle

4.2.2.1 Effect of variety

The variation due to variety was significant for total number of spikelets/ panicle (Fig. 9). From the results of present experiment it is found that BRRI dhan37 produced significantly higher number of spikelets/ panicle (198.17) indicating its superiority to BRRI dhan38. On the other hand BRRI dhan38 produced lower number of spikelets/ panicle (160.71). Differences in number of total spikelets/ panicle due to varieties were also reported by BRRI (1994). Devi and Nair (1984) also found that total number of spikelets/ panicle differs significantly due to varietial differences. This varital differences regarding the number of total spikelets/ panicle was probably due to their differences in genetic make-up.

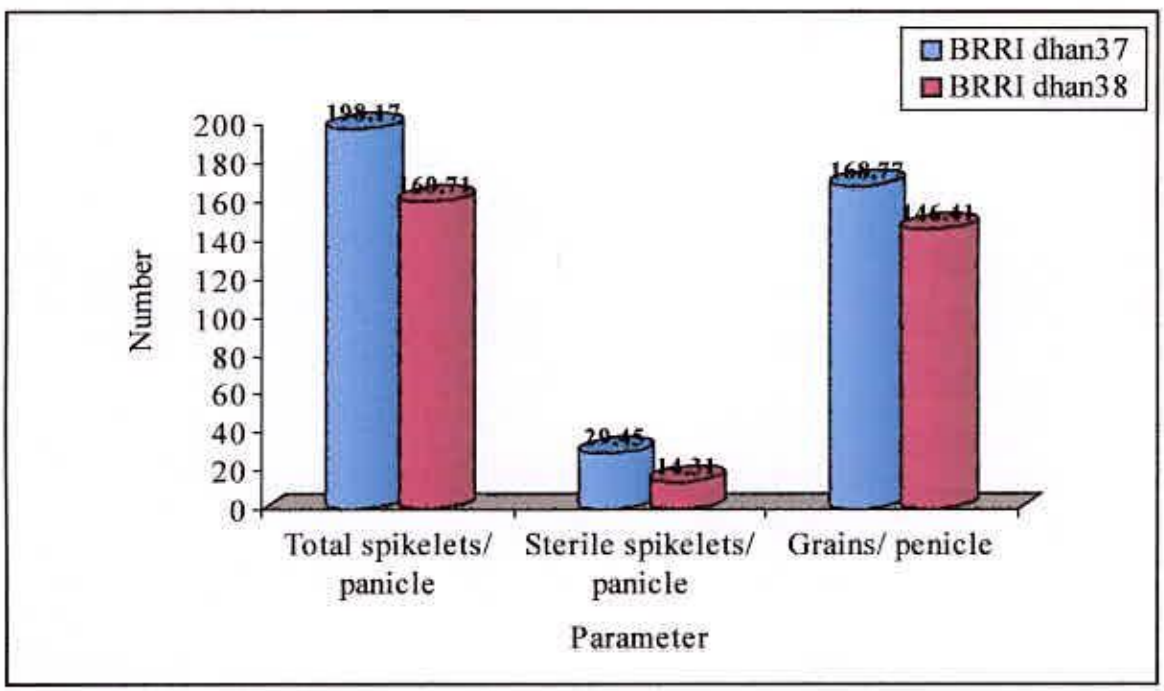

Fig. 9. Effect of variety on the number of total spikelets/ panicle (LSD $_{0.05}$ = 0.838), number of sterile spikelets/ panicle (LSD $_{0.05}$ = 0.601) and grain/ panicle (LSD $_{0.05}$ = 0.621) of aromatic rice

4.2.2.2 Effect of seedling age

The effect of different age of seedlings on the total number of spikelets/ panicle was found to be significant (Fig. 10). Significantly highest number of spikelets/ panicle (189.58) was obtained when 30 days old seedlings were transplanted and it was statistically similar with 25 days old seedlings (189.21). The lowest spikelets (165.49) were obtained when 15 days old seedlings were transplanted. Intermediate spikelets (179.27) were produced from 40 days old seedlings.

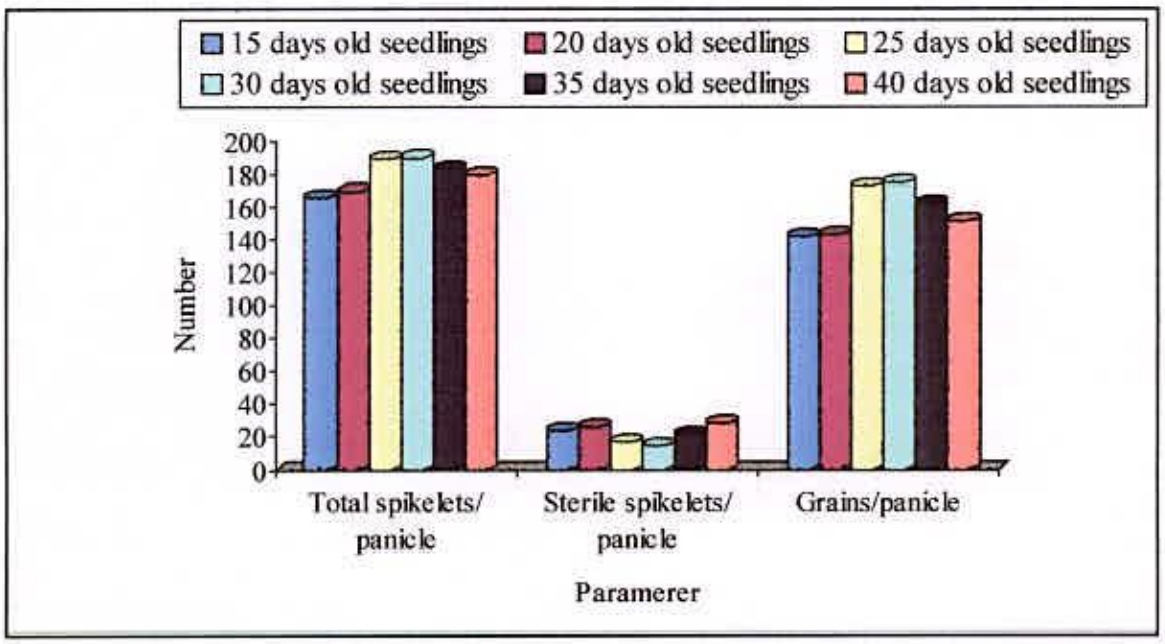

Fig. 10. Effect of variety on the number of total spikelets/ panicle (LSD $_{0.05}$ = 1.452), number of sterile spikelets/ panicle (LSD $_{0.05}$ = 1.040) and grain/ panicle (LSD $_{0.05}$ = 1.076) of aromatic rice

4.2.2.3 Interaction effect between variety and seedling age

Interaction effect of variety and seedling age on number of spikelets/ panicle was also found to be significant (Table 4). Significantly highest number of spikelets/ panicle (212.70) was obtained from BRRI dhan37 with 25 days old seedlings whereas the lowest

number (150.60) from BRRI dhan38 with 20 days old seedlings. The second highest spikelets (206.33) and intermediate (173.85) were produced from BRRI dhan37 with 30 and 15 days old seedlings respectively.

4.2.3 Number of sterile spikelets/ panicle

4.2.3.1 Effect of variety

Among the undesirable traits, number of sterile spikelets/ panicle was the most significant and plays a vital role in yield reduction. Effect of variety on the number of sterile spikelets/ panicle was significant (Fig. 9). BRRI dhan37 produced significantly higher number of sterile spikelets/ panicle (29.45) whereas BRRI dhan38 showed lower number (14.31). This indicated that BRRI dhan38 was superior to BRRI dhan37. Chowdhury *et al.* (1993) and BINA (1993) also reported that sterility differed significantly due to varietal differences. This variation might be due to genetic characteristics of the varieties

4.2.3.2 Effect of seedling age

The effect of different age of seedling on the number of sterile spikelets/ panicle was significant (Fig. 10). Significantly highest number of sterile spikelets/ panicle (28.12) was obtained when 40 days old seedlings were transplanted and the lowest (14.88) was obtained when 30 days old seedlings were transplanted. Intermediate sterile spikelets (21.75) were found in 35 days old seedlings. The climatic and nutritional factors influenced the yield contributing characters especially unfilled or sterile spikelets/ panicle. Result shows that the number of sterile spikelets/ panicle gradually decreased up to 30 days old seedlings, reached lowest when 30 days old seedlings were transplanted

and then gradually increased and reached at peak when 40 days old seedlings were transplanted.

4.2.3.3 Interaction effect between variety and seedling age

Interaction effect of variety and seedling age on number of sterile spikelets/ panicle was not found to be significant (Table 4). However, the highest number (39.69) was obtained from BRRI dhan37 with 20 days old seedlings whereas the lowest number (10.33) was found in BRRI dhan38 when 30 days old seedlings were transplanted.

Table 4. Interaction effect of variety and seedling age of aromatic rice on panicle length, number of total spikelets/ panicle, number of sterile spikelets/ panicle and grains/ panicle

Treatment (Variety x Seedling age)	*Panicle length (cm)*	*Total spikelets/ panicle*	*Sterile spikelets/ panicle*	*Grains/ Penicle*
V_1 A_{15}	23.75	173.85	29.73	144.45
V_1 A_{20}	24.89	188.69	39.69	149.00
V_1 A_{25}	24.68	212.70	22.57	190.13
V_1 A_{30}	26.84	206.33	19.43	186.90
V_1 A_{35}	24.37	203.87	29.23	174.63
V_1 A_{40}	24.33	203.57	36.07	167.50
V_2 A_{15}	29.47	157.12	17.53	139.59
V_2 A_{20}	28.25	150.60	12.73	137.87
V_2 A_{25}	29.97	165.73	10.80	154.93
V_2 A_{30}	29.09	172.83	10.33	162.50
V_2 A_{35}	27.23	163.03	14.27	148.77
V_2 A_{40}	26.52	154.97	20.17	134.80
LSD(0.05)	NS	2.053	NS	1.521
CV(%)	5.03	8.68	9.97	10.57

V_1 = BRRI dhan37, V_2 = BRRI dhan38 and A = Age of seedlings, subscripted number after A denotes days after sowing.

4.2.4 Number of grains/ panicle

4.2.4.1 Effect of variety

The effect of variety on the number of grains/ panicle was statistically significant (Fig. 9). It was observed that BRRI dhan37 produced higher grains/ panicle (168.77) whereas the lower number (146.30) was produced by BRRI dhan38. Xiu *et al.* (2001) also reported that number of grains/ panicle differed significantly due to variety. These results were also supported by Singh and Gangwer (1989) who stated that varietal differences regarding the number of grains/ panicle might be due to their differences in genetic constituents. In the present experiment, grains of BRRI dhan37 were densely arranged which might have contributed to produce more grains/ panicle.

4.2.4.2 Effect of seedling age

Number of grains/ panicle was significantly influenced by seedling age (Fig. 10). Thirty days old seedlings produced significantly highest number of grains/ panicle (174.70) and the lowest number of grains/ panicle (142.02) was shown in 15 days old seedlings. The second highest grains/ panicle (172.53) was found in 25 days old seedlings. Yoshii *et al.* (1998) reported that when seedlings of different ages were transplanted, number of grains also varied.

4.2.4.3 Interaction effect between variety and seedling age

Number of grains/ panicle was significantly influenced by the interaction between variety and seedling age (Table 4). Significantly highest number of grains/ panicle (190.13) was obtained from BRRI dhan37 with 25 days old seedlings and the lowest number (134.80) was obtained in BRRI dhan38 with 40 days old seedlings. Intermediate grains/ panicle (162.50) was found in BRRI dhan38 with 30 days old seedlings.

4.2.5 Thousand grain weight (g)

4.2.5.1 Effect of variety

From the results it was observed that variety had significant influence on the weight of 1000-grains (Fig. 11). The result expresses that BRRI dhan38 produced significantly higher weight of 1000-grains (17.75 g) than BRRI dhan37 (15.17 g). It might be due to its longer grain size whereas BRRI dhan37 produced smaller sized grain. The variation of 1000-grains weight might be due to differences in length and breadth of the grains that were partly controlled by genetic make-up of the studied varieties. Present results corroborate with the results reported by Shamsuddin *et al.* (1988) who recorded differences in 1000-grains weight among nine varieties. Chowdury *et al.* (1993) and Bhowmick and Nayak (2000) also reported the same view.

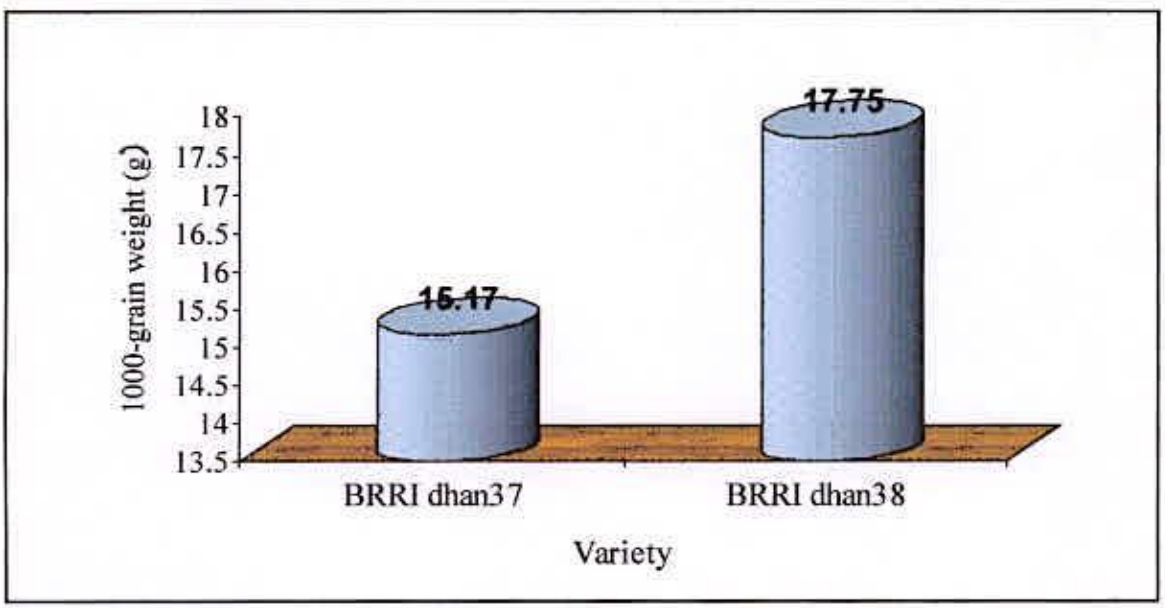

Fig. 11. Effect of variety on 1000-grain weight (LSD $_{0.05}$ = 0.669) of aromatic rice

4.2.5.2 Effect of seedling age

Seedling age had significant influence on the weight of 1000-grain (Fig. 12). From the results it was observed that 30 days old seedlings produced significantly highest weight of 1000-grain (18.69) was statistically similar with 25 days old seedlings. On the other hand significantly lowest (15.08) was obtained from 15 days old seedlings was also statistically with that of 20. The results are in contradiction with those of Mejos and Pava (1980) who reported that 1000-grain weight was not affected by seedling ages. But in the present experiment, insufficient nutrient supply during grain filling period could be attributed to the reasons of the lowest 1000-grain weight in 15 days old seedlings. Fifteen and twenty days old seedlings exhausted nutrient for vigorous vegetative growth and that is why plant could not supply enough nutrient for proper grain filling probably for the reasons, grains became small sized and ultimately these small grains influenced the weight of 1000-grain negatively. Mohapatra and Kar (1991), Mori *et al.* (1994) and Mozumder (1997) also reported differences in 1000-grain weight due to seedling age.

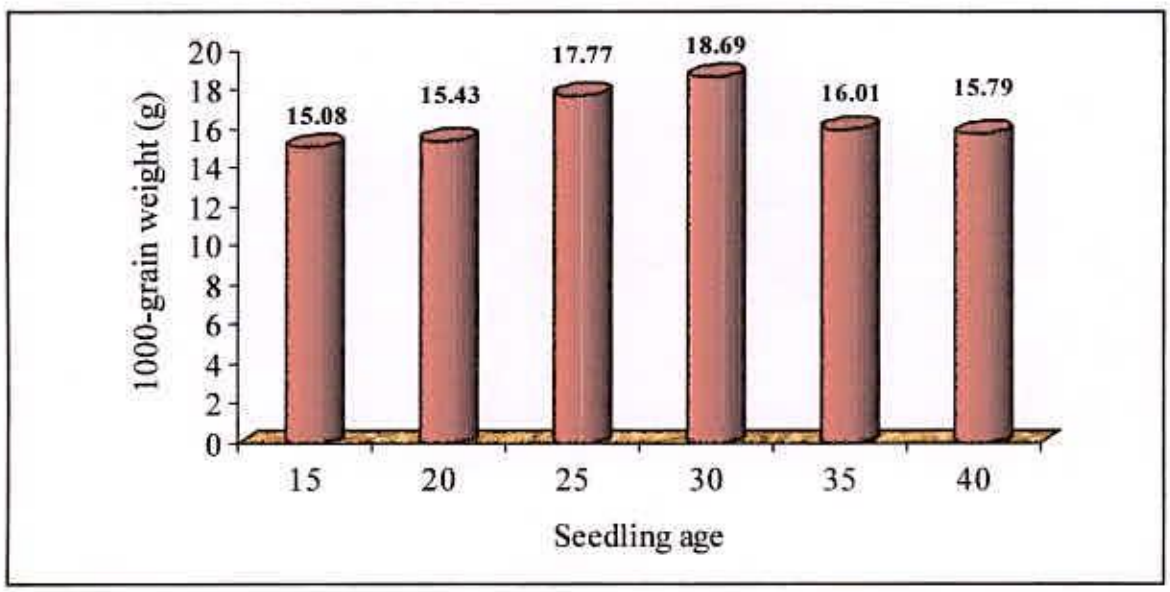

Fig. 12. Effect of seedling age on 1000-grain weight (LSD $_{0.05}$ = 1.159) of aromatic rice

4.2.5.3 Interaction effect between variety and seedling age

Thousand grains weight was significantly affected by the interaction between variety and seedling age (Table 5). Numerically, the highest 1000-grain weight (20.32 g) was recorded in BRRI dhan38 with 30 days old seedlings, which was statistically similar with 25 days old seedlings of same variety. On the other hand significantly lowest (13.80) were produced from BRRI dhan37 with 45 days old seedlings than other interaction treatment.

Table 5. Interaction effect of variety and seedling age of aromatic rice on the weight of 1000-grain and grain yield

Treatment (Variety x Seedling age)	*1000-grain weight (gm)*	*Grain yield (t/ ha)*
$V_1 A_{15}$	14.31	2.82
$V_1 A_{20}$	13.80	2.81
$V_1 A_{25}$	16.52	3.25
$V_1 A_{30}$	17.06	3.30
$V_1 A_{35}$	14.36	3.03
$V_1 A_{40}$	14.98	2.99
$V_2 A_{15}$	15.86	2.95
$V_2 A_{20}$	17.06	3.03
$V_2 A_{25}$	19.02	3.20
$V_2 A_{30}$	20.32	3.30
$V_2 A_{35}$	17.66	3.01
$V_2 A_{40}$	16.60	2.98
LSD(0.05)	1.639	7.370
CV(%)	5.88	9.57

V_1 = BRRI dhan37, V_2 = BRRI dhan38 and A = Age of seedlings, subscripted number after A denotes days after sowing.

4.2.6 Grain yield (t/ ha)

4.2.6.1 Effect of variety

Grain yield was significantly influenced by studied varieties (Fig. 13). The result expresses that BRRI dhan38 produced significantly higher grain yield (3.08 t/ ha) than BRRI dhan37 (3.03 t/ ha) but it was statistically similar. This result indicates that both BRRI dhan37 and BRRI dhan38 had almost equal potentiality to produce similar grain yield. BRRI (1995) also found that grain yield differed due to vatietal differences.

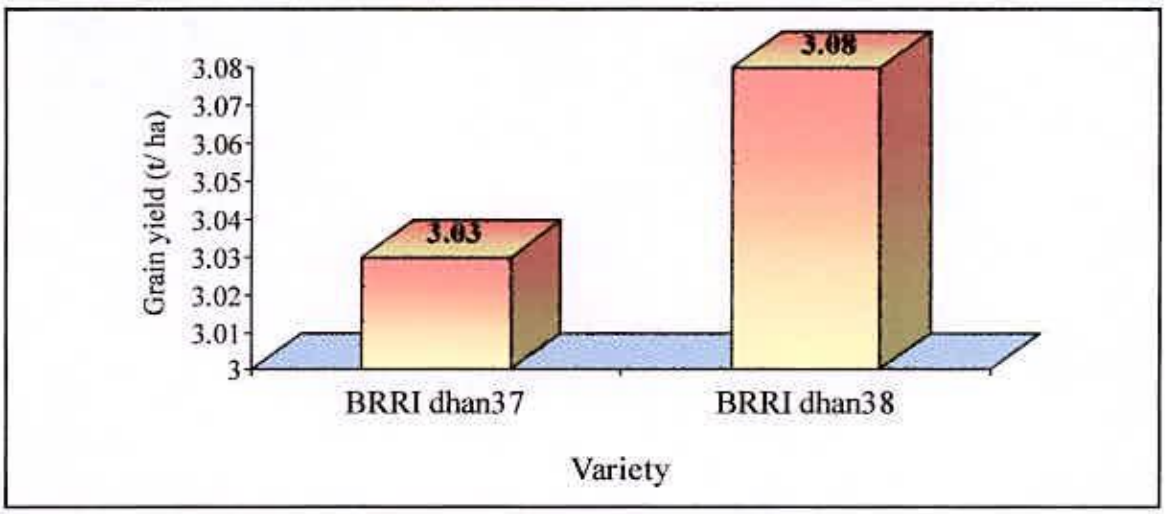

Fig. 13. Effect of variety on grain yield (LSD $_{0.05}$ = 3.009) of aromatic rice

4.2.6.2 Effect of seedling age

Grain yield was significantly influenced by different seedling age (Fig. 14). Significantly highest grain yield (3.30 t/ ha) was found when 30 days old seedlings were transplanted and it was statistically similar with that of 25. Grain yield was the lowest (2.89 t/ ha) in 15 days old seedlings. The better performance of 30 days old seedlings was probably due to its superiority on yield enhancing characters like panicle length, number of total spikelets/ panicle, lower number of sterile spikelets/ panicle, number of grain/ panicle and

weight of 1000-grain compared with 15, 20, 25, 35 and 40 days old seedlings. Besides, the climatic, edaphic and genetic factors also might be favoured for the maximizing grain yield. Shi *et al.* (1999), Islam and Ahamed (1981) and Seerai (1972) also observed similar results. They reported that 30 days old seedlings gave significantly the highest grain yield than those of 20 and 40 days old seedlings.

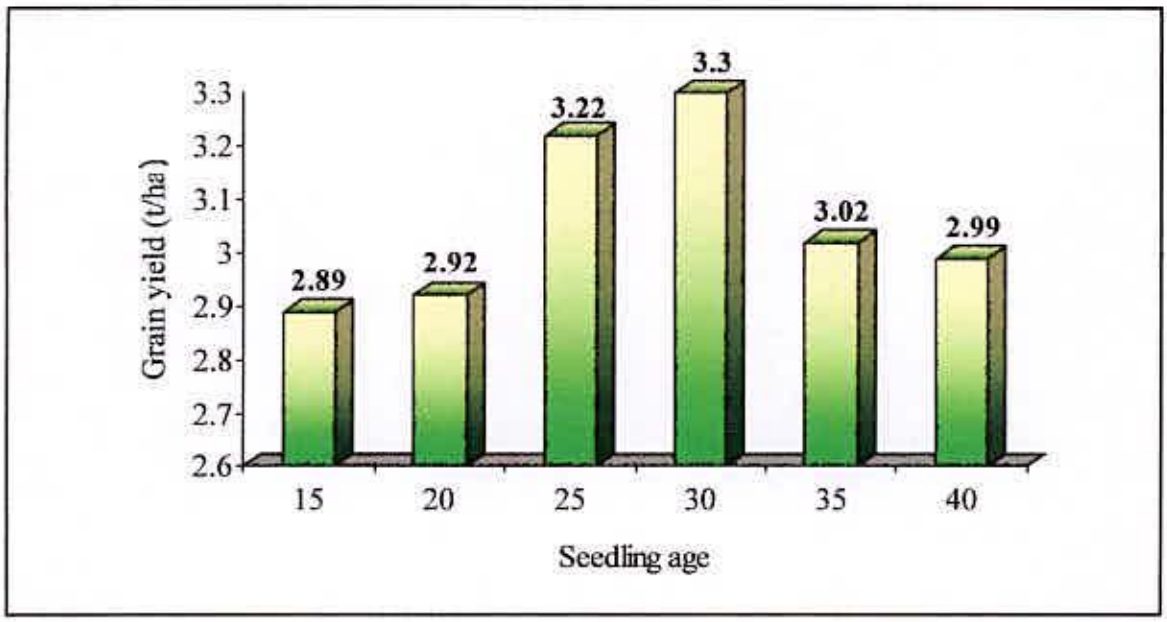

Fig. 14. Effect of seedling age on grain yield (LSD $_{0.05}$ = 5.211) of aromatic rice

4.2.6.3 Interaction effect between variety and seedling age

Interaction between variety and seedling age showed significant effect on grain yield (Table 6). It was observed that both BRRI dhan37 and BRRI dhan38 gave the significantly highest grain yield (3.30 t/ ha) with 30 days old seedlings. The second highest grain yield (3.25 t/ ha) was found in BRRI dhan37 with 25 days old seedlings. Among the interaction BRRI dhan37 gave the significantly lowest grain yield (2.81 t/ ha) with 20 days old seedlings.

4.2.7 Straw yield (t/ ha)

4.2.7.1 Effect of variety

There was a significant variation in straw yield due to variety (Fig. 15). Significantly higher straw yield (8.71 t/ ha) was recorded from BRRI dhan37 followed by BRRI dhan38 (7.53 t/ ha). In the case of BRRI dhan37, increased plant height probably may had resulted in the increased straw yield. These results are in conformity with those obtained by Chowdhury *et al.* (1993) also stated similar relationship between straw yield and plant height.

4.2.7.2 Effect of seedling age

Fig. 16 indicates significant differences among seedling age treatments in respect of straw yield. Significantly highest straw yield (10.74 t/ ha) was obtained when 15 days old seedlings were transplanted. On the other hand the lowest straw yield (6.45 t/ ha) was obtained from 40 days old seedlings. Intermediate amount of straw (8.84 t/ ha) was found in 25 days old seedlings. The lowest plant height in 40 days old seedlings probably may had resulted in the lowest yield of straw. The results are in contradiction with those of Das and Mukherjee (1989) who reported that seedling age had no effect on straw yield. The reduction in plant height and total tillers/ hill due to 40 days old seedlings was mainly responsible for this reduction in straw yield. These results are in conformity with those obtained by Panikar *et al.* (1981) and Rao (1976) who stated that the straw yield significantly increased with 21 days old seedlings than that of 28 or 35 days old seedlings.

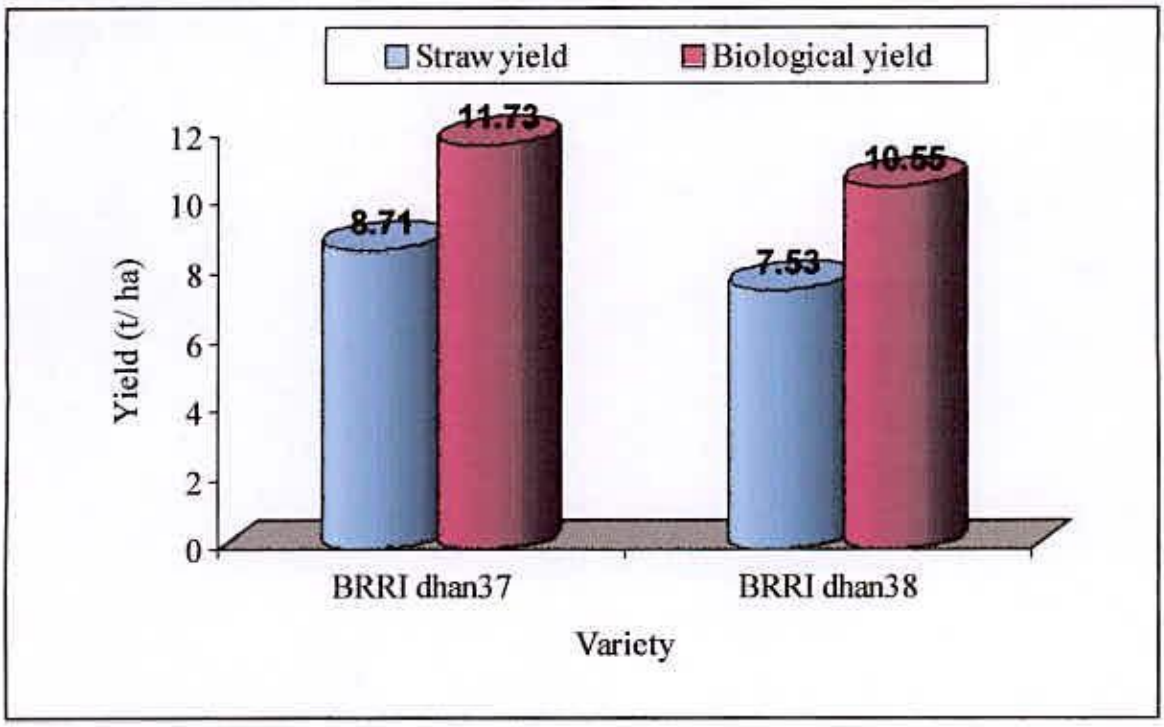

Fig. 15. Effect of variety on the straw (LSD $_{0.05}$ = 6.982) and biological yield (LSD $_{0.05}$ = 0.236) of aromatic rice

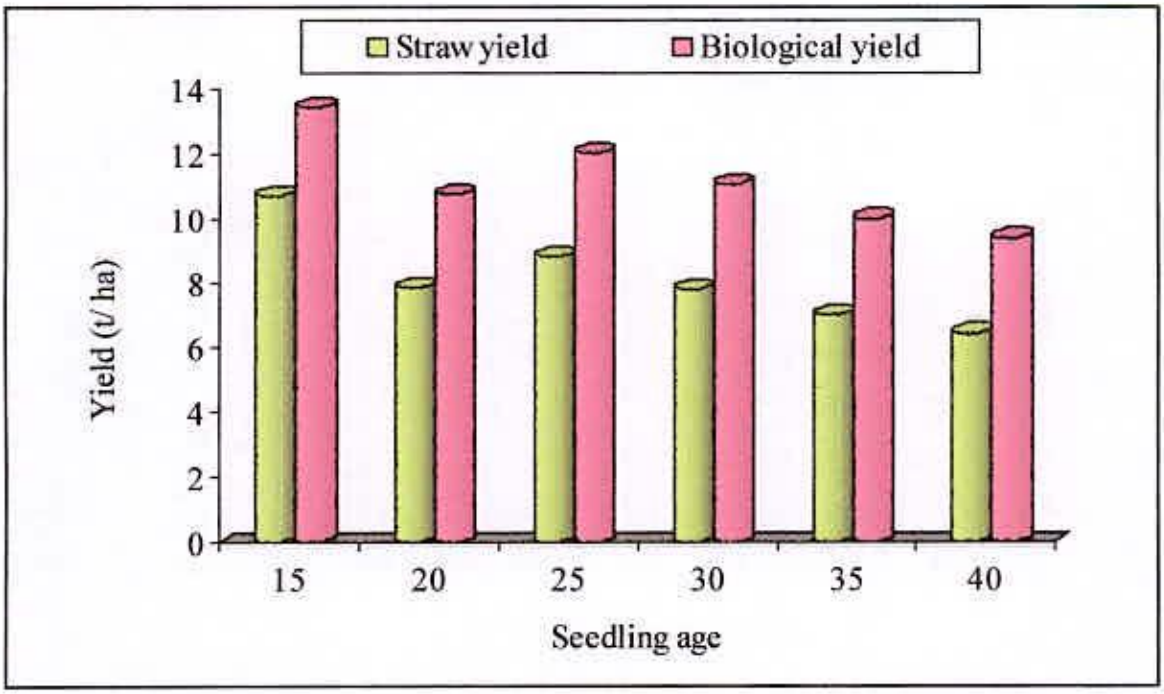

Fig. 16. Effect of seedling age on the straw (LSD $_{0.05}$ = 12.093) and biological yield (LSD $_{0.05}$ = 0.410) of aromatic rice

4.2.7.3 Interaction effect between variety and seedling age

The effect of interaction between variety and seedling age was not found to be significant on the straw yield (Table 6). However, the highest straw yield (12.44 t/ ha) was obtained from BRRI dhan37 with 15 days old seedlings whereas the lowest straw yield (5.98 t/ ha) was obtained from BRRI dhan38 with 40 days old seedlings.

4.2.8 Biological yield (t/ ha)

4.2.8.1 Effect of variety

Biological yield was significantly influenced by variety (Fig. 15). Significantly higher biological yield (11.73 t/ ha) was obtained from BRRI dhan37 and lower one (10.55 t/ ha) from BRRI dhan38. From the result it was observed that the biological yield differed due to the combined effect of grain and straw yield.

4.2.8.2 Effect of seedling age

Biological yield was significantly affected by seedling age (Fig. 16). The highest biological yield (13.28 t/ ha) was recorded from 15 days old seedlings whereas the lowest (9.44 t/ ha) from 40 days old seedlings. Intermediate biological yield (11.1 t/ ha) was obtained from 30 days old seedlings which was statistically similar with that of 20. From the result it was observed that biological yield differed due to combined weight of grain and straw. The lowest grain yield and highest straw yield, in case of younger seedling obviously resulted in the lowest biological yield.

4.2.8.3 Interaction effect between variety and seedling age

Biological yield was significantly affected by the interaction of variety and seedling age (Table 6). Significantly highest biological yield (15.22 t/ ha) was obtained from BRRI dhan37 with 15 days old seedlings but the lowest (8.96 t/ ha) from BRRI dhan38 for 40 days old seedlings, was statistically similar with 35 days old seedlings of same variety.

Table 6. Interaction effect of variety and seedling age of aromatic rice on straw yield, biological yield and harvest index

Treatment (Variety x Seedling age)	*Straw yield (t/ ha)*	*Biological yield (t/ ha)*	*Harvest index (%)*
$V_1 A_{15}$	12.44	15.22	18.34
$V_1 A_{20}$	8.10	10.92	26.19
$V_1 A_{25}$	8.95	12.19	26.64
$V_1 A_{30}$	8.25	11.50	28.59
$V_1 A_{35}$	7.60	10.63	28.50
$V_1 A_{40}$	6.92	9.91	30.17
$V_2 A_{15}$	9.04	11.66	23.51
$V_2 A_{20}$	7.62	10.65	28.46
$V_2 A_{25}$	8.72	11.92	26.85
$V_2 A_{30}$	7.41	10.70	30.90
$V_2 A_{35}$	6.42	9.43	31.92
$V_2 A_{40}$	5.98	8.96	33.26
LSD (0.05)	NS	0.579	0.996
CV(%)	13.94	11.07	12.12

V_1 = BRRI dhan37, V_2 = BRRI dhan38 and A = Age of seedlings, subscripted number after A denotes days after sowing.

4.2.9 Harvest index (%)

4.2.9.1 Effect of variety

Variety exerted a significant effect on harvest index (Fig. 17). Significantly higher harvest index (29.15%) was found from BRRI dhan38 and lower (26.41%) from BRRI dhan37. It was evident from the present experiment that BRRI dhan37 was less efficient to translocate assimilates towards the grain due to lack of sunlight resulting from lodging of plants which in turn resulted in lower harvest index. Shah *et al.* (1991) reported that variety had a great influence to harvest index. They also reported that harvest index decreased with the increase of plant height

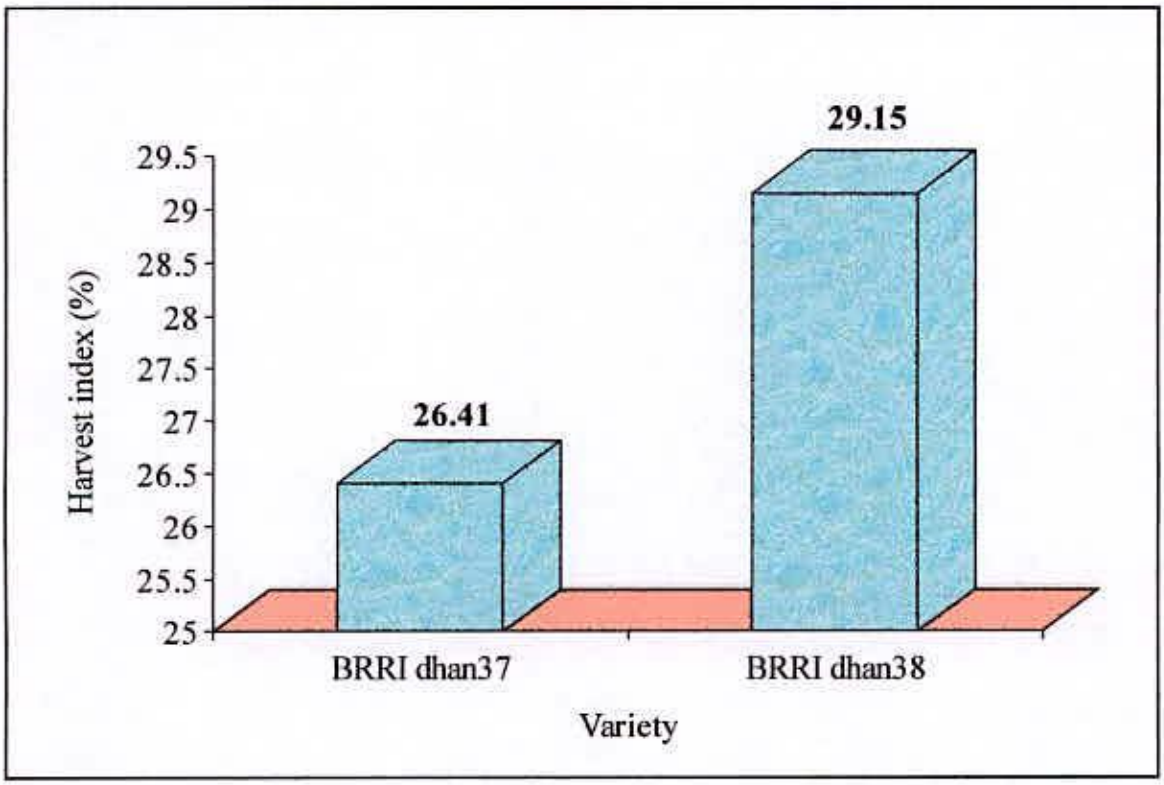

Fig. 17. Effect of variety on harvest index (LSD $_{0.05}$ = 0.407) of aromatic rice

4.2.9.2 Effect of seedling age

Harvest index was also significantly affected by seedling age (Fig. 18). The highest harvest index (31.72%) was obtained from 40 days old seedlings followed by 35 days old seedlings (30.21%). Fifteen days old seedlings produced significantly lowest harvest index (20.93%). The lowest grain yield and the highest straw yield, in case of younger seedling might have resulted in the lowest harvest index.

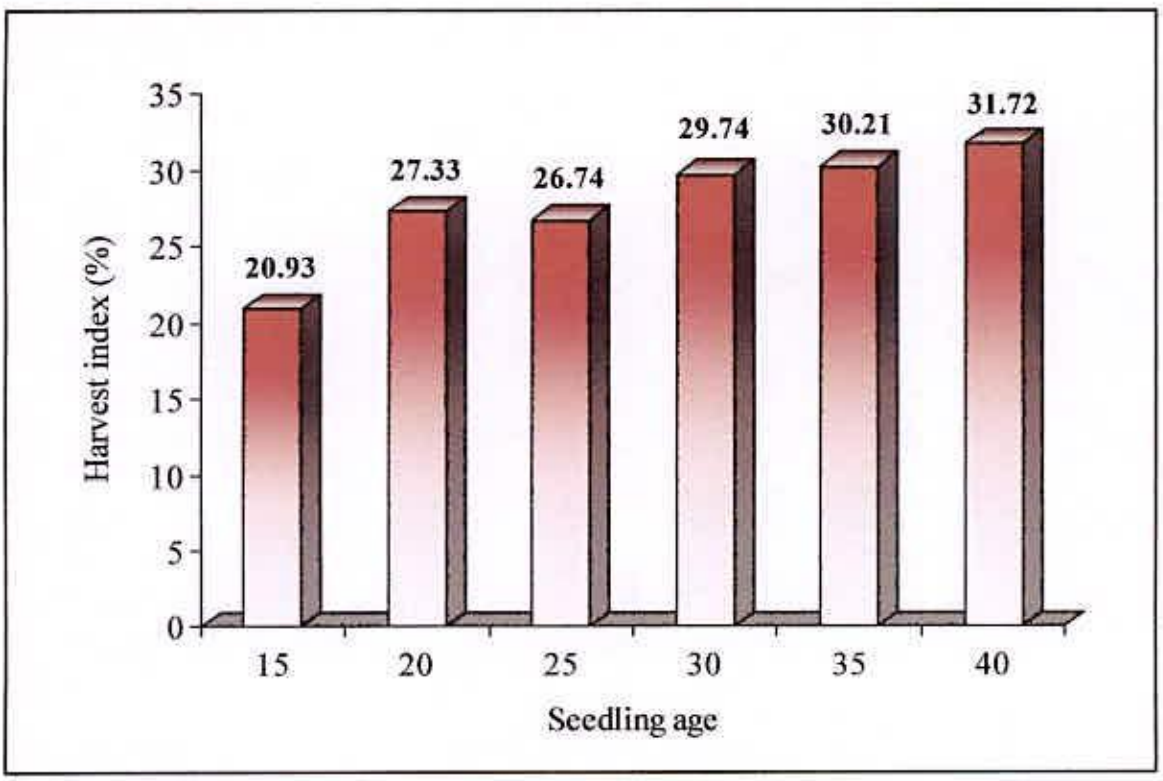

Fig. 18. Effect of seedling age on harvest index (LSD $_{0.05}$ > 0.704) of aromatic rice

4.2.9.3 Interaction effect between variety and seedling age

Interaction between variety and seedling age significantly affected harvest index (Table 6). The highest harvest index (33.26%) was obtained from BRRI dhan38 with 40 days old. On the other hand BRRI dhan37 produced the significant lowest (18.34%) 15 days old seedlings.

CHAPTER 5

Summary and conclusion

SUMMARY AND CONCLUSION

The field experiment was conducted at the Agronomy Field Laboratory, Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka during the period from July, 2006 to December, 2006 to study the effect of seedling age on the yield of two modern varieties of aromatic rice under Modhupur tract (AEZ 28). The experiment comprised of two different factors viz. A. Variety (2): BRRI dhan37 (V_1) and BRRI dhan38 (V_2), B. Seedling age: 15, 20, 25, 30, 35 and 40 days old seedlings (A_{15}, A_{20}, A_{25}, A_{30}, A_{35} and A_{40} respectively). The experiment was laid out in Randomized Complete Block Design (Factorial) with three replications. Numbers of total unit plots were 36. The size of unit plot was 10 m^2 (4.0 m x 2.5 m). The distance mentioned between two unit plots was 0.75 m and blocks was 1.5 m. The land was fertilized with recommended rates of urea, TSP, MP and gypsum. Then the 15 days old seedlings of two rice varieties were transplanted on the well puddled experimental plot on July 26, 2006 at the rate of 3 seedlings/ hill with 25cm x 15 cm spacing and rest of them were transplanted at each 5 days intervals. Intercultural operations viz. weeding, water management and pest management were done as and when necessary.

Five hills (excluding border hills) were randomly selected from each plot and tagged just after transplanting for recording data on growth parameters and yield and yield contributing characters. The data for measuring different parameters like plant height, number of total tillers/ hill, number of effective tillers/ hill, number of non-effective tillers/ hill, straw and biological yield, panicle length, number of total spikelets/ panicle, number of sterile spikelets/ panicle, grain/ panicle, 1000-grain weight, grain yield and

harvest index were recorded at 15 days intervals from the beginning at 25 DAT to harvesting the crop. The recorded and calculated

data were analyzed statistically and mean differences were adjudged by Least Significant Difference (LSD) Test at 5% level of significance.

Result revealed that variety had significant influence on all of the crop characters except number of non-effective tillers/ hill. Plant height and number of total tillers/ hill at all sampling dates varied significantly due to variety. BRRI dhan38 produced significantly higher number of total tillers/ hill, effective tillers/ hill, non-effective tillers/ hill, panicle length, weight of 1000 grains, grain yield and harvest index. On the other hand, Plant height, number of total spikelets/ panicle, number of sterile spikelets/ panicle, number of grains/ panicle, straw yield and biological yield were higher in BRRI dhan37.

There was a significant influence of seedling age on all of the parameters at all sampling dates. The tallest plant and highest tillers/ hill was obtained from 15 days old seedlings and the shortest ones from 40 days old seedlings. At harvest all the crop characters were influenced by age of seedlings significantly. The number of effective tillers/ hill (7.80) were the highest in 30 days old seedlings whereas the lowest (6.14) in 40 days old seedlings. In case of the longest panicle (27.97 cm) and the highest number of total spikelets/ panicle (189.58), number of grains/ panicle (174.70), weight of 1000-grain (18.69 g) and grain yield (3.3 t/ ha) but the lowest number of non-effective tillers/ hill (2.53) and sterile spikelets/ panicle (14.88) were found in 30 days old seedlings. On the contrary, 15 days old seedlings showed the lowest number of total spikelets/ panicle (165.49), number of grains/ panicle (142.02), weight of 1000-grain (15.08 g), grain yield

(2.89 t/ ha) and harvest index (20.93%). The shortest panicle (25.42 cm) and the lowest straw and biological yield (6.45 and 9.93 t/ ha respectively) and the highest number of sterile spikelets/ panicle (28.12) and harvest index (31.72%) were produced by 40 days old seedlings.

Interaction effect of variety and seedling age was not significant in respect of plant characters viz. number of total tillers, effective tillers, non-effective tillers/ hill, panicle length, number of sterile spikelets/ panicle and straw yield whereas interaction effects on the rest of the parameters were significantly influenced. Combination of BRRI dhan38 with 25 days old seedlings was found the best in respect of number of effective tillers/ hill (8.00) and panicle length (29.97 cm) whereas significantly the highest number of total tillers/ hill (9.10) and the number of non-effective tillers/ hill (2.18) were found in BRRI dhan38 with 15 days old seedlings. Besides, total number of spikelets/ panicle (212.70) and number of grains/ panicle (190.13) were the highest in the combination of BRRI dhan37 with 25 days old seedlings. Significantly the highest 1000-grain weight (20.32 g), grain yield (3.3 t/ ha) and the lowest sterile spikelets/ panicle (10.33) were found in BRRI dhan38 with 30 days old seedlings. In case of straw yield (12.44 t/ ha) and biological yield (15.22 t/ ha), BRRI dhan37 with 15 days old seedlings was in the first position. The highest harvest index (33.26%) was found in BRRI dhan38 with 40 days old seedlings.

Based on the results of the present study, the conclusion may be drawn-

- Evaluation of the modern aromatic varieties, BRRI dhan38 performed the best compared to BRRI dhan37.

- Considering seedling age 30 days old seedlings showed the best performance in respect of yield and yield contributing characters. It may also be concluded that too young and too old seedlings were not suitable for transplanting *aman* rice.
- BRRI dhan38 coupled with 30 days old seedlings were a proven combination compared to others for higher yield and yield components.

However, to reach a specific conclusion and recommendation transplant *aman*, more research work on variety and seedling age should be done over different agro-ecological zones.

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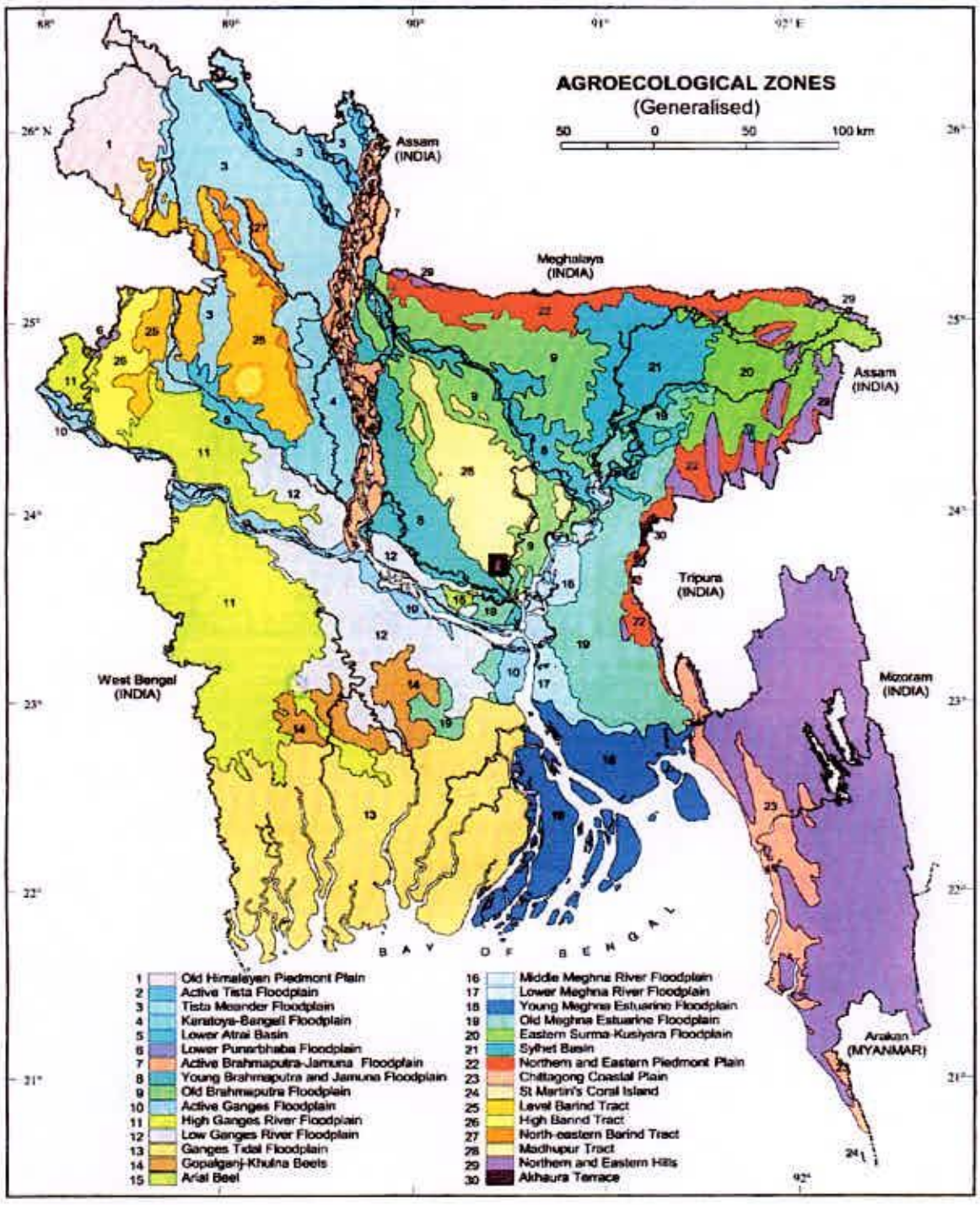
Appendices

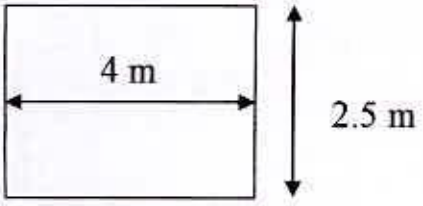
APPENDICES

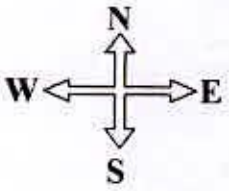
Appendix I. Map showing the experimental site under study



The experimental site under study

Appendix II. Lay out of experimental field





V_1A_{40}	V_2A_{30}	V_1A_{35}	V_2A_{20}	V_2A_{25}	V_1A_{15}
V_2A_{15}	V_1A_{20}	V_1A_{25}	V_2A_{35}	V_1A_{40}	V_2A_{30}
V_1A_{25}	V_1A_{35}	V_2A_{40}	V_2A_{15}	V_1A_{30}	V_1A_{20}
V_2A_{35}	V_1A_{15}	V_2A_{30}	V_1A_{40}	V_2A_{20}	V_1A_{25}
V_1A_{30}	V_2A_{40}	V_1A_{20}	V_2A_{25}	V_2A_{15}	V_2A_{35}
V_2A_{20}	V_2A_{25}	V_1A_{15}	V_1A_{30}	V_1A_{35}	V_2A_{40}

R_1 R_2 R_3

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

A. Morphological characteristics of the experimental field

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

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	*Value*
Partical size analysis	
% Sand	27
%Silt	43
% Clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV: Monthly record of air temperature, rainfall, and relative humidity during the period from July – December, 2006

Month	*RH (%)*	*Air temperature (°C)*			*Rainfall*
		Max.	*Min.*	*Mean*	*(mm)*
July	81	31.4	25.8	28.6	542
August	82	32.0	26.6	29.3	361
September	81	32.7	26.0	29.35	514
October	80	30.5	24.3	27.4	417
November	72	29.0	19.8	24.4	3
December	66	27.0	15.6	21.3	0

Source: Bangladesh Meterological Department (Climatic Division), Agargaon, Dhaka-1207.

PLATES

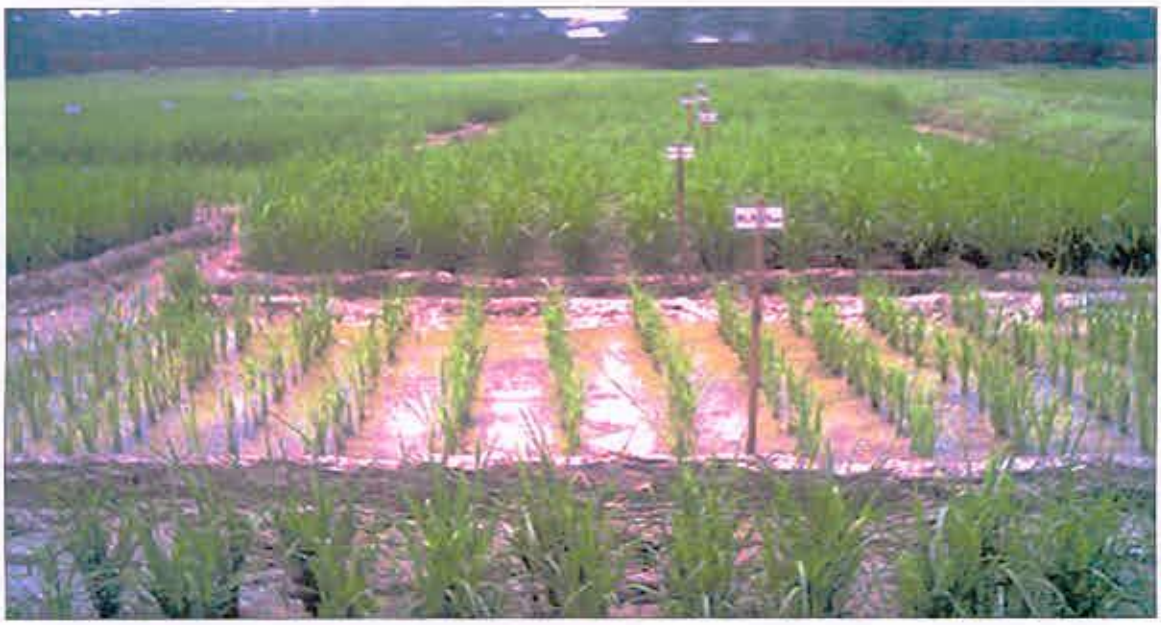


Plate I. Field view of the experimental plots showing varied plant heights due to use of different ages seedling

Plate II. Field view of the experimental plots showing the visual difference of plant height of 40 days old seedlings with others

Plate III. Field view at tillering stage of BRRI dhan38 when 15 days old seedlings were transplanted

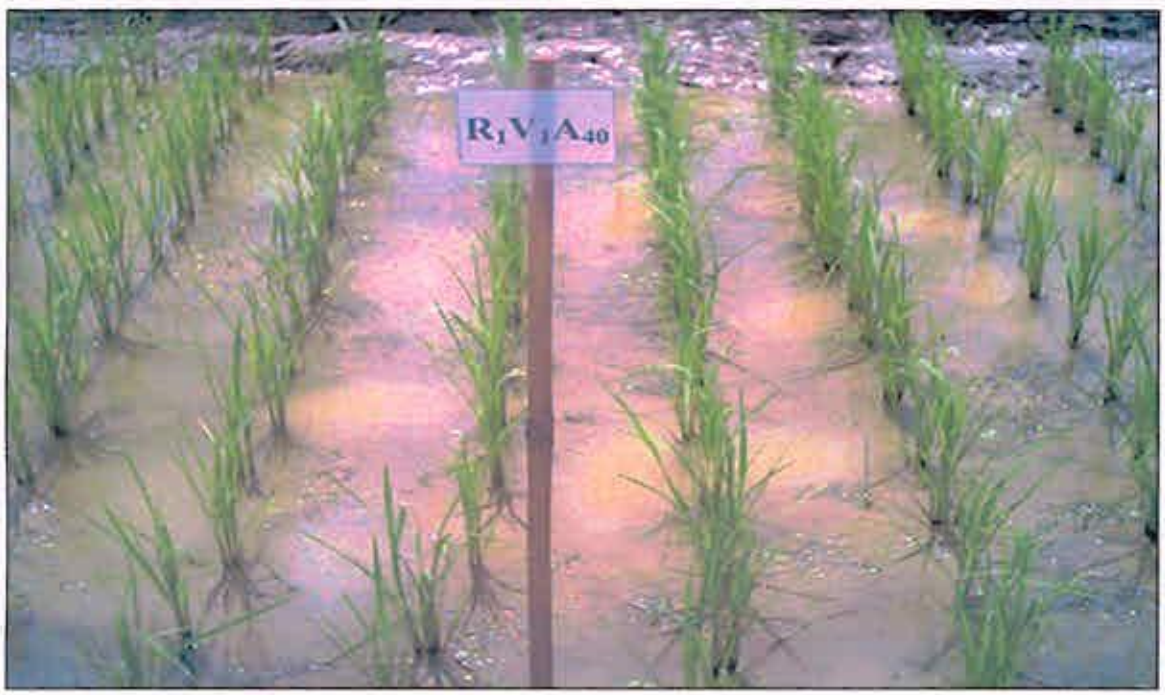


Plate IV. Field view at tillering stage of BRRI dhan37 when 40 days older seedlings were transplanted