EFFECT OF STORAGE DURATIONS OF UPROOTED RICE SEEDLINGS AT DIFFERENT AGES ON THE PERFORMANCE OF BRRI dhan31 AND BRRI dhan34

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CERTIFICATE

This is to certify that the thesis entitled, **"Effect of Storage Durations of Uprooted Rice Seedlings at Different Ages on the Performance of BRRI dhan31 and BRRIdhan34"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) IN AGRONOMY**, embodies the result of a piece of *bona fide* research work carried out by **MD. JANNATUL JALAL**, Registration No. **04-01255** 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: 11-05-2011
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Dedicated to my

Beloved Father Alhaj Md. Jalal Uddin

and

Beloved Mother Alhaj Lutfa Jalal

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ABSTRACT

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 June, 2008 to December, 2008 to study the effect of storage durations of uprooted rice seedlings at different ages on the performance of BRRI dhan31 and BRRIdhan34 under Modhupur tract (AEZ 28). The experiment comprised three different factors viz. A. Variety (2): BRRI dhan31 (V_1) and BRRI dhan34 (V_2), B. Seedling age (2): 30 days old seedlings (A_1) and 40 days old seedlings (A_2) and C. Storage durations (4): 0, 2, 4 and 6 days after uprooting (D_0, D_2, D_4 and D_6 respectively). The experiment was laid out in Randomized Complete Block Design (Factorial) with three replications. Results indicated that BRRI dhan31 performed better than BRRI dhan34. BRRI dhan31 produced significantly higher number of total tillers $hill^{-1}$, effective tillers $hill^{-1}$, weight of 1000 grains, grain yield (4.41 t ha^{-1}), straw yield and biological yield and harvest index. The results also revealed that 30 days old seedlings showed the better performance than 40 days old seedlings. In respect of the longer panicle (26.64 cm) and the higher number of total grains $panicle^{-1}$ (160.26), number of filled grains $panicle^{-1}$ (134.84), weight of 1000-grain (20.22 g) and grain yield (4.38 t ha^{-1}). Among the storage durations of uprooted rice seedlings, 0 days storage durations showed best performance. Showing higher plant height (126.66 cm), number of total grains $panicle^{-1}$ (158.86), number of filled grains $panicle^{-1}$ (138.54), 1000-grain weight (20.62 g), grain yield (3.98 t ha^{-1}), straw yield (6.68 t ha^{-1}), biological yield (10.66 t ha^{-1}) and harvest index (37.33%) were found from 0 days storage duration. It was concluded that BRRI dhan31 with 30 days old seedlings stored for up to 4 days and 40 days old seedlings stored for 2 days showed no yield loss. Seedlings of BRRI dhan34 variety could be stored for 2 days of both aged seedlings.

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ACRONYMS AND ABBREBIATIONS

%	Percentage
°C	Degree Centigrade
AEZ	Agro- Ecological Zone
ANOVA	Analysis of variance
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
BRRI	Bangladesh Rice Research Institute
cm	Centimeter
CV %	Percent Coefficient of Variance
cv.	Cultivar (s)
DAT	Days After Transplanting
DMRT	Duncan's Multiple Range Test
e.g.	Example given
et al.	et alia (and others)
FAO	Food and Agriculture Organization
Fig.	Figure
g	Gram (s)
HI	Harvest Index
hr	Hour(s)
i.e.	That is
IFDC	International Fertilizer Development Centre
IRRI	International Rice Research Institute
K_2O	Potassium Oxide
kg	Kilogram (s)
lb	Pound
LSD	Least Significant Difference
m^2	Square meter
m^{-2}	Per square meter
mm	Millimeter
MP	Muriate of Potash
N	Nitrogen
No.	Number
NS	Non Significant
P_2O_5	Phosphorus Penta Oxide
PU	Prilled Urea
S	Sulphur
SAU	Sher-e-Bangla Agricultural University
t ha^{-1}	Ton per hectare
var.	Variety
Viz.	Namely
wt.	Weight

Chapter 1
Introduction

CHAPTER 1
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 consumes rice as a major source of calorie (Banik, 1999). Among the major rice growing countries of the world, Bangladesh ranges third in respect of area and fourth in respect of production (BRRI, 2000a). 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 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, rain fed and deepwater 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).

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

Different varieties of rice have different characters. Rice grain is categorized into coarse, medium coarse and fine with different colour based on physical properties. Some of them have special appeal for their aroma. There are two types of transplant aman rice viz. coarse and fine rice and some of the fine rices are aromatic. The major aromatic varieties identified are Kalizira, Chinigura, Kataeibhog, BR 5, Bashful, BRRI dhan34, BRRI dhan37, BRRI dhan38 (Bashmotitype), Khaskani, Badshabhog, Dudshagar, Tulsimala, Khishabhog, Parbatjira, Khasha, Modhumadab, Tilkapur, Chinikanai, Khirkon and Shakhorkhora.

Aromatic rice is a high valued commodity in agricultural trade market of Bangladesh. It has high export potentials, great taste as well as better eating qualities and is used to prepare special dishes such as Polau, Khir, Firny, Paish, Chira, Khoi, Jarda etc. Milled aromatic rice is used as a luxurious food in ceremonies like marriage day, Eid day etc. According to Bangladesh Rice Exporters Association (BREA) statistics (Anon,2005), Bangaldesh exported 700 metric tons of aromatic rice in 2001, 780 metric tons in 2002, 1000 metric tons in 2003, and 3300 metric tons in 2004. Export value of aromatic and fine rice stood at 200,000 US dollars in 2003-2004 fiscal years. So the production of aromatic rice in the country is economically profitable.

The Bangladesh agriculture is prone to numerous risks and hazards like drought, excessive rainfall, storm, flood and so on. Recently the magnitude and frequency of flood throughout the country have crossed the previous records. During the recent flood more than 50% of the total area of the country became inundated within the period of less than 48 hours of time.

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^{-1} and other yield contributing characters (Islam & Ahmed, 1981 ; BRRI, 1981). The vegetative development of *indica* cultivars is, in general more effected by age of seedlings than other cultivars (Langfield and Basinski, 1960). Different scientists throughout the world studied extensively the influence of seedlings age on growth, yield & yield contributing characters of rice. Many of them obtained better results from younger and some from seedlings regarding yield (Alim *et al*., 1962). Islam (1986) concluded that 25 to 30 day old seedling is 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.

Due to unexpected incessant rainfall or flash flood during the transplanted aman season, most of the cultivated lands, especially in the low laying areas go under water causing severe damage to the rice seedlings in the nursery beds as well as in the freshly transplanted fields. As a result, an acute shortage of rice seedlings occurs very frequently when the flood water recedes. Under such situation, the rice seedlings may be saved by uprooting them from the nursery beds at the advent of floods and stored in a suitable place for some time so that those can be transplanted after recession of flood water. Sometimes it is seen that due to scarcity of good seeds or some other reasons farmers cannot produce rice seedlings up to their requirement. So, they have to purchase seedlings from a far market wasting a considerable period of time from uprooting to transplanting of rice seedlings in the field. Uprooted rice seedlings are found to be preserved under various conditions such as in water, in the sun, in mud and under shade and so on. Sometimes, seedlings are transported keeping them in bundles inside the gunny bags. It is expected that the viability and strength of uprooted rice seedlings may be adversely affected in different manners under variable condition of preservation.

Under severe flood situation especially when it prolongs causes severe damage to standing crops and also causes delay in further transplantation. Under this situation farmers have to use old seedlings, when there is possibilities of the seedbed being drowned farmers have to uproot seedlings and store. It is not yet clearly known how and how long the uprooted rice seedlings may be preserved without deteriorating their qualities and vigour.

BRRI dhan31 and BRRI dhan34 are the modern varieties of rice, which have been developed by Bangladesh Rice Research Institute (BRRI). In intensive cropping system the farmers can not transplant T. *aman* rice with proper aged seedlings due to late harvest of aus rice, over flooding condition of cultivable land and lack of proper knowledge regarding the effect of seedlings 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 prospects. However such works on BRRI dhan31 and BRRI dhan34 are scanty. So, present study was conducted with the following objectives.

1. To identify the effect of various storage durations of the uprooted seedlings on the performance of BRRI dhan31 and BRRI dhan34.
2. To find out the optimum age of uprooted seedlings for storage.
3. To evaluate the interaction effect of storage durations of uprooted seedlings and different ages on the performance of BRRI dhan31 and BRRI dhan34.

Chapter 2
Review of Literature

CHAPTER 2

REVIEW OF LITERAURE

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. In Bangladesh, T. aman rice grown in the area where the depth of water does not exceed 0.5 m. Very often the transplanting schedule of transplant aman rice can not be maintained in this country particularly in the low lying areas due to tidal inundation or flash flood caused by incessant rainfall. In the country, the scarcity of rice seedlings of transplant aman after recession of flood water was also a common phenomenon for the last few years. Proper attention had not been given on the storage durations of uprooted rice seedlings which were usually stored for certain period before transplanting due to unfavorable conditions. Experimental evidences on these aspects are a few both at home and abroad. 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, age and storage durations of seedlings on the performance of some transplant aman rice varieties.

2.1 Effect of variety on plant characters and yield of rice

2.1.1 Plant height

In Bangladesh, BRRI (2000b) 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 (1998a) 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 (15 cm) lines.

Om *et al.* (1998) working with hybrid rice cv. ORI 161 and PMS 2A × IR 31802 found taller plants in ORI 161 than PMS 2A × 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^{-1} 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.

2.1.2 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^{-1} 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^{-1} and effective tillers hill^{-1} 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 bearnig tillers hill^{-1} 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^{-1}.

BRRI (1991) reported that the number of effective tillers hill^{-1} was produced by transplant *aman* rice varieties which ranged from 7-14. Number of effective tillers hill^{-1} significantly differed among the varieties. In local varieties namely, Haloi, Tilockachari, Nizersail and Latishail, number of effective tillers hill^{-1} 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^{-1} 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 $hill^{-1}$ differed among the tested varieties.

Babiker (1986) conducted an experiment with rice cv. Gazi 171 and Gazi 180 and observed that total tillers $hill^{-1}$ were significantly affected by the varieties.

2.1.3 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 $panicle^{-1}$ 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 $hill^{-1}$ 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.

2.1.4 Number of spikelets $panicle^{-1}$

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 $panicle^{-1}$ and BR14 produced the lowest number of spikelets $panicle^{-1}$.

Chowdhury *et al.* (1993) revealed that the variety Pajam produced significantly higher number of total spikelets as well as unfilled spikelets than that of BR 23.

Devi and Nair (1984) noted that the number of spikelets panicle^{-1} in four drought resistant tall upland rice varieties differed significantly.

2.1.5 Number of grains panicle^{-1}

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^{-1} were 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^{-1} 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^{-1} and BR14 produced the lowest number of grains panicle^{-1}.

Chowdhury *et al.* (1993) found that Pajam produced significantly higher number of grains panicle^{-1} than that of BR 23. In another experiment, Bhowmick and Nayak, (2000) showed that CNHR 2 produced more grains panicle^{-1} (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-6314 and found that grains panicle^{-1} was the highest for C-14-8 among the four varieties.

Niu *et al.* (2001) conducted an experiment with three rice varieties viz. Hong 12A/ Tianjin 1244, Hong 21/A Tianjin 1244 and Hong 264/ Tianjin 1244.

Result revealed that filled grains panicle^{-1} was 186.2, 139.2 and 205.7 respectively.

2.1.6 Thousand grain weight

Islam (2006) studied twenty varieties of aromatic rice. Results showed that 1000-grain weight of the studied varieties ranged from 9.76g (Sorukamini) to 19.90g (BRRI dhan38). BRRI dhan34 had 10.12g 1000-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 (27.7g) among the four varities.

BRRI (1998a) revealed that 1000-grain weight 24, 22, 25, 20, 23, 18 and 17 g in Kuicha Binni, Leda Binni, Chanda Binni, Dudh Methi, Maraka Binni, Nizarshail and one high yielding varity 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 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 from an experiment with 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 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 weighed differed significantly among the varieties. They reported that weight of 1000-grain of nine varieties ranged from 21.1 to 31.0 g.

2.1.7 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^{-1}) though they possessed much higher straw yield than the modern ones. The yield was attributed the higher panicle/ hill and number of grains $panicle^{-1}$.

Patel (2000) studied the varietal performance of Kranti and IR36. He observed that Kranti produced significantly higher grain and straw yield than IR 36. 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. Kataribhogh and Khaskani werw used as standard check and Chinking, Basmati, Kalijira, Phillppine Katari, Chinigura, Chinatop 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^{-1}. 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^{-1} respectively.

BAU (1998) conducted a field trial with seven hybrids and one modern variety of rice during *aman* season. It was found that variety 93024 gave the highest grain yield (7.58 t ha^{-1}) followed by Alok 6201 (7.33 t ha^{-1}) and the check one (BR22) gave the lowest yield (4.75 t ha^{-1}).

BINA (1998a) 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 (1998b) in field trial with seven hybrid rice varieties found that hybrid rice 93024 gave the highest grain yield of 6.04 t ha^{-1}. The lowest grain yield was given by hybrid rice 92017. Alok6201 gave the grain yield of 5.71 t ha^{-1}.

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^{-1} respectively while BRRI (1995) in another trial observed that BR25 out yielded over BR22 and Nizershail. The farmer preferred BR25 for its finer grain and straw qualities.

BRRI (1994) conducted ann 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^{-1}).

Ali and Murship (1993) conducted an experiment during July to Deecember, 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, BINA 13 and BINA 19. It was found that grain yield did not differ significantly. No 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 performance over Pajam in respect of yield and yield contributing characters.

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

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^{-1} 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^{-1}) and minimum in Purbachi (2.31 t ha^{-1}). Minimum straw yield was produced by BR7 (7.46 t ha^{-1}) and maximum by Purbachi (12.80 t ha^{-1}).

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 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^{-1} to 7.7 t ha^{-1} among the varieties he studied. Kubher and Sonar (1978) reported variables effects of rice varieties on grain yield.

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

2.2 Effect of seedling age on plant characters and yield of rice

2.2.1 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 seedlings 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 (34 to 60 days old seedlings).

Rahamn (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 seedlings 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.

2.2.2 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) started 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.

An experiment was conducted by Molla (2001) during 1998 and 1999 wet season in West Bengal, India to examine the performance of hybrids rice and high-yielding variety (HYV) with different seedling ages and seedling number per hill. The treatments consisted of 2 hybrid rice (Pro-Agro 6201 and CNRH 3) and one HYV (IET4786), 2 seedling ages (21 and 28 days old) and 2 levels of seedling number per hill (1 and 2 seedlings per hill for hybrid rice and 3 and 6 seedlings per hill for HYV). Results revealed that 28 days old seedlings produced more tiller, panicles m^{-2}, and grain yield that 21 days old seedlings. Seedlings per hill significantly influenced the number of tillers, mature panicles m^{-2} and grain yield. Two seedlings per hill had significantly higher yield than one seedling, including other parameters, in hybrids. For HYV, no significant response was obtained by increasing the number of seedlings from 3 to 6.

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 older ones.

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 tilleres/ 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 of effective tillers retarded when aged seedlings were transplanted.

Mejos and Pava (1980) in a trial 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.

Reedy and Narayana (1981) observed that panicle length decreased significantly with each 10 days increase in seedling age.

2.2.3 Number of total and sterile spikelets panicle^{-1}

Khisha (2002) found that the highest number of sterile spikelets panicle^{-1} was obtained from 16 days old seedlings.

Reedy and Narayana (1981) observed that number of total spikelets panicle^{-1} 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 seedling respectively.

2.2.4 Number of grains panicle^{-1}

A field experiment was carried out by Pattar *et al.* (2001) in Karnataka, India, during the kharif season of 1998 and 1999 to study the effect of planting date and seedling age on rice (cv. Sonamasuri) yield. Seedlings of 25, 35 and 45 days were planted on the first and second fortnight of A u g u s t and the first Fortnight of September. Planting on the first fortnight of August had higher yield than those planted on later dates. Planting of 35 or 45 days old seedlings produced significantly higher yields, grain weight and number of filled grains per panicle compared to 25-day-old seedlings. When transplanting was delayed to the second fortnight of August, the performance of both 35 and 45 days old seedlings was greater than that of 25 days old seedlings. In general, there was a drastic reduction in yield when planting was done in the first fortnight of September.

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^{-1} was produced by the oldest seedlings (60 days old).

Yoshi *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.

2.2.5 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 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 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.

2.2.6 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^{-1}) was obtained from 15 days old seedlings. The lowest grain yield (4.42 t ha^{-1}) was recorded from 9 days old seedlings.

Kewat (2002) conducted an investigation during the rainy seasons of 1998 and 1999 at Jabalpur, Madhya Pradesh. India to evaluate the effect of divergent plant spacings and seedling age on the yield and economics of 'Pro-Agro 6201' hybrid rice (*Oryza sativa).* Transplanting of 21 and 28 day old seedlings recorded significantly higher grain and straw yields, net monetary returns and benefit: cost ratio than transplanting 14 days old seedlings.

A field experiment was conducted by Kumar *et al.* (2002) during kharif 1998 and 1999 in New Delhi, India, to determine the proper age of seedlings and appropriate plant density of a scented (Pusa RH-10) and non-scented (Pusa RH-6) hybrid rice. The treatments comprised 3 ages of seedlings (20, 25 and 30 days old) and 3 plant densities (25, 33 and 50 plants m^{-2}). Transplanting of 20 days old seedlings exhibited higher growth and yield parameters and registered 11.6% higher grain yield over 30 days old seedlings. Plant density of 25 plants m^{-2} appeared more appropriate and yielded 7.6 and 17.5% higher grain yield over 33 and 50 plants m^{-2} respectively.

From the field study at Kumarganj, Uttar Pradesh, Singh and Singh (1998) 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^{-1} 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^{-1} 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 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^{-1}) while delayed transplanting (up to 60 day old) decreased yield (2.28 - 2.52 t ha^{-1}).

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. Sonamashuri 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 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 (1978) 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 stem 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).

2.2.7 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.

Paniker *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 that 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).

2.3 Effect of storage durations on plant characters and yield of rice

2.3.1 Plant height

Karim (2007) reported that plant height exhibited a decreasing trend with the increase in the storage durations of uprooted rice seedlings from 0 to 10 days at 45, 75 DAT and at harvest.

2.3.2 Tillering pattern

Karim (2007) reported that number of total tillers hill^{-1} was gradually increased when seedlings were stored for 0-10 days. Probably, this happened because of the fact that in these treatments the numbers of hills m^{-2} were lesser than other treatments which facilitated the scope of having more space for tillering.

Karim (2007) reported that number of non-effective tillers hill^{-1} was significantly affected by different storage durations.

Khatun (1995) observed that the tiller production was higher with 30 days old seedlings in transplant aman season than others.

Karim (2007) reported that panicle length did not show any significant variation due to the effect of storage durations of uprooted rice seedlings.

2.3.3 Number of spikelets panicle^{-1}

Karim (2007) reported that number of total grains panicle^{-1} showed significant variation due to the effect of storage durations of uprooted rice seedlings.

2.3.4 Number of grains panicle^{-1}

Karim (2007) reported that number of filled grains panicle^{-1} showed significant variation due to the effect of storage durations of uprooted rice seedlings but that not significant in respect of unfilled grains panicle^{-1}.

2.3.5 Thousand grain weight

Karim (2007) reported that 1000-grain weight (g) did not show any significant variation due to the effect of storage durations of uprooted rice seedlings.

Haque (1997) observed that the uprooted seedlings of BR11 rice can be stored in water even up to 8 days in case of emergency and in the sun or shade for 0 to 2 days without any appreciable loss in grain yield.

BRRI (1996) conducted a field trial with preserving uprooted seedlings of BR23 and Sadamata rice varieties before transplanting in gunny, floating in water and on mud for 0, 5 and 10 days. The institute observed that seedlings of both the varieties preserved for 5 days gave significantly higher grain yield than that those stored for 10 days in each of the storage conditions. The grain yield obtained from BR23 rice seedlings stored for 5 days under various conditions, was identical to that of fresh seedlings which were not stored before transplanting. But the yield from the seedlings of the same storage condition for 10 days was significantly lower than that of fresh seedlings. The variety Sadamata also showed similar performance as did the variety BR 23.

Islam (1995) carried out an experiment to determine the effect of storage period of uprooted boro rice seedlings up to 72 hours on the grain yield. He reported that 0 and 24 hours storage periods produced higher grain yield of 5.6 and 5.4 tha^{-1} respectively, each of which was significantly higher than that (5.2 tha^{-1}) obtained from the seedlings stored for 48 and 72 hours. There was no significant variation between the yields from 0 and 24 hours and between 48 and 72 hours of seedling storage. The straw yield also showed similar response due to different storage periods.

2.3.6 Effect on grain and straw yield

Karim (2007) conducted an experiment to evaluate the effect of storage conditions and storage durations of uprooted seedlings with two storage conditions such as in mud and in water and six storage durations (0, 2, 4, 6 8 and 10 days storage of uprooted seedlings). Best performance was exhibited by seedlings stored in mud followed by those stored in water was significant. Gradual decrease in the value of subsequent crop characters occurred within increase in the period of storage from on mud up to 4 days and in water up to 2 days.

Kaykobad *et al.* (2003) conducted an experiment to evaluate the effect of storage conditions and storage durations of uprooted seedlings with five storage conditions such as in mud, in water, in shade, in sun and in shade with frequent watering and four storage durations (0, 24, 48 and 72 hours storage of seedlings). Best performance was exhibited by seedlings stored in mud followed by those stored in water, in shade with time to time watering and in sun and the difference was significant. Some decrease in the value of subsequent crop characters occurred with in increase in the period of storage from 0 to 72 hours. However, the differences between treatments were not significant.

In a field experiment Das and Mukherjee (1992) did not find any significant variation in grain and straw yield of IR36 rice due to storing of uprooted seedlings from 0 to 6 days, although a numerical decrease in grain yield was observed from seedlings transplanted 6 days after uprooting.

BRRI (1991) revealed that a significant decrease in grain yield was observed due to storage of uprooted rice seedlings in mud than those transplanted immediately after uprooting irrespective of seedling age, although the grain yield was not less than about 3.0 tha^{-1}. But in case of seedlings stored in water, the grain yield was severely affected in negative direction. However, more than

3.0 tha^{-1} of grain yield was obtained from 40 days old seedlings in water for 7 days, but the 20 day old seedlings stored for the same period in water produced much lower grain yield of only 1.4 t ha^{-1}.

Gomosta *et al* (1990) evaluated the performance of uprooted rice seedlings which were stored in water as well as in mud for a number of days. They observed that 20 and 40 day old seedlings of BR 11 rice, transplanted after 1 to 4 weeks of storage in mud, showed 85% survivability irrespective of age of seedlings. The survivability percentage decreased with the increase in storage duration in case of water storage. In some cases the grain yield became even nil when the seedlings were stored in water for 3 to 4 weeks. On the other hand, it varied from 2.8 to 3.5 t ha^{-1} in case of mud storage of seedlings. They concluded that to obtain reasonable grain yield, uprooted seedlings of transplant aman rice is to be stored in mud up to 4 weeks irrespective of seedling age ranging from 20 to 40 days.

Kumar and Gupta (1990) conducted an experiment on the yield performance of IR36 rice *(Oryza saliva L.)* with three uprooting times. Twenty days old seedlings were uprooted 0, 3, and 6 days before transplanting. They found that the seedlings uprooting time did not affect grain and straw yields of rice significantly, though declining trend in grain yield was observed with seedlings transplanted 6 days after uprooting.

From the presented review, it is clear that the variety, seedling age and storage durations of uprooted rice seedlings played significant role on yield and yield contributing characters of rice.

Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

This chapter deals with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recordings and their analyses.

3.1 Site description

The experiment was conducted at the Sher-e-Bangla Agricultural University farm, Dhaka under the Agro-ecological zone of Modhupur Tract, AEZ-28 during the Aman season (Jun - Dec) of 2008. The land area was situated at 23°41′N latitude and 90°22′E longitude at an altitude of 8.6 meter above sea level. The experimental site has been shown in the AEZ Map of Bangladesh in Appendix I.

3.2 Climate

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

3.3 Soil

The soil of the experimental field belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. The experimental area was flat having available irrigation and drainage system. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done from Soil Resources and

Development Institute (SRDI), Dhaka. The physicochemical property of the soil has presented in Appendix II and Appendix III.

3.4 Crop/Planting materials

BRRI dhan31

A high yielding variety of Aman rice BRRI dhan31 was used as a test crop. The variety BRRI dhan31 was developed from the cross between BR 11 and ARC10550 by the Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Bangladesh. It inheritance number was BR1725-13-7-1-6. The height of the variety is 115 cm. it is characterized by deep green and erect leaves. The life cycle of this variety ranges from 140-145 days. Its grain size is medium-coarse and color of kernel is white. The variety was released in 1994 for cultivation in aman season. BRRI dhan31 is highly resistant to Brown plant hopper and moderately resistant to Leaf Blight and Tungro (BRRI, 2004).

BRRI dhan34

BRRI dhan34 is a variety of aromatic Aman rice. The variety BRRI dhan34 was developed from the selection process from local Khaskani rice of Jessore district by the Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Bangladesh. This is aromatic rice and small fine rice as Kalizira rice and is very much applicability to make polao. The yield of this variety is 3.5 t ha^{-1}, height 135 cm and the life cycle of this variety ranges from 130-135 days.

3.5 Experimental treatments:

The experiment consisted of the following treatments:

Factor A: Rice variety (2)

i) BRRI dhan31 (V_1)

ii) BRRI dhan34 (V_2)

Factor B. Seedling age (2)

i) 30 days old seedling (A_1)

ii) 40 days old seedling (A_2)

Factor C. Storage durations of uprooted rice seedling (4)

i) 0 days after uprooting (D_0)

ii) 2 days after uprooting (D_2)

iii) 4 days after uprooting (D_4)

iv) 6 days after uprooting (D_6)

3.6 Design and layout of the experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each block was divided into sixteen unit plots. Total number of unit were 48. The net size of unit plot was 4.0 m × 3.0 m = 12 m^2. The distances between plot to plot were 1.0 m and block to block were 1.5 m, respectively.

3.7 Collection and preparation of initial soil sample

The initial soil samples from the main field were collected before land preparation from a 0-15 cm soil depth. The samples were collected by means of an auger from different locations covering the whole experimental plot and mixed thoroughly to make a composite sample. After collection of soil samples, the plant roots, leaves were picked up and removed. Then the sample was air-dried and sieved through a 10-mesh sieve and stored in a clean plastic container for physical and chemical analysis.

3.8 Crop production practices

3.8.1 Nursery bed preparation and raising of seedlings

A piece of high land was selected for the nursery bed. The nursery bed was prepared well by puddling with repeated ploughing followed by laddering to level the soil. The nursery bed was cleaned properly by removing of weeds and stubble. Healthy and vigorous seeds of BRRI dhan31 and BRRI dhan34 were collected from BRRI. Seeds were than soaked in water in a bucked for 24 hours. Thereafter, the seeds were taken out of water and kept thickly in gunny bags for sprouting. After 48 hours, the sprouted seeds were sown in the finely prepared nursery bed on 20 June 2008. Care was taken to see that there was no damage by birds and no infestation of pest and diseases. Weeds were removed and irrigation was given in the nursery bed as and when necessary. Proper care was taken to raise healthy seedlings.

3.8.2 Preparation of main land for transplanting

The experimental main field was first opened on July 18, 2007 with the help of a disc plough and later on, the land was irrigated and prepared by three successive ploughing and cross-ploughing. Each ploughing was followed by laddering to have a good puddled field. The corners of the land were spaded. All kinds of weeds and residues of previous crop were removed from the field. The field layout was made on July 20, 2008 according to design immediately after final land preparation. Individual plots were cleaned and finally leveled with the help of wooden ladder. The land was then ready for transplanting.

3.8.3 Fertilizer application

At the time of first ploughing cowdung at the rate of 10 t ha^{-1} was applied. The experimental field was fertilized with 220, 80, 120, 55 and 10 kg ha^{-1} N, P_2O_5, K_2O, S and Zn applied in the form of urea, triple super phosphate (TSP), muriate of potash (MOP), gypsum and zinc sulphate respectively. The whole amounts of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation as a basal dose. Urea was top dressed 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.

3.8.4 Uprooting of seedlings

The nursery bed was made wet by applying water in the morning and evening on the previous day before uprooting the seedlings to reduce mechanical injury to the roots. The seedlings were uprooted at 30 and 40 DAS as per treatment and kept on soft mud in shade before they were transplanted.

3.8.5 Transplanting of seedlings

The uprooted seedlings of 0, 2, 4 and 6 days storage durations were transplanted on well puddle plots on 04 August 2008 of thirty days old seedlings and as followed by 40 days old seedlings and maintained spacing 25 cm x 20 cm for BRRI dhan31 and 20 cm x 20 cm for BRRI dhan34 variety (as per recommendation of BRRI) according to the experimental design . Transplanting was done by using 3 seedlings hill^{-1}.

3.8.6 Intercultural operations

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

Gap filling

After one week of transplanting, a minor gap filling was done where it was necessary using the seedling from the same source.

Weeding

During plant growth period three hand weeding were done. First weeding was done at 20 days after transplantation followed by second weeding at 15 days after first weeding and third weeding at 15 days after second weeding.

Irrigation and drainage

Irrigation water was added to each plot as per requirements maintaining proper depth. Before ripening, the field was allowed to become dry for all the treatments. The drainage system was good and the ails of individual plot was high because it was the time of rainy season.

Plant protection measures

During the growth period some plants were infested with rice stem borer (*Scirpophaga incertulus*) and rice hispa (*Dicladispa armigera*) to some extent which were successfully controlled by applying Diazinon two times @ 10 ml/ 10 liter of water for 5 decimal lands and by Ripcord one time @ 10 ml/ 10 liter of water for 5 decimal lands. Crop was protected from birds and rats during the grain filling period. Field trap and poisonous bait were used to control the rat. For controlling the birds watching was done properly, especially during morning and afternoon.

3.8.7 General observation of the experimental field

The field looked nice with normal green plants. The plants in the wider spacing appeared to be more vigorous and luxuriant than that of closer spacing. Field was observed time to time to detect visual difference among the treatment and any kind of infestation by weeds, insects and diseases so that considerable losses by pest was minimized. Incidence of stem borer, leaf roller and rice hispa (*Dicladispa armigera*) was observed during tillering stage but controlled properly.

3.8.8 Sampling and harvesting

Ten hills (excluding border hills) from each plot were randomly selected from which different growth and yield attributes data were collected and 3 m^2 areas from middle portion (pre-marked) of each plot was separately harvested and bundled, properly tagged and then brought to the threshing floor for recording grain and straw yield. Maturity of crop was determined when 90% of the grains became golden yellow in color. The harvesting was done at full maturity. Threshing was done by using pedal thresher. The grains were cleaned and sun dried to a moisture content of 12 %. Straw was also sun dried properly. Grain and straw yields $plot^{-1}$ were converted to t ha^{-1}.

3.9 Collection of data

Experimental data (Growth and yield) were collected from 20, 40 and 60 days after transplanting and at harvest. The following data were recorded during the experimentation.

A. Growth data:

1. Plant height (at 45 DAT and at harvest)
2. Number of tillers $hill^{-1}$ (at 45, 75 DAT and at harvest)

B. Plant, yield components and yield data:

1. Number of effective tillers $hill^{-1}$ (At harvest)
2. Number of non-effective tillers $hill^{-1}$ (At harvest)
3. Length of panicle (cm)
4. Number of fertile spikelets $panicle^{-1}$ (Filled grain)
5. Number of sterile spikelets $panicle^{-1}$ (Unfilled grain)
6. Number of total grains $panicle^{-1}$
7. Weight of 1000-grains (g)
8. Grain yield (t ha^{-1})
9. Straw yield (t ha^{-1})
10. Biological yield (t ha^{-1})
11. Harvest Index (%)

3.10 Procedures of recording data

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

A. Crop Growth data

Plant height (cm)

The height of the preselected 10 hills were taken by measuring the distance from the base of the plant to the tip of the leaf before heading, and to the tip of flag leaf after heading. The collected data were finally averaged.

Number of tillers hill^{-1}

Number of tillers hill^{-1} was counted from 10 preselected hills at 20, 40 and 60 DAT. Tillers, which had at least one visible leaf, were counted. Finally average them to have numbers of tillers hill^{-1}.

B. Yield components and yield data

Number of effective tillers hill^{-1}

The effective tillers from ten hills were counted and averaged to have hill^{-1} basis. The panicles which had at least one grain was considered as effective tillers.

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

The non-effective tillers from ten hills were counted and averaged to have hill^{-1} basis. The panicles which had no grain were considered as ineffective tillers.

Panicle length (cm)

Measurement of panicle length was taken from basal node of the rachis to the apex of each panicle. Each observation was an average of 20 panicles.

Number of filled grains panicle^{-1}

Filled grain was considered to be fertile if any kernel was present there in. The number of filled grains present on each ten panicles were recorded and averaged.

Number of unfilled grains panicle^{-1}

Unfilled spikelet present on each ten panicles were counted and averaged.

Total number of grains panicle^{-1}

The number of filled grains panicle^{-1} plus the number of unfilled grains panicle^{-1} gave the total number of grains panicle^{-1}. The total number of grains panicle^{-1} was calculated with the following formula:

Total Number of grains panicle^{-1} = Number of filled grains panicle^{-1} + number of unfilled grains panicle^{-1}.

Weight of 1000-grain (g)

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

Grain yield (t ha^{-1})

Grain yield was determined from the central 3 m^2 area of each plot and expressed as t ha^{-1} on 12% moisture basis. Grain moisture content was measured by using a digital moisture tester.

Straw yield (t ha^{-1})

Straw yield was determined from the central 3 m^2 area of each plot, after separating the grains. The sub-samples were oven dried to a constant weight and finally converted to t ha^{-1}. The weight was then adjusted to 12 % moisture.

Biological yield (t ha^{-1})

Grain yield and straw yield together are regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield + Straw yield

Harvest index (%)

It is the ratio of economic yield to biological yield and was calculated with the following formula.

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

3.11 Statistical analysis of the data

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

CHAPTER 4
RESULTS AND DISCUSSION

Present experiment was conducted with different ages and storage durations of uprooted rice seedlings to study the effect on the performance of BRRI dhan31 and BRRI dhan34. The effects of variety, seedling age and storage durations on growth, yield and yield contributing characters have been shown in Fig. 1 to 24 The interaction effect of variety, seedling age and storage durations 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, seedling age and storage durations on different vegetative growth parameters, such as plant height and number of tillers $hill^{-1}$ are discussed below.

4.1.1 Plant Height (cm)

4.1.1.1 Effect of variety

The growth behaviors of two rice varieties in term of plant height differed significantly in all sampling dates (Fig. 1). From the results, it was found that BRRI dhan34 produced taller plants from the early growth stage of the crop to final harvest. At 45 DAT (days after transplanting), BRRI dhan34 produced taller plants (83.91 cm) whereas shorter ones (77.04 cm) was produced by BRRI dhan31. At harvest, BRRI dhan34 produced taller plants (135.32 cm) whereas shorter ones (111.4 cm) were produced by BRRI dhan31. 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 also the fact as reported by BRRI (2000b) was working on varieties.

4.1.1.2 Effect of seedling age

It was observed that plant height differed significantly due to age of seedling (Fig. 2). The taller plants were produced by the 30 days old seedlings at 75 DAT and at harvest but at 45 DAT taller plants were produced by 40 days old seedlings. At 45 DAT, the taller plants (81.59 cm) were produced by the 40 days old seedlings whereas the shorter ones (79.36 cm) was produced by the 30 days old seedlings. Higher height of the old seedlings while in seedbed probably also caused earlier growth in the main field. At harvest, the taller plants (124.47 cm) were produced by the 30 days old seedlings whereas the shorter ones (122.25 cm) were produced by the 40 days old seedlings. 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 older ones. Akber (2004) reported that plant height differed due to seedling age. He also reported that younger seedling when transplanted produce the tallest plant at the final harvest.

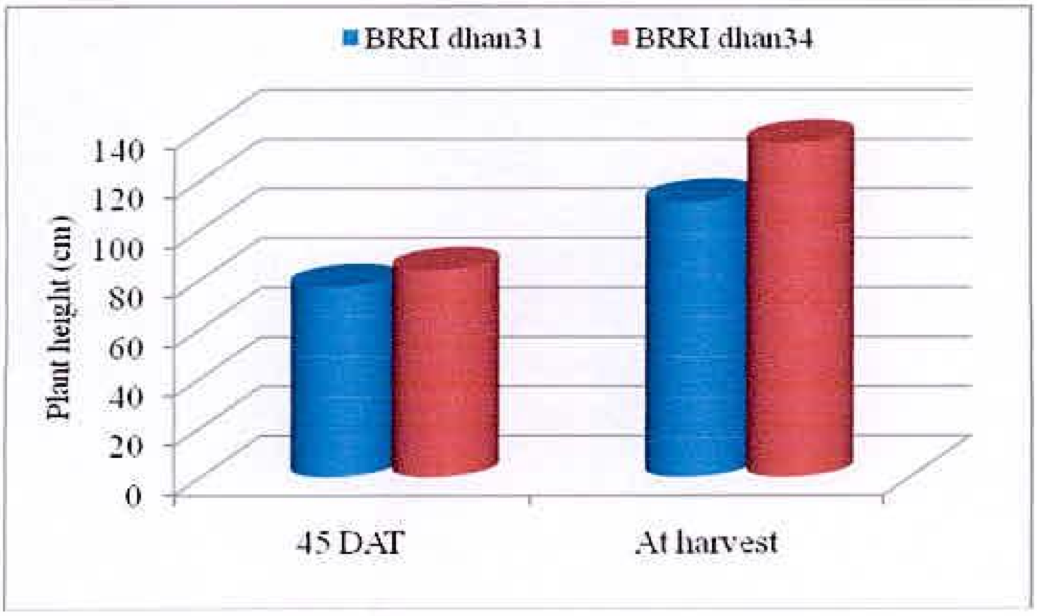

Fig. 1. Effect of variety on plant height at different days after transplanting ($LSD_{0.05}$ =1.286 and 1.084 at 45 DAT and at harvest respectively)

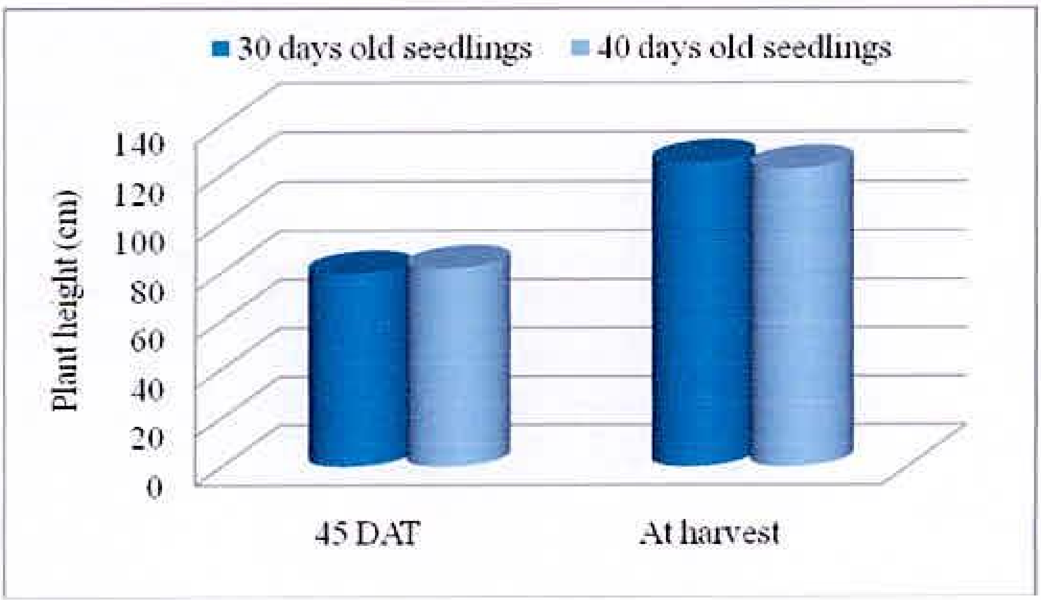

Fig. 2. Effect of seedlings age on plant height at different days after transplanting ($LSD_{0.05}$ = 1.182 and 1.055 at 45 DAT and at harvest respectively)

4.1.1.3 Effect of storage durations

The plant height differed significantly due to storage durations (fig. 3). At all the growth stages, the tallest plant height was produced in the treatment 0 day of storage and the shortest plant height was found when seedlings were stored for 6 days. At 45 DAT, the tallest plants (83.66 cm) were produced by the seedlings stored for 0 days whereas the shortest ones (77.12 cm) were produced by the seedlings stored for 6 days. At harvest, the tallest plants (126.66 cm) were produced by the seedlings stored for 0 days whereas the shortest ones (120.03 cm) were produced by the seedlings stored for 6 days. Probably, due to prolonged storage durations, the vigour of the seedlings decreased which intern decreased plant height. Similar findings were also reported by Karim (2007). He reported that plant height exhibited a decreasing trend with the increase in the storage durations of uprooted rice seedlings.

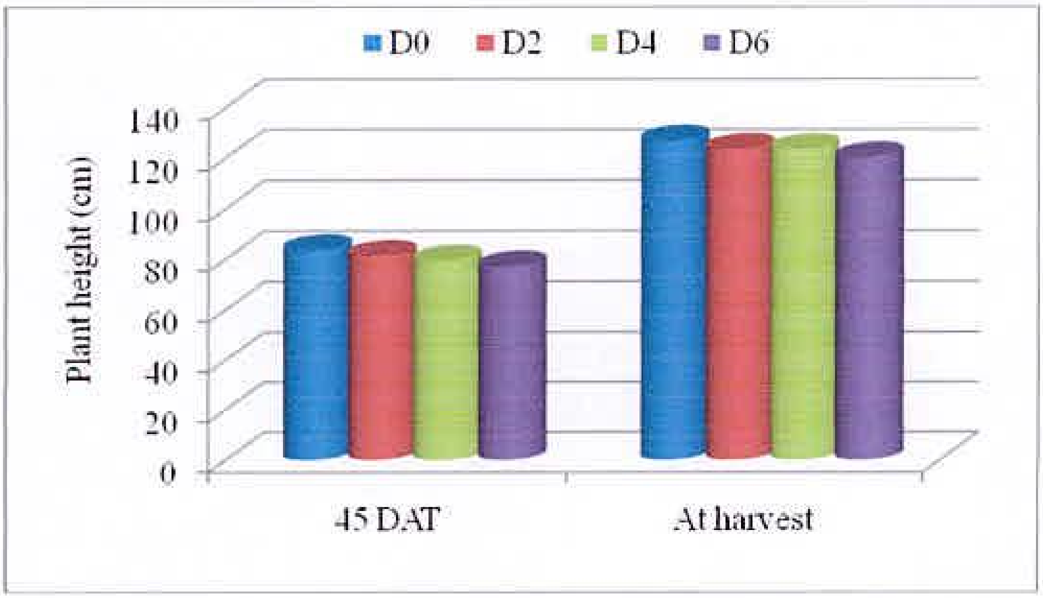

Fig. 3. Effect of storage durations of uprooted rice seedlings on plant height at different days after transplanting ($LSD_{0.05}$ = 2.128 and 1.656 at 45 DAT and at harvest respectively)

4.1.1.4 Interaction effect of variety, seedlings age and storage durations

The interaction effect of variety, seedlings age and storage durations on plant height was significant at different stages of growth (Table 1). At 45 DAT, the tallest plant height (87.37 cm) was obtained from the 40 days old seedlings which were stored for 0 days in BRRI dhan34 variety which was statistically similar up to 2 days stored for same age and variety. The shortest plant height (70.40 cm) was found from 30 days old seedlings which were stored for 6 days in BRRI dhan31 variety.

At harvest, the tallest plant height (142.72 cm) was obtained from the 30 days old seedlings which were stored for 0 days in BRRI dhan34 variety. The shortest plant height (100.53 cm) was found from 40 days old seedlings which were stored for 6 days in BRRI dhan31 variety.

Table 1. Interaction effect of variety, seedling age and storage duration of uprooted rice seedlings on plant height (cm)

Treatment (Variety × Age × Duration)	Plant height (cm)	
	45 DAT	At harvest
$V_1A_1D_0$	78.59	117.82
$V_1A_1D_2$	77.70	114.63
$V_1A_1D_4$	74.84	109.21
$V_1A_1D_6$	70.40	106.54
$V_1A_2D_0$	82.30	115.66
$V_1A_2D_2$	79.60	112.15
$V_1A_2D_4$	78.12	107.84
$V_1A_2D_6$	75.77	100.53
$V_2A_1D_0$	84.71	142.72
$V_2A_1D_2$	83.63	138.52
$V_2A_1D_4$	83.05	136.56
$V_2A_1D_6$	80.47	134.54
$V_2A_2D_0$	87.37	137.42
$V_2A_2D_2$	86.53	133.61
$V_2A_2D_4$	83.79	130.92
$V_2A_2D_6$	79.27	128.58
$LSD_{(0.05)}$	2.651	2.166
CV (%)	6.64	8.22

V_1 = BRRI dhan31

V_2 = BRRI dhan34

A_1= 30 days old seedling

A_2 = 40 days old seedling

D_0 = 0 days after uprooting

D_2 = 2 days after uprooting

D_4 = 4 days after uprooting

D_6 = 6 days after uprooting

4.1.2 Number of total tillers hill^{-1}

4.1.2.1 Effect of variety

It is evident from Fig. 4 that the number of total tillers hill^{-1} was significantly influenced by variety at all stages of growth up to harvest. At all stages of growth up to harvest, BRRI dhan31 produced significantly higher number of tillers (15.55, 12.41 and 8.51) compared to BRRI dhan34 (13.51, 10.82 and 7.42). In case of both the varieties total number of tillers hill^{-1} decreased gradually. This difference in the number of total tillers hill^{-1} could due to genetic variation between varieties. This fact is in agreement with that of *Hussain et al.* (1989). He observed in an experiment that number of total tillers hill^{-1} differed among varieties.

4.1.2.2 Effect of seedling age

Number of total tillers hill-1 was significantly influenced by age of seedling at all stages of growth (Fig. 5). Thirty days old seedlings produced the significantly highest number of total tillers hill^{-1} (15.61, 12.92 and 8.95 respectively) whereas the lowest one (13.45, 10.22 and 7.83 respectively) from forty days old seedlings. Akbar (2004) also found similar trend. From the results, he stated that number of total tillers hill-1 was significantly influenced by the seedling age in all growth stages. He also found that younger plants produced higher number of total tillers hill^{-1}. The seedlings over 30 days old when transplanted in the field recovered more slowly than 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.

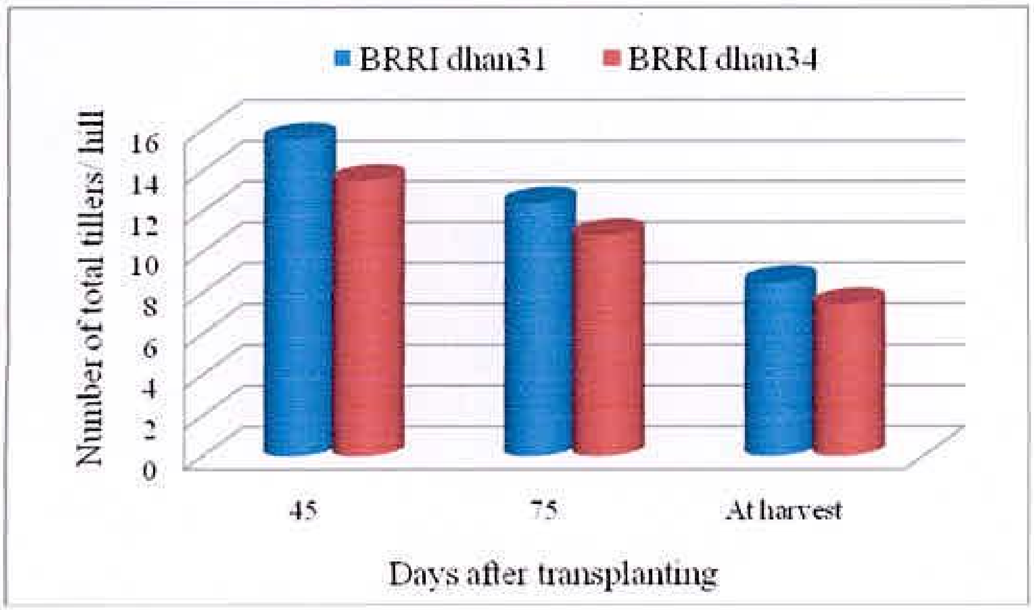

Fig. 4. Effect of variety on number of total tillers hill[-1] at different days after transplanting ($LSD_{0.05}$ = 0.722, 0.624 and 0.554 at 45, 75 DAT and at harvest respectively)

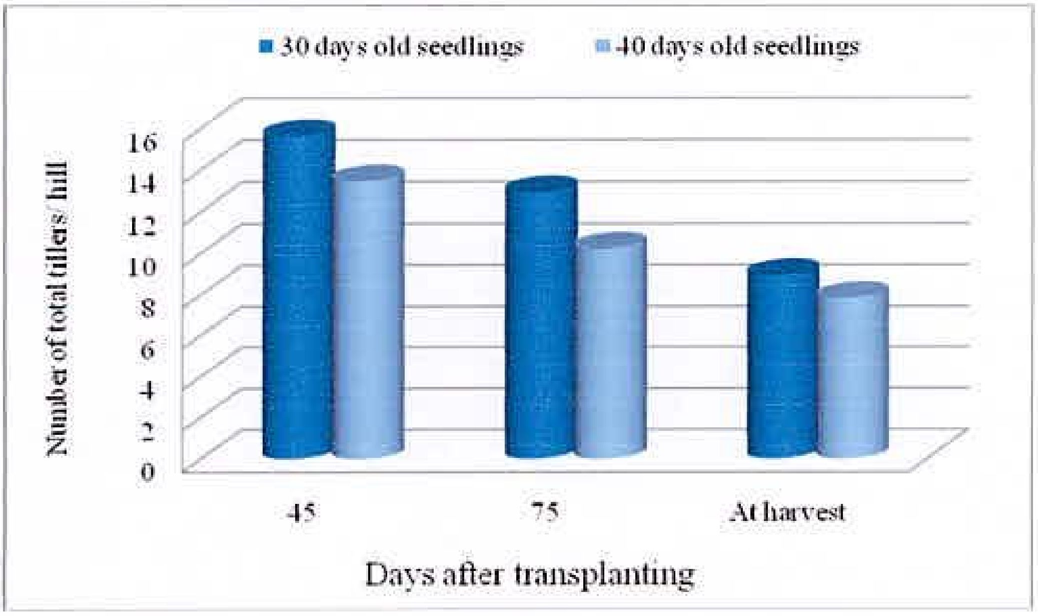

Fig. 5. Effect of seedlings age on number of total tillers hill[-1] at different days after transplanting ($LSD_{0.05}$ = 1.024, 0.821 and 0.758 at 45, 75 DAT and at harvest respectively)

4.1.2.3 Effect of storage durations

Number of total tillers $hill^{-1}$ was significantly influenced by storage durations at all stages of growth except harvest (Fig. 6). At 45 DAT, the maximum number of tillers $hill^{-1}$ (16.65) was obtained from seedlings stored for 0 days and the minimum (13.31) by seedlings stored for 6 day which was statistically identical with the seedlings stored for 4 days.

At 75 DAT, the maximum number of total tillers $hill^{-1}$ (13.76) was obtained from seedlings stored for 0 days and the minimum number of total tillers $hill^{-1}$ (10.95) by seedlings stored for 6 day which was statistically identical with seedlings stored for 4 days.

At harvest, there was no significant difference among storage durations. The maximum number of total tillers $hill^{-1}$ (9.32) from seedlings stored for 6 days and the minimum number of total tillers $hill^{-1}$ (8.94) from seedlings stored for o day. In this study it was observed that number of total tillers $hill^{-1}$ was gradually increased when seedlings were stored for 0-6 days. This happened because of the fact that number of non-effective tiller was increased gradually.

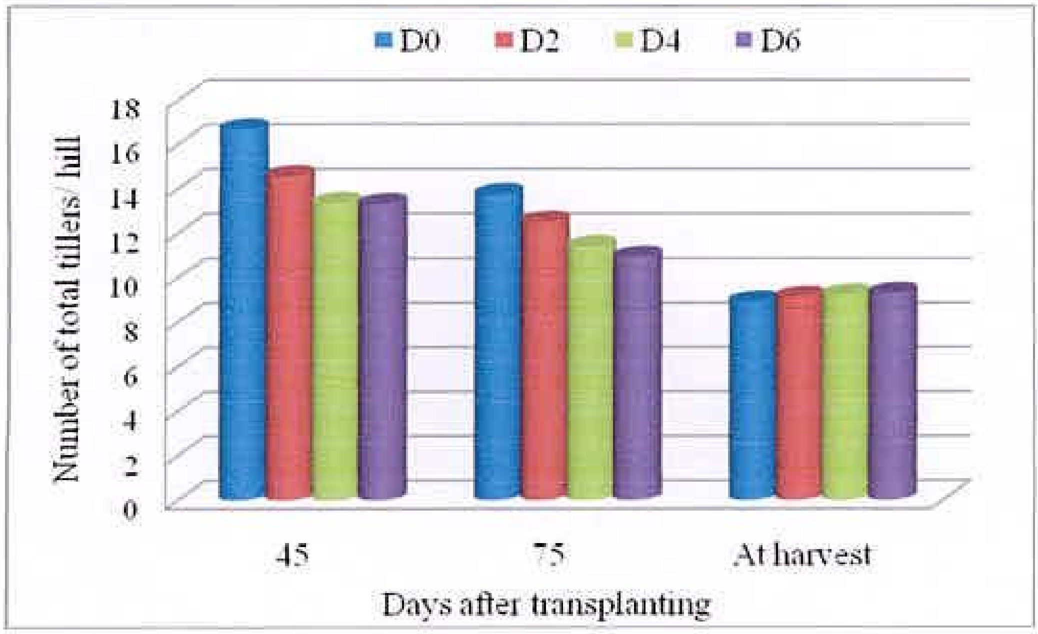

Fig. 6. Effect of storage durations of uprooted rice seedlings on number of total tillers hill^{-1} at different days after transplanting ($LSD_{0.05}$ = 1.151, 1.224 and NS at 45, 75 DAT and at harvest respectively)

4.1.2.4 Interaction effect of variety, seedlings age and storage durations

The interaction effect of variety, seedlings age and storage durations on number of total tillers hill^{-1} was significant at different stages of growth (Table 2). At 45 DAT, the maximum number of total tillers hill^{-1} (16.33) was obtained from the 30 days old seedlings which were stored for 0 day in BRRI dhan31 variety which was statistically similar for 2 days stored for both age and variety. The minimum number of total tillers hill^{-1} (10.47) was found from 40 days old seedlings which were stored for 6 days in BRRI dhan34 which was statistically similar for same storage duration of both age and variety.

At 75 DAT, the maximum number of total tillers hill^{-1} (13.74) was obtained from the 30 days old seedlings which were stored for 0 day in BRRI dhan31 variety which was statistically similar for same storage duration of both age and variety. The minimum number of total tillers hill^{-1} (9.42) was found from

40 days old seedlings which were stored for 6 days in BRRI dhan34 variety and that was statistically identical with 4 days stored for both age and variety

At harvest, the maximum number of total tillers $hill^{-1}$ (8.41) was obtained from the 30 days old seedlings which were stored for 0 day in BRRI dhan31 variety. The minimum number of total tillers $hill^{-1}$ (7.06) was found from 40 days old seedlings which were stored for 4 days in BRRI dhan34 variety.

Table 2. Interaction effect of variety, seedling age and storage duration of uprooted rice seedlings on Number of total tillers $hill^{-1}$

Treatment (Variety × Age × Duration)	Number of total tillers $hill^{-1}$		
	45 DAT	75 DAT	At harvest
$V_1A_1D_0$	16.33	13.74	8.41
$V_1A_1D_2$	15.67	11.32	7.82
$V_1A_1D_4$	13.73	10.18	7.85
$V_1A_1D_6$	12.8	9.86	7.84
$V_1A_2D_0$	15.67	11.92	8.35
$V_1A_2D_2$	15.33	11.42	8.12
$V_1A_2D_4$	13.67	11.22	7.56
$V_1A_2D_6$	12.53	10.56	7.82
$V_2A_1D_0$	15.13	12.4	7.95
$V_2A_1D_2$	14.4	11.58	7.75
$V_2A_1D_4$	15.13	10.56	7.38
$V_2A_1D_6$	10.73	9.22	7.77
$V_2A_2D_0$	14.67	11.75	7.46
$V_2A_2D_2$	14.4	11.46	7.46
$V_2A_2D_4$	13.47	10.73	7.06
$V_2A_2D_6$	10.47	9.42	7.59
$LSD_{(0.05)}$	2.228	1.284	NS
CV (%)	8.56	10.32	9.88

V_1 = BRRI dhan31

V_2 = BRRI dhan34

A_1= 30 days old seedling

A_2 = 40 days old seedling

D_0 = 0 days after uprooting

D_2= 2 days after uprooting

D_4 = 4 days after uprooting

D_6 = 6 days after uprooting

4.2 Yield contributing characters

4.2.1 Number of effective tillers hill^{-1}

4.2.1.1 Effect of variety

The number of effective tillers hill^{-1} is one of the yield contributing characters that determines the yield of rice. Higher effective tillers hill^{-1} was reported to produce higher grain yield. In the present experiment, the number of effective tillers hill^{-1} was significantly affected by variety (Fig. 7). Higher number of effective tillers hill^{-1} (7.26) was produced from BRRI dhan31 whereas BRRI dhan34 produced the lowest (5.11). Probable reason for differences in producing the effective tillers hill^{-1} 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^{-1} differed significantly due to varieties.

4.2.1.2 Effect of seedling age

Seedling age had significant influence on the production of effective tillers hill^{-1} (Fig. 8). Significantly the highest number of effective tillers hill^{-1} (7.66) was produced from 30 days old seedlings whereas the lowest ones (5.01) by 40 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^{-1}. Agragones and Wada (1989) and Mandal *et al.* (1984) also found similar results.

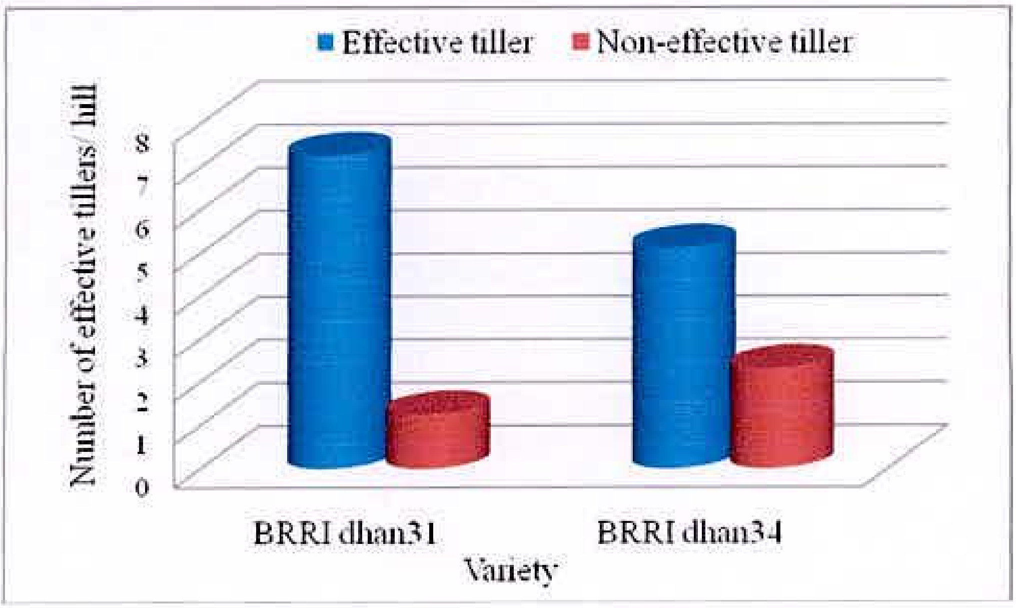

Fig. 7. Effect of variety on number of effective tillers hill^{-1} ($LSD_{0.05}$ = 0.491) and non-effective tillers hill^{-1} ($LSD_{0.05}$ = NS)

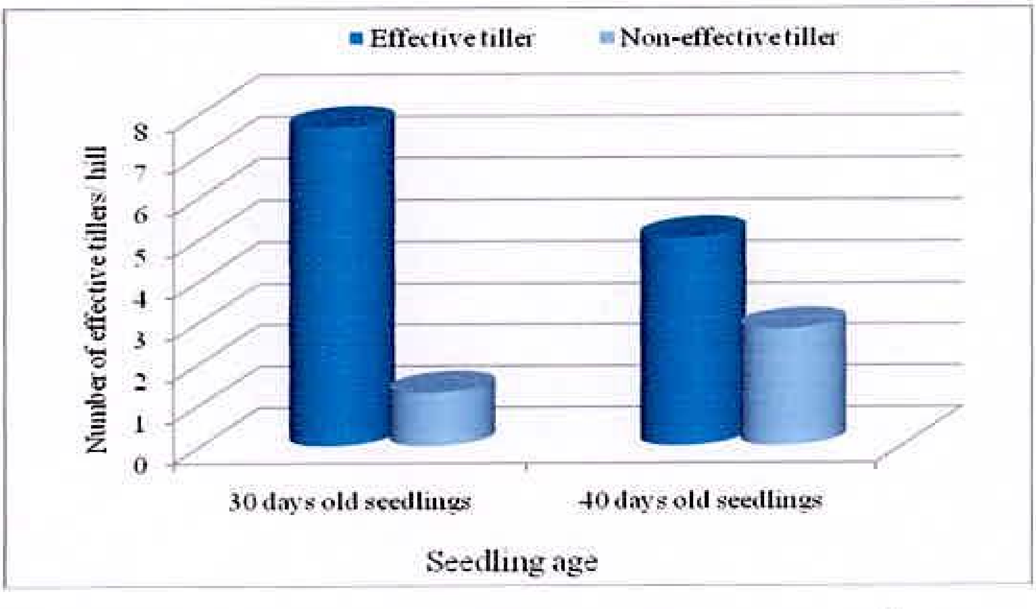

Fig. 8. Effect of seedlings age on number of effective tillers hill^{-1} ($LSD_{0.05}$ = 0.292) and non-effective tillers hill^{-1} ($LSD_{0.05}$ = 0.334)

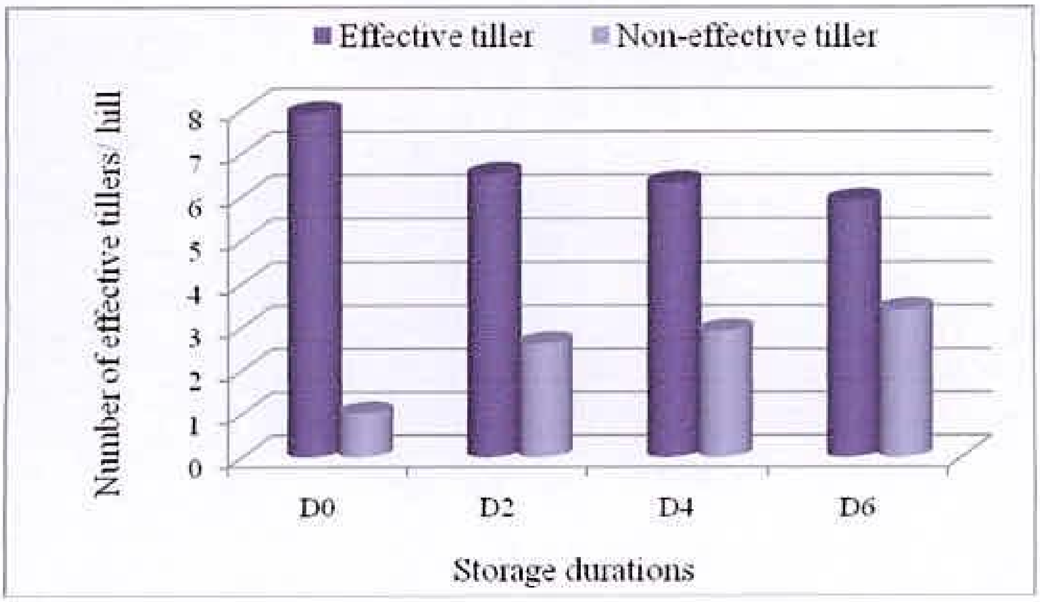

Fig. 9. Effect of storage durations of uprooted rice seedlings on the number of effective tillers hill^{-1} ($LSD_{0.05}$ = NS) and non effective tillers hill^{-1} ($LSD_{0.05}$ = 1.762)

4.2.1.3 Effect of storage durations

The number of effective tillers hill^{-1} in all treatments is not varied significantly from each other due to different storage durations of the uprooted seedlings (Fig. 9). The maximum number of effective tillers hill^{-1} (7.93) resulted from o day storage. The lowest number of effective tillers hill^{-1} (5.91) was observed from 6 days storage.

4.2.1.4 Interaction effect of variety, seedlings age and storage duration

The number of effective tillers hill^{-1} showed significant difference due to the interaction effect of variety, seedling age and storage durations of uprooted rice seedlings (Table 3). The maximum number of effective tillers hill^{-1} (7.43) was obtained from the 30 days old seedlings which were stored for 0 day in BRRI dhan31 variety. The minimum number of effective tillers hill^{-1} (4.87) was found from 40 days old seedlings which were stored for 6 days in BRRI dhan34 variety.

Table 3. Interaction effect of variety, seedling age and storage duration of uprooted rice seedlings on Number of effective and non-effective tillers $hill^{-1}$

Treatment (Variety × Age × Duration)	Number of effective tillers $hill^{-1}$	Number of non-effective tillers $hill^{-1}$
$V_1A_1D_0$	7.43	0.98
$V_1A_1D_2$	6.56	1.26
$V_1A_1D_4$	6.21	1.64
$V_1A_1D_6$	5.59	2.25
$V_1A_2D_0$	7.29	1.06
$V_1A_2D_2$	6.69	1.43
$V_1A_2D_4$	5.62	1.94
$V_1A_2D_6$	5.18	2.64
$V_2A_1D_0$	6.33	1.62
$V_2A_1D_2$	6.06	1.69
$V_2A_1D_4$	5.62	1.76
$V_2A_1D_6$	5.09	2.68
$V_2A_2D_0$	5.82	1.64
$V_2A_2D_2$	5.68	1.78
$V_2A_2D_4$	5.22	1.84
$V_2A_2D_6$	4.87	2.72
$LSD_{(0.05)}$	1.542	1.722
CV (%)	12.25	9.2

V_1 = BRRI dhan31

V_2 = BRRI dhan34

A_1= 30 days old seedling

A_2 = 40 days old seedling

D_0 = 0 days after uprooting

D_2 = 2 days after uprooting

D_4 = 4 days after uprooting

D_6 = 6 days after uprooting

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

4.2.2.1 Effect of variety

Result of the present experiment indicated that the number of non-effective tillers hill^{-1} was not significantly affected by the varieties studied (Fig. 7). However, higher number of non-effective tillers hill^{-1} (2.31) was produced in BRRI dhan34 and lower one (1.25) was produced by BRRI dhan31. Varietal differences regarding non-effective tiller production might be due to their differences in genetic make-up.

4.2.2.2 Effect of seedling age

It was evident from the Fig. 8 that seedling age had significant influence on the production of non-effective tillers hill^{-1}. Significantly highest number of non-effective tillers hill^{-1} (2.82) was produced from 40 days old seedlings and the lowest (1.29) from 30 days old seedlings. Khatun (1995) also noticed a significant effect of seedling age on non-effective tillers hill^{-1}.

4.2.2.3 Effect of storage durations

The number of non-effective tillers hill^{-1} in all treatments is varied significantly from each other due to different storage durations of the uprooted seedlings (Fig. 9). The maximum number of non-effective tillers hill^{-1} (3.41) resulted from 6 days storage which was statistically identical with 4 days of storage durations. The lowest number of non-effective tillers hill^{-1} (1.01) was observed from 0 day storage which was statistically identical with 2 days of storage durations. Karim (2007) also found similar results.

4.2.2.4 Interaction effect of variety, seedlings age and storage duration

The number of non-effective tillers hill^{-1} showed significant difference due to the interaction effect of variety, seedling age and storage durations of uprooted rice seedlings (Table 3). The maximum number of non-effective tillers hill^{-1} (2.72) was obtained from the 40 days old seedlings which were stored for 6 days in BRRI dhan34 variety which was statistically similar with 4 days and 6 days storage durations of both age and variety. The minimum number of non-effective tillers hill^{-1} (0.98) was found from 30 days old seedlings which were stored for 0 day in BRRI dhan31 variety which was statistically similar with 2 days storage durations of same variety and both aged of seedling and o day storage for BRRI dhan34 variety and both aged seedling.

4.2.3 Panicle length (cm)

4.2.3.1 Effect of variety

Results of the experiment indicated that the panicle length showed significant variation due to variety (Fig. 10). Significantly longer panicle (26.68 cm) was found in BRRI dhan34 whereas shorter (25.43 cm) from BRRI dhan31. 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.

4.2.3.2 Effect of seedling age

Panicle length was significantly affected by seedling age (Fig. 11). It was found that 30 days old seedlings produced significantly longest panicle (26.64 cm). On the other hand the shortest panicle (24.95 cm) was produced when 40 days old seedlings were transplanted. 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.

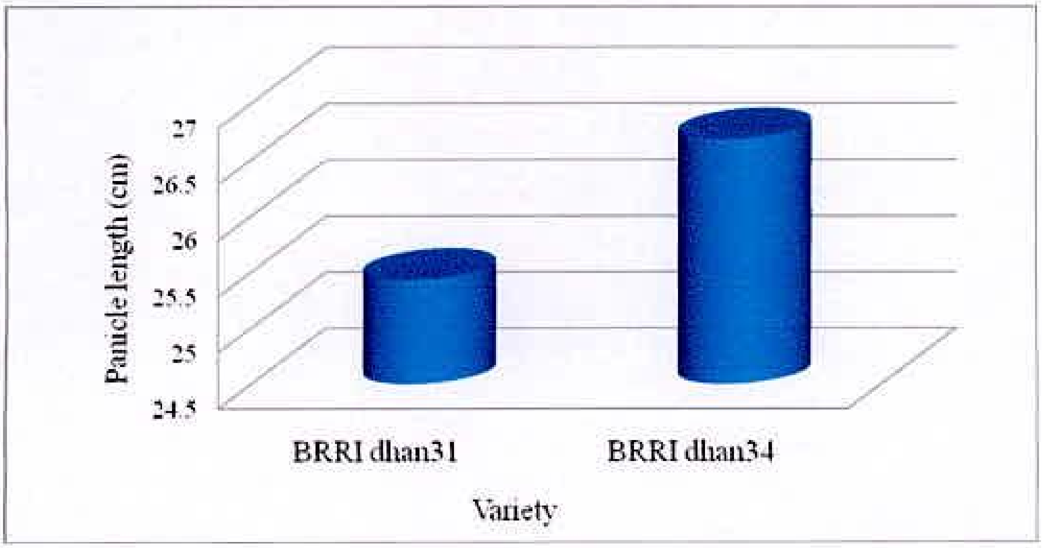

Fig. 10. Effect of variety on the panicle length ($LSD_{0.05}$ = 1.224)

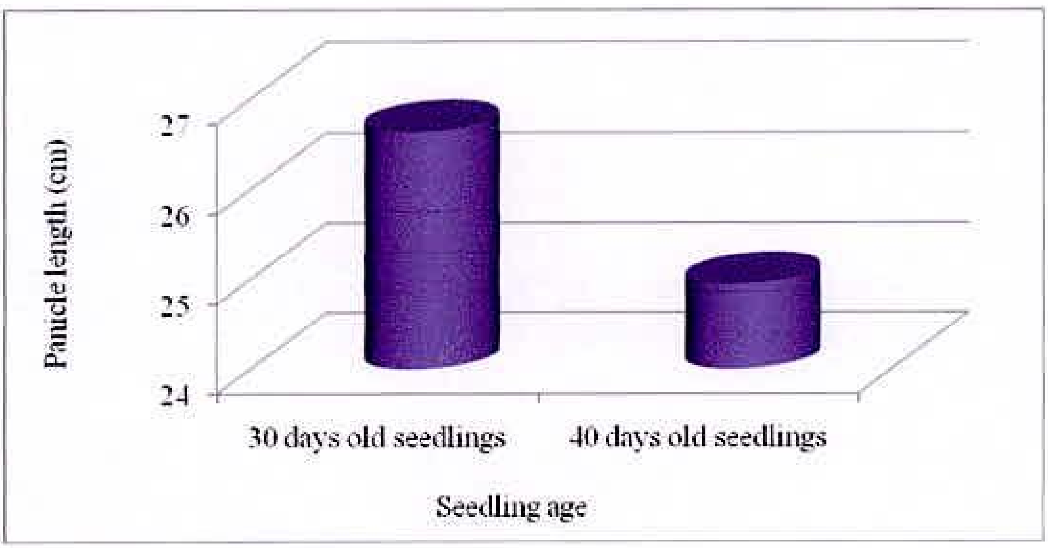

Fig. 11. Effect of seedling age on the panicle length ($LSD_{0.05}$ = 1.426)

4.2.3.3 Effect of storage durations

The panicle length did not show any significant variation due to the effect of storage durations of uprooted rice seedlings (Fig. 12). The highest panicle length (26.42 cm) was observed from the seedlings which was stored for 2 days and the lowest (24.93 cm) was recorded from the seedlings stored for 6 days. Similar findings were also reported by Karim (2007).

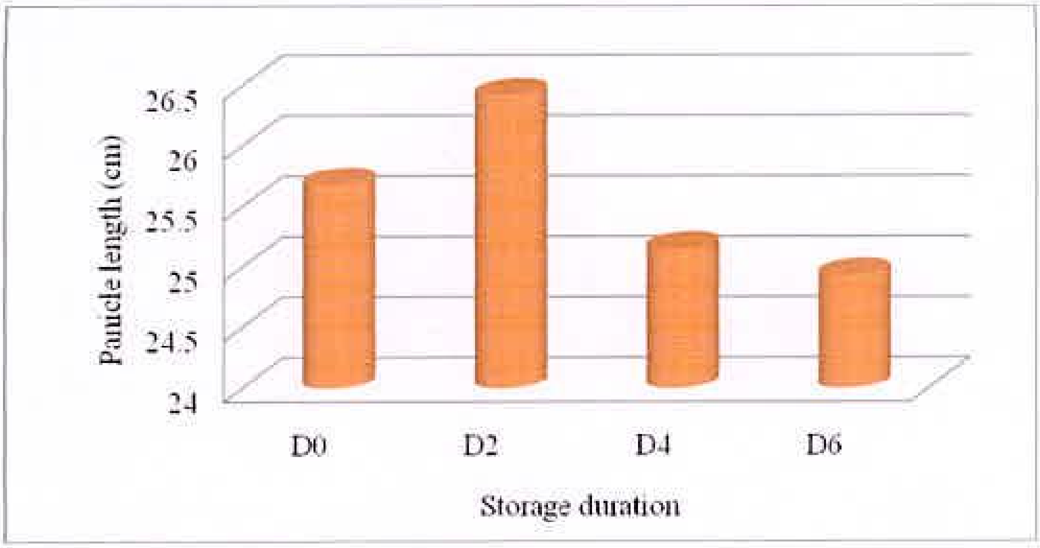

Fig. 12. Effect of storage durations of uprooted rice seedlings on panicle length ($LSD_{0.05}$ = NS)

4.2.3.4 Interaction effect of variety, seedlings age and storage durations

No significant influence was observed on panicle length due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings, although the numerical values were found to be different in each storage duration (Table 4). The highest panicle length (26.63 cm) was observed from the BRRI dhan34 variety of and 30 days old seedlings which was stored for 2 days. The lowest panicle length (24.84 cm) was observed from the BRRI dhan31 variety of 40 days old seedlings which was stored for 6 days.

4.2.4 Number of total grains panicle^{-1}

4.2.4.1 Effect of variety

The variation due to variety was significant for total number of grains panicle^{-1} (Fig.13). From the results of present experiment it is found that BRRI dhan34 produced significantly higher number of total grains panicle^{-1} (147.81) indicating its superiority to BRRI dhan31. On the other hand BRRI dhan31 produced lower number of total grains panicle^{-1} (140.85). Differences in number of total grains panicle^{-1} due to varieties were also reported by BRRI (1994). Devi and Nair (1984) also found that total number of grains panicle^{-1} differs significantly due to varietal differences. This varietal differences regarding the number of total grains panicle^{-1} was probably due to their differences in genetic make-up.

4.2.4.2 Effect of seedling age

The effect of different age of seedlings on the total number of grains panicle^{-1} was found to be significant (Fig. 14). Significantly highest number of total grains panicle^{-1} (145.26) was obtained when 30 days old seedlings were transplanted. The lowest number of total grains panicle^{-1} (142.29) were obtained when 40 days old seedlings were transplanted.

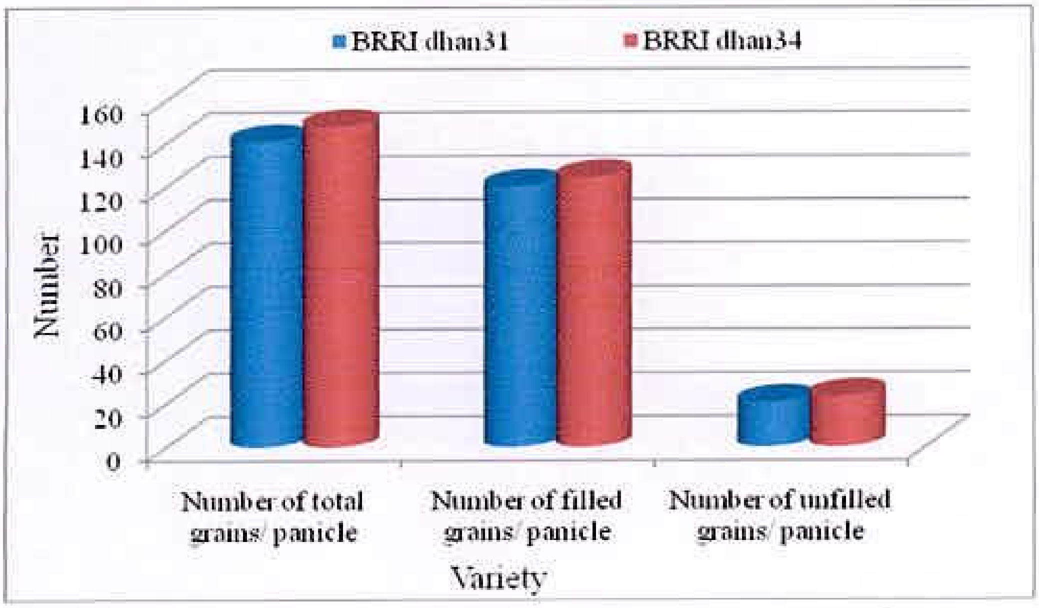

Fig. 13. Effect of variety on the number of total grains panicle^{-1} ($LSD_{0.05}$ = 1.881), number of filled grains panicle^{-1} ($LSD_{0.05}$ = 1.422) and unfilled grains panicle^{-1} ($LSD_{0.05}$ = 1.654)

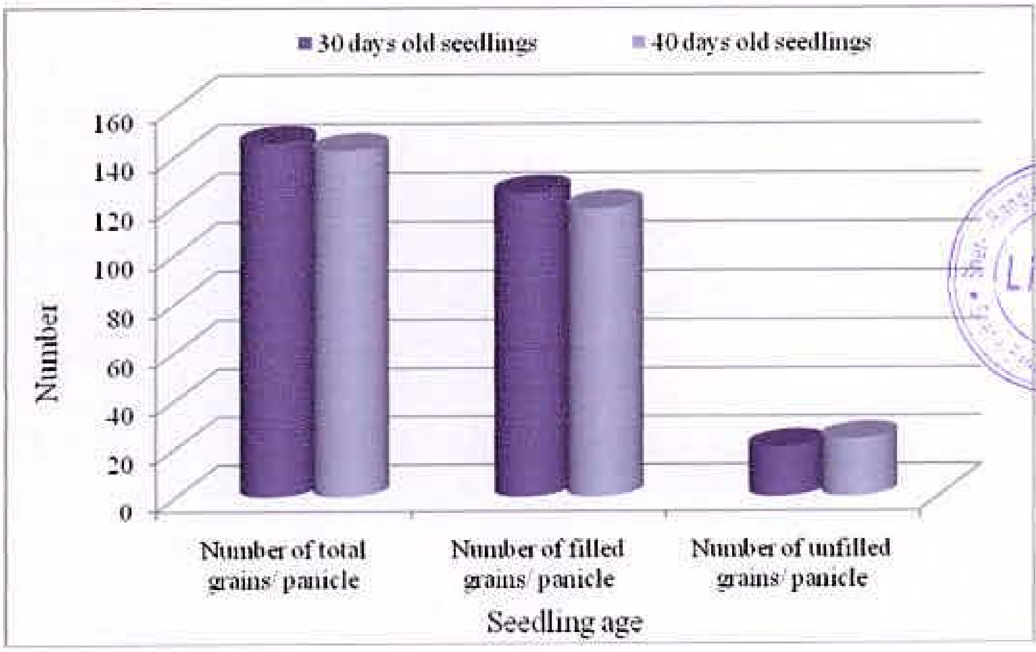

Fig. 14. Effect of seedling age on the number of total grains panicle^{-1} ($LSD_{0.05}$ = 1.281), number of filled grains panicle^{-1} ($LSD_{0.05}$ = 1.343) and unfilled grains panicle^{-1} ($LSD_{0.05}$ = 1.562)

4.2.4.3 Effect of storage durations

Number of total grains panicle^{-1} varied significantly due to the variation in the storage durations (Fig. 15). A decreasing trend in the number of total grains panicle^{-1} was observed with the increase in the storage durations. The maximum number of total grains panicle^{-1} (148.86) was produced by the seedlings stored for 0 days. The lowest number of total grains panicle^{-1} (143.29) was produced by the seedlings stored for 6 days. Similar findings were also reported by Karim (2007).

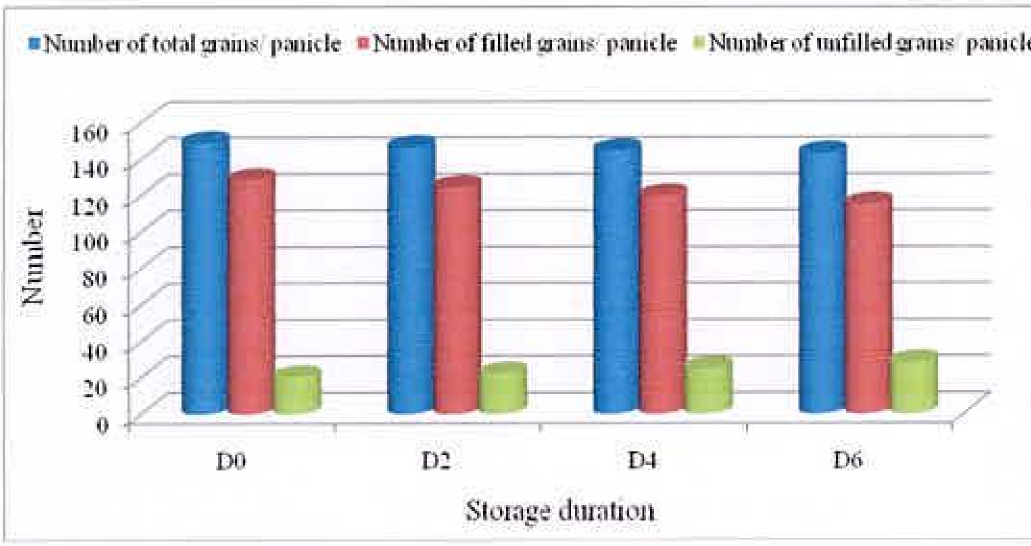

Fig. 15. Effect of storage durations on the number of total grains panicle^{-1} ($LSD_{0.05}$ = 1.554), number of filled grains panicle^{-1} ($LSD_{0.05}$ = 1.825) and unfilled grains panicle^{-1} ($LSD_{0.05}$ = NS)

4.2.4.4 Interaction effect of variety, seedlings age and storage durations

No significant influence was observed on number of total grains panicle^{-1} due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings, although the numerical values were found to be different in each storage duration (Table 4). The highest number of total grains panicle^{-1} (151) was observed from the BRRI dhan34 variety of and 30 days old seedlings which was stored for 0 days. The lowest number of total grains panicle^{-1}

(141.12) was observed from the BRRI dhan31 variety of 30 days old seedlings which was stored for 6 days.

Table 4. Interaction effect of variety, seedling age and storage duration of uprooted rice seedlings on different yield attributes

Treatment (Variety × Age × Duration)	Panicle length (cm)	Number of total grains panicle^{-1}	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}
$V_1A_1D_0$	25.62	143.86	124.24	19.62
$V_1A_1D_2$	25.44	143.26	123.22	20.04
$V_1A_1D_4$	24.92	141.47	121.25	20.22
$V_1A_1D_6$	24.74	141.12	119.56	21.56
$V_1A_2D_0$	25.82	146.11	123.66	22.45
$V_1A_2D_2$	25.29	145.34	122.45	22.89
$V_1A_2D_4$	24.88	143.02	120.56	22.46
$V_1A_2D_6$	24.84	141.69	118.45	23.24
$V_2A_1D_0$	25.92	151.00	126.44	24.56
$V_2A_1D_2$	26.63	150.02	124.35	25.67
$V_2A_1D_4$	25.56	149.07	122.89	26.18
$V_2A_1D_6$	24.84	147.60	121.56	26.04
$V_2A_2D_0$	25.78	150.42	125.34	25.08
$V_2A_2D_2$	25.43	150.55	124.66	25.89
$V_2A_2D_4$	25.12	148.13	122.88	25.25
$V_2A_2D_6$	24.82	146.67	120.45	26.22
LSD $_{(0.05)}$	NS	NS	2.882	NS
CV (%)	4.29	8.66	7.65	10.22

V_1 = BRRI dhan31

V_2 = BRRI dhan34

A_1 = 30 days old seedling

A_2 = 40 days old seedling

D_0 = 0 days after uprooting

D_2 = 2 days after uprooting

D_4 = 4 days after uprooting

D_6 = 6 days after uprooting

4.2.5 Number of filled grains panicle^{-1}

4.2.5.1 Effect of variety

The effect of variety on the number of filled grains panicle^{-1} was statistically significant (Fig. 13). It was observed that BRRI dhan34 produced higher number of filled grains panicle^{-1} (124.43) whereas the lower number of filled grains panicle^{-1} (120.22) was produced by BRRI dhan31. Niu *et al.* (2001) also reported that number of number of filled grains panicle^{-1} differed significantly due to variety. These results were also supported by Singh and Gangwer (1989) who stated that varietal differences regarding the number of filled grains panicle^{-1} might be due to their differences in genetic constituents.

4.2.5.2 Effect of seedling age

Number of filled grains panicle^{-1} was significantly influenced by seedling age (Fig. 14). Thirty days old seedlings produced significantly highest number of filled grains panicle (124.84) and the lowest number of filled grains panicle^{-1} (118.65) was shown in forty days old seedlings. Yoshii *et al.* (1998) reported that when seedlings of different ages were transplanted, number of grains also varied.

4.2.5.3 Effect of storage durations

Number of filled grains panicle^{-1} in all treatments was significantly influenced by different storage durations of uprooted seedlings (Fig. 15). The maximum number of filled grains panicle^{-1} (128.54) was resulted from 0 days storage duration. The lowest number of filled grains panicle^{-1} (115.04) observed from 6 days storage. Probably, prolonged storage durations resulted in the decreased number of filled grains panicle^{-1} which could be attributed to the increased competition among the tillers the long duration treatments. Similar result was also obtained by Karim (2007) and Roy *et al.* (1992b).

4.2.5.4 Interaction effect of variety, seedlings age and storage durations

Significant influence was observed on number of filled grains panicle^{-1} due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings (Table 3). The highest number of total grains panicle^{-1} (126.44) was observed from the BRRI dhan34 variety of and 30 days old seedlings which was stored for 0 days. The lowest number of total grains panicle^{-1} (118.45) was observed from the BRRI dhan31 variety of 40 days old seedlings which was stored for 6 days.

4.2.6 Number of unfilled grains panicle^{-1}

4.2.6.1 Effect of variety

Among the undesirable traits, number of unfilled grains panicle^{-1} was the most significant and plays a vital role in yield reduction. Effect of variety on the number of unfilled grains panicle^{-1} was significant (Fig. 13). BRRI dhan34 produced significantly higher number of unfilled grains panicle^{-1} (23.38) whereas BRRI dhan31 showed lower number (20.63). This indicated that BRRI dhan31 was superior to BRRI dhan34. BRRI (1994) also reported that sterility differed significantly due to varietal differences. This variation might be due to genetic characteristics of the varieties

4.2.6.2 Effect of seedling age

The effect of different age of seedling on the number of unfilled grains panicle^{-1} was significant (Fig. 14). Significantly highest number of unfilled grains panicle^{-1} (23.64) was obtained when 40 days old seedlings were transplanted and the lowest (20.42) was obtained when 30 days old seedlings were transplanted. The climatic and nutritional factors influenced the yield contributing characters especially the number of unfilled grains panicle^{-1}.

4.2.6.3 Effect of storage durations

The number of unfilled grains panicle^{-1} did not show any significant variation due to the effect of storage durations of uprooted rice seedlings (Fig. 15). The highest number of unfilled grains panicle^{-1} (28.25) was observed from the seedlings which was stored for 6 days and the lowest (20.32) was recorded from the seedlings stored for 0 days. Similar findings were also reported by Karim (2007).

4.2.6.4 Interaction effect of variety, seedlings age and storage durations

No significant influence was observed on number of unfilled grains panicle^{-1} due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings (Table 3). The highest number of unfilled grains panicle^{-1} (26.22) was observed from the BRRI dhan34 variety of 40 days old seedlings which was stored for 6 days. The lowest number of unfilled grains panicle^{-1} (19.62) was observed from the BRRI dhan31 variety of 30 days old seedlings which was stored for 0 days.

4.2.7 1000-grain weight (g)

4.2.7.1 Effect of variety

From the results it was observed that variety had significant influence on the weight of 1000-grains (Fig. 16). The result expresses that BRRI dhan31 produced significantly higher weight of 1000-grains (24.18 g) than BRRI dhan34 (11.06 g). 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. This results agrees well to the findings of Islam (2006) who reported that the BRRI dhan34 had 10.12g of 1000-grain weight.

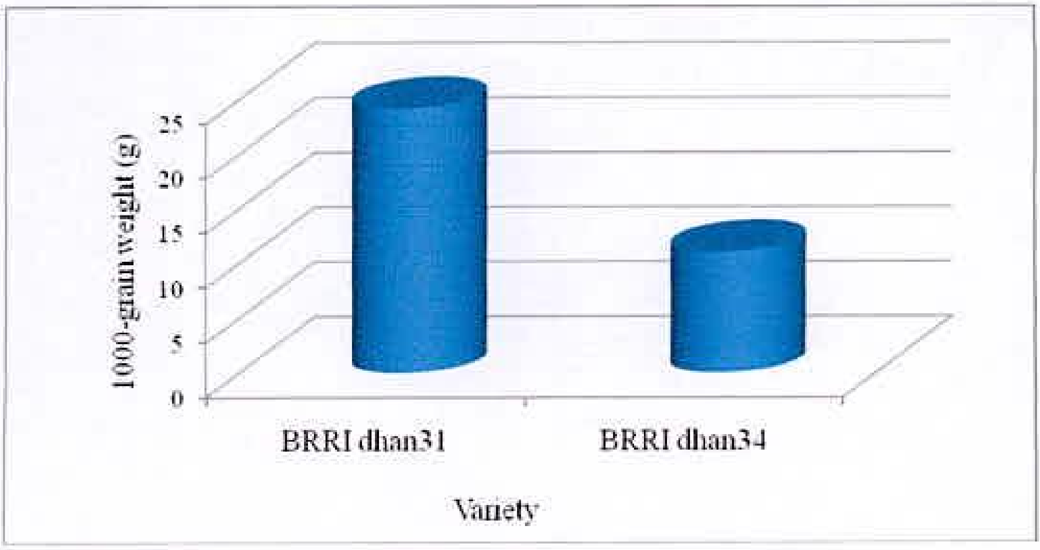

Fig. 16. Effect of variety on 1000-grain weight ($LSD_{0.05}$ = 0.669)

4.2.7.2 Effect of seedling age

Seedling age had significant influence on the weight of 1000-grain (Fig. 17). From the results it was observed that 30 days old seedlings produced significantly highest weight of 1000-grain (20.22 g). On the other hand significantly lowest (18.25 g) was obtained from 40 days old seedlings. Mohapatra and Kar (1991), Mori *et al.* (1994) and also reported differences in 1000-grain weight due to seedling age.

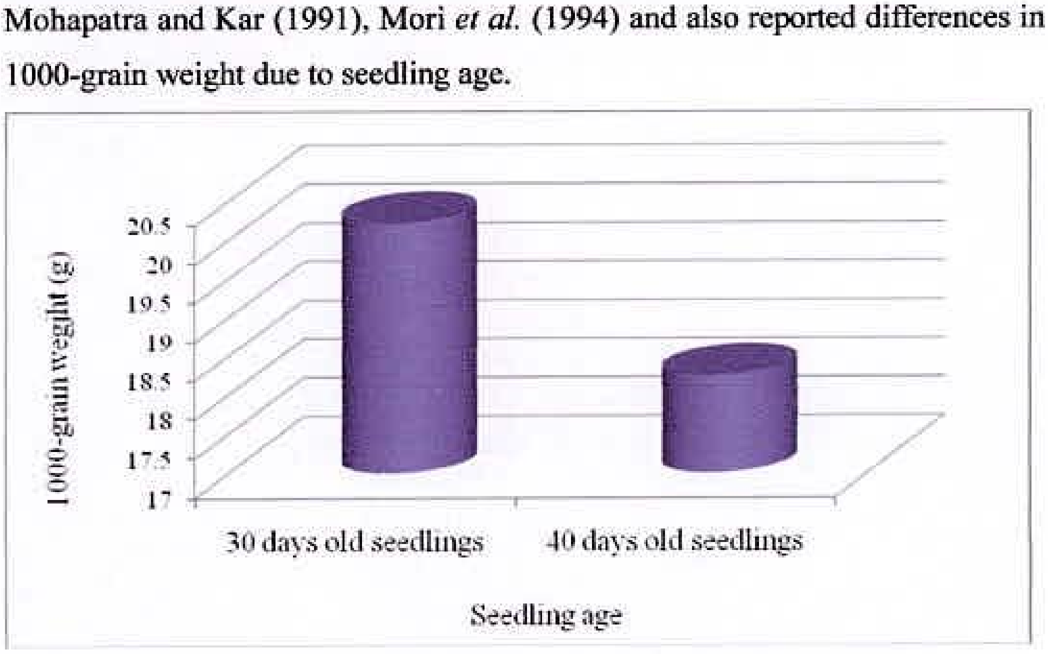

Fig. 17. Effect of seedling age on 1000-grain weight ($LSD_{0.05}$ = 1.159)

4.2.7.3 Effect of storage durations

Storage durations of uprooted rice seedlings had no significant effect on the weight of 1000 grains (Fig. 18). The maximum weight of 1000 grains (20.62 g) was resulted from 0 day storage and the minimum weight of 1000 grains (19.66 g) was observed from 6 days. Similar findings were also reported by Karim (2007).

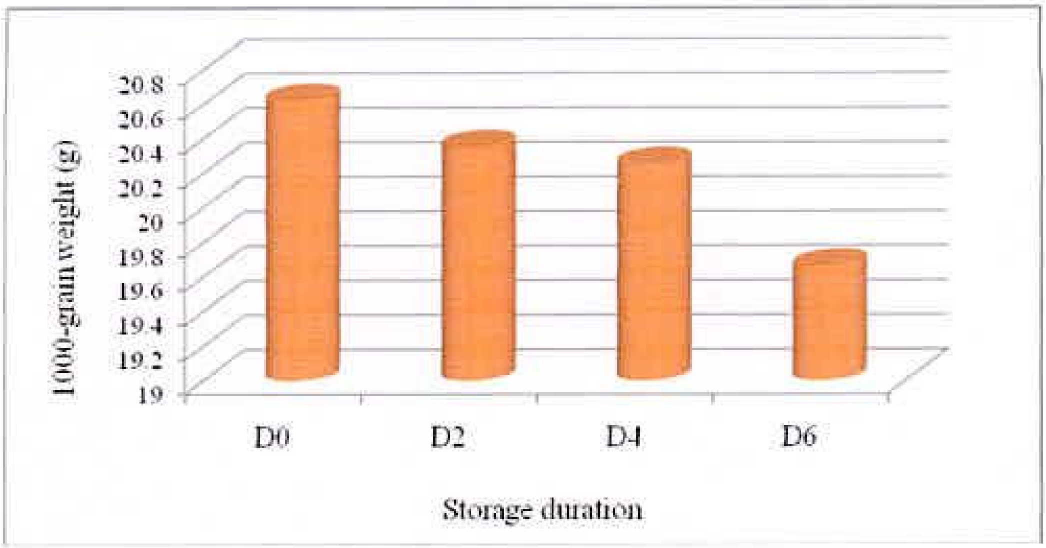

Fig. 18. Effect of storage duration on 1000-grain weight ($LSD_{0.05}$ = NS)

4.2.7.4 Interaction effect of variety, seedlings age and storage durations

No significant influence was observed on weight of 1000-grains due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings (Table 5). The maximum weight of 1000-grains (24.22 g) was observed from the BRRI dhan31 variety and of 30 days old seedlings which was stored for 0 days. The minimum weight of 1000-grains (10.16 g) was observed from the BRRI dhan34 variety of 40 days old seedlings which was stored for 6 days.

Table 5. Interaction effect of variety, seedling age and storage duration of uprooted rice seedlings on 1000-grain weight (g) and grain yield (t/ha)

Treatment (Variety × Age × duration)	1000-grain weight (gm)	Grain yield (t/ha)
$V_1A_1D_0$	24.22	4.34
$V_1A_1D_2$	24.02	4.11
$V_1A_1D_4$	23.88	3.78
$V_1A_1D_6$	23.42	3.02
$V_1A_2D_0$	23.85	3.92
$V_1A_2D_2$	23.66	3.79
$V_1A_2D_4$	23.22	3.25
$V_1A_2D_6$	22.45	2.98
$V_2A_1D_0$	11.15	3.18
$V_2A_1D_2$	11.04	2.85
$V_2A_1D_4$	10.65	2.68
$V_2A_1D_6$	10.24	1.91
$V_2A_2D_0$	10.75	2.98
$V_2A_2D_2$	10.46	2.62
$V_2A_2D_4$	10.24	2.18
$V_2A_2D_6$	10.16	1.78
$LSD_{(0.05)}$	1.246	0.56
CV (%)	5.62	8.05

V_1 = BRRI dhan31

V_2 = BRRI dhan34

A_1= 30 days old seedling

A_2 = 40 days old seedling

D_0 = 0 days after uprooting

D_2= 2 days after uprooting

D_4 = 4 days after uprooting

D_6 = 6 days after uprooting

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

4.2.8.1 Effect of variety

Grain yield was significantly influenced by studied varieties (Fig. 19). The result expresses that BRRI dhan31 produced significantly higher grain yield (4.41 t ha^{-1}) than BRRI dhan34 (3.22 t ha^{-1}). BRRI (1995) also found that grain yield differed due to varietal differences.

4.2.8.2 Effect of seedling age

Grain yield was significantly influenced by different seedling age (Fig. 20). Significantly highest grain yield (4.38 tha^{-1}) was found when 30 days old seedlings were transplanted. Grain yield was the lowest (3.18 t ha^{-1}) in 40 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 40 days old seedlings. 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 40 days old seedlings.

4.2.8.3 Effect of storage durations

The storage durations of uprooted rice seedlings had significant effect on grain yield. The grain yield exhibited a regular decreasing trend with the increase in the storage duration from 0 to 6 days after uprooting (Fig. 21). The maximum grain yield (4.38 t ha^{-1}) was obtained from 0 days storage which was statistically identical with the seedlings stored for 2 and 4 days. The lowest grain yield (1.98 t ha^{-1}) was obtained from 6 days storage. Low grain yield of the long duration treatments could be attributed to lower value of total hills^{-2} coupled with lower number of filled grains panicle^{-1}. The result of the present experiment suggested that after uprooting, the seedlings should be transplanted within 4 days to get maximum grain yield. The findings of the present study are in partial agreement with those of Haque (1997), BRRI (1996) and Islam (1995) who observed significant yield difference under different storage durations. Similar findings were also reported by Karim (2007).

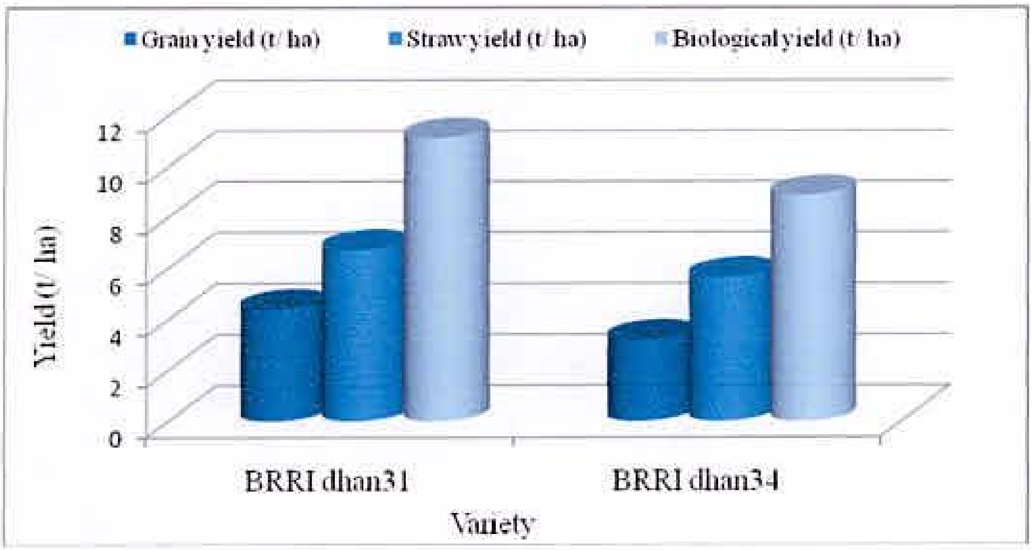

Fig. 19. Effect of variety on grain yield ($LSD_{0.05}$ = 0.061), straw yield ($LSD_{0.05}$ = 0.164) and biological yield ($LSD_{0.05}$ = 0.652)

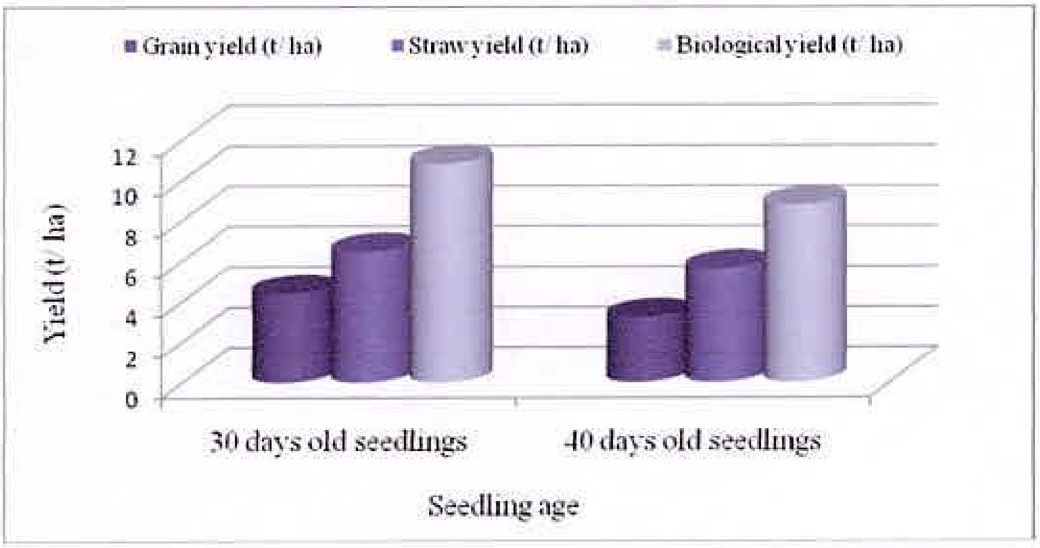

Fig. 20. Effect of seedling age on grain yield ($LSD_{0.05}$ = 1.282), straw yield ($LSD_{0.05}$ = 1.842) and biological yield ($LSD_{0.05}$ = 1.543)

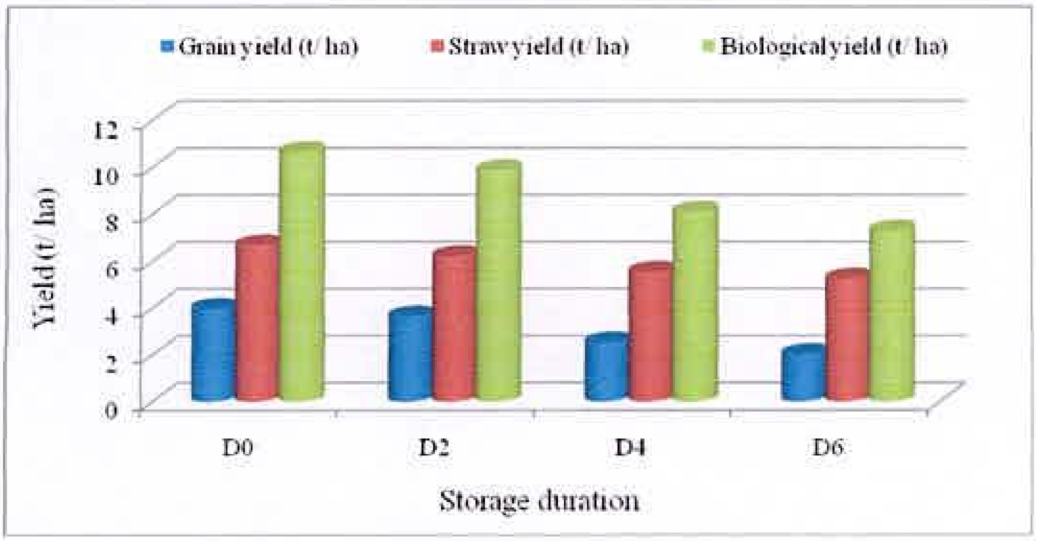

Fig. 21. Effect of storage durations of uprooted seedlings on grain yield ($LSD_{0.05}$ = 0.386), straw yield ($LSD_{0.05}$ = 0.562) and biological yield ($LSD_{0.05}$ = 0.928)

4.2.8.4 Interaction effect of variety, seedlings age and storage durations

Significant influence was observed on grain yield (t ha^{-1}) due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings (Table 5). Significantly the maximum grain yield (4.34 t ha^{-1}) was observed from the BRRI dhan31 variety and of 30 days old seedlings which was stored for 0 days. But this was statistically identical with those stored for up to 4 days of 30 days old seedling and 2 days stored for 40 days old seedling of BRRI dhan31 variety and 2 days stored for both age seedlings of BRRI dhan34 variety. The minimum grain yield (1.78 t ha^{-1}) was observed from the BRRI dhan34 variety of 40 days old seedlings which was stored for 6 days.

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

4.2.9.1 Effect of variety

There was a significant variation in straw yield due to variety (Fig. 19). Significantly higher straw yield (6.74 t ha^{-1}) was recorded from BRRI dhan31 followed by BRRI dhan34 (5.66 t ha^{-1}). These results are in conformity with those obtained by BINA (2001) also stated similar relationship between straw yield and grain yield. Similar findings were also reported by Patel (2000).

4.2.9.2 Effect of seedling age

Fig. 20 indicates significant differences among seedling age treatments in respect of straw yield. Significantly highest straw yield (6.44 t ha^{-1}) was obtained when 30 days old seedlings were transplanted. On the other hand the lowest straw yield (5.59 t ha^{-1}) was obtained from 40 days old seedlings. The lowest plant height at harvest in 40 days old seedlings probably may have 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 $hill^{-1}$ 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.

4.2.9.3 Effect of storage duration

The straw yield was significantly affected by the storage durations of uprooted rice seedlings (Fig. 21). The maximum straw yield (6.68 t ha^{-1}) was recorded from 0 day storage which was significantly different from other storage durations. The minimum straw yield (5.26 t ha^{-1}) was obtained from 6 days storing of seedlings. Low straw yield of the long duration treatments could be attributed to shorter plant height. These results were not supported by Kumar and Gupta (1990) reported that the seedlings uprooting time did not affect straw yield of rice significantly. Similar findings were also reported by Karim (2007).

4.2.9.4 Interaction effect of variety, seedlings age and storage durations

Significant influence was observed on straw yield (t ha^{-1}) due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings (Table 6). Significantly the maximum straw yield (6.69 t ha^{-1}) was observed from the BRRI dhan31 variety and of 30 days old seedlings which was stored for 0 days. The minimum straw yield (4.48 t ha^{-1}) was observed from the BRRI dhan34 variety of 40 days old seedlings which was stored for 6 days.

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

4.2.10.1 Effect of variety

Biological yield was significantly influenced by variety (Fig. 19). Significantly higher biological yields (11.15 t ha-1) were obtained from BRRI dhan31 and lower one (8.88 t ha^{-1}) from BRRI dhan34. From the result it was observed that the biological yield differed due to the combined effect of grain and straw yield.

4.2.10.2 Effect of seedling age

Biological yield was significantly affected by seedling age (Fig. 20). The highest biological yield (10.82 t ha^{-1}) was recorded from 30 days old seedlings whereas the lowest (8.77 t ha^{-1}) from 40 days old seedlings. From the result it was observed that biological yield differed due to combined weight of grain and straw.

4.2.10.3 Effect of storage duration

Biological yield was significantly affected by the storage durations of uprooted rice seedlings (Fig. 21). The maximum biological yield (10.66 t ha^{-1}) was recorded from 0 day storage which was significantly different from other storage durations. The minimum biological yield (7.31t ha^{-1}) was obtained from 6 days storing of seedlings. Low biological yield of the long duration treatments could be attributed to lower grain and straw yield.

4.2.10.4 Interaction effect of variety, seedlings age and storage durations

Significant influence was observed on biological yield (t ha^{-1}) due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings (Table 6). Significantly the maximum biological yield (11.03 t ha^{-1}) was observed from the BRRI dhan31 variety and of 30 days old seedlings which was stored for 0 days. The minimum biological yield (6.26 t ha^{-1}) was observed from the BRRI dhan34 variety of 40 days old seedlings which was stored for 6 days.

4.2.11 Harvest index (%)

4.2.11.1 Effect of variety

Variety exerted a significant effect on harvest index (Fig. 22). Significantly higher harvest index (39.55%) was found from BRRI dhan31 and lower (36.26%) from BRRI dhan34. It was evident from the present experiment that BRRI dhan34 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.

4.2.11.2 Effect of seedling age

Harvest index was also significantly affected by seedling age (Fig. 23). The highest harvest index (40.48%) was obtained from 30 days old seedlings. Forty days old seedlings produced significantly lowest harvest index (36.37%).

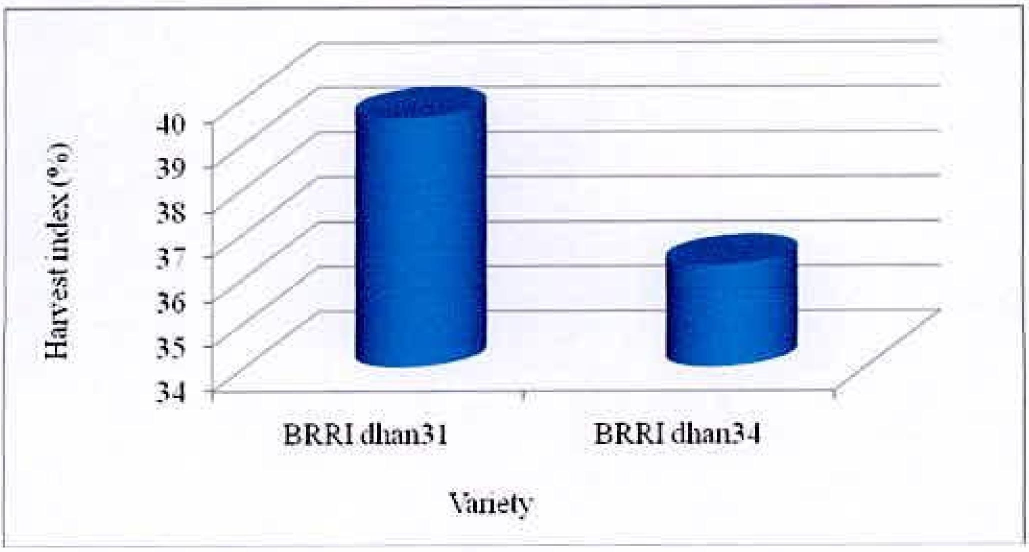

Fig. 22. Effect of variety on harvest index (%) ($LSD_{0.05}$ = 0.476)

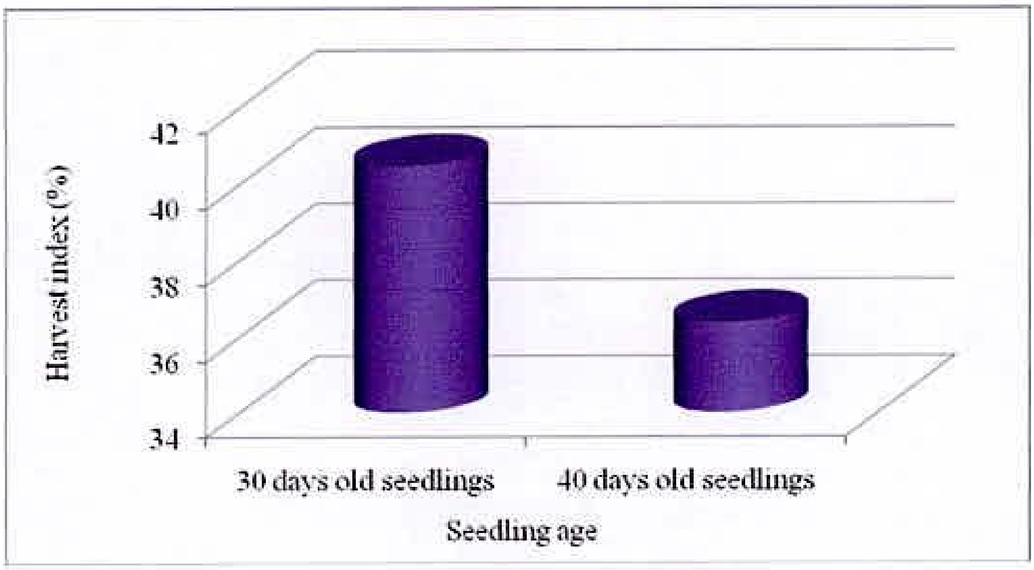

Fig. 23. Effect of seedling age on harvest index (%) ($LSD_{0.05}$ = 0.542)

4.2.11.3 Effect of storage duration

Harvest index was significantly affected by the storage durations of uprooted rice seedlings (Fig. 24). The maximum harvest index (37.33%) was recorded from 0 day storage which was significantly different from other storage durations. The minimum harvest index (28.04%) was obtained from 6 days storing of seedlings. Low harvest index (%) of the long duration treatments could be attributed to lower grain yield.

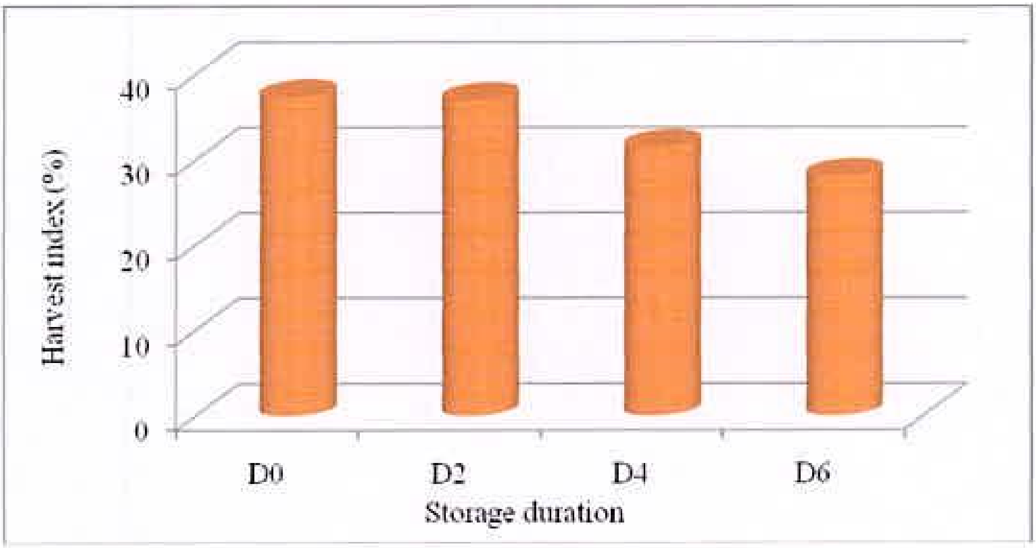

Fig. 24. Effect of storage durations of uprooted seedlings on harvest index (%) ($LSD_{0.05}$ = 0.322)

4.2.11.4 Interaction effect of variety, seedlings age and storage durations

Significant influence was observed on harvest index (%) due to the interaction effect of variety, seedling age and durations of uprooted rice seedlings (Table 6). Significantly the maximum harvest index (39.36%) was observed from the BRRI dhan31 variety and of 30 days old seedlings which was stored for 2 days. The minimum harvest index (28.43%) was observed from the BRRI dhan34 variety of 40 days old seedlings which was stored for 6 days.

Table 6. Interaction effect of variety, seedling age and storage duration of uprooted rice seedlings on Straw yield (t ha^{-1}), Biological yield (t ha^{-1}) and Harvest index (%)

Treatment (Variety × Age × Duration)	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
$V_1A_1D_0$	6.69	11.03	39.34
$V_1A_1D_2$	6.33	10.44	39.36
$V_1A_1D_4$	5.85	9.63	39.25
$V_1A_1D_6$	5.12	8.14	37.10
$V_1A_2D_0$	5.92	9.84	39.83
$V_1A_2D_2$	5.78	9.57	39.60
$V_1A_2D_4$	5.35	8.60	37.79
$V_1A_2D_6$	5.15	8.13	36.65
$V_2A_1D_0$	5.54	8.72	36.46
$V_2A_1D_2$	5.08	7.93	35.93
$V_2A_1D_4$	4.68	7.36	36.41
$V_2A_1D_6$	4.29	6.26	30.80
$V_2A_2D_0$	5.05	8.03	37.11
$V_2A_2D_2$	4.89	7.51	34.88
$V_2A_2D_4$	4.62	6.80	32.05
$V_2A_2D_6$	4.48	6.26	28.43
$LSD_{(0.05)}$	NS	1.12	1.03
CV (%)	8.22	7.28	8.34

V_1 = BRRI dhan31

V_2 = BRRI dhan34

A_1= 30 days old seedling

A_2 = 40 days old seedling

D_0 = 0 days after uprooting

D_2 = 2 days after uprooting

D_4 = 4 days after uprooting

D_6 = 6 days after uprooting

Chapter 5

Summary and Conclusion

CHAPTER 5

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 June, 2008 to December, 2008 to study the effect of storage durations of uprooted rice seedlings at different ages on the performance of BRRI dhan31 and BRRIdhan34 of under Modhupur tract (AEZ 28). The experiment comprised of three different factors viz. A. Variety (2): BRRI dhan31 (V_1) and BRRI dhan34 (V_2), B. Seedling age (2): 30 days old seedlings (A_1) and 40 days old seedlings (A_2) and C. Storage durations (4): 0,2,4 and 6 days after uprooting (D_0, D_2, D_4 and D_6 respectively). The experiment was laid out in Randomized Complete Block Design (Factorial) with three replications. Numbers of total unit plots were 48. The size of unit plot was 12 m^2 (4.0 m x 3.0 m). The distance mentioned between two unit plots was 1 m and blocks were 1.5 m. The land was fertilized with recommended rates of urea, TSP, MP and gypsum. Then the 30 days old seedlings and o days storage duration of two rice varieties were transplanted on the well puddled experimental plot on August 04, 2008 at the rate of 3 seedlings $hill^{-1}$ with 25cm x 20 cm spacing for BRRI dhan31 and 20 cm x 20 cm for BRRI dhan 34 variety and rest of them were transplanted at each 2, 4 and 6 days storage durations. Intercultural operations viz. weeding, water management and pest management were done as and when necessary.

Ten 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 $hill^{-1}$, number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, straw and biological yield, panicle length, number of total grain $panicle^{-1}$, number of filled grain panicle-1, number of unfilled grain $panicle^{-1}$, 1000-grain weight, grain yield and harvest index were recorded. 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^{-1}. Plant height and number of total tillers hill^{-1} at all sampling dates varied significantly due to variety. BRRI dhan31 produced significantly higher number of total tillers hill^{-1}, effective tillers hill^{-1}, weight of 1000 grains, grain yield (4.41 t ha^{-1}), straw yield and biological yield and harvest index. On the other hand, Plant height, number of non-effective tillers hill^{-1}, panicle length, number of total grains panicle^{-1}, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, were higher in BRRI dhan34.

There was a significant influence of seedling age on all of the parameters at all sampling dates. The taller plant and higher tillers hill^{-1} was obtained from 30 days old seedlings and the shorter 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^{-1} (9.95) were the highest in 30 days old seedlings whereas the lowest (8.83) in 40 days old seedlings. In case of the longer panicle (26.64 cm) and the higher number of total grains panicle^{-1} (160.26), number of filled grains panicle^{-1} (134.84), weight of 1000-grain (20.22 g) and grain yield (4.38 t ha^{-1}) but the lowest number of non-effective tillers hill^{-1} (1.29) and unfilled grains panicle^{-1} (25.42) were found in 30 days old seedlings. On the contrary, 40 days old seedlings showed the lower number of total grains panicle-1 (158.29), lower number of filled grains panicle^{-1} (128.65), lower weight of 1000-grain (18.25 g), grain yield (3.19 t ha^{-1}).

The storage durations of uprooted seedlings also exhibited significant effect on the studied crop parameters. The higher plant height (126.66 cm), number of total grains panicle^{-1} (158.86), higher number of filled grains panicle^{-1} (138.54), maximum 1000-grain weight (20.62 g), maximum grain yield (3.98 t ha^{-1}), straw yield (6.68 t ha^{-1}), biological yield (10.66 t ha^{-1}) and harvest index (37.33%) were found from 0 days storage duration. There was a regular trend of decrease in the values of the studied crop parameters with the increase in the durations of storage from 0 to 6 days.

The interaction effect of variety, seedlings age and storage durations were significant in most crop parameters. The higher plant height (117.82 cm), lower number of unfilled grains panicle^{-1} (19.62), maximum 1000-grain weight (24.22 g), maximum grain yield (4.34 t ha^{-1}), straw yield (6.69 t ha^{-1}) and biological yield (11.03 t ha^{-1}) were found from 0 days storage duration and 30 days old seedlings of BRRI dhan31 variety.

Based on the result of the present study the following conclusion may be made:

- ✓ In case of variety, BRRI dhan31 showed better performance in respect of than BRRI dhan34. BRRI dhan31 variety can be stored for 4 days without yield loss whereas BRRI dhan34 can be stored safely for 2 days only.
- ✓ In case of seedling age, 30 days old seedlings showed better performance than 40 days old seedlings. 30 days old seedlings could be stored for 4 days without yield loss whereas 40 days old seedlings for 2 days only.
- ✓ 30 days old seedlings of BRRI dhan31 variety can be stored for up to 4 days and 40 days old seedlings for 2 days without yield loss. Seedlings of BRRI dhan34 variety could be stored for 2 days of both aged seedlings.

However, to reach specific conclusion and recommendation, more research work on variety, seedling age and storage durations before transplantations of rice seedlings should be done over different agro-ecological zones involving more varieties of aromatic and non-aromatic rice.

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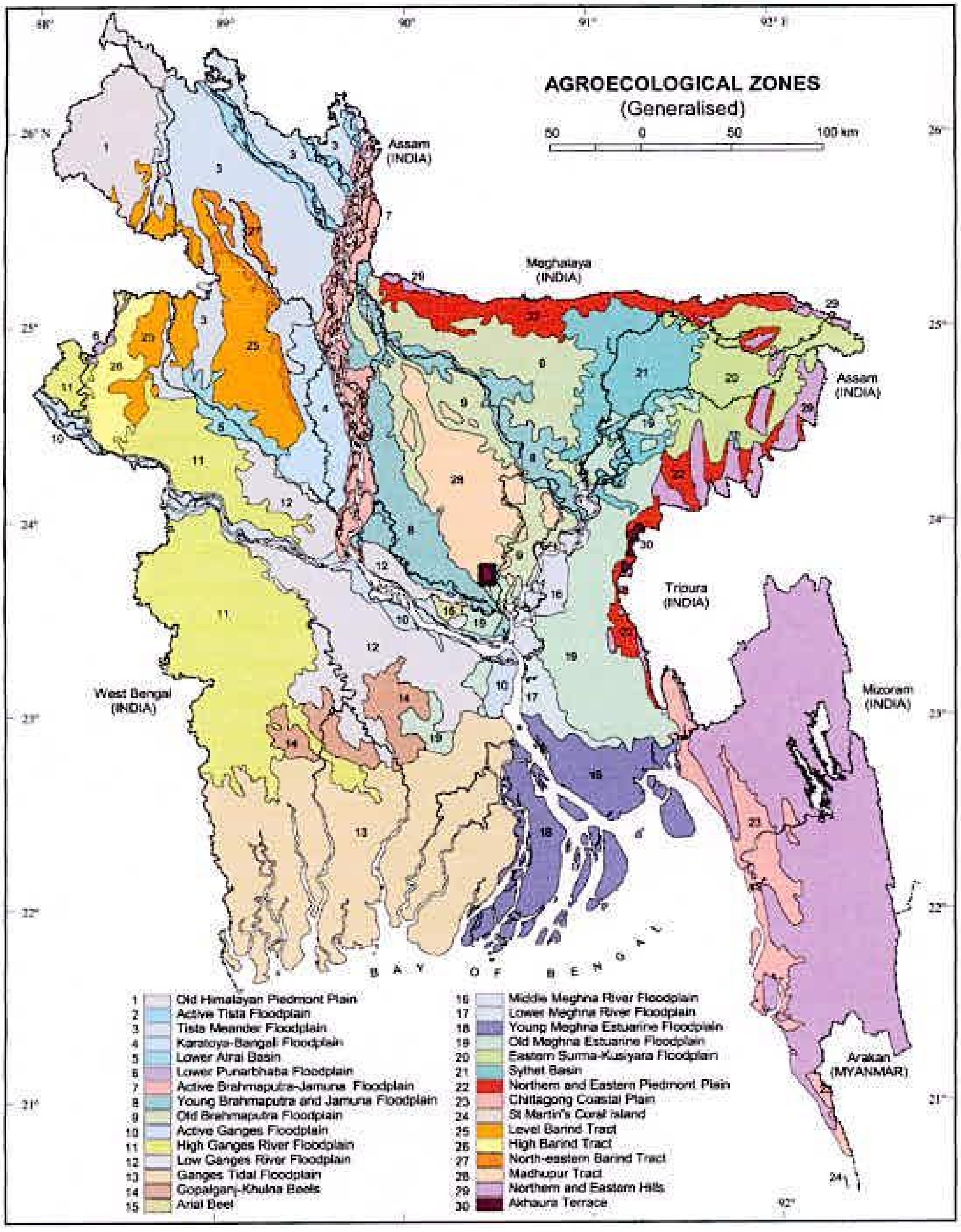
Appendices

APPENDICES

Appendix I. Map showing the experimental sites under study



■ **The experimental site under study**

Appendix II. 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 Resources Development Institute (SRDI), Dhaka-1207

Appendix III. Physiochemical characteristics of the initial soil

Characteristics	Value
Partical size analysis	
% Sand	26
% Silt	45
% Clay	29
Textural class	Silty clay
P^H	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 Resources Development Institute (SRDI), Dhaka-1207

Appendix IV: Monthly record of relative humidity (RH), air temperature and rainfall during the period from July-December, 2008

Month	*RH (%)*	*Air temperature (^0C)*			*Rainfall (mm)*
		Max.	*Min.*	*Mean*	
July	83	31.52	26.13	28.83	455
August	81	32.23	26.44	29.33	266.75
September	81	32.55	26.21	29.38	197
October	77	31.59	23.23	27.41	244.15
November	69	29.69	18.53	24.11	0
Demcember	79	25.71	16.43	21.07	0

Source: Bangladesh Meteorological Department (Climate Vivision), Agargaon, Dhaka-1207.