INFLUENCE OF SEEDLING AGE AND NUMBER OF SEEDLINGS PER HILL ON THE PERFORMANCE OF BRRI dhan 44

BY

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CERTIFICATE

This is to certify that the thesis entitled **"Influence of Seedling Age and Number of Seedlings per Hill on the Performance of BRRI dhan 44"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE in AGRONOMY**, embodies the result of a piece of bonafide research work carried out by **Md. Tariqul Islam**, Registration number: **01029** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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The Author

ABSTRACT

An experiment was conducted in the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from June to November 2007 to study the influence of the seedling age and number of seedlings $hill^{-1}$ on the performance of BRRI dhan44. The experiment comprised three seedling ages (20, 30 and 40 days and four levels of number of seedlings $hill^{-1}$ (1, 2, 3 and 4 seedlings $hill^{-1}$). The experiment was laid out with two factor Randomized Complete Block Design with three replications. The highest tiller (17.96 $hill^{-1}$), filled grains (92.25 $panicle^{-1}$), grain yield (5.52 t ha^{-1}), straw yield (5.94 t ha^{-1}) was shown by 30 days old seedling. Likewise, two seedling $hill^{-1}$ showed the highest plant height at harvest (85.76 cm), effective tillers $hill^{-1}$ (12.63), filled grains (89.03 $panicle^{-1}$), grain yield (5.36 t ha^{-1}) and straw yield (5.87 t ha^{-1}). The interaction treatment of two 30 days old seedling $hill^{-1}$ showed the highest effective tillers (13.99 $hill^{-1}$), filled grains (93.74 $panicle^{-1}$), grain yield (5.95 t ha^{-1}) and straw yield (6.18 t ha^{-1}).

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CHAPTER I

INTRODUCTION

Rice is the most important food grain in the world. The geographical, climatic and edaphic conditions of Bangladesh are favorable for year round rice cultivation. However, the national average rice yield (2.34 t ha^{-1}) is very low compared to that of other rice growing countries as the average rice yield in China is about 6.3 t ha^{-1}, Japan is 6.6 t ha^{-1} and Korea is 6.3 t ha^{-1} (FAO, 2002). The population of Bangladesh is increasing at an alarming rate and the cultivable land is reducing due to urbanization and industrialization resulting in more shortage of food. As it is not possible to have horizontal expansion of rice area, rice yield $unit^{-1}$ area should be increased to meet this ever-increasing demand of food in the country.

Among the production factors affecting crop yield, management practices is one of the most important factor that plays a dominant role in yield increase. There is need to develop appropriate management technique to evaluate the performance and to assess the nutrient requirement for rice cultivation in the country. Optimum planting time, number of seedling $hill^{-1}$ are essential to influence vegetative growth but early and delay planting may cause excessive vegetative growth, prolong growth duration and delay crop maturity with reduction in grain yield (Brady, 1988).

Based on the current demand for rice consumption, country's rice production level is suffering from a yearly shortage of around 2 million tons. The stagnating or declining yield of modern rice varieties is indicative of imbalance of nutrient that are not being supplied as fertilizer. HYV rice responds well to the optimum planting time. To achieve high yield, adjustment of light, temperature and sunshine hour greatly influence photosynthesis, respiration etc. through addressing day length.

The age of rice seedling plays a vital role in the growth and development of rice and as well as the production of grain. Early aged seedlings utilize maximum time for vegetative growth, whereas older seedling recover slowly particularly when injured during up rooting and produce fewer tillers, delay maturity and may reduce yield (De Datta, 1981). In this regard De Datta (1987) mentioned that the best age for transplanting wet-bed seedling is 20-30 days and according to BRRI (2003), the optimum age of seedling for aus, aman and boro rice are 20-30, 30-40 and 35-50 days, respectively (DAE, 1992).

Number of seedling(s) hill^{-1} is an important factor for the growth and yield of rice. Optimal population density and leaf area influence the availability of sunlight and nutrients for growth and development. Competition within the hill is an integral part of the physical environment and the competition by neighbors often accentuate the complexity. Both the factors contribute to the determination of yield. Plasticity of the plant and the influence of competition by neighboring plants effects on yield (Donald, 1963). As growth proceeds, intra plant competition becomes progressively operative, until when flowering and seed setting occur. The load of panicles is as great as to lead to competition among the panicles themselves and thereby to reduce the efficiency of seed production in the individual inflorescence and ultimate results was the lowest yield.

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

1. to find out the optimum number of seedling $hill^{-1}$ for achieving higher production of BRRI dhan 44.
2. to find out the optimum seedling age to get higher yield from BRRI dhan 44.
3. to study the effect of interaction between seedling age and number of seedlings $hill^{-1}$.

Chapter II
Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Management practices have considerable effects on the growth and development of any crop particularly rice. Among these, seedling age and number of seedlings $hill^{-1}$ are the two important factors. Numerous studies have been performed evaluating the influence of seedling age and number of seedlings $hill^{-1}$ on the performance of rice. Age of seedling plays a vital role in grain yield. Likewise, the number of seedlings $hill^{-1}$ for higher yield had been proved to be assessed. Under above circumstances the influences of seedling age and number of seedlings hill-1 on the growth and yield of rice have been reviewed in this chapter.

2.1 Influence of seedling age on the growth and yield of rice

In transplanting rice culture, seedlings are raised in especially cared nursery bed. Seedling quality affects growth and development of the plant after transplanting (Sattar *et al.*, 1986). Seedling quality was affected considerably by management and seedling age and the proper age of rice seedling during transplanting was of prime importance for uniform stand establishment (Kosta *et al.*, 1987). The optimum age of seedling for transplanting aus, aman and boro rice are 20 - 30, 30 - 40 and 35 - 45 days respectively (DAE, 1992).

Generally, plant height of rice is a genetically controlled trait which varies with species as well as varieties within the same species. For example, the modern rice cultivars are generally short to intermediate stature, where as the traditional cultivars are taller (Anon., 1993; Hossain *et al.*, 1991). However, management practices also influence plant height as well. Twenty day old seedling produced the tallest plant as compared to seedling age of 28 and 36 days (Kosta *et al.*, 1982; Sundersingh *et al.*, 1983). Seedling height and seedling strength at transplanting increased with the increase in seedling age (BRRI, 1983).

Tillering is one of the most important development stages of rice, since it has a decisive character bearing on yield. Tiller number, particularly effective tiller is strongly correlated with grain yield, depending on the cultivar and crop environment. The number of tillers is regulated by tillering duration, which varies with cultivars seedling age, environmental conditions, availability of nutrients in the soil, etc. (Roy *et al.*, 1992).

Older seedlings recovered slowly, produced fewer tillers which ultimately reduced grain yield (De Datta, 1981). Tillering was retarded when aged seedlings were planted which could be compensated to some extent by nitrogen application (Mondal and Roy, 1984). BRRI variety planted December with 60 days old seedlings showed reduced tillering in duration with fewer tiller production (BRRI, 1985).

Seedling age affects dry matter accumulation. Crop raised with young seedling showed higher dry matter accumulation than older seedling (Mondal and Roy, 1984). However, dry matter at flowering and at harvest decreased with the increase in seedling age in varieties insensitive to photo-period in wet season (Padalia, 1981).

Growth duration, a varietal characteristics, varies with time of planting and seedling ages irrespective of the season. BRRI (1985) reported a decrease in field duration with the increase in seedling age irrespective of the aus season. Although the field duration was shorter when older seedlings were transplanted, the total growth duration was higher with older seedling that with younger seedlings (BRRI, 1981). However, this increase was not proportional to the increase in seedling age. Older seedling reduced field duration more than the younger seedlings (BRRI, 1981) and compared to 30 days old seedlings, 60 days old seedlings of BR 6 enhanced crop maturity by more than one weeks, respectively (BRRI, 1985).

Maurya and Yadav (1987) in India observed that yield components were adversely affected by planting over-aged seedlings resulting in lower grain yield irrespective of the varieties. Padalia (1981) concluded that the decrease in yield components was possibly due to shorter effective duration. He also indicated that it was the panicle weight but not the panicle number that decreased with increase in seedling age of the photo-period sensitive varieties in wet season. In Southern India planting of up to 50 day old seedling did not affect plant height and yield components during the wet season (Balasubramaniyan, 1987).

In a pot experiment the number of panicles per plant, spikelets per panicle, plants per pot and the percentage of filled spikeletes decreased with the increase in seedling age while increased the incidence of post-mature flowering (Sabah, 1986). Mannan *et al.* (1991) mentioned that the average number of panicles in the September 30 planting did not differ significantly due to seedling age while in the

October 15 planting, 60 days old seedlings contributing to more number of panicles than the seedling 30, 45 and 75 days old in T. aman rice. Roy *et al.* (1992) reported other wise, where they mentioned that the number of panicles per plant decreased as seeding age increased. The 20 days old seedlings of IR 50 produced 24 panicles and this number decreased to 21 in 80 days old seedlings. In highest number of field grains/panicle of BR 14 and IR 50 was obtained with 60 days and seedling then those of 20 and 40 days old seedlings. He also mentioned that grain weight decreased with the increase in seedling age irrespective of the type of tillers, which also agreed later by Aziz and Rakibul (2000).

Aashraf and Mahmood (1989) studied the effect of over aged seedlings of two Basmati rice varieties and reported that yield and yield attributes declined significantly with the increase in seedling age; the reduction in yield was partly attributed to fewer productive tillers per hill and fewer spikelets per panicle. The filled grain percentage and 1000 grain weight were significantly higher with 30 and 40 days old seedlings than with 50 days old ones during the wet season at Pantnagar, India (Datta and Goutam, 1988). There was no significant difference in filled grain/panicle due to difference in seedling age and spacing as reported by BRRI (2001).

Straw yield decreased significantly with the increase of seedling age beyond 60 and 40 days in BR14 and IR50, respectively. Though not significant, straw yield of BR 14 was reduced by 3% and 14% as seedling age increased from 20 to 40 and 60 days respectively. Likewise, straw yield of IR 50 was reduced by about 13% when seedling age increased from 20 to 40 days (Roy *et al.*, 1992). The older seedlings had reduced number of tillers per plant due to the reduction in field duration and thus, low yield were observed.

Harvest index increased with the increase of seedling age. It was 0.41 for 20 and 0.51 for 80 days old seedlings of BR 14 and for IR50 it was 0.45 for 20 and 0.57 for 80 days old seedling (Roy *et al.*, 1992). The lower harvest index with younger seedlings indicates that the partitioning of dry matter in their case was less efficient as compared to the older seedlings (Roy *et al.*, 1992).

Rangasamy and Narayansamy (1977) reported that a progressive decrease in paddy yield with the increase in seedling age. Sarma *et al.* (1979) agreed with this agreement. Lal *et al.* (1981) mentioned otherwise where they reported that the yield reduction caused by transplanting older (55 days) seedlings were small and non significant as compared to younger (25 days) ones. In boro, optimum seedling ages were 20-40 days for long and 20 days for short duration varieties but in aus rice, seedling age had no effect on grain yield.

Mannan *et al.* (1991) mentioned that 45 - 60 days old seedling produced the highest grain yield at September 30 planting in T. aman. In another experiment Mannan *et al.* (1991) mentioned that 50 days old seedling of BR11 and BR22 and 70 days old seedling Nizersail produced significantly higher yield than 30 days old seedling. The older seedling (50 days old) was better than the younger ones (30 days old) for increasing yield of late T. aman rice (BRRI, 1986). Banarjee *et al.* (1992) reported that seedlings of 25 days old were the best yield potential of aman rice. Harun *et al.* (1991) however, mentioned that grain yield decreased gradually with increased of seedling age in Boro. BRRI (2001) agreed with this agreement.

De Datta (1981) reported that younger seedling recover faster than the older seedling when transplanted. The grain yield was affected by seedling age but the effect was not similar in all varieties. In BR14 the highest grain yield (6.61 t/ha) was obtained from 40 days old seedlings which was statistically identical to that from 20 and 60 days old seedlings but in IR50 the highest grain yield (6.30t/ha) was obtained from 20 days old seedling although yield with age up to 80 days did not vary significantly (Roy *et al.* 1992). In 15 September planting, 30 and 45 days old seedlings gave slightly higher grain yield than 60 days old seedlings in Joydebpur (BRRI, 1991). BRRI (1991) further reported that 20 to 40 days old seedling produce higher grain yield.

2.2 Influence of number of seedlings hill^{-1} on growth and yield of rice

Higher number of seedlings per hill induced a large number of tillers and panicle per m^2. But the number of spikelets per panicle and the percentage of ripened grains were smaller. The seed size was not affected by the seedling(s) number per hill. Grain yield was negatively correlated with increasing seedling per hill. The increase of seedling per hill decreased the tillering rate. The degree of the diameter decrease for the increase of tiller and panicles in the higher hill density was larger than the degree of diameter decrease in the lower density (Nakano and Mizushima, 1994).

The number of tillers was higher in the hills with many seedlings than the hills with a few seedlings at every development stage. Both the estimated emergence stage of the last tiller and the maximum tiller number stage appeared fasted in the hills with many seedlings than the hills with a few seedlings. The dry weight of stems decreased as the seedling number per hill increased (Yamamoto *et al.*, 1994).

Ghosh *et al.* (1998) observed than panicles per m^2 increased but grains per panicle and panicle weight were decreased with increasing seedlings per hill. Increasing seedlings per hill at a constant level did not influence on grain yield production, but after that grain yield decreased. There was no response among the seed and seedling(s) per hill.

Plant height, panicles per hill and grain yield increased with seedlings per hill, but panicle length, filled spikelets per panicle and size decreased (Singh, 1990). On the other hand, Ramasamy *et al.* (1987) stated that tillers per hill, panicle weight, spikelets per panicle and grain yield were decreased with increasing seedling per hill. Sing and Hari (1987) found that seedling(s) per hill had no effect on panicles per hill, grains per panicle and grain yield. Same result observed by IRRI (1981) and Chakraborty and De (1978) that seedling(s) per hill had no effect on grain yield. Grain yield increased with increasing seedlings per hill (Pande *et al.*, 1987). Where as opposite result was obtained by IRRI (1986).

In an experiment Chandrakar (1998) observed that grain yield difference between the seedling(s) per hill was not marked but panicles per m^2 increased with increasing seedlings per hill. The influence of seedling(s) per hill was not significant on grain yield but tillers and panicles per hill were significantly affected by the seedling(s) per hill (IRRI, 1979).

Islam *et al.* (1994) stated that tillers and panicles per hill were increased but plant height, filled grain percentage, grain size and grain yield had no significant effect with increasing seedlings per hill. On the other hand Chawdhury *et al.* (1993) found that plant height, panicle length, filled grains per panicle, spikelets per panicle and seed size decreased with increasing seedlings per hill but tillers, panicles and grain yield were increased. Once more Shah *et al.* (1991) reported that tillers per hill, panicles per hill, spikelets per panicle, seed size, grain yield, straw yield and harvest index had no significant effect on increasing seedlings per hill but plant height and grains per panicle were decreased.

Seedling(s) per hill was not found to have no significant effect on plant height, panicles per hill, panicle length, filled grains per panicle, spikelets per panicle, seed size and grain yield but tillers per hill and straw yield increased with increasing seedlings per hill (Sarker *et al.*, 1998). On the other hand, Das *et al.* (1988) reported that panicles, panicles weight, straw weight, total dry matter weight and grain yield increased with increasing seedlings per hill.

Tanaka (1964) stated that plant height, tillers, panicles per hill and total dry weight increased with increasing seedlings per hill but spikelets per panicle and panicle weight decreased with increasing seedlings per hill. While, effect on seed size and filled grain percentage were equal. Almost same result obtained by

Choudhury *et al.* (1995) and reported that panicles and grain yield increased with increasing seedlings per hill.

In an experiment of Karim *et al.* (1987), Nizersail was planted maintaining 1, 2, 3, 4 and 5 seedlings per hill. The highest grain yield of Nizersail was obtained with 4 followed by 3 seedlings per hill. Resembleness highest grain yield with 6 seedlings per hill was also observed by Zhang and Huang (1990) from 1, 2, 3, 4, 5 and 6 seedlings per hill respectively in rice cv. Ewan 5. On the other hand Budhar *et al.* (1989) observed paddy yield in early maturing rice cv. CR 666-18 grown with 2 or 4 seedlings per hill though the yield difference was not significant. Shahi *et al.* (1976) also did not observe a significant difference in grain yield of rice from 1-4 seedling(s) per hill.

Sarma *et al.* (1979) reported that increased grain yield when seedling(s) per hill was increased from 2 to 4. Nair *et al.* (1971) obtained highest grain yield by planting 2 seedlings per hill over 4 or 6 seedlings per hill. Mian and Gaffer (1970) reported that increasing seedlings per hill from 1 or 2 to 3 or 4 increased the grain yield. BRRI (1972) stated that two or three seedlings per hill did not produce any difference effect for grain yield. Tillers in initial stage were depended on mother shoot of rice (Ishizuka, 1963).

Chapter III
Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from June to November 2007 to study the influence of seedling age and number of seedlings $hill^{-1}$ on the performance of BRRI dhan 44. The details of the materials and methods have been presented below:

3.1 Description of the experimental site

3.1.1 Location

The present piece of research work was conducted in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is $23^{0}74^{\prime}$ N latitude and $90^{0}35^{\prime}$ E longitude with an elevation of 8.2 meter from sea level.

3.1.2 Soil

The soil belongs to "The Modhupur Tract", AEZ – 28 (FAO, 1988). Top soil was silty clay in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and has organic carbon 0.45%. The experimental area was flat having available irrigation and drainage system and above flood level. The selected plot was medium high land. The details were presented in Appendix I.

3.1.3 Climate

The geographical location of the experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October (Edris *et al.*, 1979). Details of the metrological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment was collected from the Weather Station of Bangladesh, Sher-e Bangla Nagar, presented in Appendix II.

3.2 Test crop and its characteristics

BRRI dhan 44 was used as the test crop in this experiment. This variety was developed at the Bangladesh Rice Research Institute. It is recommended for aman season. Average plant height of the variety is 90-95 cm at the ripening stage. The grains are medium fine and white. It requires about 155-160 days completing its life cycle with an average grain yield of 5.5 t ha^{-1} (BRRI, 2004).

3.3 Experimental details

3.3.1 Treatments

The experiment comprised as two factors.

Factor A: Seedling ages: 3 levels

i. 20 days old seedling - A_1

ii. 30 days old seedling - A_2

iii. 40 days old seedling - A_3

Factor B: Number of seedlings $hill^{-1}$: 4 levels

i. 1 seedling $hill^{-1}$ - S_1

ii. 2 seedlings $hill^{-1}$ - S_2

iii. 3 seedlings $hill^{-1}$ - S_3

iv. 4 seedlings $hill^{-1}$ - S_4

TAs such there were 12 (3 × 4) treatment combinations viz. A_1S_1, A_1S_2, A_1S_3, A_1S_4, A_2S_1, A_2S_2, A_2S_3, A_2S_4, A_3S_1, A_3S_2, A_3S_3 and A_3S_4.

3.3.2 Experimental design and layout

The experiment was laid out in two factor Randomized Complete Block Design with three replications. The layout of the experiment was prepared for distributing the combination of date of transplanting and number of seedlings $hill^{-1}$. There were 12 plots of size 4 m × 3 m in each of 3 replications. The 12 treatment combination of the experiment was assigned at random into 12 plots of each replication (Figure 1).

3.4 Growing of crops

3.4.1 Raising seedlings

3.4.1.1 Seed collection

The seeds of the test crop i.e. BRRI dhan 44 were collected from Bangladesh Rice Research Institute (BRRI), Joydevpur, Gazipur.

3.4.1.2 Seed sprouting

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

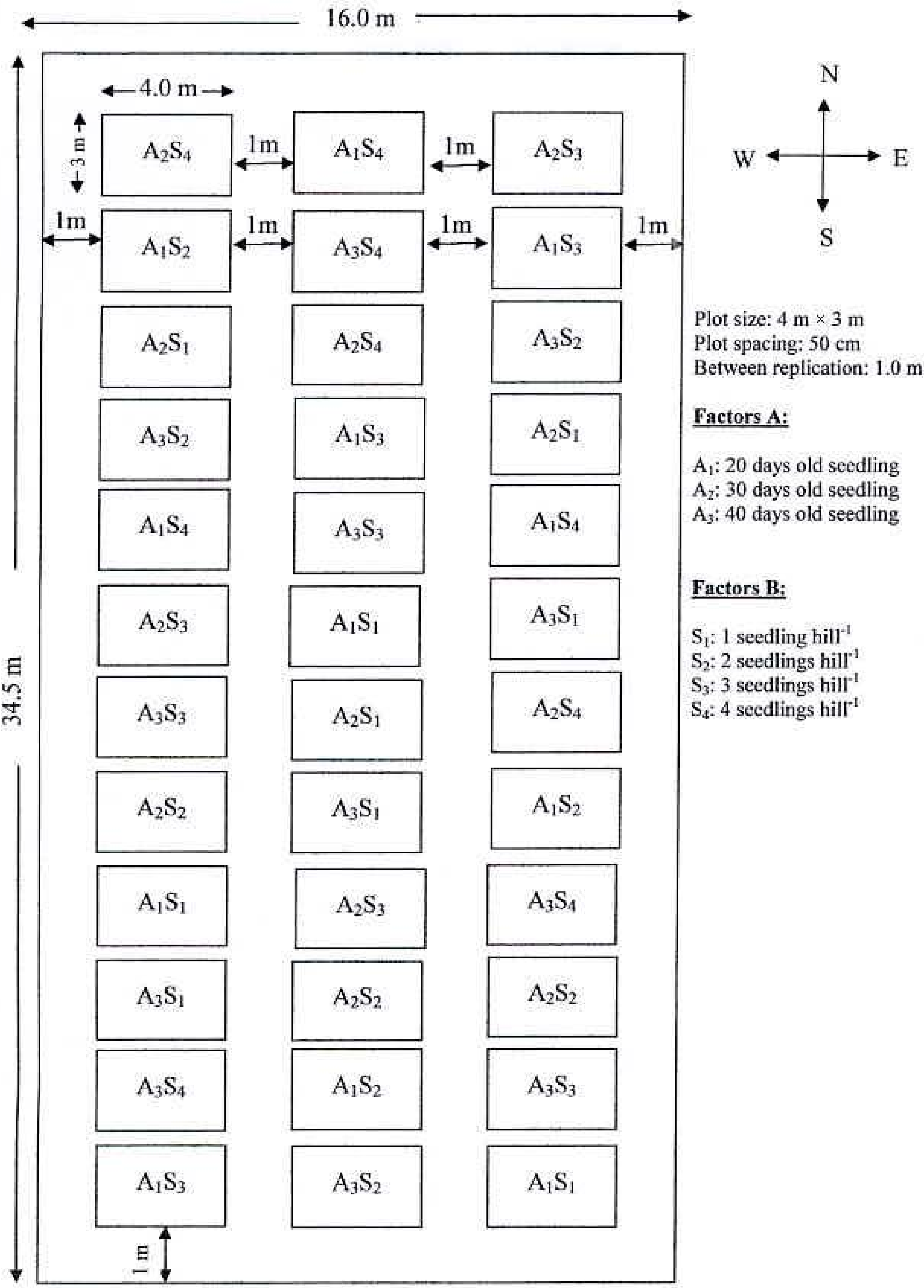

Figure 1. Layout of the experimental plot

3.4.1.3 Preparation of seedling nursery bed and seed sowing

As per BRRI recommendation seedbed was prepared with 1 m wide adding nutrients as per the requirements of soil. Seeds were sown in the seed bed on June 15, 2007, June 25, 2007 and July 5, 2007 in order to transplanting the seedlings in the main field.

3.4.2 Preparation of the main field

The plot selected for the experiment was opened in the second week of July 2007 with a power tiller, and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubble were removed, and finally obtained a desirable tilth of soil for transplanting of seedlings.

3.4.3 Fertilizers and manure application

The fertilizers N, P, K, S and B in the form of urea, TSP, MP, Gypsum and borax, respectively were applied. The entire amount of TSP, MP, Gypsum, Zinc sulphate and borax were applied during the final preparation of land. Urea was applied in two equal installments at tillering and panicle initiation stage. The dose and method of application of fertilizer are shown in Table 1.

Table 1. Dose and method of application of fertilizers in rice field

Fertilizers	Dose (kg/ha)	Application (%)		
		Basal	1st installment	2nd installment
Urea	160	33.33	33.33	33.33
TSP	100	100	--	--
MP	100	100	--	--
Gypsum	60	100	--	--
Borax	10	100	--	--

Source: Adunik Dhaner Chash, BIRI, Joydebpur, Gazipur

3.4.4 Uprooting seedlings

The nursery bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted on July 24, 2007 for transplant on the date of July 25, 2007 without causing much mechanical injury to the roots.

3.4.5 Transplanting of seedlings in the field

On the scheduled dates as per experiment the rice seedlings were transplanted in lines each having a line to line distance of 30 cm and plant to plant distance 25 cm in the well prepared plot.

3.4.6 After care

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

3.4.6.1 Irrigation and drainage

Flood irrigation was given to maintain a constant level of standing water upto 6 cm in the early stages to enhance tillering and 10-12 cm in the later stage to discourage late tillering. The field was finally dried out 15 days before harvesting.

3.4.6.2 Gap filling

First gap filling was done for all of the plots at 10 days after transplanting (DAT).

3.4.6.3 Weeding

Weedings were done to keep the plots free from weeds, which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully at tillering stage and at panicle initiation stage by mechanical means.

3.4.6.4 Top dressing

After basal dose, the remaining doses of urea were top-dressed in 2 equal installments. The fertilizers were applied on both sides of seedlings rows with the soil.

3.4.6.5 Plant protection

Furadan 57 EC was applied at the time of final land preparation and later on other insecticides were applied as and when necessary.

3.5 Harvesting, threshing and cleaning

The rice was harvested depending upon the maturity of plant and harvesting was done manually from each plot. The harvested crop of each plot was bundled separately, properly tagged and brought to threshing floor. Enough care was taken for harvesting, threshing and also cleaning of rice seed. Fresh weight of grain and straw were recorded plot wise. The grains were cleaned and finally the weight was adjusted to a moisture content of 14%. The straw was sun dried and the yields of grain and straw $plot^{-1}$ were recorded and converted to t ha^{-1}.

3.6 Data recording

3.6.1 Plant height

The height of plant was recorded in centimeter (cm) at the time of 30, 50, 70, 90 DAT (Days after transplanting) and at harvest. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of the tiller.

3.6.2 Number of tillers hill^{-1}

The number of tillers hill^{-1} was recorded at the time of 30, 50, 70 and 90 DAT by counting total tillers. Data were recorded as the average of 10 hills selected at random from the inner rows of each plot.

3.6.3 Dry matter plant^{-1}

Total dry matter plant^{-1} was recorded at the time of 30, 50, 70, 90 DAT and at harvest by drying plant sample. Data were recorded as the average of 3 sample hill^{-1} selected at random from the inner rows of each plot and it was expressed in gram.

3.6.4 Effective tillers hill^{-1}

The total number of effective tiller hill^{-1} was counted as the number of panicle bearing hill plant^{-1}. Data on effective tiller hill^{-1} were counted from 10 selected hills at harvest and average value was recorded.

3.6.5 Non-effective tillers hill^{-1}

The total number of non effective tillers hill^{-1} was counted as the number of non panicle bearing tillers plant^{-1}. Data on non effective tiller hill^{-1} were counted from 10 selected hills at harvest and average value was recorded.

3.6.6 Length of panicle

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

3.6.7 Filled grain panicle^{-1}

The total number of filled grains was collected randomly from selected 10 plants of a plot on the basis of grain in the spikelet and then average number of filled grains panicle^{-1} was recorded.

3.6.8 Unfilled grains panicle^{-1}

The total number of unfilled grains was collected randomly from selected 10 plants of a plot on the basis of not grain in the spikelet and then average number of unfilled grains panicle^{-1} was recorded.

3.6.9 Weight of 1000 seeds

One thousand seeds were counted randomly from the total cleaned harvested seeds of each individual plot and then weighed in grams and recorded.

3.6.10 Grain yield

Grains obtained from each unit plot were sun-dried and weighed carefully. The dry weight of grains of central 1 m^2 area and five sample plants were added to the respective unit plot yield to record grain yield plot^{-1} and converted to t ha^{-1}.

3.6.11 Straw yield

Straw obtained from each unit plot were sun-dried and weighed carefully. The dry weight of straw of central 1 m^2 area and five sample plants were added to the respective unit plot yield to record the final straw yield plot^{-1} and finally converted to t ha^{-1}.

3.6.12 Biological yield

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

Biological yield = Grain yield + Straw yield.

3.6.13 Harvest index

Harvest index was calculated from the grain and straw yield of rice for each plot and expressed in percentage.

$$HI = \frac{\text{Economic yield (grain weight)}}{\text{Biological yield (Total dry weight)}} \times 100$$

3.7 Statistical Analysis

The data obtained for different characters were statistically analyzed to observe the significant difference among the treatment. The mean values of all the characters were calculated and analysis of variance was performed. The significance of the difference among the treatments means was estimated by the Duncan's Multiple Range Difference (DMRT) test at 5% level of probability (Gomez and Gomez, 1984).

Chapter IV
Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to determine the influence of the seedling age and number of seedlings hill^{-1} on the performance of BRRI dhan 44. Data on different growth parameters and yield was recorded. The analyses of variance (ANOVA) of the data on different parameters are presented in Appendix III-VII. The results have been presented and possible interpretations are given under the following headings:

4.1 Plant height

Statistically significant variation was recorded for plant height due to the seedling age of BRRI dhan 44 at 30, 50, 70, 90 DAT and at harvest (Table 2). At different days of recording plant height of BRRI dhan 44 viz. 30, 50, 70, 90 DAT (Days after transplanting) and at harvest the A_1 (20 days old seedling) produced significantly the tallest plants comparing to those recorded from the other seedling age of A_2 and A_3. The height of the tallest plants recorded from A_1 at 30, 50, 70, 90 DAT and at harvest were 24.14 cm, 31.00 cm, 44.78 cm, 69.05 cm and 86.58 cm, respectively while those from A_2 were 22.60 cm, 29.85 cm, 43.29 cm, 65.09 cm and 86.02 cm and from A_3 were 20.93 cm, 27.24 cm, 41.42 cm, 60.48 cm and 80.24 cm, respectively. The values of plant height recorded from 40 days old seedling (A_3) were significantly the lowest. It was revealed that 20 days old seedlings produced tallest plant than the other seedling age. Twenty day old seedlings produced the tallest plant as compared to seedling age of 28 and 36 days (Kosta *et al.,* 1982; Sundersingh *et al.,* 1983). Seedling height and seedling strength at transplanting increased with the increase in seedling age (BRRI, 1983).

Table 2. Effect of seedling age and number of seedlings hill^{-1} on plant height of BRRI dhan 44

Treatments	Plant height (cm) at				
	30 DAT	50 DAT	70 DAT	90 DAT	Harvest
Seedling age					
A_1	24.14 a	31.00 a	44.78 a	69.05 a	86.58 a
A_2	22.60 b	29.85 b	43.29 b	65.09 b	86.02 a
A_3	20.93 c	27.24 c	41.42 c	60.48 c	80.24 b
$LSD_{(0.05)}$	0.644	0.853	0.687	0.842	1.177
Level of significance	0.01	0.01	0.01	0.01	0.01
Number of seedlings hill^{-1}					
S_1	22.95 ab	29.67 ab	43.67 ab	65.06 b	84.03 b
S_2	23.17 a	30.28 a	43.83 a	67.42 a	85.76 a
S_3	22.35 bc	28.88 bc	42.98 b	64.27 b	83.80 b
S_4	21.76 c	28.61 c	42.17 c	62.74 c	83.54 b
$LSD_{(0.05)}$	0.743	0.985	0.793	0.973	1.359
Level of significance	0.01	0.01	0.01	0.01	0.01

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Plant height of BRRI dhan 44 differed significantly due to the different number of seedlings $hill^{-1}$ at 30, 50, 70, 90 DAT and at harvest (Table 2). At 30, 50 and 70 DAT (Days after transplanting) 2 seedling $hill^{-1}$ (S_2) produced the tallest plants viz. 23.17 cm, 30.28 cm and 43.83 cm which were statistically similar to the corresponding plant heights of 22.95 cm, 29.67 cm and 43.67 cm obtained from the treatment of 1 seedling $hill^{-1}$ (S_1) but were significantly higher than the corresponding plant height obtained from S_3 (3 seedlings $hill^{-1}$) and S_4 (4 seedling $hill^{-1}$). At 90 DAT and at harvest S_2 produced significantly the tallest plants (67.42 cm and 85.76 cm) compared to the corresponding plant heights obtained from S_1, S_3 and S_4, while S_1 produced higher with S_3 and S_4 though the last one (S_4) was the lowest. More seedlings $hill^{-1}$ created intra hill competition for light and other resources and the ultimate results was the shortest plant. The competition was more intense where the number of seedlings $hill^{-1}$ was higher. The results are in agreement with Islam *et al.* (1994) but in conflict with Singh (1990).

Interaction effect of seedling age and number of seedlings $hill^{-1}$ showed statistically significant differences in terms of plant height of BRRI dhan 44 at 30, 50, 70, 90 DAT and at harvest (Table 3). The interaction of A_1S_2 (20 days old seedling and 2 seedlings $hill^{-1}$) produced significantly the tallest plants at all DAT but at 30 DAT and at harvest the A_2S_1, A_2S_4 and A_3S_2 produced similar plant heights. The taller plants obtained from A_1S_2 at 30, 50, 70, 90 DAT and at harvest were 25.31 cm, 32.60 cm, 46.03 cm, 74.20 cm and 88.87 cm, respectively while, the shortest plant 19.80 cm, 24.91 cm, 39.88 cm, 57.28 cm and 75.81 cm were obtained from the interaction of A_3S_4 (Table 3) on the above mentioned dates, respectively.

Table 3. Interaction effect of seedling age and number of seedlings $hill^{-1}$ on plant height of BRRI dhan 44

Treatments	Plant height (cm) at				
	30 DAT	50 DAT	70 DAT	90 DAT	Harvest
A_1S_1	24.04 ab	30.72 bc	44.30 b	69.60 b	85.05 bc
A_1S_2	25.31 a	32.60 a	46.03 a	74.20 a	88.87 a
A_1S_3	23.25 b-d	29.38 b-d	44.53 b	65.56 cd	85.88 bc
A_1S_4	23.96 b	31.29 ab	44.23 b	66.84 c	86.50 a-c
A_2S_1	22.87 b-e	29.17 cd	43.38 bc	64.43 de	85.33 bc
A_2S_2	22.47 c-e	29.53 b-d	43.25 bc	65.33 cd	86.80 ab
A_2S_3	23.53 bc	31.07 a-c	44.15 b	66.50 c	86.01 bc
A_2S_4	21.53 ef	29.63 b-d	42.39 c	64.10 de	85.94 bc
A_3S_1	21.93 de	29.13 cd	43.33 bc	61.15 fg	81.70 de
A_3S_2	21.73 e	28.70 d	42.22 c	62.73 ef	83.97 cd
A_3S_3	20.27 fg	26.20 e	40.26 d	60.75 g	79.50 e
A_3S_4	19.80 g	24.91 e	39.88 d	57.28 h	75.81 f
$LSD_{(0.05)}$	1.287	1.705	1.374	1.685	2.354
Level of significance	0.01	0.01	0.01	0.01	0.01

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2 Number of tillers

Statistically significant variation was recorded for number of tillers $hill^{-1}$ due to the seedling age of BRRI dhan 44 at 30, 50, 70 and 90 DAT (Table 4). As revealed from the Table 4 significantly the maximum number of tillers $hill^{-1}$ viz 5.60, 11.55, 22.23 and 17.96 was recorded from A_2 (30 days old seedling), at 30, 50, 70 and 90 DAT, respectively and the respective lowest number of tillers $hill^{-1}$ obtained from A_1 (20 days old seedling) were 3.83, 8.56, 16.57 and 12.78. The respective number of tillers $hill^{-1}$ obtained from A_3 were 4.77, 10.14, 19.35 and 15.62 which were significantly higher than the respective number of tillers $hill^{-1}$ obtained from A_1 but lower than those obtained from A_2. The number of tillers is regulated by tillering duration, which varies with cultivars seedling age, environmental conditions, availability of nutrients in the soil. (Roy *et al.*, 1992).

Number of tillers $hill^{-1}$ of BRRI dhan 44 varied significantly due to the different number of seedlings $hill^{-1}$ at 30, 50, 70 and 90 DAT (Table 4). It was observed from the Table 4 that 1 seedling $hill^{-1}$ (S_1), 2 seedlings $hill^{-1}$ (S_2) and 3 seedlings $hill^{-1}$ (S_3) produced statistically the similar number of tillers $hill^{-1}$ at all DATs except 30 DAT. at which S_3 produced lower number of tillers $hill^{-1}$ S_4 (4 seedlings $hill^{-1}$) produced the lowest number of tillers $hill^{-1}$ at all DATs. The respective maximum number of tillers recorded from S_2 were 5.05, 10.66, 20.12 and 16.30) and the lowest obtained from S_4 were 4.48, 9.46, 18.18 and 14.71. The magnitude of difference in tiller number due to seedlings $hill^{-1}$ was decreasing at maturity stage possibly the intra hill competition was more after flowering stage. The mortality of tillers was always higher with greater number of seedlings $hill^{-1}$.

Table 4. Effect of seedling age and number of seedlings $hill^{-1}$ on number of tillers $hill^{-1}$ of BRRI dhan 44

Treatment	Number of tillers $hill^{-1}$ at			
	30 DAT	50 DAT	70 DAT	90 DAT
Seedling age				
A_1	3.83 c	8.56 c	16.57 c	12.78 c
A_2	5.60 a	11.55 a	22.23 a	17.96 a
A_3	4.77 b	10.14 b	19.35 b	15.62 b
$LSD_{(0.05)}$	0.320	0.632	0.840	0.876
Level of significance	0.01	0.01	0.01	0.01
Number of seedlings $hill^{-1}$				
S_1	4.76 ab	10.22 ab	19.79 a	15.47 ab
S_2	5.05 a	10.66 a	20.12 a	16.30 a
S_3	4.63 b	10.00 ab	19.44 a	15.33 ab
S_4	4.48 b	9.46 b	18.18 b	14.71 b
$LSD_{(0.05)}$	0.370	0.730	0.970	1.011
Level of significance	0.05	0.05	0.01	0.05

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

The results compare favorably with those of Yamamoto *et al.* (1994), Islam *et al.* (1994), but disagreed with Ramasamy *et al.*, (1987).

A statistically significant variation was recorded due to interaction effect of seedling age and number of seedlings hill^{-1} in terms of number of tillers hill^{-1} of BRRI dhan 44 at 30, 50, 70 and 90 DAT (Table 5). The interaction of 30 days old seedling and 2 seedlings hill^{-1} (A_2S_2) produced the highest number of tillers hill^{-1} which were 6.27, 12.73, 24.55 and 19.99 obtained at 30, 50, 70 and 90 DAT, respectively and the respective lowest number of tillers hill^{-1} 3.45, 7.30, 15.48 and 11.58 recorded from the interaction of A_1S_4. It appears from the interaction table 5 that the effect of the combination of the 30 days old seedling and respective seedling number hill^{-1} showed the better performance than the combination of other seedling age with any number of seedlings hill^{-1} under study.

4.3 Dry matter of plant

Statistically significant difference was recorded for dry matter plant^{-1} due to use of different days old seedling of BRRI dhan 44 at 30, 50, 70, 90 DAT and at harvest (Table 6). As it is revealed from the table 6 that the maximum dry matter production plant^{-1} was obtained from 30 days old seedling (A_2) and they were 0.52 g, 3.28 g, 14.50 g, 24.82 g and 56.38 g recorded at 30, 50, 70, 90 DAT and at harvest, respectively. The corresponding lowest dry matter plant^{-1} were 0.38 g, 2.21 g, 9.26 g, 19.30 g and 41.12 which were found from 20 days old seedling 7 (A_1). The A_3 (40 days old seedling) produced the respective dry matter plant^{-1} as 0.44 g, 2.65 g, 11.79 g, 21.53 g and 52.27 g which were significantly higher than the

Table 5. Interaction effect of seedling age and number of seedlings hill^{-1} on number of tillers hill^{-1} of BRRI dhan 44

Treatments	Number of tillers hill^{-1} at			
	30 DAT	50 DAT	70 DAT	90 DAT
A_1S_1	4.08 ef	9.73 cd	17.75 de	13.86 ef
A_1S_2	4.13 ef	9.31 d	16.57 ef	13.54 ef
A_1S_3	3.64 f	7.93 e	16.49 ef	12.14 fg
A_1S_4	3.45 f	7.30 e	15.48 f	11.58 g
A_2S_1	5.56 b	11.12 bc	22.31 b	17.43 b
A_2S_2	6.27 a	12.73 a	24.55 a	19.99 a
A_2S_3	5.15 b-d	11.19 b	21.17 b	16.72 b-d
A_2S_4	5.41 bc	11.18 b	20.87 bc	17.71 b
A_3S_1	4.65 de	9.81 b-d	19.31 cd	15.13 de
A_3S_2	4.74 c-e	9.95 b-d	19.26 cd	15.36 c-e
A_3S_3	5.10 b-d	10.90 bc	20.65 bc	17.13 bc
A_3S_4	4.59 de	9.92 b-d	18.18 de	14.86 de
$LSD_{(0.05)}$	0.640	1.264	1.681	1.752
Level of significance	0.05	0.01	0.01	0.01

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

respective dry matter plant^{-1} produced by A_1. Crop raised with young seedling showed higher dry matter accumulation than older seedling (Mondal and Roy, 1984). However, dry matter at flowering and at harvest decreased with the increase in seedling age in varieties sensitive to photo-period in wet season (Padalia, 1981).

Dry matter plant^{-1} of BRRI dhan 44 differed significantly due to the different number of seedlings hill^{-1} at 30, 50, 70, 90 DAT and at harvest (Table 6). It appeared from the table 6 that seedling number 1, 2 and 3 seedling hill^{-1} showed more or less similar performances in respect of dry matter plant^{-1} recorded at the data collection date except 50 DAT at which 2 seedlings hill^{-1} (S_2) performed the best of all number of seedlings hill^{-1}. At the respective data recording dates the highest dry matter plant^{-1} were 0.46 g, 3.04 g, 12.72 g, 22.80 g and 52.67 g while the respective lowest dry matter plant^{-1} were 0.42 g, 2.46 g, 10.77 g, 20.45 g and 47.83 g recorded from S_4. Dry matter increased progressively with increasing time and reached at maximum stage. Similar trend have been reported by Sattar, 1996. The dry weight of stems decreased as the seedling number per hill increased (Yamamoto *et al.*, 1994). Tanaka *et al.* (1964) stated that total dry weight increased with increasing seedlings per hill.

Table 6. Effect of seedling age and number of seedlings hill^{-1} on total dry matter plant^{-1} of BRRI dhan 44

Treatments	Dry matter per plant (g) at				
	30 DAT	50 DAT	70 DAT	90 DAT	Harvest
Seedling age					
A_1	0.38 c	2.21 c	9.26 c	19.30 c	41.12 c
A_2	0.52 a	3.28 a	14.50 a	24.82 a	56.38 a
A_3	0.44 b	2.65 b	11.79 b	21.53 b	52.27 b
$LSD_{(0.05)}$	0.027	0.235	0.903	0.847	2.498
Level of significance	0.01	0.01	0.01	0.01	0.01
Number of seedlings hill^{-1}					
S_1	0.45 a	2.65 b	12.01 a	22.31 a	49.84 ab
S_2	0.46 a	3.04 a	12.72 a	22.80 a	52.67 a
S_3	0.45 a	2.70 b	11.90 a	21.98 a	49.34 b
S_4	0.42 b	2.46 b	10.77 b	20.45 b	47.83 b
$LSD_{(0.05)}$	0.031	0.271	1.043	0.978	2.884
Level of significance	0.05	0.01	0.01	0.01	0.05

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Interaction effect of seedling age and number of seedlings hill^{-1} in terms of dry matter plant^{-1} of BRRI dhan 44 showed statistically significant differences at 30, 50, 70, 90 DAT and at harvest (Table 7). The highest dry matter plant^{-1} (0.59 g, 3.92 g, 16.65 g, 26.78 g and 58.62 g) was recorded from A_2S_2 (30 days old seedling + 2 seedlings hill^{-1}) at 30, 50, 70, 90 DAT and at harvest, respectively where as the lowest dry matter plant^{-1} (0.33 g, 1.93 g, 7.63 g, 17.41 g and 36.16 g) was recorded from A_1S_4 (20 days old seedling + 4 seedlings hill^{-1}) combination.

4.4 Effective tillers hill^{-1}

Statistically significant variation was recorded for number of effective tillers hill^{-1} due to the seedling age of BRRI dhan 44 (Table 8). The 30 days old seedling (A_2) produced significantly the highest number of effective tillers hill^{-1} (13.32), while 20 days old seedling (A_1) produced the lowest number of effective tillers hill^{-1} (10.10) On the other hand, 40 days old seedling (A_3) produced the effective number of tiller hill^{-1} as 12.35 which was statistically higher than A_1 but lower than A_2). Generally, the number of effective tillers hill^{-1} is regulated by tillering duration, which varies with cultivars, seedling age, environmental conditions, availability of nutrients in the soil, etc. (Roy *et al.*, 1992).

Number of effective tillers hill^{-1} of BRRI dhan 44 varied significantly due to the different number of seedlings hill^{-1} (Table 8). From the table 8 it revealed that the maximum number of effective tillers hill^{-1} (12.63) was recorded from 2 seedlings hill^{-1} which was statistically similar (11.95) with S_1 (1 seedling hill^{-1}) where as the

Table 7. Interaction effect of seedling age and number of seedlings $hill^{-1}$ on total dry matter $plant^{-1}$ of BRRI dhan 44

Treatments	Dry matter per plant at				
	30 DAT	50 DAT	70 DAT	90 DAT	Harvest
A_1S_1	0.43 cd	2.25 cd	10.10 de	20.49 fg	42.52 ef
A_1S_2	0.40 de	2.61 bc	10.39 de	20.35 fg	46.55 de
A_1S_3	0.36 ef	2.05 d	8.93 ef	18.96 gh	39.23 fg
A_1S_4	0.33 f	1.93 d	7.63 f	17.41 h	36.16 g
A_2S_1	0.48 bc	3.06 b	14.37 b	25.23 ab	55.56 ab
A_2S_2	0.59 a	3.92 a	16.65 a	26.78 a	58.62 a
A_2S_3	0.49 bc	3.06 b	13.70 b	24.35 bc	55.54 ab
A_2S_4	0.51 b	3.08 b	13.26 bc	22.92 cd	55.78 ab
A_3S_1	0.44 cd	2.64 bc	11.55 cd	21.22 d-f	49.95 cd
A_3S_2	0.41 d	2.58 bc	11.12 d	21.28 d-f	52.83 bc
A_3S_3	0.51 b	2.99 b	13.08 bc	22.63 c-e	54.75 a-c
A_3S_4	0.40 de	2.36 cd	11.41 cd	21.01 ef	51.54 b-d
$LSD_{(0.05)}$	0.054	0.470	1.806	1.693	4.996
Level of significance	0.01	0.05	0.01	0.05	0.05

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

minimum number of effective tillers $hill^{-1}$ (11.44) was obtained from S_4 (4 seedlings $hill^{-1}$) which was statistically similar (11.68) by S_3 as 3 seedlings $hill^{-1}$. The number of tillers was higher in the hills with many seedlings than the hills with a few seedlings at every development stage. The maximum tiller number stage appeared earlier in the hills with many seedlings than the hills with a few seedlings (Yamamoto *et al.,* 1994).

A statistically significant variation was recorded due to interaction effect of seedling age and number of seedlings $hill^{-1}$ in terms of number of effective tillers $hill^{-1}$ of BRRI dhan 44 (Table 9). The maximum number of effective tillers $hill^{-1}$ (13.99) was found from A_2S_2 (30 days old seedling + 2 seedlings $hill^{-1}$) and the minimum number of effective tillers $hill^{-1}$ (9.23) was obtained from A_1S_4 (20 days old seedling + 4 seedlings $hill^{-1}$) combination while A_2S_2 was found to be similar with A_2S_3, A_2S_4 and A_3S_3.

4.5 Non-effective tiller $hill^{-1}$

Number of non-effective tillers $hill^{-1}$ differed significantly due to the seedling age of BRRI dhan 44 (Table 8). Maximum number of non-effective tillers $hill^{-1}$ (4.25) was obtained from A_1 (20 days old seedling) which was closely followed (3.38) by A_3 as 40 days old seedling. Again, the minimum number of non-effective tillers $hill^{-1}$ (2.69) was found from A_2 (30 days old seedling). BRRI (1991) reported that 20 to 40 days old seedling produce higher non-effective tillers $hill^{-1}$.

Table 8. Effect of seedling age and number of seedlings hill^{-1} on yield contributing characters of BRRI dhan 44

Treatments	Effective tiller hill^{-1} (No.)	Non-effective tiller hill^{-1} (No.)	Length of panicle (cm)	Filled grain plant^{-1} (No.)	Unfilled grain plant^{-1} (No.)
Seedling age					
A_1	10.10 c	4.25 a	21.69 c	79.70 c	8.84 a
A_2	13.32 a	2.69 c	23.82 a	92.25 a	5.52 c
A_3	12.35 b	3.38 b	22.77 b	88.74 b	7.30 b
$LSD_{(0.05)}$	0.598	0.394	0.641	1.318	0.303
Level of significance	0.01	0.01	0.01	0.01	0.01
Number of seedlings hill^{-1}					
S_1	11.95 ab	3.44 ab	23.03 ab	87.42 b	6.90 c
S_2	12.63 a	3.85 a	23.51 a	89.03 a	6.54 d
S_3	11.68 b	3.36 b	22.66 b	86.81 b	7.52 b
S_4	11.44 b	3.13 b	21.84 c	84.33 c	7.92 a
$LSD_{(0.05)}$	0.690	0.454	0.741	1.522	0.350
Level of significance	0.01	0.05	0.01	0.01	0.01

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Table 9. Interaction effect of seedling age and number of seedlings $hill^{-1}$ on yield contributing characters of BRRI dhan 44

Treatments	Effective tillers $hill^{-1}$ (No.)	Non-effective tillers $hill^{-1}$ (No.)	Length of panicle (cm)	Filled grains $plant^{-1}$ (No.)	Unfilled grains $plant^{-1}$ (No.)
A_1S_1	10.37 ef	3.03 c-f	22.87 bc	81.40 f	7.96 b
A_1S_2	11.53 de	2.91 d-f	22.67 bc	84.77 e	8.56 b
A_1S_3	9.27 f	2.63 ef	20.96 de	78.93 f	9.39 a
A_1S_4	9.23 f	2.21 f	20.26 e	73.70 g	9.44 a
A_2S_1	13.01 ab	3.91 bc	23.70 ab	92.53 ab	5.59 e
A_2S_2	13.99 a	5.38 a	24.69 a	93.74 a	4.56 f
A_2S_3	12.87 a-c	3.74 b-d	23.37 ab	91.33 a-c	5.83 e
A_2S_4	13.43 ab	3.98 b	23.50 ab	91.40 a-c	6.10 de
A_3S_1	12.47 b-d	3.38 b-e	22.52 bc	88.33 d	7.17 c
A_3S_2	12.37 b-d	3.25 b-e	23.16 bc	88.57 cd	6.49 d
A_3S_3	12.90 a-c	3.71 b-d	23.66 ab	90.17 b-d	7.33 c
A_3S_4	11.67 cd	3.19 b-e	21.75 cd	87.90 d	8.21 b
$LSD_{(0.05)}$	1.195	0.787	1.283	2.636	0.606
Level of significance	0.05	0.05	0.05	0.01	0.01

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Statistically significant variation was recorded for number of non-effective tillers $hill^{-1}$ of BRRI dhan 44 due to the different number of seedlings $hill^{-1}$ (Table 8). From the data it was revealed that 2 seedlings $hill^{-1}$ produced maximum number of non-effective tillers $hill^{-1}$ (3.85) which was statistically similar (3.44) with S_1 (1 seedling $hill^{-1}$) where as the minimum (3.13) was recorded from S_4 (4 seedlings $hill^{-1}$) which was statistically similar (3.36) to S_3 as 3 seedlings $hill^{-1}$. Shah *et al.* (1991) reported that non-effective tillers per hill had no significant effect on increasing seedlings per hill.

Interaction effect of seedling age and number of seedlings $hill^{-1}$ showed statistically significant differences in terms of number of non-effective tillers $hill^{-1}$ of BRRI dhan 44 (Table 9). The maximum number of non-effective tillers $hill^{-1}$ (5.38) was obtained in A_2S_2 (30 days old seedling + 2 seedlings $hill^{-1}$). On the other hand, the minimum (2.21) was recorded from A_1S_4 (20 days old seedling + 4 seedlings $hill^{-1}$) combination.

4.6 Length of panicle

Length of panicle showed statistically significant variation due to the seedling age of BRRI dhan 44 (Table 8). It was revealed from the Table 8 that the highest length of panicle (23.82 cm) was found from A_2 (30 days old seedling) which was closely followed (22.77 cm) by A_3 as 40 days old seedling. Again, the lowest length of panicle (21.69 cm) was found from A_1 (20 days old seedling). Padalia (1981) reported that the decrease in yield components was possibly due to shorter effective duration. It was revealed that the panicle length decreased with increase in seedling age of the photo-period sensitive varieties in wet season.

Statistically significant variation was recorded for length of panicle due to the different number of seedlings $hill^{-1}$ (Table 8). Transplanting of 2 seedlings $hill^{-1}$ showed the highest length of panicle (23.51 cm) which was statistically similar (23.03 cm) with S_1 (1 seedling $hill^{-1}$) where as the lowest length of panicle (21.84 cm) was obtained from S_4 (4 seedlings $hill^{-1}$) which was closely followed by S_3 (22.66 cm) as 3 seedlings $hill^{-1}$.

Statistically significant variation was recorded due to interaction effect of seedling age and number of seedlings $hill^{-1}$ in terms of length of panicle of BRRI dhan 44 (Table 9). In the interaction effect of 30 days old seedling + 2 seedlings $hill^{-1}$ (A_2S_2) produced the highest length of panicle (24.69 cm). On the other hand, the lowest length of panicle (20.26 cm) was recorded from A_1S_4 (20 days old seedling + 4 seedlings $hill^{-1}$) combination.

4.7 Number of filled grains

Number of filled grains $panicle^{-1}$ showed statistically significant differences due to the seedling age of BRRI dhan 44 (Table 8). The highest number of filled grains $panicle^{-1}$ (92.25) was obtained from A_2 (30 days old seedling) which was closely followed (88.74) by A_3 as 40 days old seedling. Again, the lowest number of filled grains $panicle^{-1}$ (79.70) was found from A_1 (20 days old seedling). Percentage of filled spiklete decreased with the increase in seedling age while increased the incidence of post mature flowering (Sabah, 1986).

Due to the different number of seedlings hill^{-1} the number of filled grains panicle^{-1} of BRRI dhan 44 differed significantly (Table 8). The highest number of filled grains panicle^{-1} (89.03) was recorded from S_2 (2 seedlings hill^{-1}) which was closely followed (87.42) by S_1 (1 seedling hill^{-1}) where as the lowest (84.33) was recorded from S_4 (4 seedlings hill^{-1}) which was closely followed (86.81) by S_3 as 3 seedlings hill^{-1}. The numbers of spikelets per panicle were smaller for maximum number of seedlings (Nakano and Mizushima, 1994).

Interaction effect of seedling age and number of seedlings hill^{-1} showed a statistically significant variation in number of filled grains panicle^{-1} of BRRI dhan 44 (Table 9). The interaction effect of 30 days old seedling + 2 seedlings hill^{-1} (A_2S_2) produced the highest number of filled grains panicle^{-1} (93.74) while the lowest number of filled grains panicle^{-1} (73.70) was recorded from A_1S_4 (20 days old seedling + 4 seedlings hill^{-1}) combination.

4.8 Number of unfilled grains

Number of unfilled grains panicle^{-1} showed statistically significant variation due to the seedling age of BRRI dhan 44 (Table 8). In respect of unfilled grains panicle^{-1} it was revealed from the table 8 that 30 days old seedling (A_2) produced the lowest number of unfilled grains panicle^{-1} (5.52) which was closely followed (7.30) by A_3 as 40 days old seedling. Again, the highest number of unfilled grains panicle^{-1} (8.84) was found from A_1 (20 days old seedling).

Number of unfilled grains panicle^{-1} of BRRI dhan 44 differed significantly due to the different number of seedlings hill^{-1} (Table 8). Among the 4 different number of seedlings hill^{-1}, 2 seedlings hill^{-1} produced the lowest number of unfilled grains panicle^{-1} (6.54) which was closely followed (6.90) by S_1 (1 seedling hill^{-1}) where as the highest number of unfilled grains panicle^{-1} (7.92) was obtained from S_4 (4 seedlings hill^{-1}) which was closely followed (7.52) by S_3 as 3 seedlings hill^{-1}.

Statistically significant variation was recorded due to interaction effect of seedling age and number of seedlings hill^{-1} in terms of number of unfilled grains panicle^{-1} of BRRI dhan 44 (Table 9). The lowest number of unfilled grains panicle^{-1} (4.56) was obtained from A_2S_2 (30 days old seedling + 2 seedlings hill^{-1}). On the other hand, the highest number of unfilled grains panicle^{-1} (9.44) was recorded from A_1S_4 (20 days old seedling + 4 seedlings hill^{-1}) combination.

4.9 Weight of 1000 seeds

Weight of 1000 seeds showed statistically significant variation due to the seedling age of BRRI dhan 44 (Table 10). The seedling age 30 days old (A_2) recorded the highest weight of 1000 seeds (22.07 g), while 20 days old seedling (A_1) recorded the lowest weight of 1000 seeds (20.27 g) and 40 days old seedling (A_3) recorded the weight of 1000 seeds as 21.34 g which was significantly lower than of A_2 but higher than that of A_1. Grain weight decreased with the increase in seedling age that was agreed by Aziz and Rakibul (2000).

Weight of 1000 seeds of BRRI dhan 44 showed statistically non significant differences due to the different number of seedlings hill^{-1} (Table 10). Numerically the maximum weight of 1000 seeds (21.46 g) was observed from S_2 (2 seedlings hill^{-1}) where as the minimum weight of 1000 seeds (20.90 g) was obtained from S_4

as 4 seedlings hill^{-1}. Ghosh *et al.* (1998) observed weight of highest 1000 seeds from 2 seedlings per hill^{-1} which ensured maximum vegetative and also reproductive growth.

Statistically significant variation was recorded due to interaction effect of seedling age and number of seedlings hill^{-1} in terms of weight of 1000 seeds of BRRI dhan 44 (Table 11). The maximum weight of 1000 seeds (22.34 g) was recorded from A_2S_2 (30 days old seedling + 2 seedlings hill^{-1}). On the other hand, the minimum weight of 1000 seeds (19.83 g) was found from A_1S_4 (20 days old seedling + 4 seedlings hill^{-1}) combination.

4.10 Grain yield

Grain yield differed significantly due to the seedling age of BRRI dhan 44 (Table 10). The highest grain yield (5.52 t ha^{-1}) was recorded from A_2 (30 days old seedling) and the lowest grain yield (4.47 t ha^{-1}) was recorded from A_1 (20 days old seedling) which was statistically similar (4.87 t ha^{-1}) to A_3 as 40 days old seedling. Ashraf and Mahmood (1989) studied the effect of over aged seedlings of two Basmati rice varieties and reported that yield and yield attributes declined significantly with the increase in seedling age; the reduction in yield was partly attributed to fewer productive tillers per hill and fewer spikelets per panicle.

Grain yield of BRRI dhan 44 showed statistically significant differences due to the different number of seedlings hill^{-1} (Table 10). The highest grain yield (5.36 t ha^{-1}) was obtained from S_2 (2 seedlings hill^{-1}) which was statistically similar (5.01 t ha^{-1}) with S_1 (1 seedling hill^{-1}). Again the lowest grain yield (4.57 t ha^{-1}) was recorded from S_4 (4 seedlings hill^{-1}) which was statistically similar (4.87 t ha^{-1}) with S_3 as 3 seedlings hill^{-1}. These results supported by Islam *et al.* (1994), Sarker (1988) and Shah *et al.* (1991), but contrary with Singh (1990), Das *et al.* (1988). Grain yield increased with increasing seedlings per hill (Pande *et al.*, 1987). Where as opposite result was found by IRRI earlier (1986). BRRI (1972) stated that two or three seedlings per hill did not produce any difference effect for grain yield (Ishizuka, 1963).

Interaction effect of seedling age and number of seedlings hill^{-1} showed significant variation in grain yield of BRRI dhan 44 (Table 11). The highest grain yield (5.95 t ha^{-1}) was obtained from A_2S_2 (30 days old seedling + 2 seedlings hill^{-1}). On the other hand, the lowest grain yield (3.63 t ha^{-1}) was found from A_1S_4 (20 days old seedling + 4 seedlings hill^{-1}) combination.

4.11 Straw yield

Statistically significant variation was recorded for straw yield due to the seedling age of BRRI dhan 44 (Table 10). The highest straw yield (5.94 t ha^{-1}) was recorded from A_2 (30 days old seedling). While, the lowest straw yield (5.17 t ha^{-1}) was found from A_1 (20 days old seedling) which was closely followed (5.56 t ha^{-1}) by A_3 as 40 days old seedling. Straw yield decreased significantly with the increase of seedling age beyond 60 and 40 days in IR50. Likewise, straw yield of IR50 was reduced by about 13% when seedling age increased from 20 to 40 days (Roy *et al.*, 1992).

Table 10. Effect of seedling age and number of seedlings $hill^{-1}$ on yield contributing characters and yield of BRRI dhan 44

Treatments	Weight of 1000 Seeds (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Seedling age				
A_1	20.27 c	4.47 b	5.17 c	46.24
A_2	22.07 a	5.52 a	5.94 a	48.16
A_3	21.34 b	4.87 b	5.56 b	46.54
$LSD_{(0.05)}$	0.407	0.398	0.295	--
Level of significance	0.01	0.01	0.01	NS
Number of seedlings $hill^{-1}$				
S_1	21.36	5.01 ab	5.55 ab	47.37
S_2	21.46	5.36 a	5.88 a	47.69
S_3	21.19	4.87 b	5.54 ab	46.65
S_4	20.90	4.57 b	5.26 b	46.22
$LSD_{(0.05)}$	--	0.460	0.340	--
Level of significance	NS	0.05	0.01	NS

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Table 11. Interaction effect of seedling age and number of seedlings $hill^{-1}$ on yield contributing characters and yield of BRRI dhan 44

Treatments	Weight of 1000 Seeds (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
A_1S_1	20.53 cd	4.79 b-d	5.34 bc	47.29
A_1S_2	20.53 cd	5.30 a-c	5.89 ab	47.37
A_1S_3	20.17 d	4.18 de	4.94 cd	45.80
A_1S_4	19.83 d	3.63 e	4.52 d	44.50
A_2S_1	22.23 a	5.45 a-c	5.85 ab	48.16
A_2S_2	22.34 a	5.95 a	6.18 a	49.18
A_2S_3	21.90 ab	5.18 a-c	5.85 ab	46.91
A_2S_4	21.80 ab	5.51 ab	5.88 ab	48.38
A_3S_1	21.30 bc	4.81 b-d	5.47 bc	46.67
A_3S_2	21.50 ab	4.84 b-d	5.56 a-c	46.50
A_3S_3	21.50 ab	5.24 a-c	5.83 ab	47.24
A_3S_4	21.07 bc	4.57 cd	5.38 bc	45.77
$LSD_{(0.05)}$	0.814	0.796	0.589	--
Level of significance	0.05	0.05	0.05	NS

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Straw yield of BRRI dhan 44 showed statistically significant differences due to the different number of seedlings $hill^{-1}$ (Table 10). The highest straw yield (5.87 t ha^{-1}) was recorded from S_2 (2 seedlings $hill^{-1}$) which was statistically similar (5.55 t ha^{-1} and 5.54 t ha^{-1}) with S_1 (1 seedling $hill^{-1}$) and S_3 (3 seedlings $hill^{-1}$). Again the lowest straw yield (5.26 t ha^{-1}) was obtained from S_4 as 4 seedlings $hill^{-1}$. Straw yield increased with increasing seedlings per hill (Sarker *et al.*, 1998). On the other hand, Das *et al.* (1988) reported that straw weight increased with increasing seedlings per hill.

Statistically significant variation was recorded due to interaction effect of seedling age and number of seedlings $hill^{-1}$ in terms of straw yield of BRRI dhan 44 (Table 11). The highest straw yield (6.18 t ha^{-1}) was observed from A_2S_2 (30 days old seedling + 2 seedlings $hill^{-1}$). On the other hand, the lowest straw yield (4.52 t ha^{-1}) was obtained from A_1S_4 (20 days old seedling + 4 seedlings $hill^{-1}$) combination.

4.12 Biological yield

Seedling age of BRRI dhan 44 showed statistically significant variation for biological yield (Figure 2). The highest biological yield (11.47 t ha^{-1}) was found from A_2 (30 days old seedling). While, the lowest (10.43 t ha^{-1}) was found from A_1 (20 days old seedling) which was closely followed (9.65 t ha^{-1}) by A_3 as 40 days old seedling. Harun *et al.* (1991) however, mentioned that biological yield decreased gradually with increased of seedling age, BRRI (1989, 2001) agreed with this agreement.

Biological yield of BRRI dhan 44 showed statistically significant variation due to the different number of seedlings $hill^{-1}$ (Figure 3). The highest biological yield (11.24 t ha^{-1}) was recorded from S_2 (2 seedlings $hill^{-1}$) which was closely followed (10.57 t ha^{-1} and 10.41 t ha^{-1}) by S_1 (1 seedling $hill^{-1}$) and S_3 (3 seedlings $hill^{-1}$). Again the lowest biological yield (9.83 t ha^{-1}) was recorded from S_4 as 4 seedlings $hill^{-1}$.

Interaction effect of seedling age and number of seedlings $hill^{-1}$ in terms of biological yield of BRRI dhan 44 showed statistically significant variation (Figure 4). The highest biological yield (12.13 t ha^{-1}) was found from A_2S_2 (30 days old seedling + 2 seedlings $hill^{-1}$). On the other hand, the lowest biological yield (8.15 t ha^{-1}) was recorded from A_1S_4 (20 days old seedling + 4 seedlings $hill^{-1}$) combination.

4.13 Harvest index

Harvest index differed non significantly due to the seedling age of BRRI dhan 44 (Table 10). Numerically the maximum harvest index (48.16%) was obtained from A_2 (30 days old seedling) and the minimum harvest index (46.24%) was found from A_1 as 20 days old seedling. Harvest index increased with the increase of seedling age (Roy *et al.*, 1992). The lower harvest index with younger seedlings indicated that the partitioning of dry matter in their case was less efficient as compared to the older seedlings (Roy *et al.*, 1992).

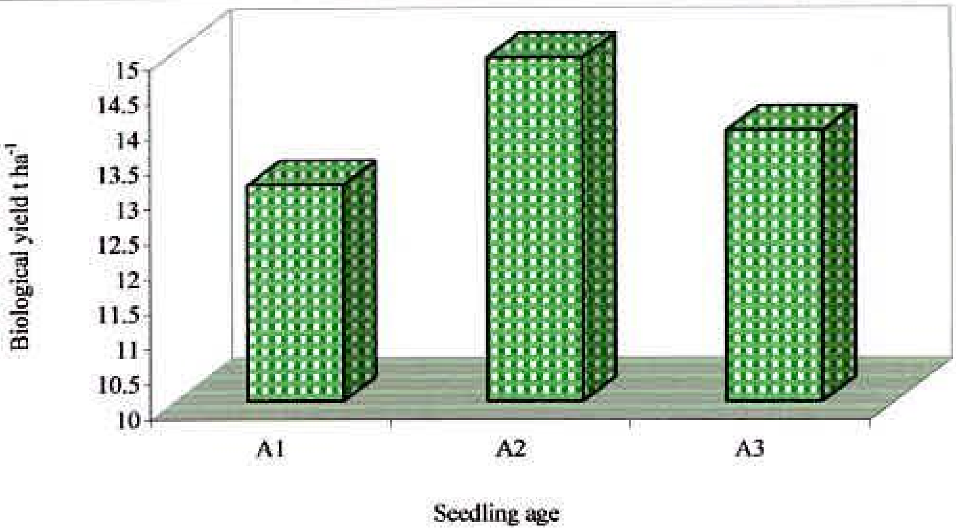

Figure 2. Effect of seedling age on the biological yield of BRRI dhan 44

A_1: 20 days old seedling
A_2: 30 days old seedling
A_3: 40 days old seedling

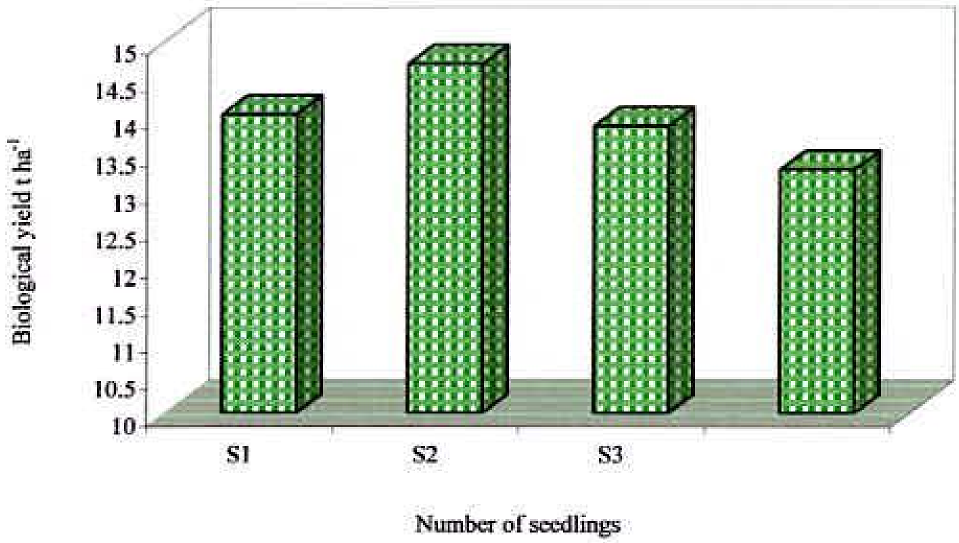

Figure 3. Effect of number of seedlings hill^{-1} on biological yield of BRRI dhan 44

S_1: 1 seedling hill^{-1} S_2: 2 seedlings hill^{-1}
S_3: 3 seedlings hill^{-1} S_4: 4 seedlings hill^{-1}

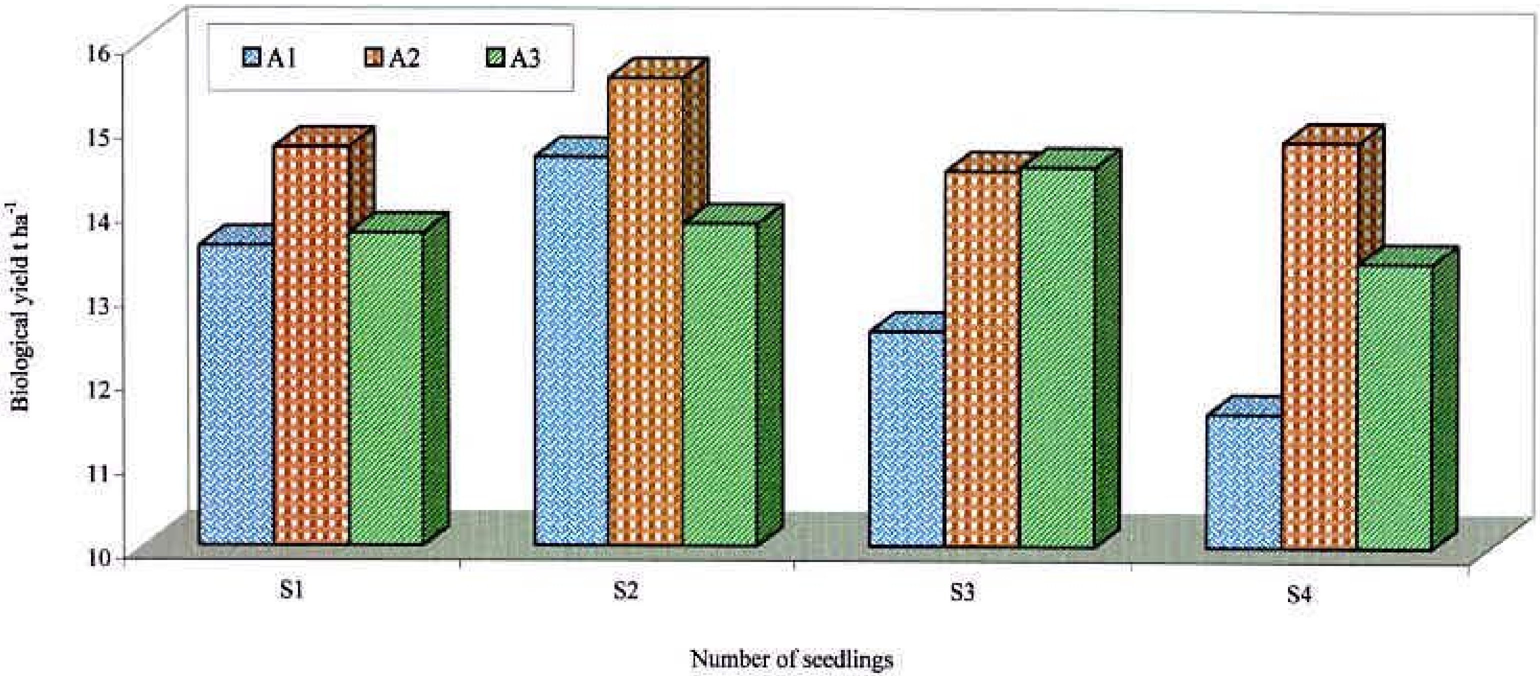

Figure 4. Interaction effect seedling age and number of seedlings hill^{-1} on biological yield of BRRI dhan 44

A_1: 20 days old seedling
A_2: 30 days old seedling
A_3: 40 days old seedling

S_1: 1 seedling hill^{-1} S_2: 2 seedlings hill^{-1}
S_3: 3 seedlings hill^{-1} S_4: 4 seedlings hill^{-1}

Statistically non significant differences were obtained for harvest index of BRRI dhan 44 due to the different number of seedlings $hill^{-1}$ (Table 10). The maximum harvest index (47.69%) was found from S_2 (2 seedlings $hill^{-1}$). Again the minimum harvest index (46.22%) was recorded from S_4 as 4 seedlings $hill^{-1}$.

No statistically significant variation was recorded due to interaction effect of seedling age and number of seedlings $hill^{-1}$ in terms of harvest index of BRRI dhan 44 (Table 11). Numerically the maximum harvest index (49.18%) was recorded from A_2S_2 (30 days old seedling + 2 seedlings $hill^{-1}$) and the minimum harvest index (44.50%) was recorded from A_1S_4 (20 days old seedling + 4 seedlings $hill^{-1}$) combination.

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from June to November 2007 to study the seedling age and number of seedlings hill^{-1} on the performance of BRRI dhan 44. The experiment considered as two factors. Factor A: Seedling age: 3 levels such as A_1: 20 days old seedling; A_2: 30 days old seedling and A_3: 40 days old seedling, Factor B: number of seedlings hill^{-1}: 4 levels, such as S_1: 1 seedling hill^{-1}; S_2: 2 seedlings hill^{-1}; S_3: 3 seedlings hill^{-1} and S_4: 4 seedlings hill^{-1}. The experiment was laid out in the Randomized Complete Block Design with three replications.

At 30, 50, 70, 90 DAT and at harvest the tallest plant (24.14 cm, 31.00 cm, 44.78 cm, 69.05 cm and 86.58 cm) was recorded from A_1 and the shortest (20.93 cm, 27.24 cm, 41.42 cm, 60.48 cm and 80.24 cm) was found from A_3. At 30, 50, 70 and 90 DAT the maximum number of tillers hill^{-1} (5.60, 11.55, 22.23 and 17.96) was recorded from A_2 the minimum (3.83, 8.56, 16.57 and 12.78) was found from A_1. At 30, 50, 70 and 90 DAT the highest dry matter plant^{-1} (0.52 g, 3.28 g, 14.50 g, 24.82 g and 56.38 g) was recorded from A_2 and the lowest (0.38 g, 2.21 g, 9.26 g, 19.30 g and 41.12 g) was found from A_1. The maximum number of effective tillers hill^{-1} (13.32) was recorded from A_2 again the minimum (10.10) was found from A_1. The highest length of panicle (23.82 cm) was recorded from A_2 and the lowest (21.69 cm) was found from A_1. The highest number of filled grains panicle^{-1} (92.25) was recorded from A_2 and the lowest (79.70) was found from A_1. The maximum weight of 1000 seeds (22.07 g) was recorded from A_2 and the minimum (20.27 g) was found from A_1. The highest grain yield (5.52 t ha^{-1}) was recorded from A_2 again, the lowest (4.47 t ha^{-1}) was found from A_1. The highest straw yield (5.94 t ha^{-1}) was recorded from A_2 and the lowest straw yield (5.17 t ha^{-1}) was found from A_1. The highest biological yield (11.47 t ha^{-1}) was recorded from A_2 and the lowest (9.65 t ha^{-1}) was found from A_1. The maximum harvest index (48.16%) was recorded from A_2 and, the minimum (46.24%) was found from A_1.

At 30, 50, 70, 90 DAT and at harvest the tallest plant (23.17 cm, 30.28 cm, 43.83 cm, 67.42 cm and 85.76 cm) was observed from S_2 and, the shortest (21.76 cm, 28.61 cm, 42.17 cm, 62.74 cm and 83.54 cm) was recorded from S_4. At 30, 50, 70 and 90 DAT the maximum number of tillers $hill^{-1}$ (5.05, 10.66, 20.12 and 16.30) was observed from S_2 where as the minimum (4.48, 9.46, 18.18 and 14.71) was recorded from S_4. At 30, 50, 70, 90 DAT and harvest the highest dry matter $plant^{-1}$ (0.46 g, 3.04 g, 12.72 g, 22.80 g and 52.67 g) was observed from S_2 again the lowest (0.42 g, 2.46 g, 10.77 g, 20.45 g and 47.83 g) was recorded from S_4. The maximum number of effective tillers $hill^{-1}$ (12.63) was observed from S_2 where as the minimum (11.44) was recorded from S_4. The maximum number of non-effective tillers $hill^{-1}$ (3.85) was observed from S_2 whereas the minimum (3.13) was recorded from S_4. The highest length of panicle (23.51 cm) was observed from S_2 where as the lowest (21.84 cm) was recorded from S_4. The highest number of filled grains $panicle^{-1}$ (89.03) was observed from S_2 where as the lowest (84.33) was recorded from S_4. The maximum weight of 1000 seeds (21.46 g) was observed from S_2 where as the minimum (20.90 g) were recorded from S_4. The highest grain yield (5.36 t ha^{-1}) was observed from S_2

and the lowest (4.57 t ha^{-1}) was recorded from S_4. The highest straw yield (5.88 t ha^{-1}) was observed from S_2 and the lowest straw yield (5.26 t ha^{-1}) was recorded from S_4. The highest biological yield (11.24 t ha^{-1}) was observed from S_2 again, the lowest (9.83 t ha^{-1}) was recorded from S_4. The maximum harvest index (47.69%) was observed from S_2 and the minimum (46.22%) was recorded from S_4.

At 30, 50, 70, 90 DAT and at harvest the tallest plant (25.31 cm, 32.60 cm, 46.03 cm, 74.20 cm and 88.87 cm) was observed from A_1S_2 where as the shortest (19.80 cm, 24.91 cm, 39.88 cm, 57.28 cm and 75.81 cm) was recorded from A_3S_4. The maximum number of tillers $hill^{-1}$ (6.27, 12.73, 24.55 and 19.99) was observed from D_2S_2 at 30, 50, 70 and 90 DAT, respectively and the minimum (3.45, 7.30, 15.48 and 11.58) was recorded from A_1S_4. At 30, 50, 70 and 90 DAT the highest dry matter $plant^{-1}$ (0.59 g, 3.92 g, 16.65 g, 26.78 g and 58.62 g) was observed from A_2S_2 where as the lowest dry matter $plant^{-1}$ (0.33 g, 1.93 g, 7.63 g, 17.41 g and 36.16 g) was recorded from A_1S_4. The maximum number of effective tillers $hill^{-1}$ (13.99) was observed from A_2S_2 and the minimum (9.23) was recorded from A_1S_4. The highest length of panicle (24.69 cm) was observed from A_2S_2 and the lowest (20.26 cm) was recorded from A_1S_4. The highest number of filled grains $panicle^{-1}$ (93.74) was observed from A_2S_2 and the lowest (73.70) was recorded from A_1S_4. The maximum weight of 1000 seeds (22.34 g) was observed from A_2S_2 and the minimum (19.83 g) was recorded from A_1S_4. The highest grain yield (5.95 t ha^{-1}) was observed from A_2S_2 and the lowest (3.63 t ha^{-1}) was recorded from A_1S_4. The highest straw yield (6.18 t ha^{-1}) was observed from A_2S_2 and, the lowest straw yield (4.52 t ha^{-1}) was recorded from A_1S_4. The highest biological yield (12.13 t ha^{-1}) was observed from

A_2S_2 and, the lowest biological yield (8.15 t ha^{-1}) was recorded from A_1S_4. The maximum harvest index (49.18%) was observed from A_2S_2 and the minimum (44.50%) was recorded from A_1S_4.

Considering the results of the present experiment, further studies may be carried out in different agro-ecological zones (AEZ) of Bangladesh for regional compliance including more management practices to achieve maximum yield potentials of BRRI dhan 44.

Chapter VI
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Appendices

APPENDICES

Appendix I. Characteristics of Agronomy Farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy Farm Field , SAU, Dhaka
AEZ	Madhupur 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

B. Physical and chemical properties of the initial soil

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

Source: SRDI

Appendix II. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from June to November 2007

Month (2007)	*Air temperature (^{0}c)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
June	27.1	16.7	67	30	8.6
July	31.4	19.6	54	11	7.9
August	33.6	23.6	69	163	8.1
September	22.4	13.5	74	00	7.6
October	29.18	18.26	81	39	7.4
November	25.82	16.04	78	00	8.1

* Monthly average,

Source: Bangladesh Meteorological Department (Climate & weather division),Agargoan, Dhaka - 1212

Appendix III. Analysis of variance of the data on plant height of BRRI dhan 44 as influenced seedling age and number of seedlings hill^{-1}

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		30 DAT	50 DAT	70 DAT	90 DAT	Harvest
Replication	2	0.227	0.182	0.421	0.989	0.773
Seedling age (A)	2	30.833**	44.634**	33.90**	221.03**	147.52**
Number of seedlings (B)	3	3.599**	5.181**	5.196**	34.288**	9.088**
Interaction (A×B)	6	2.037**	7.239**	3.274**	14.417**	18.181**
Error	22	0.578	1.014	0.658	0.990	1.932

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on number of tiller hill^{-1} of BRRI dhan 44 as influenced by seedling age of transplanting and number of seedlings hill^{-1}

Source of variation	Degrees of freedom	Mean square			
		Number of tiller hill^{-1} at			
		30 DAT	50 DAT	70 DAT	90 DAT
Replication	2	0.007	0.061	0.193	0.130
Seedling age (A)	2	9.438**	26.833**	95.891**	80.849**
Number of seedlings (B)	3	0.516*	2.228*	6.513**	3.822*
Interaction (A×B)	6	0.327*	2.153**	3.737**	4.465**
Error	22	0.143	0.557	0.985	1.070

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on dry matter per plant of of BRRI dhan 44 as influenced by seedling age and number of seedlings $hill^{-1}$

Source of variation	Degrees of freedom	Mean square				
		Dry matter per plant at				
		30 DAT	50 DAT	70 DAT	90 DAT	Harvest
Replication	2	0.0001	0.018	1.053	0.088	2.030
Seedling age (A)	2	0.056**	3.465**	82.168**	92.495**	748.08**
Number of seedlings (B)	3	0.004*	0.522**	5.874**	9.292**	36.798**
Interaction (A×B)	6	0.008**	0.245*	4.002**	3.186*	20.976*
Error	22	0.001	0.077	1.138	1.000	8.704

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on yield contributing characters of BRRI dhan 44 as influenced by seedling age of transplanting and number of seedlings $hill^{-1}$

Source of variation	Degrees of freedom	Mean square						
		Effective tiller $hill^{-1}$ (N0.)	Non-effective tiller $hill^{-1}$ (N0.)	Total tiller $hill^{-1}$ (N0.)	Length of panicle (cm)	Filled grain (N0.)	Unfilled grain (N0.)	Total grain (N0.)
Replication	2	0.408	0.063	0.790	0.645	6.794	0.091	1.232
Seedling age (A)	2	32.827**	7.319**	69.829**	13.549**	503.286**	33.109**	289.076**
Number of seedlings (B)	3	2.362**	0.811*	5.912*	4.489**	34.159**	3.427**	16.962**
Interaction (A×B)	6	1.374*	0.739*	2.986*	1.798*	18.900**	0.483**	20.002**
Error	22	0.498	0.216	1.115	0.574	2.423	0.128	2.173

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on yield contributing characters and yield of BRRI dhan 44 as influenced by seedling age and number of seedlings $hill^{-1}$

Source of variation	Degrees of freedom	Mean square				
		Weight of 1000 Seed (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
Replication	2	0.106	0.012	0.025	0.019	1.754
Seedling age (A)	2	9.859**	3.380**	1.767**	9.979**	12.748
Number of seedlings (B)	3	0.534	0.970*	0.574**	3.017**	4.034
Interaction (A×B)	6	0.067	0.572*	0.321*	1.721**	2.659
Error	22	0.231	0.221	0.121	0.363	7.580

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability