EFFECT OF TRANSPLANTING DATES AND SEEDLING NUMBER HILL^{-1} ON GROWTH AND YIELD OF AROMATIC RICE VARIETIES

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DECEMBER, 2018

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BY

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REG. NO. : 17-08284

A Thesis
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 (MS)
IN
AGRONOMY

SEMESTER: JULY-DECEMBER, 2018

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CERTIFICATE

This is to certify that the thesis entitled **'Effect of Transplanting Dates and Seedling Number Hill^{-1} on Growth and Yield of Aromatic Rice Varieties'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agronomy**, embodies the result of a piece of *bona fide* research work carried out by **Nahid Rayhan**, Registration No.: **17-08284** 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.

Dated:
Dhaka, Bangladesh

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Dedicated To

My Respectable Parents

ACKNOWLEDGEMENTS

All praises are due to the Omnipotent Allah, the Supreme Ruler of the universe who enables the author to complete this present piece of work. The author deems it a great pleasure to express profound gratefulness to his respected parents, who entiled much hardship inspiring for prosecuting his studies and also receiving proper education.

The author feels proud to express his heartiest gratitude, sincere appreciation and immense indebtedness to his Supervisor ***Dr. H. M. M. Tariq Hossain,*** *Professor, Department of Agronomy, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh for his continuous scholastic and intellectual guidance, cooperation, constructive criticism and suggestions in carrying out the research work and preparation of thesis, without his intense co-operation this work would not have been possible.*

The author feels proud to express his deepest respect, sincere appreciation and immense indebtedness to his Co-supervisor ***Dr. Tuhin Suvra Roy****, Professor, Department of Agronomy, SAU, Dhaka, for his scholastic and continuous guidance, constructive criticism and valuable suggestions during the entire period of course and research work and preparation of this thesis.*

The author also expresses his sincere respect and sence of gratitude to ***Dr. Md. Shahidul Islam****, Professor and Chairman, Departement of Agronomy, SAU, Dhaka for valuable suggestions and cooperation during the study period. The author also expresses his heartfelt thanks to all the teachers of the Department of Agronomy, SAU, for their valuable teaching, suggestions and encouragement during the period of the study.*

The author expresses his sincere appreciation to his brothers, sister, relatives, well-wishers and friends for their inspiration, help and encouragement throughout the study.

The Author

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ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from July to December, 2018 with a view to study the effect of transplanting dates and seedling number hill^{-1} on growth and yield of aromatic rice varieties. The experiment consisted of three factors. Factor A: two varieties viz. V_1 (BRRI dhan34) and V_2 (Tulsimala). Factor B: four transplanting date viz. T_1 (14th August), T_2 (21st August), T_3 (28th August) and T_4 (4th September). Factor C: three treatment of number of seedlings hill^{-1} viz. S_1 (2 seedling hill^{-1}), S_2 (3 seedlings hill^{-1}) and S_3 (4 seedlings hill^{-1}). The experiment was laid out in RCBD (Factorial) design with three replications. The results showed that variety, transplanting date and number of seedlings hill^{-1} had the significant effects on plant height, number of tillers hill^{-1}, dry matter weight hill^{-1}, total tillers hill^{-1}, number of filled and unfilled grains panicle^{-1}, grain yield, straw yield, and biological yield and harvest index. Results showed that V_2 (Tulsimala) transplanted on T_1 (14th August) with S_2 (3 seedling hill^{-1}) produced tallest plant (153.60 cm) and V_1 (BRRI dhan34) transplanted on T_4 (4th September) with S_2 (3 seedling hill^{-1}) provided shortest plant (107.44 cm). Interaction of $V_1T_2S_2$ gave maximum dry matter weight hill^{-1} (36.28 g) and minimum from $V_2T_4S_2$ (19.95 g). BRRI dhan34 (V_1) transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2) provided highest number of total tillers hill^{-1} (17.51), effective tiller hill^{-1} (16.33), panicle weight (2.42 g), number of grain panicle^{-1} (263.7), number of filled grains panicle^{-1} (206.33), grain yield (5.01 t ha^{-1}), and biological yield (13.88 t ha^{-1}). $V_2T_1S_3$ provide highest straw yield (10.23 t ha^{-1}). Minimum grain yield (2.09 t ha^{-1}) and Biological yield (7.55 t ha^{-1}) were found with the interaction of $V_2T_4S_1$.

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LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
BBS	Bangladesh Bureau of Statistics
BRRI	Bangladesh Rice Research Institute
BR	Bangladesh Rice
cm	Centimeter
CV %	Percent Coefficient of variation
cv.	Cultivar (s)
DAT	Days After Transplanting
et al.	and others
etc.	Etcetera
e.g.	*exampli gratia* (L), for example
FAO	Food and Agriculture Organization
g	Gram (s)
i.e.	*id est* (L), that is
IRRI	International Rice Research Institute
Kg	Kilogram (s)
LSD	Least Significance Difference
m^2	Square meter
mm	Millimeter
MoP	Muriate of Potash
No.	Number
ppm	Parts per million
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources Development Institute
t ha^{-1}	Ton per hectare
TSP	Triple Super Phosphate
var.	Variety
^{O}C	Degree Celsius
%	Percentage

CHAPTER I

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important food in tropical and subtropical regions (Singh *et al*., 2012) and the staple food of more than three billion people in the world (IRRI, 2009). In Asia, more than 2 billion people obtain 60-70% of their calories from rice (Dowling *et al.*, 1998). Rice production and consumption is concentrated in Asia, where more than 90% of all rice is consumed (FAO, 2006). The slogan 'Rice is life' is most appropriate for Bangladesh as this crop plays a vital role in our food security and is a means of livelihood for millions of rural peoples. About 84.67% of total cultivated area of Bangladesh is used for rice production, with annual production of 30.42 million tons from 10.4 million hectare of land (BBS, 2014). Moreover, rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh (BBS, 2018).

Rice is grown in Bangladesh in three distinct rice growing seasons namely Aus, Aman and Boro. Among these seasons, aman rice covers about 5.66 million hectares with a production of 13.3 million tons (BBS, 2018). Among the cultivated rice, however, aromatic rice constitutes a small but special group of rice which is considered the best in quality. Aromatic rice as reported by (Singh *et al.*, 2000), had 15 times more 2- acetyl -1- pyrroline content than non - aromatic rice (0.14 and 0.009 ppm, respectively). In addition to 2- acetyl -1- pyrroline, there are about 100 other volatile compounds, including 13 hydrocarbons, 14 acids, 13 alcohols, 16 aldehydes, 14 ketones, 8 esters, 5 phenols and some other compounds, which are associated with the aroma development in rice (Singh *et al.*, 2000). The demand for special purpose of aromatic rice has dramatically increased over the past two decades in the world.

Most of the aromatic rice varieties in Bangladesh are traditionally photoperiod sensitive and grown during aman season (Baqui *et al.*, 1997). Cultivation of fine as well as aromatic rice has been gaining popularity in Bangladesh over the recent years, because of its huge demand both for internal consumption and export (Das and Baqui, 2000). In northern districts of Bangladesh, 30% of the rice cultivated area were covered by aromatic rice cultivars during aman season (Islam *et al.*, 2012). Aromatic rice varieties are rated best in quality and fetch much higher price in international market. Aromatic rice plays a vital role in international rice trading. Bangladesh has a bright prospect for export of aromatic rice thereby earning foreign exchange (Islam *et al.*, 2012).

The growth process of rice plants under a given agro-climatic condition differs with variety (Alam *et al*., 2012). BRRI dhan34, BRRI dhan37 and BRRI dhan38 are the modern varieties of aromatic rice, which have been developed by Bangladesh Rice Research Institute. Among the aromatic rice Badshabhog, Kataribhog, Kalizira, Tulshimala, Chinigura, and BRRI dhan34 is the most highly valued commodity in Bangladesh agricultural trade market for having small grain and pleasant aroma.

Planting time for successful rice production widely depends on varietal life duration, sensitivity to photoperiod, temperature, rainfall and other environmental factors. Seeding and transplanting time can be influenced directly or indirectly by weather condition. Singh *et al.*, (1997) reported some factors which adversely affects aroma such as hot weather during flowering and development, nitrogenous fertilizer particularly urea, poor soil, transplanting date and delayed harvesting after maturity. Late transplanting of photoperiod-sensitive aman rice does not produce flower due to higher day length. Narayanaswamy *et al.*, (1982) reported that early transplanting of Aman rice in 1st July produced the higher grain yield 2.6 t/ha than 15th July and 1st August. Number of seedlings hill^{-1} is an important factor for successful rice production because it affects plant population per unit area, availability of sunlight and nutrients, photosynthesis and respiration, which ultimately influence the yield contributing characters and yield (Chowdhury *et al.*, 1993). Among various factors, the number of seedlings hill^{-1} is now considered as the major reason for low yield of rice in Bangladesh (Islam *et al*., 2012). Optimum number of seedlings hill^{-1} may facilitate the rice plant to grow properly both in its aerial and underground parts by utilizing maximum radiant energy, nutrient, space and water and also can reduce seedling cost. Excess number of seedlings hill^{-1} may produce higher number of tillers hill^{-1} resulting in shading, lodging and thus favor the production of straw instead of grain. On the other hand, the lower number of seedlings hill^{-1} may cause insufficient tiller number, thus keeping space and nutrients underutilized and at the end, total number of panicles unit^{-1} area may be reduced resulting in poor gain yield.

Based on above proposition, this research work was designed to evaluate the yield and yield components performance of two selected aromatic rice varieties in different transplanting date and different number of seedlings hill^{-1} with the following objectives:

- To determine the optimum transplanting time of aromatic rice varieties
- To determine the optimum number of seedlings hill^{-1} of aromatic rice varieties
- To determine the interaction effects of transplanting times with number of seedlings hill^{-1} of aromatic rice varieties

CHAPTER II

REVIEW OF LITERATURE

Growth, development and yield of rice are prominently influenced by environmental aspects, variety and agronomic practices. The high yielding cultivar of rice plays an important role in producing higher yield unit^{-1} area. Among the different agronomic practices, transplanting date, and number of seedlings hill^{-1} is important. Many research works have been carried out within and outside the country in this line. However, some of the research works related to the present study have been reviewed in this chapter.

2.1. Performances of different variety of rice

Bhuiyan *et al.* (2014) carried out an experiment with aimed to determine the adaptability and performance of different hybrid rice varieties and to identify the best hybrid rice variety in terms of plant growth and recommend it to rice farmers. Based on the findings of the study, the different hybrid rice varieties evaluated had significant effects on plant height at maturity.

Khalifa (2009) conducted a field experiment at the experimental farm of Rice research and training centre (RRTC), Sakha, Kafr-El sheikh governorate, Egypt rice season for physiological evaluation of some hybrid rice varieties under different sowing dates. Four hybrid rice H1, H2, GZ 6522 and GZ 6903 were evaluated at six different sowing dates. Results indicated that H1 hybrid rice variety surpassed other varieties in terms of plant height.

Masum *et al.* (2008) found that total dry matter production differed due to varieties. Total dry matter of BRRI dhan44 Nizershail significantly varied at different sampling dates.

Amin *et al.* (2006) conducted a field experiment to find out the influence of variable doses of N fertilizer on growth, tillering and yield of three traditional rice varieties viz. Jharapajam, Lalmota, Bansful Chikon was compared with that of a modern variety viz. KK-4 and reported that traditional varieties accumulated higher amount of vegetative dry matter than the modern variety.

Murthy *et al.* (2004) conducted an experiment with six varieties of rice genotypes Mangala, Madhu, J-13, Sattari, CR 666-16 and Mukti, and observed that Mukti gave the longest plant compared to the others.

Mandavi *et al.* (2004) reported from their experiment that plant height was negatively correlated with grain yield. Thus, in improved genotypes, plant height was not a limiting factor for grain yield because of reduced lodging and conducted better translocation of assimilates.

Rahman *et al.* (2002) carried out an experiment with 4 varieties of transplant aman rice viz., BR1l, BR22, BR23 and Tulsimala and 6 structural arrangement of rows viz., 25 cm + 25 cm, 30 cm + 20 cm, 35 cm + 1 5 cm, 40 cm + 10 cm) and 45 cm + 05 cm and haphazard planting at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. Thousand grain weight and grain yield were highest in BR23 and these were the lowest in Tulsimala.

Obulamma *et al.* (2002) conducted an experiment with hybrid rice DRRHI and APHR-2 at Andhra Pradesh, India. The treatments were 4 spacing (15x10, 20 x10, 15x15 and 20x15 cm) 2 and 3 seedling densities (1, 2 and 3 seedlings hill^{-1}). APHR-2 was found to produce higher yield than DRRH-l.

BINA (1998) conducted a field trial during the boro season of 1997-98. It was found that the hybrid rice Alok 6201 gave higher number of tillers hill^{-1} and effective tillers hill^{-1} than the modern variety IRATOM 24.

Dwivedi (1997) observed that fine rice cultivars Kamini, RP 615, Harbans, Basmati, Kasturi and Sugandha produced 2.43, 1.94, 1 .92, 2.01 and 2.56 t ha-1 grain yields, respectively.

BRRI (1995a) carried out an experiment to find out varietal performances of BR4, BR 10, BR l1, BR.12, BR23 and BR25 including two local checks Rajasail Challish and Nizersail planted at 20 cm x 20cm spacing with 2-3 seedlings hill^{-1}. 'Me results indicated that BR4, BR 10, BR 11, Challish and Nizersail produced yields of 4.38, 3.12, 3.12, 3.12 and 2.70 t ha-1 respectively. Cha.llish variety flowered earlier than all other varieties.

BRRI (1995b) conducted an experiment including modern varieties BR22, BR25 and Nizersail during the transplant aman season at three locations in Godagari, Noahata and Puthia in Rajshahi. In all three locations, BR25 yielded the highest and the farmer preferred it due to its fine grain and straw qualities.

BRRI (1994) found out the performance of BR14, Pajam, BR5 and Tulsimala. Tulsimala produced the highest and BRl4 produced the lowest number of spikelets. They observed that the finer the grain size, the highest was the number of spikelets.

BINA (1993) evaluated the performance of three advanced rice line and one variety viz. IRATOM24, BRI4, BTNAl3 and BINA19. It was found that varieties/advanced lines differed significantly for plant height, number of non-bearing tillers, panicle length and sterile spikelets panicle^{-1}. Results showed that grain yield did not differ significantly.

Ali and Murshid (1993) conducted an experiment daring July to December 1989 to determine a suitable variety for late transplant aman rice with cvs, BR23, BR 11 and Kunuagoir. They reported that local Kumragoir statistically out yielded the modem cultivars BR23 and BR11.

BINA (1992) reported that grain yield of BINA l3 and B1NA 19 were 5.39 and 5.57 ton ha^{-1}, respectively, under transplanting condition in kharif season.

Hossain *et al.* (1991a) noticed that the grain yields of six modern varieties of born rice differed significantly in a varietal trial in haor area; the yield recorded were 4.59, 5.30, 5.73, 4.86, 3.75 and 4.64 t ha-1 with BR3, BR11, BRl4, IR8, Pajarn and BR 16, respectively.

Hossain el al. (1991b) in another study in haor area recorded grain yields of 2. 12, 2.18, 3.17, 2.27 and 3.05 ton ha-1 with BR 14, BR 11, BR9, IR8 and BR3, respectively.

BRRI (1991a) reported that the number of effective tillers produced by some transplant aman rice ranged from 7 to 14 and it significantly differed with variety.

Idris and Matin (1990) conducted an experiment with different rice varieties and reported that panicle length differed among varieties.

Singh and Gongwer (1989) recorded from an experiment with four rice cultivars C-14-8, CR-1009, IET-5656 and IET-6314 that grain number panicle^{-1}, 1000-grain weight and biological yield were the highest for C-14-8 among the three varieties.

Shamsuddin *et al.* (1988) conducted an experiment at the Agronomy Field. Laboratory, Bangladesh Agricultural University, Mymensingh to evaluate the performance of nine modem rice cultivars BR1, BR3, BR6, BR7, BR8, BR9, BR 13, Purbachi and IR 18. The highest grain yield was found in BRl (5060 kg ha-1) and the lowest in Purbachi (2313 kg ha^{-1}). The highest straw yield was produced by BR7 (7460 kg ha^{-1}) and the lowest by Purbachi (1280 kg ha^{-1}).

Kamal *et al.* (1988) conducted an experiment at the Bangladesh Agricultural University Farm; Mymensingh pointed out that among three rice varieties. BR3 produced the highest grain yield and Pajam 2 yielded the lowest.

BRRI (1985) conducted an experiment to find out performance of four modern and local varieties BR4, BR16, Rajasail and Kazalsail. In aman season BR4 and BR16 were found to yield better than Rajasail and Kazalsail.

Islam and Ahmed (1981) stated that four cultivars of rice Nazirshail, Latishail, IRS and 1R20 were significantly different in respect of their yield performances. The two exotic cultivars IRS and IR20 independently gave significantly higher grain yield than either of the two local cultivars.

2.2 Performances of different date of transplanting on rice

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

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

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

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

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

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

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

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

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

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

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

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

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

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

BRRI (1988) reported that three photosensitive varieties viz. BR4, BR10 and BR11 transplanted on 2 and I8 September and showed that the grain yield was reduced in all the varieties in 18 September transplanting compared to 2nd September transplanting.

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

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

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

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

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

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

2.3 Performances of different seedlings number hill^{-1} on rice

Biswas *et al.* (2015) reported that hill density had significantly influence independently and also in combination on yield and yield components of transplant aman rice var. BRRI dhan52. Number of effective tillers hill^{-1} (13.67) was found the highest at four seedlings hill^{-1} treatment.

Asbur (2013) reported that reducing seedling number hill^{-1} from 5 to 3 and 1, respectively, increased plant growth significantly.

An experiment was carried out by Alam *et al.* (2012) at Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi during the kharif season to study the effect of variety, spacing and number of seedlings hill^{-1}on the yield potentials of transplant aman rice. The experiment consisted of three high yielding varieties viz. BRRI dhan32, BRRI dhan33 and BR11, four levels of spacing and four levels of number of seedlings hill^{-1}viz. 2 seedlings hill^{-1}, 3 seedlings hill^{-1}, 4 seedlings hill^{-1}and 5 seedlings hill^{-1}. Effect of the number of seedlings hill^{-1}was also significant on almost all the yield enhancing characters. The highest plant height were found when 2 seedlings were transplanted hill^{-1}.

An experiment was conducted by Islam *et al.* (2012) at the Agronomy Farm of Bangladesh Agricultural University, Mymensingh to investigate the effect of hill density and number of seedlings hill^{-1} on the yield performance of fine rice (cv. Kalizira). The experiment consisted of three hill densities, viz. 25 cm × 20 cm, 25 cm × 15 cm, 25 cm × 10 cm and two levels of number of seedlings hill^{-1} viz. 2 and 4. The highest number and the lowest of non-effective tillers hill^{-1} were found in case of 2-seedilings hill^{-1} and 4-seeedlings hill^{-1}, respectively.

Bhowmik *et al.* (2012) conducted an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to find out the effect of spacing and number of seedlings hill^{-1} on the performance of Aus rice cv. NERICA 1. Four spacing and four number of seedlings hill^{-1} viz. 2, 3, 4 and 5 were included in the experiment. The highest value of total tillers m^{-2}, number of effective tillers m^{-2} were obtained from five seedlings hill^{-1}.

Sarkar *et al.* (2011) reported that the effect of row arrangement, age of tiller seedlings and number of tiller seedlings hill^{-1} on the vegetative characters, yield and yield contributing characters of transplant aman rice. The experiment consisted of three levels of row arrangement, two types of tiller seedlings, and three levels of number of tiller seedling hill^{-1} viz. 2, 4 and 6 seedlings hill^{-1}. Number of total tillers hill^{-1} and number of non-bearing tillers hill^{-1}were the highest when 6 tiller seedlings were transplanted hill^{-1}.

A field experiment was conducted by Faruk *et al.* (2009) at the Agronomy Research Field, Hajee Mohammad Danesh Science and Technology University, Dinajpur to find out the effect of age of seedling and number of seedlings hill^{-1} on the yield of short duration transplant aman rice named BRRI dhan33. The treatments consisted of four seedling ages viz. 2, 3, 4 and 5 weeks old and three levels of number of seedling hill^{-1} viz. one, two and three. Different levels of number of seedlings hill^{-1} significantly influenced the yield parameters. Two seedlings hill^{-1} were the best performer in respect of yield and yield components. Effective tillers hill^{-1} were higher than one or three seedlings hill^{-1}.

Ali (2008) studies the effect of spacing and number of seedlings hill^{-1}on the performance of BRRI dhan41. The experiment included two sets of treatment namely (A) Spacing and (B) Number of seedlings hill^{-1} namely 1, 2, 3 and 4 seedlings hill^{-1}. Number of seedlings hill^{-1} had significant influence on plant height.

Haque and Nasiruddin (1988) conducted an experiment where aus rice was established at initial densities of 50, 100, 150, 200, 225 or 350 seedlings m^{-2}, tillering increased linearly with density up to the rainfed stage with an average total of 5.8 tillers plant^{-1} in low density plots, 3 tillers plant^{-1} in medium density plots. Tillers number decreased at high rainfed condition by 13.6, 21.4 and 20.2% in low, medium and higher density plots respective panicle density at maturity varied only from 186 to 224 panicles m^{-2}.

Muhammad *et al.* (1987) reported that when rice Basmati 370 was grown with 2 seedlings hill^{-1} and at 6, 11, 25 or 44 hills m^{-2}, the number of tillers hill^{-1}, the number of panicle bearing tillers hill^{-1} decreased with increasing plant density.

Islam *et al.* (1980) conducted a field experiment to determine the suitable number of seedlings hill^{-1} for transplant aus rice variety. The results revealed that 2-3 seedlings hill^{-1} were as good as 3-4 seedling hill^{-1} with respect to effective tillers hill^{-1} production.

A field experiment was conducted by Faruk *et al.* (2009) at the Agronomy Research Field, Hajee Mohammad Danesh Science and Technology University, Dinajpur to find out the effect of age of seedling and number of seedlings hill^{-1} on the yield of short duration transplant aman rice named BRRI dhan33. The treatments consisted of four seedling ages viz. 2, 3, 4 and 5 weeks old and three levels of number of seedling hill^{-1} viz. one, two and three. Different levels of number of seedlings hill^{-1} significantly influenced dry matter content.

Singh and Singh (1992) conducted an experiment with 2, 4 or 6 seedlings hill^{-1} to study their effect on the yield and yield components of rice cv. Madhukar and found that for all factors 4 seedlings hill^{-1} was better for dry matter content.

Muhammad *et al.* (1987) reported that when rice Basmati 370 was grown with 2 seedlings hill^{-1} and at 6, 11, 25 or 44 hills m-2 and reported that dry matter content decreased with increasing plant density.

Islam (1986) revealed that 2-3 seedlings hill^{-1} were as good as 3-4 seedlings hill^{-1} with respect to dry matter content.

A field experiment was carried out by Biswas *et al.* (2015) to investigate the optimization of row spacing and hill density on the yield of transplant aman rice cv. BRRI dhan52 at the Agronomy Field Laboratory of Patuakhali Science and Technology University, Dumki, Patuakhali. There four row spacing were considered as main plot, while four different hill density viz., S1= two, S2= four, S3= six and S4= eight seedlings hill^{-1} were considered as sub plot. The result of the experiment showed that hill density had significantly influence independently and also in combination on yield and yield components of transplant aman rice var. BRRI dhan52. Panicle length (25.16 cm), number of filled grains panicle^{-1} (142.63) and 1000 grain weight (27.75 g) were found the highest at four seedlings hill^{-1}.

Asbur (2013) carried out an experiment to determine the effects of seedling number hill^{-1} and seedling age on plant growth, and grain yield Ciherang rice and reported that reducing seedling number hill^{-1} from 5 to 3 and 1, respectively, increased grain yield significantly.

Ingale *et al.* (2005) carried out a study was number of seedlings hill^{-1} (one or two) and nitrogen rates (50, 100 and 150 kg/ha) on the yields of Sahyadri rice hybrid. Transplanting two seedlings hill^{-1} at 20×15 cm spacing produced significantly a higher yield than transplanting of one seedling hill^{-1}.

Srivastava and Tripathi (2000) carried out an experiment with rice cv. hybrid 6201 and R 320-300 grown at different weed density at 1, 2 or 3 seedlings hill^{-1} and observed that cv. R 320-300 grown at the low weed density at 2 seedlings hill^{-1} produced the highest grain yield of 7.59 t ha^{-1}.

Asif *et al.* (1998) conducted an experiment with rice cv. Basmati 385 grown at l, 2 or 3 seedlings hill^{-1} and observed that grain yield was highest at 2 seedlings hill^{-1} but different grain quality parameters were not significantly affected by plant density.

Banik *et al.* (1997) conducted a field experiment in Bihar with 30, 40, 50, or 60 day old rice cv. Pankaj and Patnation seedlings were direct seeded at 2, 4, 6 or 8 seedlings hill^{-1}. There was no significant variation in yield between the cultivars. Mean grain yield was the highest (4.74 t/ ha) from pots of direct seeded with 40 day old seedlings, yield was the highest with 4 seedlings hill^{-1} (4.22 t ha^{-1}).

Chowdhury *et al.* (1993) conducted an experiment with 2, 4 and 6 seedlings hill^{-1} to study their effect on the yield and yield components of rice cv. BR23 during the aus season. It reported that 6 seedlings hill^{-1} gave the highest grain yields.

Rao and Reddy (1993) conducted a field experiment with rice cv. Rasi in the Kharif (monsoon) season at 33, 44, 50, 67 or 200 hills m^{-2} with 1, 2, 4, 6, 8 or 10 seedlings hill^{-1}. They reported that grain yield increased with decreasing weeding density from 30-200 hills m^{-2} with 1 seeding hill^{-1}, when 10 seedlings hill^{-1} were planted yield decreased even at the very low weed population.

Prasad *et al.* (1992) conducted an experiment with 2, 3, 4 and 5 seedlings hill^{-1} to study their effect on the yield and yield components of rice cv. Sarjoo-52 and found that 4 seedlings hill^{-1} was better for grain yield.

Singh and Singh (1992) conducted an experiment with 2, 4 or 6 seedlings hill^{-1} to study their effect on the yield and yield components of rice cv. Madhukar and found that for all factors 4 seedlings hill^{-1} was better for grain yield.

BRRI (1991) conducted an experiment in Barishal sub-station to study the effect of seedling number (2, 3, 4 and 5 seedlings hill^{-1}) on the yield and yield components of BR3, BR9 and BR14. The results showed that there was no significant effect of seedling number on the yield of BR3 and BR14. Planting of 4-5 seedlings hill^{-1} gave significantly higher yield for BR9 than 2-3 seedlings hill^{-1} although such differences were not apparent in yield components.

Hossain and Haque (1990) reported that the number of basal tillers plot^{-1} increased with increasing seedling number. Rainfed tolerance decreased with increased seedlings hill^{-l}. Grain yields were the highest with 2 seedlings hill^{-1}.

Mohapatra (1989) found that the number of seedlings hill^{-1} had significant effect on yield. He stated that the highest grain and straw yields were produced by 4 seedlings hill^{-1} while 1 seedling hill^{-1} yielded the lowest.

Islam (1986) conducted a field experiment to determine the number of seedlings hill^{-1} for transplant aus rice. The results revealed that 2-3 seedlings hill^{-1} were as good as 3-4 seedlings hill^{-1} with respect to grain yield.

Reddy and Mittra (1984) investigated the effect of time of planting, age and number of seedlings hill^{-1} on the yield of aus rice varieties. They found that grain yields were the highest at earlier sowing dates and were unaffected by number of seedlings hill^{-1}.

Relwani (1982) studied the effect of seedling number hill^{-1} on grain yield and reported that 6 seedlings hill^{-1} produced significantly higher yield than 4 seedlings hill^{-1} which was significantly superior to 2 seedlings hill^{-1}.

CHATEPR III

MATERILAS AND METHODS

The experiment was took place to find out the effect of transplanting date and number of seedlings hill^{-1} on yield and yield components of two aromatic rice varieties. This chapter presents a brief description about experimental period, site description, climatic condition, crop or planting materials, treatments, experimental design, crop growing procedure, fertilizer application, uprooting of seedlings, intercultural operations, data collection and statistical analysis.

3.1 Description of the experimental site

3.1.1 Experimental period

Duration of the experiment was 6 months from July to December, 2018.

3.1.2 Experimental location

The present research work was conducted at the Department of Agronomy farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is $23^{0}74^{/}$N latitude and $90^{0}35^{/}$E longitude with an elevation of 8.2 meter from sea level. Experimental location presented in Appendix I.

3.1.3 Soil characteristics

The soil of the experimental site’s belong 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 had organic carbon 0.45%. The experimental area was flat having available irrigation and drainage system and above flood level. The details have been presented in Appendix II.

3.1.4 Climatic condition

The geographical location of the experimental site was under the subtropical climate and its climatic conditions is characterized by three distinct seasons, namely winter season from the month of November to February, the pre-monsoon period or hot season from the month of March to April and monsoon period from the month of May to October (Edris *et al.*, 1979). Details of the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment has been presented in Appendix III.

3.2 Experimental details

3.2.1 Planting material

BRRI dhan34 and Tulshimala were used as the study materials in this experiment.

3.2.2 Treatment of the experiment

The experiment consisted of three factors:

Factor A: Rice Variety

(i) Tulshimala
(ii) BRRI dhan34

Factor B: Transplanting date

(i) 14th August, 2018
(ii) 21st August, 2018
(iii) 28th August, 2018
(iv) 4th September, 2018

Factor C: Number of seedling hill^{-1}

(i) 2 seedlings hill^{-1}
(ii) 3 seedlings hill^{-1}
(iii) 4 seedlings hill^{-1}

3.2.3 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications (Appendix-IV), where the experimental area was alienated into three blocks representing the replications to reduce soil heterogenetic effects. Each block was divided into 24 unit plots as treatments demarked with raised bunds. Thus the total numbers of plots were 72. The unit plot size was 2.5 m × 2.0 m. The distance maintained between two replication and two plots were 1.0 m and 0.5 m, respectively. The layout of the experiment is shown in Appendix IV.

3.3 Growing of crops

3.3.1 Seed collection and sprouting

Seeds of BRRI dhan34 were collected from Bangladesh Rice Research Institute, Gazipur and seeds of Tulshimala were collected from Regional Agriculture Research Station, Jamalpur. Seeds were collected just before 20 days of the sowing of seeds in seed bed. For seedling rising, clean seeds were immersed in water in a bucket for 24 hours. The imbibed seeds were then taken out of water and kept in gunny bags. The seeds started sprouting after 48 hours which were suitable for sowing in 72 hours.

3.3.2 Raising of seedlings

The nursery bed was prepared by puddling with repeated ploughing followed by laddering. The sprouted seeds were sown on beds as uniformly as possible. Irrigation was gently provided to the bed as and when needed. No fertilizer was used in the nursery bed. Seeds were sown 30 days before the planting such as for 14th August transplanting seeds were sown at 15th July, for 21th August transplanting seeds were sown at 22th July, for 28th August transplanting seeds were sown at 29th July, for 4th September transplanting seeds were sawn at 4th August, 2018 in the seed beds.

3.3.3 Main field preparation

The plot selected for leading the experiment was opened in the 2nd August, 2018 with a power tiller, and left exposed to the sun for 7 days. After 7 days the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good puddle condition. Weeds and stubbles were removed. The experimental plot was divided into unit plots in accordance with the experimental design. Organic and inorganic manures as indicated below were mixed with the soil of each unit plot.

3.3.4 Fertilizers and manure application

The fertilizers N, P, K, S, Zn and B in the form of urea, TSP, MoP, Gypsum, zinc sulphate and borax, respectively were applied. The entire amount of TSP, MoP, gypsum, zinc sulphate and borax were applied during the final preparation of experimental plot. Urea was applied in two equal installments as top dressing at tillering and panicle initiation stages. The dose and method of application of fertilizer are shown in Table1.

Table1. Dose and method of application of fertilizers in rice field

Fertilizers	**Dose (kg ha^{-1})**	**Application (kg ha^{-1})**		
		Basal	**1st installment**	**2nd installment**
Urea	**150**	**50**	**50**	**50**
TSP	**100**	**100**	**-**	**-**
MoP	**70**	**70**	**-**	**-**
Gypsum	**60**	**60**	**-**	**-**
Borax	**10**	**10**	**-**	**-**
zinc sulphate	**15**	**15**	**-**	**-**

Source: Adunik Dhaner Chash (2018), BRRI, Joydebpur,Gazipur.

3.3.5 Transplanting of seedling

Thirty days old seedlings were carefully uprooted from the seedling nursery and transplanted as per treatment in well puddled plot. Number of seedlings hill^{-1} was used as per treatment. Plant spacing was given 25cm x 20cm for both varieties. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings of the same source whenever required followed by the treatment of number of seedlings hill^{-1}.

3.3.6 Intercultural operations

Intercultural operations were done to ensure normal growth of the crop. Plant protection measures were followed as and when necessary and intercultural operations were done.

3.3.6.1 Irrigation and drainage

In the early stages to establishment of the seedlings irrigation was provided to maintain a constant level of standing water up to 6 cm and then maintained the amount drying and wetting system throughout the entire vegetative phase. No water stress was encountered in reproductive and ripening phase. The plot was finally dried out at 15 days before harvesting.

3.3.6.2 Weeding

Weeding was done thrice to keep the plots free from weeds, which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully at 20 DAT, 35 DAT, and 50 DAT by hand pulling.

3.3.6.3 Insect and pest control

There was no infection of diseases in the field but leaf roller (*Chaphalocrosis medinalis*) was found in some plot of the field and used Malathion @ 1.12 L ha^{-1} with using a hand sprayer.

3.3.6.4 General observations of the experimental field

Regular observations were made to understand the growth stages of the crop. In general, the field looked nice with normal green plants which were lively and dense in the treatment plots than that of control plots.

3.4 Harvesting, threshing and cleaning

The maturity of crop was determined when 85-90% of the grains become golden yellow in color. From the center of each plot 1 m^2 area was harvested to determine yield of individual treatment and converted into t ha^{-1}. The harvested crop of each plot was bundled separately, tagged properly and brought to threshing floor. The bundles were dried in open sunshine, threshed and then grains were cleaned. The grain and straw weights for each plot were recorded after required drying in sun. Before harvesting, five hills were selected randomly outside the sample area of each plot and harvested at the ground level for collecting data on yield contributing characters.

3.5 Data recording

3.5.1 Plant height

The height of plant was recorded in centimeter (cm) at 30 DAT, 40 DAT, 50 DAT, and 60 DAT and at harvesting stage. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of the panicle or flag leaf.

3.5.2 Number of tillers hill^{-1}

Number of tillers hill^{1} was recorded at 30 DAT, 40 DAT, 50 DAT, and 60 DAT. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot.

3.5.3 Total dry matter hill^{-1}

Total dry matter hill^{-1} was recorded at 30 DAT, 40 DAT, 50 DAT, and 60 DAT by drying plant sample. Data were recorded as the average of 3 sample hill^{-1} collected at random from the inner rows of each plot and expressed in gram (g).

3.5.4 Effective tillers hill^{-1}

The total number of effective tillers hill^{-1} was counted as the number of panicle bearing tiller during harvesting. Data on effective tillers hill^{-1} were recorded from 5 selected hills and average value was calculated.

3.5.5 Ineffective tillers hill^{-1}

The total number of ineffective tiller hill^{-1} was counted as the number of non-panicle bearing tiller during harvesting. Data on ineffective tiller hill^{-1} were recorded from 5 selected hills and average value was calculated.

3.5.6 Total tillers hill^{-1}

The total number of tiller hill^{-1} was counted by adding the number of effective tillers hill^{-1} and non-effective tillers hill^{-1}. Data on total tillers hill^{-1} were recorded from 5 selected hills and average value was calculated.

3.5.7 Panicle weight

The weight of panicle was measured with an electronic weight scale from 5 selected plants of a plot and the average weight was recorded as per panicle in gm.

3.5.8 Filled grains panicle^{-1}

The total numbers of filled grain were collected from randomly selected 5 plants of a plot on the basis of grain in the spikelet and then average numbers of filled grains panicle^{-1} was recorded.

3.5.9 Unfilled grains panicle^{-1}

The total numbers of unfilled grain was collected from randomly selected 5 plants of a plot on the basis of empty grain in the spikelet and then average numbers of unfilled grains panicle^{-1} was recorded.

3.5.10 Total grains panicle^{-1}

The total numbers of grain was collected from randomly selected 5 plants of a plot by adding filled and unfilled grain and then average numbers of grains panicle^{-1} was recorded.

3.5.11 Weight of 1000-seeds

One thousand grains were counted randomly from the total cleaned harvested grains from each treatment and then weighed in grams and recorded.

3.5.12 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 in each plot were taken the final grain yield plot^{-1} and finally converted to ton hectare^{-1} (t ha^{-1}).

3.5.13 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 was taken from each plot and finally converted to ton hectare^{-1} (t ha^{-1}).

3.5.14 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.

3.5.15 Harvest index

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

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

3.6 Statistical analysis

The data obtained for different characters were statistically analyzed to observe the significant difference among different variety, date of transplanting, and number of seedlings hill^{-1}. The mean values of all the characters were calculated and analysis of variance was performed using the Statistix10 (analytical software) computer package program. The significance of the difference among the treatments means was estimated by the Least Significant Difference (LSD) test at 5% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

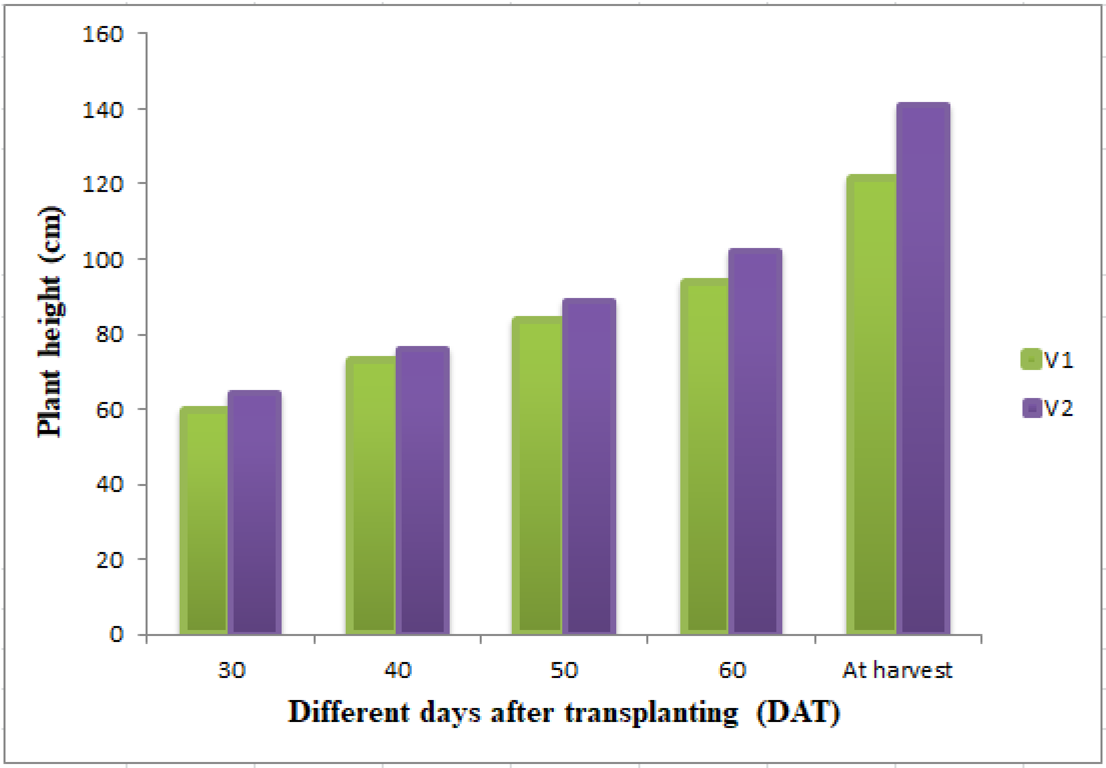
The experiment was conducted for the comparative study on the effect of different transplanting dates and seedling numbers hill^{-1} on the growth, development and yield of transplanted aromatic *aman* rice varieties cv. BRRI dhan34 and Tulsimala. Data on different growth characters, yield components and yield were recorded. The result obtain from the study have been presented, discussed and compared in this chapter through tables, figures and appendices. Analysis of variance (ANOVA) of data in the respect of all growth and yield parameters have been shown in Appendix V-VIII. The result have been presented and discussed with the help of table and graphs and possible explanations given below the following headings.

4.1 Crop growth characters

4.1.1 Plant height (cm)

4.1.1.1 Effect of variety on plant height (cm)

The plant height of aromatic rice was significantly influenced by different varieties at 30, 40, 50, 60 days after transplanting (DAT) and at harvest (Figure 1). The results of the experiment revealed that, the local variety Tulsimala (V2) consistently gave the taller plant compared to BRRI dhan34 (V1). At 30, 40, 50, 60 DAT and at harvest the taller plant height (64.30 cm, 76.19 cm, 89.24 cm, 102.63 cm and 141.03 respectively) was recorded from local variety Tulsimala (V2), on the other hand the shorter plant (59.60 cm, 72.89 cm, 83.78 cm, 93.70 cm, and 121.31 cm, respectively) was from BRRI dhan34 (V1). The plant height difference was very protruding between two rice varieties because plant height is a genetic trait where the local variety Tulsimala distinctly taller than the modern variety BRRI dhan34. The findings were similar with the findings of Mohammad *et al*. (2014), Mannan *et al*. (2009), Khisha (2002), Shah and Yadav (2001), Om *et al.* (1998).



V_1= BRRI dhan34 and V_2 = Tulsimala

Figure 1. Effect of variety on the plant height of aromatic rice at different days after transplanting (LSD $_{(0.05)}$ = 0.38, 0.45, 0.68, 0.75 and 0.61 at 30, 40, 50, 60 DAT and at Harvest, respectively)

4.1.1.2 Effect of transplanting date on plant height (cm)

Significant variation of plant height was found due to different transplanting dates in all the studied durations (Figure 2). The results revealed that at 30 DAT, the tallest plant (66.70 cm) was obtained from the rice plant transplanted on 21st August (T_3) and the shortest plant (58.04 cm) was obtained from rice plant transplanted on 14th July (T_1). At 40 DAT the tallest plant (77.70 cm) was recorded from the rice transplanting on 28th August (T_3) and the shortest plant (69.70 cm) was obtained from rice transplanting on 4th September (T_4). At 50 DAT the tallest plant (91.13 cm) was recorded from the rice transplanting on 28th August (T_3) and the shortest plant (81.13 cm) was obtained from rice transplanting on 4th September (T_4). At 60 DAT the tallest plant (101.80cm) was recorded from the rice transplanting on 28th August (T_3) and the shortest plant (95.18 cm) was obtained from rice transplanting on 4th September (T_4) which was statistically similar with rice transplanting on 14th August (T_1) (95.38 cm). The tallest plant (136.69

cm) was recorded at Harvest from the rice transplanting on 21st August (T_2) which was statistically similar with rice transplanting on 14th August (T_1) (136.18 cm) and the shortest plant (118.25 cm) was obtained from rice transplanting on 4th September (T_4).

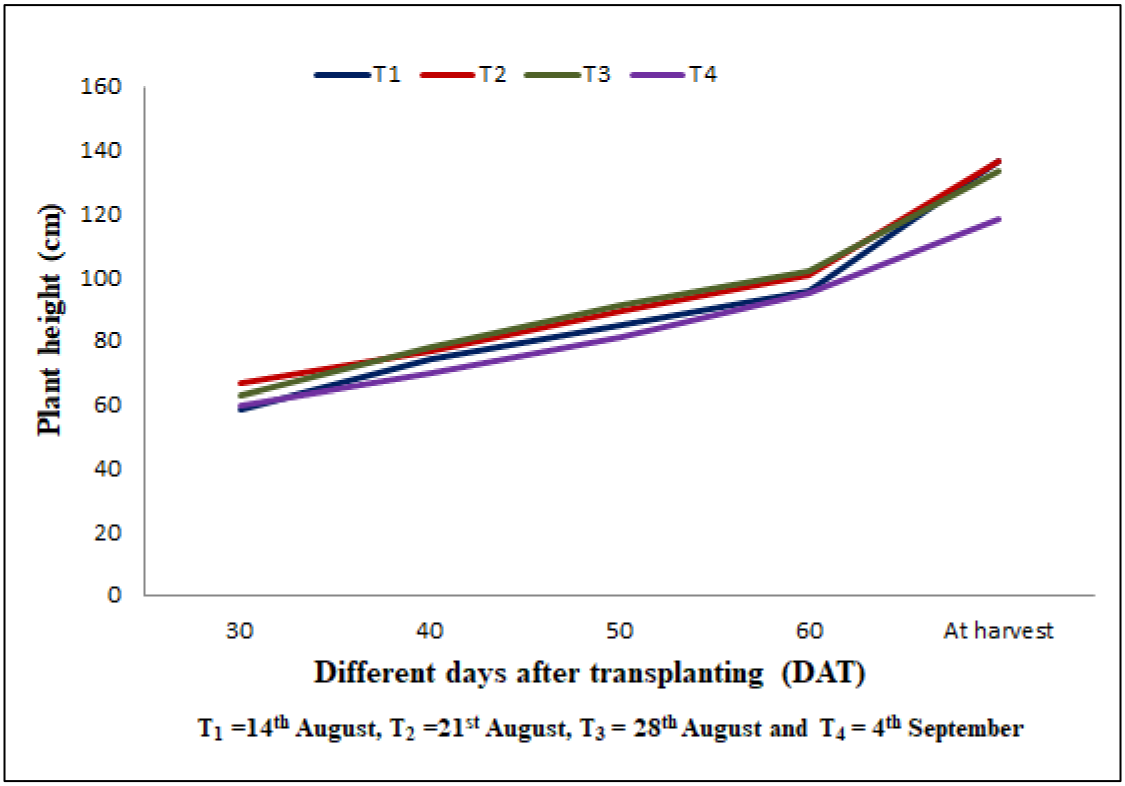
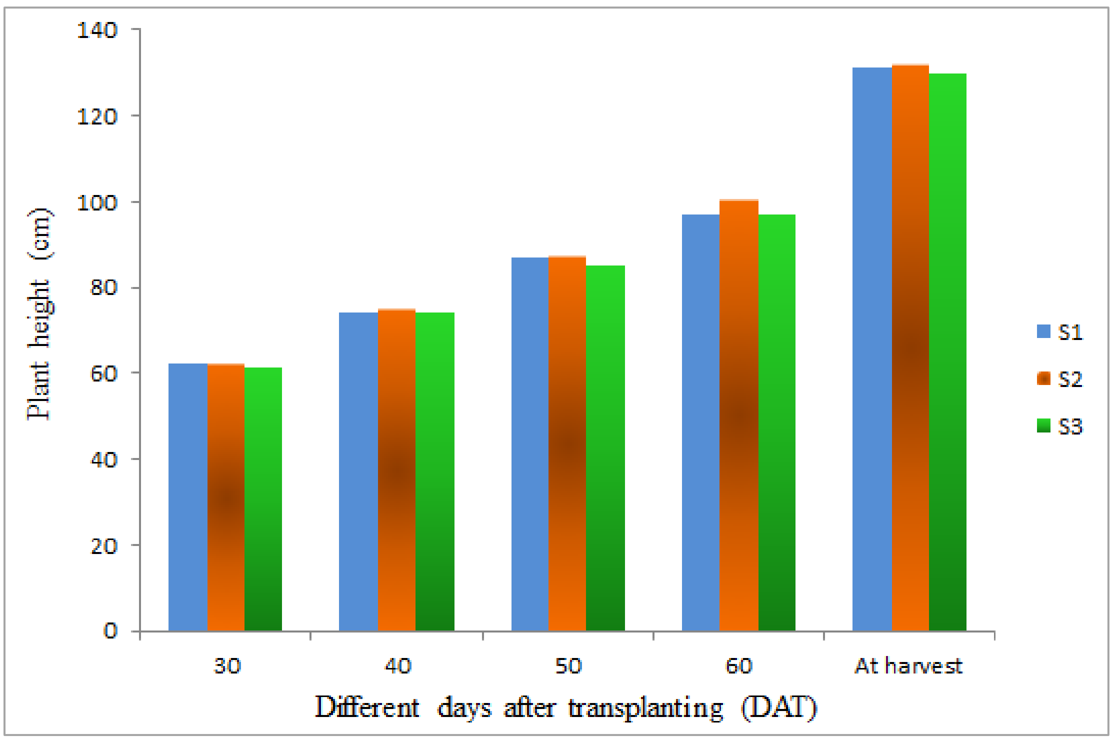


Figure 2. Effect of different transplanting dates on the plant height of aromatic rice at different days after transplanting (LSD (0.05) =0.53, 0.64, 0.96, 1.06 and 0.86 at 30, 40, 50, 60 DAT and at harvest, respectively)

4.1.1.3 Effect of number of seedlings hill^{-1} on plant height (cm)

Number of seedlings hill^{-1} showed significant differences on plant height at 30, 40, 50 and 60 DAT and at harvest (Figure 3). At 30 DAT the tallest plant (62.41cm) was found from S_2 (3 seedlings hill^{-1}) which was statistically similar (62.05cm) to S_1 (2 seedling hill^{-1}), whereas the shortest plant (61.40 cm) from S_3 (4 seedlings hill^{-1}). At 40 DAT the tallest plant (75.04 cm) were found from S_2 (3 seedlings hill^{-1}), whereas the shortest plant (74.28 cm) from S_3 (4 seedlings hill^{-1}) which was statistically similar (74.20 cm) to S_1 (2 seedling hill^{-1}). At 50 DAT the tallest plant (87.43 cm) was found from S_2 (3 seedlings hill^{-1}) which was statistically similar (62.05cm) to S_1 (2 seedling hill^{-1}), whereas the shortest plant (85.30 cm) from S_3 (4 seedlings hill^{-1}). At 60 DAT the tallest plant (100.48

cm) were found from S_2 (3 seedlings hill^{-1}), whereas the shortest plant (96.91 cm) from S_1 (2 seedlings hill^{-1}) which was statistically similar (97.12 cm) to S_3 (4 seedling hill^{-1}). At harvest the tallest plant (132.07 cm) was found from S_2 (3 seedlings hill^{-1}) which was statistically similar (131.38 cm) to S_1 (2 seedling hill^{-1}), whereas the shortest plant (130.06 cm) from S_3 (4 seedlings hill^{-1}). Optimum number of seedlings hill^{-1} may facilitate the rice plant to grow properly both in its aerial and underground parts by utilizing maximum radiant energy, nutrient, space and water. Alam *et al*. (2012) recorded the highest plant height when 2-3 seedlings were transplanted hill^{-1}.



S_1= 2 seedlings hill^{-1}, S_2= 3 seedlings hill^{-1}, S_3= 4 seedlings hill^{-1}

Figure 3. Effect of number of seedling hill^{-1} on the plant height of aromatic rice at different days after transplanting (LSD $_{(0.05)}$ = 0.46, 0.55, 0.83, 0.92 and 0.97 at 30, 40, 50, 60 DAT and at Harvest, respectively)

4.1.1.4 Interaction effect of variety and transplanting dates on plant height (cm)

Significant interaction effect between the variety and transplanting date was observed throughout the growing period (Table 2). At 30, 40, 50, 60 DAT and at harvest the tallest plant (70.08 cm, 79.48 cm, 92.36 cm, 104.64 cm and 148.40 cm, respectively) were recorded form local variety Tulsimala (V_2) interaction with rice transplanting on 21st August (T_2) which were statistically similar with V_1T_3 at 40 DAT and 50 DAT (78.60 cm and 91.30 cm, respectively). The shortest plant (54.48 cm, 65.47 cm, 76.69 cm, 87.33 cm and 108.40 cm, respectively) were recorded at 30, 40, 50, 60 DAT and at Harvest from BRRI dhan34 (V_1) in combination with rice transplanting on 4th September (T_4).

Table 2. Interaction effect of variety and transplanting dates on the plant height of aromatic rice at different days after transplanting

Treatment	Plant height at different days after transplanting (DAT) (cm)				
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**	At Harvest
V_1 T_1	55.40 f	73.63 d	81.07 e	90.18 f	125.33 ef
V_2 T_1	61.40 d	74.54 c	88.05 c	103.04 b	147.03 b
V_1 T_2	63.33 c	73.84 cd	86.07 d	95.99 e	124.99 f
V_2 T_2	70.08 a	79.48 a	92.36 a	104.64 a	148.40 a
V_1 T_3	65.20 b	78.60 a	91.30 ab	101.32 cd	126.50 e
V_2 T_3	65.30 b	76.81 b	90.96 b	102.28 bc	140.60 c
V_1 T_4	54.48 g	65.47 e	76.69 f	87.33 g	108.40 g
V_2 T_4	60.41 e	73.92 cd	85.57 d	100.58 d	128.11 d
LSD (0.05)	**0.75**	**0.90**	**1.35**	**1.49**	**1.21**
CV (%)	**1.28**	**1.27**	**1.65**	**1.60**	**0.97**

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

V_1= BRRI dhan34　　T_1 =14th August　　T_3 = 28th August

V_2 = Tulsimala　　T_2 =21st August　　T_4 = 4th September

4.1.1.5 Interaction effect of variety and number of seedlings hill^{-1} on plant height (cm)

Due to the interaction effect of varieties and number of seedlings hill^{-1}, significant variation was recorded on plant height at 30, 40, 50, 60 DAT and at harvest (Table 3). At 30, 40, 50, 60 DAT and at harvest, the tallest plant (65.79, 78.27, 93.66, 108.46 and 144.61 cm, respectively) were recorded from the combination of V_2S_2 (Tulsimala and 3 seedlings hill^{-1}), which were statistically similar with V_2S_1 (65.18 cm) at 30 DAT. At

30, 40 and 50 DAT the shortest plant (58.92 cm, 72.90 cm and 81.20 cm, respectively) were found from the combination of V_1S_1 (BRRI dhan34 and 2 seedlings hill^{-1}), which were statistically similar with V_1S_2 (71.81 cm) at 40 DAT, whereas at 60 DAT and at harvest the shortest plants (92.50 and 121.97 cm) were found from the combination of V_1S_2 (BRRI dhan34 and 3 seedlings hill^{-1}) and V_1S_3 (BRRI dhan34 and 4 seedlings hill^{-1}), which were statistically similar with V_1S_1 (122.42 cm) at harvest.

Table 3. Interaction effect of variety and number of seedlings hill^{-1} on the plant height of aromatic rice at different days after transplanting

Treatment	Plant height at different days after transplanting (DAT) (cm)				
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**	**At Harvest**
$V_1 S_1$	58.92 d	71.81 e	84.93 c	94.12 c	121.97 d
$V_2 S_1$	65.18 a	76.50 b	88.38 b	100.12 b	140.34 b
$V_1 S_2$	59.03 d	72.09 e	81.20 d	92.50 d	119.53 e
$V_2 S_2$	65.79 a	78.27 a	93.66 a	108.46 a	144.61 a
$V_1 S_3$	60.86 c	74.76 c	85.22 c	94.49 c	122.42 d
$V_2 S_3$	61.92 b	73.80 d	85.67 c	99.33 b	138.16 c
LSD (0.05)	**0.65**	**0.78**	**1.17**	**1.29**	**1.05**
CV (%)	**1.28**	**1.27**	**1.65**	**1.60**	**0.97**

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

V1= BRRI dhan34, **S_1 = 2 seedlings hill^{-1},**
V2 = Tulsimala **S_2 = 3 seedlings hill^{-1},**
S_3 = 4 seedlings hill^{-1}

4.1.1.6 Interaction effect of transplanting date and seedling number hill^{-1} on plant height (cm)

Significant interaction effect between the transplanting dates and seedling number hill^{-1} was observed throughout the growing period (Table 4). The results revealed that at 30 DAT, the tallest plant (67.70 cm) was recorded from the combination of T_2S_3 (transplanting on 21st August with 4 seedlings hill^{-1}) and the shortest plant (58.31 cm) was obtained from the combination of T_1S_2 (transplanting on 14th August with 3 seedlings hill^{-1}). At 40, 50 and 60 DAT the tallest plant (81.94 cm, 95.63 cm, and 105.03 cm, respectively) were recorded from the combination of T_3S_2 (transplanting on 28th August with 3 seedlings hill^{-1}) which were statistically similar with T_2S_2 at 60 DAT (103.22 cm). The shortest plant (68.45 cm, 80.62 cm and 92.39 cm, respectively) were recorded at 40, 50 and 60 DAT from the combination of T_4S_2 (transplanting on 4th September with 2 seedlings hill^{-1}), T_4S_3 (transplanting on 4th September with 4 seedlings hill^{-1}) and T_1S_3 (transplanting on 14th August with 4 seedlings hill^{-1}), which were statistically similar with T_4S_1 (transplanting on 4th September with 2 seedlings hill^{-1}) at 40, 50 and 60 DAT (68.62 cm, 80.74 cm and 92.96 cm, respectively). At harvest the tallest plant (139.13 cm) was recorded from the combination of T_2S_1 (transplanting on 21st August with 2 seedlings hill^{-1}), which was statistically similar (138.48 cm) with T_1S_2 (transplanting on 14th August with 2 seedlings hill^{-1}) and the shortest plant (116.44 cm) was obtained from the combination of T_4S_3 (transplanting on 4th September with 2 seedlings hill^{-1}).

4.1.1.7 Interaction effect of Variety, Transplanting date and Seedling number hill^{-1}

Significant interaction effect between variety, transplanting dates and seedling number hill^{-1} was observed throughout the growing period (Table 5). The results revealed that at 30, 40, 50, 60 DAT and at harvest the tallest plant (72.65, 83.47, 98.23, 110.73 and 153.60 cm, respectively) were recorded from the combination of $V_2T_2S_2$ (Tulsimala, transplanting on 21st August with 3 seedlings hill^{-1}), which was statistically similar with $V_2T_3S_2$ (Tulsimala, transplanting on 28th August with 3 seedlings hill^{-1}). The shortest plant (52.63 cm, 61.93 cm, 74.61 cm, 84.44 cm and 107.44 cm, respectively) were recorded from BRRI dhan34 (V1) which was transplanted on 4th September (T4) with 3 seedlings hill^{-1}(S_2) which were statistically similar with $V_1T_4S_1$ at 30 DAT, $V_1T_1S_2$ at 50 DAT, $V_1T_4S_3$ and $V_1T_4S_1$ at harvest.

Table 4. Interaction effect of transplanting date and seedling number hill^{-1} on plant height (cm) at different days after transplanting (DAT) and at harvest

Treatment	Plant height at different days after transplanting (DAT) (cm)				
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**	**At Harvest**
$T_1 S_1$	60.74 d	76.26 bc	86.70 d	95.76 e	136.31 b
$T_1 S_2$	58.31 g	72.44 f	83.43 e	97.99 d	134.48 cd
$T_1 S_3$	56.15 h	73.56 e	83.55 e	92.39 f	133.76 d
$T_2 S_1$	66.74 b	77.15 b	91.32 b	101.32 c	139.13 a
$T_2 S_2$	65.66 c	77.32 b	88.63 c	103.22 ab	136.44 b
$T_2 S_3$	67.70 a	75.52 cd	87.69cd	96.92 de	134.51 cd
$T_3 S_1$	61.38 d	75.15 d	88.43 c	97.60 d	131.03 e
$T_3 S_2$	65.84 bc	81.94 a	95.63 a	105.03 a	134.08 cd
$T_3 S_3$	61.20 d	76.02 cd	89.34 c	102.77 bc	135.54 bc
$T_4 S_1$	59.33 f	68.62 g	80.74 f	92.96 f	119.04 f
$T_4 S_2$	59.82 ef	68.45 g	82.03 ef	95.68 e	119.28 f
$T_4 S_3$	60.52 de	72.03 f	80.62 f	96.92 de	116.44 g
LSD (0.05)	**0.92**	**1.10**	**1.66**	**1.82**	**1.48**
CV (%)	**1.28**	**1.27**	**1.65**	**1.60**	**0.97**

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

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

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

Table 5. Interaction effect of variety and transplanting date and seedling number hill^{-1} on the plant height of aromatic rice at different days after transplanting

Treatment	Plant height at different days after transplanting (DAT) (cm)				
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**	**At Harvest**
$V_1T_1S_1$	56.83 k	74.12 h-j	85.81 jk	95.74 jk	127.45 ij
$V_2T_1S_1$	64.65 de	78.40 de	87.59 g-j	103.62 ef	130.75 g
$V_1T_1S_2$	55.19 l	68.10 l	75.44 n	88.31 lm	123.35 l-n
$V_2T_1S_2$	65.66 d	78.88 cd	91.42 de	107.66 bc	151.40 b
$V_1T_1S_3$	54.17 lm	74.38 hi	81.97 l	86.48 mn	125.20 kl
$V_2T_1S_3$	58.12 jk	72.84 ij	85.14 k	98.29 h-j	142.32 e
$V_1T_2S_1$	63.67 ef	72.84 ij	87.82 g-j	97.24 i-k	129.83gh
$V_2T_2S_1$	69.81 b	81.46 b	94.81 bc	105.40 c-e	148.43 c
$V_1T_2S_2$	58.67 j	73.73 h-j	81.73 l	95.72 jk	121.48 n
$V_2T_2S_2$	72.65 a	83.47 a	98.23 a	110.73 a	153.60 a
$V_1T_2S_3$	62.06 gh	74.96 gh	88.65 f-h	95.02 k	123.64 lm
$V_2T_2S_3$	67.77 c	76.07 fg	86.72 h-k	97.78 ij	145.37 d
$V_1T_3S_1$	62.19 gh	73.45 h-j	90.63 ef	97.66 ij	122.91 mn
$V_2T_3S_1$	60.58 i	76.85 ef	86.24 i-k	97.54 i-k	139.15 f
$V_1T_3S_2$	69.61 b	80.92 b	93.02 cd	104.76 de	145.18 d
$V_2T_3S_2$	67.64 c	80.42 bc	95.54 b	108.53 ab	142.32 e
$V_1T_3S_3$	63.81 ef	76.77 f	90.25 ef	101.53 fg	125.84 jk
$V_2T_3S_3$	58.58 j	73.16 ij	88.42 f-i	100.78 gh	140.32 ef
$V_1T_4S_1$	52.99 mn	63.65 m	76.61 mn	87.34 m	109.50 o
$V_2T_4S_1$	61.43 hi	73.59 h-j	84.87 k	100.78 gh	128.58 hi
$V_1T_4S_2$	52.63 n	61.93 n	74.61 n	84.44 n	107.44 o
$V_2T_4S_2$	67.01 c	74.97 gh	89.45 e-g	103.63 ef	131.12 g
$V_1T_4S_3$	57.82 jk	70.84 k	78.85 m	90.22 l	108.27 o
$V_2T_4S_3$	63.22 fg	73.21 ij	82.39 l	95.79 jk	124.62 k-m
LSD (0.05)	**1.30**	**1.56**	**2.35**	**2.59**	**2.10**
CV (%)	**1.28**	**1.27**	**1.65**	**1.60**	**0.97**

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

V_1: BRRI dhan34
V_2: Tulsimala

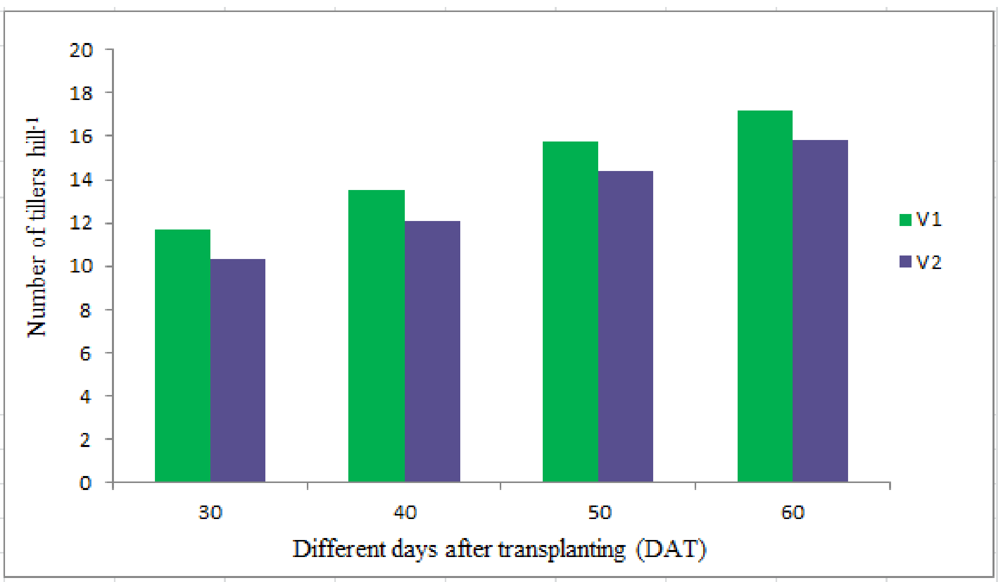
T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

4.1.2 Number of tillers hill^{-1}

4.1.2.1 Effect of variety on number of tillers hill^{-1}

The Number of tillers hill^{-1}of aromatic rice was significantly influenced by different varieties at 30, 40, 50, 60 days after transplanting (DAT) and at harvest (Figure 4). The results of the experiment shown that, BRRI dhan34 (V1) consistently gave maximum number of tillers hill^{-1} compared to the local variety Tulsimala (V2) throughout the investigation period. At 30, 40, 50 and 60 DAT the maximum number of tillers hill^{-1} (11.69, 13.53, 15.78 and 17.18, respectively) was recorded from BRRI dhan34 (V1), on the other hand minimum number of tillers hill^{-1} (10.31, 12.07, 14.41 and 15.81, respectively) was from local variety Tulsimala (V2). The probable reason of the differences in producing the tillers hill^{-1} could be the genetic make-up of the variety which was primarily influenced by heredity. Mohammad *et al*. (2014) also reported that, the highest number of total tillers hill^{-1} was observed in BR11 (16.60) and the lowest one (10.30) was counted in Pajam.

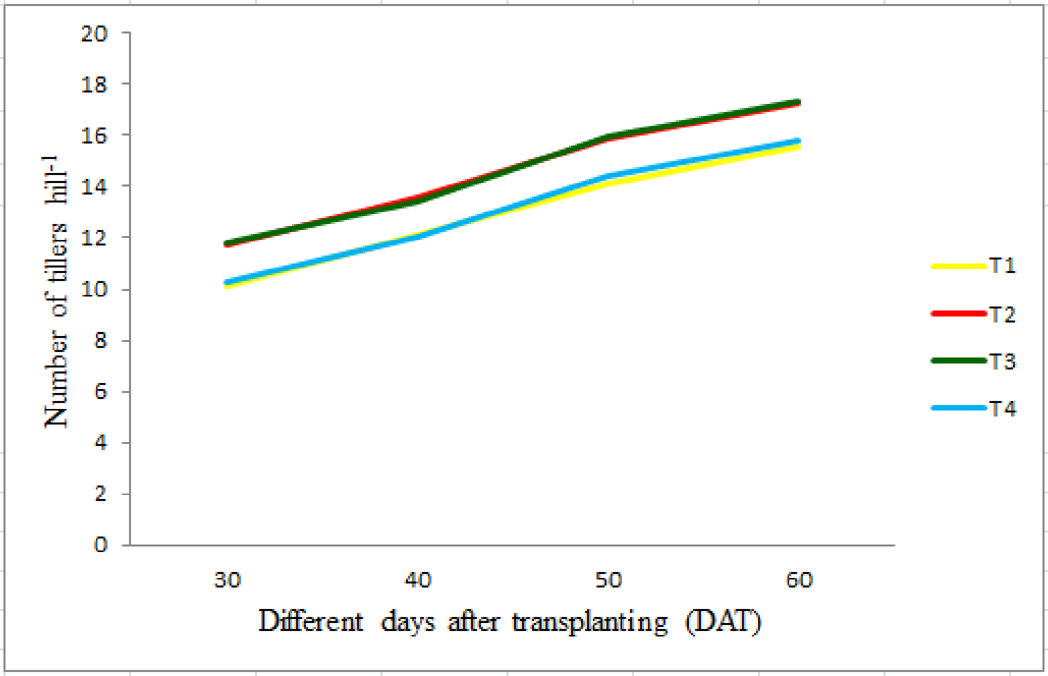


V_1= BRRI dhan34 and V_2 = Tulsimala

Figure 4. Effect of variety on the number of total tillers hill^{-1} of aromatic rice at different days after transplanting (LSD (0.05) = 0.29, 0.19, 0.25 and 0.25 at 30, 40, 50 and 60 DAT, respectively)

4.1.2.2 Effect of transplanting date on number of tillers hill^{-1}

The production of total tillers hill^{-1} was significantly influenced by different transplanting dates throughout the research period (Figure 5). Result showed that maximum number of tiller hill^{-1} (11.83) was produced when the rice transplanting on 28th August (T_3) at 30 DAT, which was statistically similar with the rice transplanting on 21st August (T_2). At 40 DAT the maximum number of tiller hill^{-1} (13.59) was produced when the rice transplanting on 21st August (T_2), which was statistically similar with the rice transplanting on 28th August (T_3). At 50 and 60 DAT the maximum number of tiller hill^{-1} (15.95 and 17.35) were produced when the rice transplanting on 28th August (T_3), which was statistically similar with the rice transplanting on 21st August (T_2). The minimum number of tillers hill^{-1} (10.14, 12.07, 14.13 and 15.55) were produced when the rice transplanting on 14th August (T_1) at 30, 40, 50 and 60 DAT, respectively, which were statistically similar with the rice transplanting on 4th September (T_4) at 30, 40, 50 and 60 DAT, respectively. The lower number of tillers hill^{-1} of the early planted crop were due to higher cloudy hours, less bright sunshine hour in the field that hampered crop growth and development. On the other hand, tillers hill^{-1} was decreasing with the delaying the transplantation date. This might be due to the shorter vegetative period had fewer chance to produce highest tillers hill^{-1}. This finding corroborates with those findings of Mannan *et al.* (2009), Salam *et al.* (2004), Chopra and Chopra (2004) and Shah and Yadav (2001).

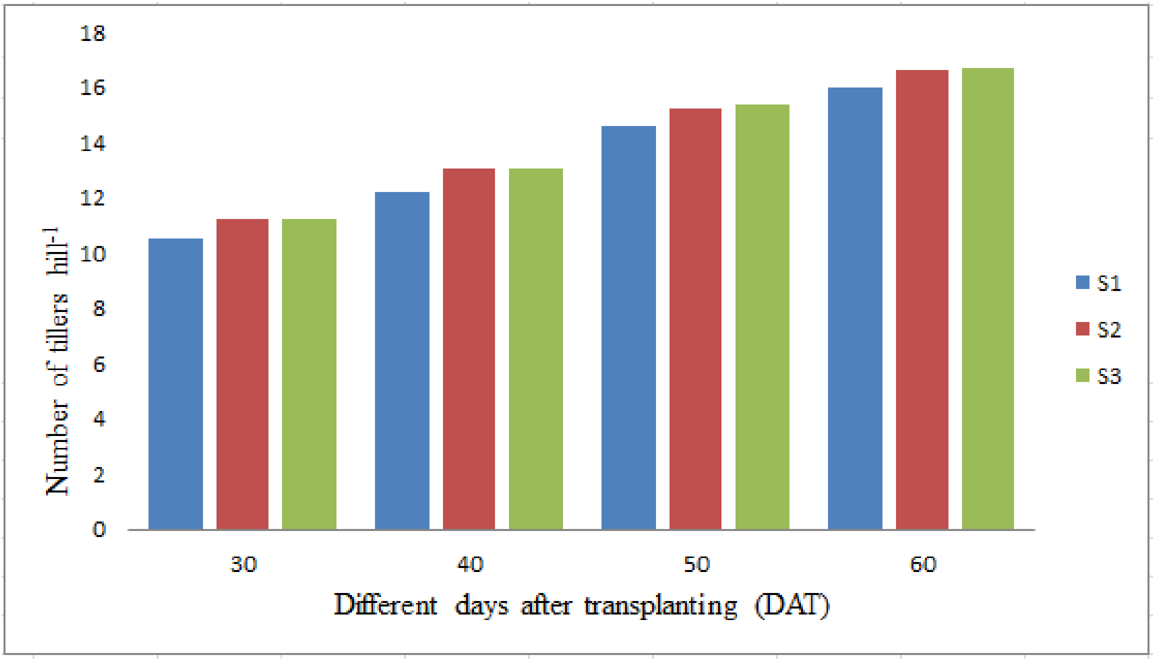


T_1 =14 August, T_2 =21st August, T_3 = 28th August and T_4 = 4th September

Figure 5. Effect of different transplanting dates on the number of tillers hill^{-1} of aromatic rice at different days after transplanting (LSD $_{(0.05)}$ = 0.40, 0.27, 0.36 and 0.36 at 30, 40, 50 and 60 DAT, respectively)

4.1.2.3 Effect of seedling number hill^{-1} on number of tillers hill^{-1}

The production of total tillers hill^{-1} was significantly influenced by different transplanting dates throughout the study period (Figure 6). The maximum number of tillers hill^{-1} was consistently observed from 4 seedlings hill^{-1} (S_3), whereas 2 seedlings hill^{-1} gave consistently poor total number of tillers hill^{-1}. Result showed that, the maximum number of tillers hill^{-1} (11.23, 13.10, 15.38 and 16.75) were produced when the rice transplanting with 4 seedlings hill^{-1} (S_3) at 30, 40, 50 and 60 DAT, respectively which were statistically similar with 3 seedlings hill^{-1} (S_2) at 30, 40, 50 and 60 DAT, respectively. At 30, 40, 50 and 60 DAT, the minimum number of tillers hill^{-1} (10.54, 12.24, 14.65 and 16.04, respectively) were produced when the rice transplanted with 2 seedling hill^{-1} (S_1).



S_1= 2 seedlings hill^{-1}, S_2= 3 seedlings hill^{-1}, S_3= 4 seedlings hill^{-1}

Figure 6. Effect of number of seedling hill^{-1} on the number of tillers hill^{-1} of aromatic rice at different days after transplanting (LSD $_{(0.05)}$ = 0.35, 0.23, 0.31 and 0.31 at 30, 40, 50 and 60 DAT, respectively)

4.1.2.4 Interaction effect of variety and transplanting date on number of tillers hill^{-1}

Interaction of variety and different transplanting date significantly influenced the production of total tillers hill^{-1} throughout the study period (Table 6). The result of the experiment revealed that, treatment combination V_1T_2 (BRRI dhan34 transplanted at 21st August) gave the maximum number of tillers hill^{-1} (12.92, 14.70, 17.11 and 18.44) at 30, 40, 50 and 60 DAT, respectively which were statistically equivalence with V_1T_3 (BRRI dhan34 transplanted at 28th August) at 30, 40, 50 and 60 DAT. On the other hand treatment combination V_2T_4 (Local variety Tulsimala transplanted at 4th September) gave the minimum number of tillers hill^{-1} (9.58, 11.36, 13.70 and 15.10) at 30, 40, 50 and 60 DAT, respectively which were statistically similar with, V_1T_1 and V_2T_1 at 30, 50 and 60 DAT.

Table 6. Interaction effect of variety and transplanting date on number of tillers hill^{-1} at different days after transplanting (DAT)

Treatment	Number of tillers hill^{-1} at different days after transplanting (DAT)			
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**
V_1T_1	10.14 cd	12.22 cd	14.07 d	15.52 d
V_2T_1	10.15 cd	11.94 d	14.19 cd	15.59 cd
V_1T_2	12.92 a	14.70 a	17.11 a	18.44 a
V_2T_2	10.55 bc	12.48 bc	14.67 bc	16.07 bc
V_1T_3	12.71 a	14.40 a	16.83 a	18.23 a
V_2T_3	10.95 b	12.51 bc	15.07 b	16.47 b
V_1T_4	11.00 b	12.78 b	15.12 b	16.52 b
V_2T_4	9.58 d	11.36 e	13.70 d	15.10 d
LSD (0.05)	**0.57**	**0.38**	**0.50**	**0.51**
CV (%)	**5.48**	**3.15**	**3.51**	**3.25**

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

V_1: BRRI dhan34 T_1: 14th August T_3: 28th August
V_2: Tulsimala T_2: 21st August T_4: 4th September

4.1.2.5 Interaction effect of variety and seedling number hill^{-1} on number of tillers hill^{-1}

Interaction of variety and different seedling number hill^{-1} significantly influenced the production of total tillers hill^{-1} throughout the study period (Table 7). The result of the experiment revealed that, treatment combination V_1S_2 (BRRI dhan34 with 3 seedling hill^{-1}) gave the maximum number of tillers hill^{-1} (12.10, 13.90, 16.18 and 17.62) at 30, 40, 50 and 60 DAT. On the other hand treatment combination V_2S_1 (local variety Tulsimala transplanted with 2 seedling hill^{-1}) gave the minimum number of tillers hill^{-1} (9.56, 11.27, 13.75 and 15.14) at 30, 40, 50 and 60 DAT.

Table 7. Interaction effect of varieties and number of seedlings hill^{-1} on number of tillers hill^{-1} at different days after transplanting (DAT)

Treatment	Number of tillers hill^{-1} at different days after transplanting (DAT)			
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**
V_1 S_1	11.53 b	13.22 b	15.56 bc	16.95 b
V_2 S_1	9.56 e	11.27 e	13.75 e	15.14 d
V_1 S_2	12.10 a	13.90 a	16.18 a	17.62 a
V_2 S_2	10.34 d	12.20 d	14.32 d	15.74 c
V_1 S_3	11.44 bc	13.45 b	15.61 b	16.96 b
V_2 S_3	11.02 c	12.75 c	15.14 c	16.54 b
LSD (0.05)	**0.49**	**0.33**	**0.44**	**0.44**
CV (%)	**5.48**	**3.15**	**3.51**	**3.25**

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

V_1= BRRI dhan34,
V_2 = Tulsimala

S_1 = 2 seedlings hill^{-1},
S_2 = 3 seedlings hill^{-1},
S_3 = 4 seedlings hill^{-1}

4.1.2.6 Interaction effect of transplanting date and seedling number hill^{-1} on number of tillers hill^{-1}

Interaction of different transplanting date and different number of seedling hill^{-1} significantly influenced the production of total tillers hill^{-1} throughout the study period (Table 8). The result of the research revealed that, treatment combination T_2S_2 (Transplanted rice at 21st August with 3 seedling number hill^{-1}) gave the maximum number of tillers hill^{-1} (12.10, 14.05, 16.22 and 17.62) at 30, 40, 50 and 60 DAT, respectively which were statistically equivalence with the combination of T_2S_3, T_3S_1, T_3S_2 and T_3S_3 at 30, 50 and 60 DAT and T_2S_3, T_3S_2 at 40 DAT. On the other hand treatment combination T_1S_1 (transplanted rice at 14th August with 2 seedling number hill^{-1}) gave the minimum number of tillers hill^{-1} (9.21, 10.93, 13.28 and 14.64) at 30, 40, 50 and 60 DAT, respectively.

Table 8. Interaction effect of transplanting date and seedling number hill^{-1} on number of tillers hill^{-1} at different days after transplanting (DAT)

Treatment	Number of tillers hill^{-1} at different days after transplanting (DAT)			
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**
T_1 S_1	9.21 f	10.93 e	13.28 f	14.64 f
T_1 S_2	10.24 e	12.17 d	14.00 e	15.52 e
T_1 S_3	10.98 cd	13.11 c	15.10 cd	16.50 cd
T_2 S_1	11.22 bc	13.07 c	15.34 bc	16.74 bc
T_2 S_2	12.10 a	14.05 a	16.22 a	17.62 a
T_2 S_3	11.88 ab	13.66 ab	16.10 a	17.40 a
T_3 S_1	11.71 ab	13.16 c	15.83 ab	17.23 ab
T_3 S_2	12.09 a	13.74 ab	16.21 a	17.61 a
T_3 S_3	11.68 ab	13.46 bc	15.80 ab	17.20 ab
T_4 S_1	10.03 e	11.81 d	14.15 e	15.55 e
T_4 S_2	10.45 de	12.23 d	14.57 de	15.97 de
T_4 S_3	10.39 de	12.17 d	14.51 de	15.91 de
LSD (0.05)	**0.70**	**0.47**	**0.62**	**0.62**
CV (%)	**5.48**	**3.15**	**3.51**	**3.25**

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

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September
S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

4.1.2.7 Interaction effect of variety, transplanting date and seedling number hill^{-1} on number of tillers hill^{-1}

Significant interaction effect between variety, transplanting dates and seedling number hill^{-1} was observed throughout the growing period (Table 9). The results shown that the maximum number of tillers hill^{-1} (13.05, 14.83, 17.38 and 18.57) was recorded from the combination of $V_1T_2S_3$ at 30, 40, 50 and 60 DAT, respectively, which were statistically similar with the combination of $V_1T_3S_2$ and $V_1T_2S_2$ at 30, 40, 50 and 60 DAT; $V_1T_2S_1$ and $V_1T_3S_1$ at 40, 50 and 60 DAT; $V_2T_1S_3$ and $V_1T_3S_3$ at 50 and 60 DAT. On the other hand treatment combination V_2 T_1S_1 gave the minimum number of tillers hill^{-1} (8.00, 10.03, 12.40 and 13.76) at 30, 40, 50 and 60 DAT, respectively, which were statistically similar with the combination of $V_2T_4S_3$ at 50 and 60 DAT.

Table 9. Interaction effect of variety and transplanting date and seedling number hill^{-1} on the number of tillers hill^{-1} of aromatic rice at different days after transplanting

Treatment	Number of tillers hill^{-1} at different days after transplanting (DAT)			
	30 DAT	40 DAT	50 DAT	60 DAT
$V_1T_1S_1$	10.42 d-f	11.83 hi	14.16 f-i	15.51 f-i
$V_2T_1S_1$	8.00 i	10.03 k	12.40 k	13.76 k
$V_1T_1S_2$	10.59 d-f	12.71 e-g	14.53 d-h	16.11 d-h
$V_2T_1S_2$	9.88 e-h	11.66 i	13.47 ij	14.93 ij
$V_1T_1S_3$	9.40 gh	12.11 g-i	13.52 ij	14.92 ij
$V_2T_1S_3$	12.56 ab	14.12 bc	16.68 ab	18.08 ab
$V_1T_2S_1$	12.72 ab	14.50 ab	16.84 a	18.24 a
$V_2T_2S_1$	9.73 f-h	11.63 i	13.85 h-j	15.25 h-j
$V_1T_2S_2$	12.99 a	14.77 ab	17.11 a	18.51a
$V_2T_2S_2$	11.21 cd	13.32 de	15.33 cd	16.73 cd
$V_1T_2S_3$	13.05 a	14.83 a	17.38 a	18.57 a
$V_2T_2S_3$	10.70 d-f	12.48 f-h	14.82 d-g	16.22 d-g
$V_1T_3S_1$	12.66 ab	14.44 ab	16.78 ab	18.18 ab
$V_2T_3S_1$	10.77 de	11.88 hi	14.89 d-g	16.29 d-g
$V_1T_3S_2$	13.03 a	14.55 ab	17.15 a	18.55 a
$V_2T_3S_2$	11.15 cd	12.93 d-f	15.27 c-e	16.67 c-e
$V_1T_3S_3$	12.44 ab	14.22 a-c	16.56 ab	17.96 ab
$V_2T_3S_3$	10.92 cd	12.70 e-g	15.04 de	16.44 c-e
$V_1T_4S_1$	10.33 d-g	12.11g-i	14.45 e-h	15.85 e-h
$V_2T_4S_1$	9.73 f-h	11.51 ij	13.85 h-j	15.25 h-j
$V_1T_4S_2$	11.80 bc	13.58 cd	15.92 bc	17.32 bc
$V_2T_4S_2$	9.10 h	10.88 j	13.22 jk	14.62 jk
$V_1T_4S_3$	10.87 c-e	12.65 fg	14.99 d-f	16.39 d-f
$V_2T_4S_3$	9.91 e-h	11.69 i	14.03 g-j	15.43 g-j
LSD (0.05)	**0.98**	**0.66**	**0.87**	**0.88**
CV (%)	**5.48**	**3.15**	**3.51**	**3.25**

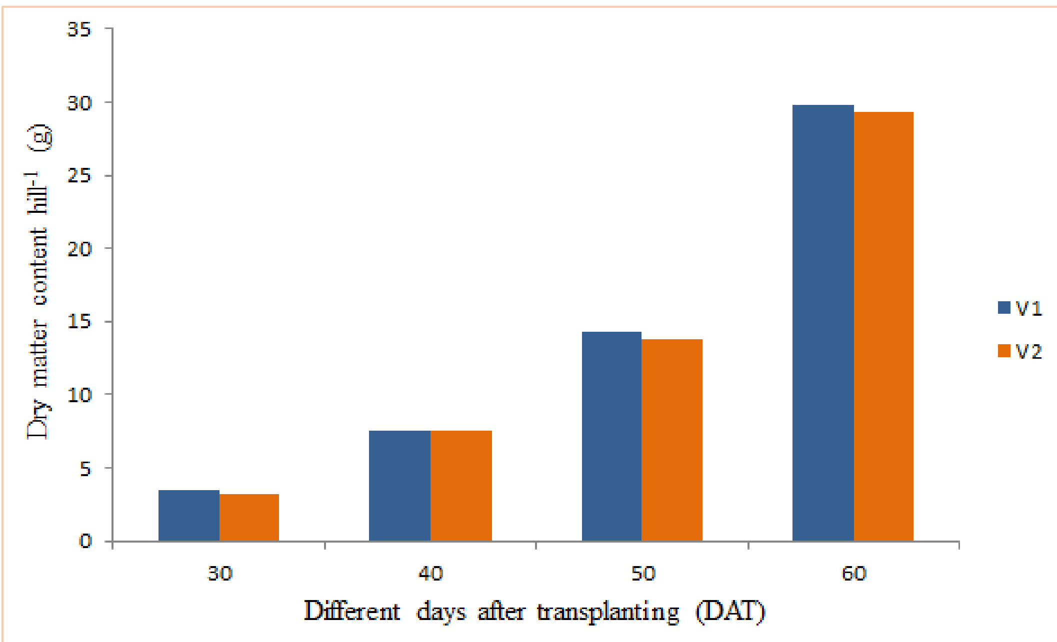
In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly at 0.05 level of probability

V_1: BRRI dhan34	T_1: 14th August	S_1: 2 Seedling hill^{-1}
V_2: Tulsimala	T_2: 21st August	S_2: 3 Seedling hill^{-1}
	T_3: 28th August	S_3: 4 Seedling hill^{-1}
	T_4: 4th September	

4.1.3 Dry matter content hill^{-1} (g)

4.1.3.1 Effect of variety on dry matter content hill^{-1} (g)

Total dry matter production (g hill^{-1}) was significantly differed among the varieties at all growth stages (Figure 7). At 30, 50 and 60 DAT, the maximum dry matter content hill^{-1} (3.42, 14.40 and 30.22 g, respectively) were observed from BRRI dhan34 (V_1), whereas the minimum dry matter content hill^{-1} were recorded from Tulsimala (V_2) (3.25, 13.66 and 28.84 g, respectively). At 40 DAT dry matters production hill^{-1} was observed same (7.47 g) from both varieties.

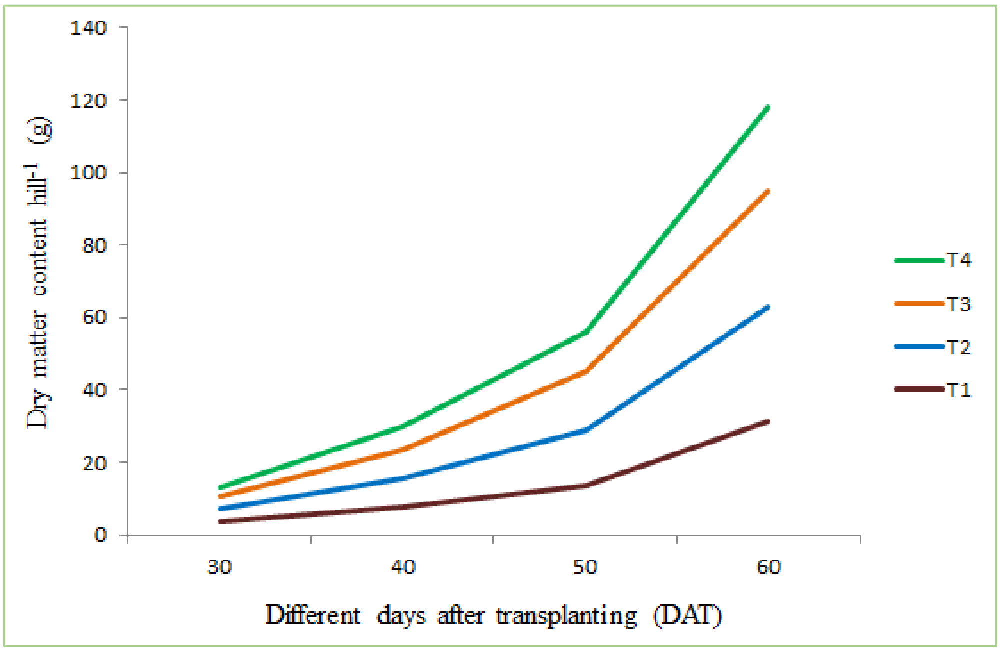


V_1= BRRI dhan34 and V_2 = Tulsimala

Figure 7. Effect of variety on dry matter content hill^{-1} (g) of aromatic rice at different days after transplanting (LSD $_{(0.05)}$ = 0.05, 0.05, 0.11 and 0.26 at 30, 40, 50 and 60 DAT, respectively)

4.1.3.2 Effect of transplanting date on dry matter content hill^{-1} (g)

The dry matter weight hill^{-1} was significantly influenced by transplanting date at all growth stages (Figure 8). At 30 and 40 DAT maximum dry matter content hill^{-1} (3.59 and 7.96 g) were observed from rice transplanted at 14th August (T_1) and 21st August (T_2), respectively, which is statistically similar with T_2 (21st August) at 30 DAT and T_3 (28th August) at 30 and 40 DAT and the minimum dry matter content hill^{-1} (2.65 and 6.29) were observed at 30 and 40 DAT from the rice transplanted at 4th September (T_4). At 50 and 60 DAT, the maximum dry matter content hill^{-1} (15.91 and 32.00 g, respectively) were observed from rice transplanted at 28th August (T_3), which were statistically similar with T_2 (21st August) at 60 DAT, whereas the minimum dry matter content hill^{-1} (11.08 and 23.26 g) were recorded from rice transplanted at 4th September (T_4).

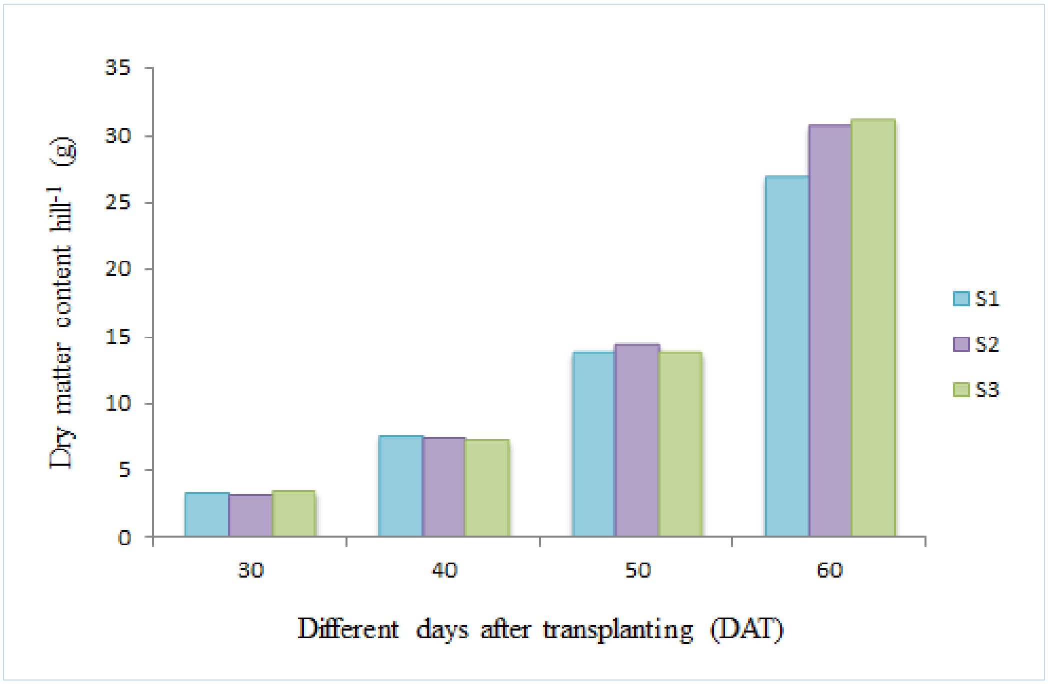


T_1 =14 August, T_2 =21st August, T_3 = 28th August and T_4 = 4th September

Figure 8. Effect of transplanting date on dry matter content hill^{-1} (g) of aromatic rice at different days after transplanting (LSD $_{(0.05)}$ = 0.07, 0.08, 0.16 and 0.36 at 30, 40, 50 and 60 DAT, respectively)

4.1.3.3 Effect of seedling number hill^{-1} on dry matter content hill^{-1} (g)

Number of seedlings hill^{-1} showed significant differences on dry matter content hill^{-1} at 30, 40, 50 and 60 DAT (Figure 9). At 30 DAT, the maximum dry matter content hill^{-1} (3.45 g) were observed from S_3 (4 seedling hill^{-1}) and the minimum dry matter content hill^{-1} (3.23) were observed from S_1 (2 seedling hiil^{-1}). At 40 and 50 DAT, the maximum dry matter content hill^{-1} (7.61 and 14.46 g) were observed from S_2 (3 seedling hill^{-1}) and the minimum dry matter content hill^{-1} (7.30 and 13.82) were observed from S_3 (4 seedling hiil^{-1}), which was statistically similar to S_1 (2 seedling hiil^{-1}) at 50 DAT. At 60 DAT the maximum dry matter content hill^{-1} was observed from S_3 (31.14 g) and it was statistically different from others while the minimum dry matter content hill^{-1} were observed from S_1.



S_1= 2 seedlings hill^{-1}, S_2= 3 seedlings hill^{-1}, S_3= 4 seedlings hill^{-1}

Figure 9. Effect of number of seedling hill^{-1} on dry matter content hill^{-1} (g) of aromatic rice at different days after transplanting (LSD $_{(0.05)}$ = 0.06, 0.07, 0.14 and 0.32 at 30, 40, 50 and 60 DAT, respectively)

4.1.3.4 Interaction effect of variety and transplanting date on dry matter content hill^{-1} (g)

Interaction of variety and different transplanting date significantly influenced the production of dry matter weight hill^{-1} throughout the study period (Table 10). The results of the experiment revealed that at 30 DAT, the maximum dry matter content hill^{-1} (3.65 g) were observed from the treatment combination V_1T_3 (BRRI dhan34 transplanted at 28th August), which were statistically equivalence with the combination of V_1T_2, V_1T_1, and V_2T_1. At 40 DAT, the maximum dry matter content hill^{-1} (7.99 g) were observed from the treatment combination V_1T_2 (BRRI dhan34 rice transplanted at 21st August), which were statistically similar with the combination of V_2T_3. At 50 DAT, the maximum dry matter content hill^{-1} (15.95 g) were observed from the treatment combination V_2T_3 (Local Tulsimala rice transplanted at 28th August), which were statistically equivalence with the combination of V_1T_3 and V_1T_2. At 60 DAT, the maximum dry matter content hill^{-1} (32.62 g) were observed from the treatment combination V_1T_3 (BRRI dhan34 rice transplanted at 28th August), which were statistically similar with the combination of V_1T_2. On the other hand treatment combination V_2T_4 (Local Tulsimala rice transplanted at 4th September) at 30, 40, 50 and 60 DAT gave the minimum dry matter content hill^{-1} (2.50, 6.16, 10.24 and 21.83 g, respectively).

Table 10. Interaction effect of variety and transplanting date on dry matter content hill^{-1} at different days after transplanting (DAT)

Treatment	Dry matter content hill^{-1} at different days after transplanting (DAT) (g)			
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**
V_1 T_1	3.60 a	7.63 d	14.18 c	31.30 b
V_2 T_1	3.58 a	7.80 c	13.24 d	30.94 b
V_1 T_2	3.63a	7.99 a	15.82 a	32.26 a
V_2 T_2	3.45 b	7.94 ab	15.01 b	31.22 b
V_1 T_3	3.65 a	7.83 bc	15.87 a	32.62 a
V_2 T_3	3.48 b	7.96 a	15.95 a	31.37 b
V_1 T_4	2.79 c	6.42 e	11.73 e	24.70 c
V_2 T_4	2.50 d	6.16 f	10.24 f	21.83 d
LSD (0.05)	**0.09**	**0.11**	**0.23**	**0.52**
CV (%)	**2.90**	**1.53**	**1.70**	**1.84**

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

V_1: BRRI dhan34	T_1: 14th August	T_3: 28th August
V_2: Tulsimala	T_2: 21st August	T_4: 4th September

4.1.3.5 Interaction effect of variety and seedling number hill^{-1} on dry matter content hill^{-1} (g)

Interaction of variety and different seedling number hill^{-1} significantly influenced the production of dry matter content hill^{-1} throughout the study period (Table 11). The result of the experiment revealed that, treatment combination V_1S_3 (BRRI dhan34 with 4 seedling hill^{-1}) gave the maximum dry matter content hill^{-1} (3.48 g) at 30 DAT, which were statistically similar with the combination of V_1S_2 and V_2S_3. The treatment combination V_2S_3 (Local Tulsimala rice transplanted with 4 seedling hill^{-1}) gave the maximum dry matter content hill^{-1} (31.43 g) at 60 DAT; which were statistically similar with the combination of V_1S_2. At 40 and 50 DAT, treatment combination V_1S_2 (BRRI dhan34 rice transplanted with 3 seedling hill^{-1}) gave the maximum dry matter content hill^{-1} (7.69 and 14.73 g, respectively). On the other hand treatment combination V_2S_1 (Local variety Tulsimala transplanted with 2 seedling hill^{-1}) gave the minimum dry matter content hill^{-1} (3.12, 13.23 and 25.06 g) at 30, 50 and 60 DAT, respectively and at 40 DAT, the minimum dry matter content hill^{-1} (7.35 g) from the combination V_2S_3, which were statistically similar with the combination of V_1S_3.

Table 11. Interaction effect of varieties and number of seedlings hill^{-1} on dry matter content hill^{-1} at different days after transplanting (DAT)

Treatment	Dry matter content hill^{-1} at different days after transplanting (DAT) (g)			
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**
V_1 S_1	3.35 b	7.47 b	14.40 b	28.55 d
V_2 S_1	3.12 d	7.51 b	13.23 e	25.06 e
V_1 S_2	3.44 a	7.69 a	14.73 a	31.25 ab
V_2 S_2	3.21 c	7.34 b	14.19 c	30.03 c
V_1 S_3	3.48 a	7.26 c	14.06 c	30.85 b
V_2 S_3	3.42 ab	7.35 c	13.55 d	31.43 a
LSD (0.05)	**0.08**	**0.09**	**0.20**	**0.45**
CV (%)	**2.90**	**1.53**	**1.70**	**1.84**

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

V_1: BRRI dhan34
V_2: Tulsimala

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

4.1.3.6 Interaction effect of transplanting date and seedling number hill^{-1} on dry matter content hill^{-1} (g)

Interaction of different transplanting date and different number of seedling hill^{-1} significantly influenced the production of dry matter content hill^{-1} throughout the study period (Table 12). The result of the research observed that, treatment combination T_2S_2 (Transplanted rice at 21st August with 3 seedling number hill^{-1}) gave the maximum dry matter content hill^{-1} (3.94, 8.70, 17.53 and 35.89 g) at 30, 40, 50 and 60 DAT, respectively On the other hand treatment combination T_4S_1 (Transplanted rice at 4th September with 2 seedling number hill^{-1}) gave the minimum dry matter content hill^{-1} (2.53, 10.60 and 20.62 g) at 30, 50 and 60 DAT, respectively. At 40 DAT, treatment combination T_4S_2 gave the minimum dry matter content hill^{-1} (6.25 g) which was statistically similar with the combination T_4S_1.

Table 12. Interaction effect of transplanting date and seedling number hill^{-1} on dry matter content hill^{-1} of aromatic rice at different days after transplanting (DAT)

Treatment	Dry matter content hill^{-1} at different days after transplanting (DAT) (g)			
	30 DAT	40 DAT	50 DAT	60 DAT
T_1 S_1	3.45 d	7.52 e	13.36 g	28.90 e
T_1 S_2	3.50 d	7.62 e	13.40 g	30.39 c
T_1 S_3	3.82 b	8.02 c	14.37 e	34.06 b
T_2 S_1	3.30 ef	8.19 b	15.02 d	29.65 d
T_2 S_2	3.94 a	8.70 a	17.53 a	35.89 a
T_2 S_3	3.40 de	7.01 f	13.70 f	29.67 d
T_3 S_1	3.66 c	8.02 c	16.29 b	28.05 f
T_3 S_2	3.23 f	7.89 cd	15.80 c	33.86 b
T_3 S_3	3.82 b	7.79 d	15.63 c	34.08 b
T_4 S_1	2.53 h	6.22 h	10.60 j	20.62 i
T_4 S_2	2.65 g	6.25 h	11.11 i	22.43 h
T_4 S_3	2.76 g	6.40 g	11.53 h	26.75 g
LSD (0.05)	**0.11**	**0.13**	**0.29**	**0.63**
CV (%)	**2.90**	**1.53**	**1.70**	**1.84**

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

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September
S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

4.1.3.7 Interaction effect of variety and transplanting date and seedling number hill^{-1} on dry matter content hill^{-1} (g)

Significant interaction effect between variety, transplanting dates and seedling number hill^{-1} was observed throughout the growing period (Table 13). The results shown that the maximum dry matter content hill^{-1} (3.95, 8.76, 17.99 and 36.28 g) was recorded from the combination of $V_1T_2S_2$ (BRRI dhan34 rice transplanting on 21st August with 3 seedlings hill^{-1}) at 30, 40, 50 and 60 DAT, respectively, which were statistically similar with the combination of $V_2T_2S_2$ and $V_2T_1S_3$ At 30; $V_2T_1S_1$ at 40 DAT and $V_2T_2S_2$ at 60 DAT. On the other hand treatment combination V_2 T_4S_1 (Local tulsimala rice transplanting at 4th September with 2 seedling number hill^{-1}) gave the minimum dry matter content hill^{-1} (2.39, 5.99, 9.51 and 18.40 g) at 30, 40, 50 and 60 DAT, respectively, which were statistically similar with the combination of $V_2T_4S_2$ at 40 DAT.

Table 13. Interaction effect of variety and transplanting date and seedling number hill^{-1} on dry matter content hill^{-1} of aromatic rice at different days after transplanting

Treatment	Dry matter content hill^{-1} at different days after transplanting (DAT) (g)			
	30 DAT	**40 DAT**	**50 DAT**	**60 DAT**
$V_1T_1S_1$	3.75 bc	7.52 f	13.73 fg	29.47 i
$V_2T_1S_1$	3.15 h	8.62 ab	12.98 h	28.34 j
$V_1T_1S_2$	3.34 fg	7.24 gh	12.82 h	29.51 i
$V_2T_1S_2$	3.66 cd	7.99 de	13.98 f	31.27 h
$V_1T_1S_3$	3.72 c	8.15 d	15.98 cd	34.91 bc
$V_2T_1S_3$	3.93 a	7.89 e	12.76 h	33.20 fg
$V_1T_2S_1$	3.45 ef	8.35 c	15.95 d	32.33 g
$V_2T_2S_1$	3.15 h	8.04 de	14.08 f	26.97 k
$V_1T_2S_2$	3.95 a	8.76 a	17.99 a	36.28 a
$V_2T_2S_2$	3.93 a	7.53 e	17.06 b	35.50 ab
$V_1T_2S_3$	3.52 de	6.87 i	13.51 g	28.15 j
$V_2T_2S_3$	3.27 gh	7.15 h	13.88 fg	31.19 h
$V_1T_3S_1$	3.52 de	7.54 f	16.22 cd	29.57 i
$V_2T_3S_1$	3.80 a-c	8.49 bc	16.36 c	26.54 k
$V_1T_3S_2$	3.70 c	8.40 c	16.19 cd	34.32 cd
$V_2T_3S_2$	2.75 j	7.39 fg	15.42 e	33.39 ef
$V_1T_3S_3$	3.74 c	7.56 f	15.19 e	33.98 d-f
$V_2T_3S_3$	3.90 ab	8.02 de	16.07 cd	34.18 c-e
$V_1T_4S_1$	2.68 jk	6.45 j	11.69 ij	22.84 m
$V_2T_4S_1$	2.39 m	5.99 l	9.51 l	18.40 o
$V_1T_4S_2$	2.77 ij	6.35 j	11.92 i	24.90 l
$V_2T_4S_2$	2.52 lm	6.15 kl	10.30 k	19.95 n
$V_1T_4S_3$	2.93 i	6.46 j	11.57 ij	26.36 k
$V_2T_4S_3$	2.58 kl	6.34 jk	11.49 j	27.14 k
LSD (0.05)	**0.15**	**0.19**	**0.39**	**0.89**
CV (%)	**2.90**	**1.52**	**1.75**	**1.85**

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

V_1: BRRI dhan34
V_2: Tulsimala

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

4.2 Yield contributing characters

4.2.1 Panicle weight (g)

4.2.1.1 Effect of aromatic rice varieties on panicle weight (g)

Panicle weight showed significant variation due to varieties (Table 14). The result of the experiment revealed that, the HYV variety- BRRI dhan34 produced highest panicle weight (1.95 g) and the lowest weight of panicle was recorded from Tulsimala (1.73 g). This confirms the report of Ahmed *et al.* (1996), Idris and Matin (1990) that panicle weight was differed due to variety.

4.2.1.2 Effect of transplanting date on panicle weight (g)

Date of transplanting had a significant effect on panicle weight (g) of rice during aman season (Table 14). Results showed that panicle weight decreased with early or delayed transplanting in aman season. The highest panicle weight was recorded when transplanted on 21st August (T_2) (1.97g), which was statistically similar with T_3 (28th August) and the lowest panicle weight was recorded from 4th September (1.72 g), which was statistically similar with T_1 (14th August).

4.2.1.3 Effect of seedling number hill^{-1} on panicle weight (g)

Seedling number hill^{-1} had a significant effect on panicle weight (g) of rice during aman season (Table 14). Results showed that, the highest panicle weight (1.89 g) was observed from S_2 (3 seedling hill^{-1}) and the lowest panicle weight (1.80 g) was observed from S_1 (2 seedling hill^{-1}), which was statistically similar with S_3 (4 seedling hill^{-1}).

4.2.1.4 Interaction effect of variety and transplanting date on panicle weight (g)

Interaction effect of variety and transplanting date had a significant effect on panicle weight (g) of rice during aman season (Table 15). Results showed that, highest panicle weight (2.20 g) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) and the lowest panicle weight (1.61 g) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) which was statistically similar with V_1T_1.

4.2.1.5 Interaction effect of variety and seedling number hill^{-1} on panicle weight (g)

Interaction effect of Variety and Seedling number hill^{-1} had a significant effect on panicle weight (g) of rice during aman season (Table 16). Results showed that, the higher panicle weight (1.98 g) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted with 3 seedling hill^{-1} (S_2), which was statistically similar with V_1S_1 and V_1S_3. On the other hand the lowest panicle weight (1.65 g) was observed from the treatment combination with local Tulsimala (V_2) when transplanted with 2 seedling hill^{-1} (S_1).

4.2.1.6 Interaction effect of transplanting date and seedling number hill^{-1} on panicle weight (g)

Interaction effect of Transplanting date and Seedling number hill^{-1} had a significant effect on panicle weight (g) of rice during aman season (Table 17). Results showed that, highest panicle weight (2.14 g) was observed from the treatment combination when rice transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2) and the lowest panicle weight (1.54 g) was observed from the treatment combination when transplanted on 14th August (T_1) with 2 seedling hill^{-1} (S_1), which was statistically similar with T_4S_2.

4.2.1.7 Interaction effect of variety and transplanting date and seedling number hill^{-1} on panicle weight (g)

Interaction effect of Variety, Transplanting date and Seedling number hill^{-1} had a significant effect on panicle weight (g) of rice during aman season (Table 18). Results showed that, highest panicle weight (2.42 g) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2) and the lowest panicle weight (1.44 g) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_2), which was similar with $V_1T_4S_2$.

4.2.2 Total number of grains panicle^{-1}

4.2.2.1 Effect of aromatic rice varieties on total number of grains panicle^{-1}

Total number of grains panicle^{-1} showed significant variation due to varieties (Table 14). The result of the experiment revealed that, the HYV variety- BRRI dhan34 produced the maximum number of grain panicle^{-1} (195.88) and the minimum number of grains panicle^{-1} were recorded from Tulsimala (166.83). This confirms the report of Ahmed *et al.* (1997), Idris and Matin (1990) that total number of grains panicle^{-1} was differed due to variety.

4.2.2.2 Effect of transplanting date on total number of grains panicle^{-1}

Date of transplanting had a significant effect on number of grains panicle^{-1} of rice during aman season (Table 14). Results showed that total number of grains panicle^{-1} decreased with early or delayed transplanting in aman season. The maximum number of grains panicle^{-1} (193.92) was recorded when rice transplanted on 21st August (T_2), which was statistically similar with T_3 (28th August) (189.14) and the minimum number of grains panicle^{-1} was recorded from 4th September (1.72 g), which was statistically similar with T_1 (14th August).

4.2.2.3 Effect of seedling number hill^{-1} on total number of grains panicle^{-1}

Seedling number hill^{-1} had a significant effect on total number of grains panicle^{-1} of rice during aman season (Table 14). Results showed that, the maximum number of grains panicle^{-1} (187.44) was observed from S_2 (3 seedling hill^{-1}); which was statistically similar with S_3 (4 seedling hill^{-1}) and the minimum number of grains panicle^{-1} (174.06) was observed from S_1 (2 seedling hill^{-1}).

4.2.2.4 Interaction effect of variety and transplanting date on total number of grains panicle^{-1}

Interaction effect of Variety and Transplanting date had a significant effect on total number of grains panicle^{-1} of rice during aman season (Table 15). Results showed that, the maximum total number of grains panicle^{-1} (223.38) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) and the minimum total number of grains panicle^{-1} (152.89) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) which was statistically similar with V_2T_3.

4.2.2.5 Interaction effect of variety and seedling number hill^{-1} on total number of grains panicle^{-1}

Interaction effect of Variety and Seedling number hill^{-1} had a significant effect on total number of grains panicle^{-1} of rice during aman season (Table 16). Results showed that, the maximum total number of grains panicle^{-1} (202.65) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted with 3 seedling hill^{-1} (S_2), which was statistically similar with V_1S_3. On the other hand the minimum total number of grains panicle^{-1} (157.91 g) was observed from the treatment combination with local Tulsimala (V_2) when transplanted with 2 seedling hill^{-1} (S_1).

4.2.2.6 Interaction effect of transplanting date and seedling number hill^{-1} on total number of grains panicle^{-1}

Interaction effect of Transplanting date and Seedling number hill^{-1} had a significant effect on total number of grains panicle^{-1} of rice during aman season (Table 17). Results showed that, the maximum total number of grains panicle^{-1} (202.20) was observed from the treatment combination when rice transplanted on 28th August (T_3) with 3 seedlings hill^{-1} (S_2) and the minimum total number of grains panicle^{-1} (148.00) was observed from the treatment combination when transplanted on 14th August (T_1) with 2 seedlings hill^{-1} (S_1).

4.2.2.7 Interaction effect of variety and transplanting date and seedling number hill^{-1} on total number of grains panicle^{-1}

Interaction effect of Variety, Transplanting date and Seedling number hill^{-1} had a significant effect on total number of grains panicle^{-1} of rice during aman season (Table 18). Results showed that, the maximum total number of grains panicle^{-1} (263.70) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2) and the minimum total number of grains panicle^{-1} (135.12) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 14th August (T_1) with 2 seedling hill^{-1} (S_1), which was statistically similar with $V_2T_4S_1$, $V_2T_3S_3$ and $V_2T_3S_1$.

4.2.3 Filled grains panicle^{-1}

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

Filled grains panicle^{-1} varied significantly due to varieties (Table 14). The result of the experiment revealed that, the HYV variety- BRRI dhan34 (V_1) produced the maximum number of filled grains panicle^{-1} (146.89) and the minimum number of filled grains panicle^{-1} was recorded from Tulsimala (V_2) (128.17). These results were in agreement with those reported by Khalifa et al. (2014), Shah and Yadav (2001), Srivastava and Thipathi (1998), Singh and Gangwer (1989). The highest number of grains panicle^{-1} (135.1) was found from BR11 the lowest results value was observed from Pajam (96.6) and (Mohammad *et al.*, 2014).

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

The different transplanting date showed significant variation on the number of filled grains panicle^{-1} (Table 14). The highest number of filled grains panicle^{-1} (152.66) was obtained from the transplanting date 21st August (T_2) and the lowest number of filled grains panicle^{-1} (124.72) was obtained from the transplanting date 4th September (T_4), which was statistically similar with T_1.

4.2.3.3 Effect of seedling number hill^{-1} on filled grains panicle^{-1}

Seedling number hill^{-1} had a significant effect on filled grains panicle^{-1} of rice during aman season (Table 14). Results showed that, the maximum filled grains panicle^{-1} (144.65) was observed from S_2 (3 seedling hill^{-1}) and the minimum filled grains panicle^{-1} (131.02) was observed from S_1 (2 seedling hill^{-1}).

4.2.3.4 Interaction effect of variety and transplanting date on filled grains panicle^{-1}

Interaction effect of variety and transplanting date had a significant effect on filled grains panicle^{-1} of rice during aman season (Table 15). Results showed that, the highest number of filled grains panicle^{-1} (169.53) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3), followed by V_1T_2 (164.00) and the lowest number of filled grains panicle^{-1} (115.55) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) which was statistically similar with V_2T_3 (117.41) and V_1T_1 (120.14).

4.2.3.5 Interaction effect of variety and seedling number hill^{-1} on filled grains panicle^{-1}

Significant variation was recorded due to the interaction effect of varieties and number of seedlings hill^{-1} on filled grains panicle^{-1} (Table 16). The maximum number of filled grains panicle^{-1} (153.00) was found from the treatment combination with BRRI dhan34 (V_1) when transplanted with 3 seedling hill^{-1} (S_2) and the minimum number of filled grains panicle^{-1} (117.87) was found from the treatment combination with local Tulsimala (V_2) when transplanted with 2 seedling hill^{-1} (S_1).

4.2.3.6 Interaction effect of transplanting date and seedling number hill^{-1}

Interaction effect of transplanting date and seedling number hill^{-1} had a significant effect on number of filled grains panicle^{-1} of rice during aman season (Table 17). Results showed that, the maximum number of filled grains panicle^{-1} (172.18) was observed from the treatment combination when rice transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2) and the minimum number of filled grains panicle^{-1} (108.98) was found from the treatment combination when transplanted on 14th August (T_1) with 2 seedling hill^{-1} (S_1), which was statistically similar with T_4S_2 (116.25).

4.2.3.7 Interaction effect of variety and transplanting date and seedling number hill^{-1} on filled grains panicle^{-1}

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on the number of filled grains panicle^{-1} of rice (Table 18). Results showed that, the maximum number of filled grains panicle^{-1} (206.33 g) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2) and the minimum number of filled grains panicle^{-1} (99.47) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_1), which was similar with $V_1T_1S_1$, $V_2T_3S_3$, $V_1T_4S_2$ and $V_2T_3S_1$.

4.2.4 Unfilled grains panicle^{-1}

4.2.4.1 Effect of aromatic rice varieties on unfilled grains panicle^{-1}

The unfilled grains panicle^{-1} varied significantly due to varieties (Table 14). The result of the experiment revealed that, the HYV variety- BRRI dhan34 (V_1) produced the maximum number of unfilled grains panicle^{-1} (48.99) and the minimum number of unfilled grains panicle^{-1} (38.66) was recorded from Tulsimala (V_2). Similar findings were reported by Mannan *et al.* (2009), BRRI (2003) and Shah and Yadav (2001) who reported that, the number of unfilled grains pancle^{-1} differed due to varietal variation.

4.2.4.2 Effect of transplanting date on unfilled grains panicle^{-1}

Analysis of variance showed that number of unfilled grains panicle^{-1} was statistically differed due to the different transplanting date (Table 14). The result showed that, the maximum number of unfilled grains panicle^{-1} (47.33) was counted when the rice was transplanted on 4th September (T_4), which was statistically similar with the rice was transplanted on 28th August (T_3) and the minimum number of unfilled grains panicle^{-1} (41.06) was counted when the rice was transplanted on 14th August (T_1), which was statistically similar with the rice was transplanted on 21th August (T_2).

4.2.4.3 Effect of seedling number hill^{-1} on unfilled grains panicle^{-1}

Seedling number hill^{-1} had a significant effect on filled grains panicle^{-1} of rice during aman season (Table 14). The maximum number of unfilled grains panicle^{-1} (45.65) was observed from S_3 (4 seedling hill^{-1}) and the minimum number of unfilled grains panicle^{-1} (42.79) was observed from S_2 (3 seedling hill^{-1}), which was statistically similar with S_1. Ali (2008) reported that number of seedlings hill^{-1} had significant influence on number of unfilled grains panicle^{-1}.

4.2.4.4 Interaction effect of variety and transplanting date on unfilled grains panicle^{-1}

Unfilled grains panicle^{-1} was statistically influenced by interaction effect of variety and transplanting date (Table 15). The highest (57.32) number of unfilled grains panicle^{-1} was recorded from the high yielding variety BRRI dhan34 (V_1) which was transplanted on 4th September (T_4), which was statistically at par with treatment combinations V_1T_3, whereas the lowest number (37.34) was counted from the local variety Tulsimala (V_2) which was transplanted on 4th September (T_4), which was statistically similar with V_2T_3, V_2T_2 and V_2T_1.

4.2.4.5 Interaction effect of variety and seedling number hill^{-1} on unfilled grains panicle^{-1}

Significant variation was recorded due to the interaction effect of varieties and number of seedlings hill^{-1} on unfilled grains panicle^{-1} (Table 16). The maximum number of unfilled grains panicle^{-1} (51.28) was found from the treatment combination with BRRI dhan34 (V_1) which was transplanted with 4 seedling hill^{-1} (S_3), which was statistically at par with treatment combinations V_1S_2 and the minimum number of unfilled grains panicle^{-1} (35.93) was found from the treatment combination with local variety Tulsimala (V_2) which was transplanted with 3 seedling hill^{-1} (S_2).

4.2.4.6 Interaction effect of transplanting date and seedling number hill^{-1} on unfilled grains panicle^{-1}

Interaction effect of Transplanting date and Seedling number hill^{-1} had a significant effect on number of unfilled grains panicle^{-1} of rice during aman season (Table 17). Results showed that, the maximum number of unfilled grains panicle^{-1} (50.05) was observed from the treatment combination when rice transplanted on 4th September (T_4) with 4 seedling hill^{-1} (S_3) and the minimum number of unfilled grains panicle^{-1} (38.53) was found from the treatment combination when rice transplanted on 14th August (T_1) with 3 seedling hill^{-1} (S_2), which was statistically similar with T_1S_1, T_2S_2 and T_2S_3.

4.2.4.7 Interaction effect of variety, transplanting date and seedling number hill^{-1} on unfilled grains panicle^{-1}

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on the number of unfilled grains panicle^{-1} of rice (Table 18). Results showed that, the maximum number of unfilled grains panicle^{-1} (62.05) was observed from the treatment combination with BRRI dhan34 (V_1) which transplanted on 4th September (T_4) with 4 seedling hill^{-1} (S_3), which was similar with $V_1T_3S_2$ and $V_1T_4S_2$ and the minimum number of unfilled grains panicle^{-1} (34.11) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) with 3 seedling hill^{-1} (S_2), which was statistically similar with $V_2T_1S_2$, $V_2T_3S_1$, $V_1T_1S_1$, $V_2T_2S_2$, $V_2T_4S_3$, $V_2T_3S_2$, $V_2T_3S_3$ and $V_2T_4S_1$.

Table 14. Effect of variety, transplanting date and number of seedlings hill^{-1} on yield contributing characters of aromatic rice

Treatment	Panicle weight (g)	Total grains panicle^{-1} (no.)	Fill grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)
Effect of Variety				
V_1	1.95 a	195.88 a	146.89 a	48.99 a
V_2	1.73 b	166.83 b	128.17 b	38.66 b
LSD (0.05)	0.03	4.55	3.87	1.74
Effect of Transplanting date				
T_1	1.73 b	170.33 b	129.27 c	41.06 b
T_2	1.97 a	193.92 a	152.66 a	41.26 b
T_3	1.95 a	189.14 a	143.47 b	45.66 a
T_4	1.72 b	172.05 b	124.72 c	47.33 a
LSD (0.05)	0.05	6.43	5.48	2.46
Effect of Seedling number hill^{-1}				
S_1	1.80 b	174.06 b	131.02 c	43.04 b
S_2	1.89 a	187.44 a	144.65 a	42.79 b
S_3	1.83 b	182.57 a	136.92 b	45.65 a
LSD (0.05)	0.04	5.57	4.74	2.13
CV (%)	**3.78**	**5.29**	**5.02**	**19.49**

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

V_1: BRRI dhan34
V_2: Tulsimala

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

Table 15. Interaction effect of variety and transplanting date on yield contributing characters of aromatic rice

Treatment	Panicle weight (g)	Total grains panicle^{-1} (no.)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)
V_1 T_1	1.67 de	162.26 e	120.14 c	42.12 b
V_2 T_1	1.79 c	178.40 d	138.40 b	40.00 bc
V_1 T_2	2.13 b	206.67 b	164.00 a	42.67 b
V_2 T_2	1.81 c	181.16 d	141.31 b	39.84 bc
V_1 T_3	2.20 a	223.38 a	169.53 a	53.85 a
V_2 T_3	1.71 d	154.89 ef	117.41 c	37.48 c
V_1 T_4	1.82 c	191.22 c	133.90 b	57.32 a
V_2 T_4	1.61 e	152.89 f	115.55 c	37.34 c
LSD (0.05)	**0.07**	**9.10**	**7.74**	**3.48**
CV (%)	**3.78**	**5.29**	**5.02**	**19.49**

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

V_1: BRRI dhan34 | T_1: 14th August | T_3: 28th August
V_2: Tulsimala | T_2: 21st August | T_4: 4th September

Table 16. Interaction effect of variety and seedling number hill^{-1} on yield contributing characters of aromatic rice

Treatment	Panicle weight (g)	Total grains panicle^{-1} (no.)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)
V_1 S_1	1.95 a	190.22 b	144.17 b	46.04 b
V_2 S_1	1.65 d	157.91 d	117.87 d	40.04 c
V_1 S_2	1.98 a	202.65 a	153.00 a	49.64 a
V_2 S_2	1.81 b	172.23 c	136.30 c	35.93 d
V_1 S_3	1.94 a	194.79 ab	143.50 b	51.28 a
V_2 S_3	1.73 c	170.36 c	130.34 c	40.02 c
LSD (0.05)	**0.06**	**7.88**	**6.71**	**3.02**
CV (%)	**3.78**	**5.29**	**5.02**	**19.49**

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

V_1: BRRI dhan34 | S_1: 2 Seedling hill^{-1}
V_2: Tulsimala | S_2: 3 Seedling hill^{-1}

S_3: 4 Seedling hill^{-1}

Table 17. Interaction effect of transplanting date and seedling number hill^{-1} on yield contributing characters of aromatic rice

Treatment	Panicle weight (g)	Total grains panicle^{-1} (no.)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)
T_1 S_1	1.54 f	148.00 g	108.98 f	39.02 ef
T_1 S_2	1.93 bc	183.34 cd	144.81 c	38.53 f
T_1 S_3	1.71 e	179.65 de	134.02 d	45.63 bc
T_2 S_1	1.99 b	204.28 b	160.58 b	43.70 cd
T_2 S_2	1.93 bc	184.66 cd	145.37 c	39.29 ef
T_2 S_3	1.99 b	192.81 c	152.03 bc	40.78 d-f
T_3 S_1	1.95 b	172.12 ef	129.30 d	42.82 c-e
T_3 S_2	2.14 a	220.20 a	172.18 a	48.02 ab
T_3 S_3	1.78 de	175.08 de	128.93 d	46.15 a-c
T_4 S_1	1.73 e	171.84 ef	125.22 de	46.63 a-c
T_4 S_2	1.56 f	161.56 f	116.25 ef	45.31 bc
T_4 S_3	1.85 cd	182.76 c-e	132.70 d	50.05 a
LSD (0.05)	**0.08**	**11.14**	**9.49**	**4.26**
CV (%)	**3.78**	**5.29**	**5.02**	**19.49**

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

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September
S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

Table 18. Interaction effect of variety and transplanting date and seedling number hill^{-1} on yield contributing characters of aromatic rice

Treatment	Panicle weight (g)	Grains panicle^{-1} (no.)	Fill grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)
$V_1T_1S_1$	1.49 mn	135.12 l	99.52 m	35.60 i-k
$V_2T_1S_1$	1.58 lm	160.88 jk	118.45 j-l	42.43 e-g
$V_1T_1S_2$	1.89 f-h	182.98 f-h	140.55 e-g	42.42 e-g
$V_2T_1S_2$	1.97 d-f	183.70 f-h	149.06 c-f	34.64 jk
$V_1T_1S_3$	1.62 kl	168.68 h-j	120.34 i-k	48.33 de
$V_2T_1S_3$	1.81 g-i	190.61 e-g	147.69 c-f	42.92 e-g
$V_1T_2S_1$	2.17 b	224.05 b	179.55 b	44.50 ef
$V_2T_2S_1$	1.80 h-j	184.50 fg	141.60 e-g	42.90 e-g
$V_1T_2S_2$	2.15 b	201.13 c-e	158.85 c	42.28 f-h
$V_2T_2S_2$	1.71 i-k	168.20 h-j	131.90 g-i	36.30 h-k
$V_1T_2S_3$	2.06 b-d	194.84 c-f	153.61 c-e	41.23 f-i
$V_2T_2S_3$	1.92 e-g	190.78 d-g	150.44 c-f	40.33 f-j
$V_1T_3S_1$	2.10 bc	197.30 c-f	146.65 c-f	50.65 cd
$V_2T_3S_1$	1.80 h-j	146.94 kl	111.94 k-m	35.00 jk
$V_1T_3S_2$	2.42 a	263.70 a	206.33 a	57.37 ab
$V_2T_3S_2$	1.85 gh	176.70 g-i	138.03 f-h	38.67 f-k
$V_1T_3S_3$	2.09 bc	209.13 bc	155.61 cd	53.52 b-d
$V_2T_3S_3$	1.47 mn	141.03 l	102.25 m	38.78 f-k
$V_1T_4S_1$	2.03 c-e	204.38 c-e	150.97 c-f	53.42 b-d
$V_2T_4S_1$	1.44 n	139.30 l	99.47 m	39.84 f-k
$V_1T_4S_2$	1.44 n	162.78 ij	106.28 lm	56.50 a-c
$V_2T_4S_2$	1.69 j-l	160.34 jk	126.22 h-j	34.11 k
$V_1T_4S_3$	1.99 c-f	206.49 cd	144.44 d-g	62.05 a
$V_2T_4S_3$	1.72 i-k	159.02 jk	120.96 i-k	38.06 g-k
LSD (0.05)	**0.11**	**7.28**	**13.41**	**6.03**
CV (%)	**3.78**	**5.29**	**5.02**	**19.49**

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

V_1: BRRI dhan34
V_2: Tulsimala

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

4.2.5 Total tillers hill^{-1}

4.2.5.1 Effect of aromatic rice varieties on total tillers hill^{-1}

Total tillers hill^{-1} varied significantly due to varieties (Table 19). The result of the experiment revealed that, the HYV variety- BRRI dhan34 produced the maximum number of total tillers hill^{-1} (14.64) and the minimum number of total tillers hill^{-1} was recorded from Tulsimala (12.41).

4.2.5.2 Effect of transplanting date on total tillers hill^{-1}

Total tillers hill^{-1} showed statistically significant differences due to different date of transplanting (Table 19). Maximum number of total tillers hill^{-1} (14.67) was recorded when rice transplanted on 21st August (T_2) and the minimum number of total tillers hill^{-1} was recorded from T_1 (14th August). Khalifa (2009) reported that hybrid rice variety surpassed other varieties in consideration of total tillers hill^{-1}.

4.2.5.3 Effect of seedling number hill^{-1} on total tillers hill^{-1}

The number of total tillers hill^{-1} was not significantly influenced by seedling number hill^{-1} (Table 19). Numerically the maximum number of total tillers hill^{-1} (13.65) was observed from S_2 (3 seedling hill^{-1}) and the minimum one (13.35) observed from S_3 (4 seedling hill^{-1}).

4.2.5.4 Interaction effect of variety and transplanting date on total tillers hill^{-1}

Interaction effect of variety and transplanting date had a significant effect on the number of total tillers hill^{-1} of rice during aman season (Table 20). Results showed that, maximum number of total tillers hill^{-1} (15.71) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3), which was statistically similar with V_1T_2 and the minimum number of total tillers hill^{-1} (11.81) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) which was statistically similar with V_2T_1 and V_2T_3.

4.2.5.6 Interaction effect of variety and seedling number $hill^{-1}$ on total tillers $hill^{-1}$

Interaction effect of variety and seedling number $hill^{-1}$ had a significant effect on the number of total tillers $hill^{-1}$ of rice during aman season (Table 21). Results showed that, the maximum number of total tillers $hill^{-1}$ (14.85) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted with 2 seedling $hill^{-1}$ (S_1), which was statistically similar with V_1S_2 and V_1S_3. On the other hand the minimum number of total tillers $hill^{-1}$ (12.19) was observed from the treatment combination with local Tulsimala (V_2) when transplanted with 4 seedling $hill^{-1}$ (S_3), which was statistically similar with V_2S_1.

4.2.5.6 Interaction effect of transplanting date and seedling number $hill^{-1}$ on total tillers $hill^{-1}$

Interaction effect of transplanting date and seedling number $hill^{-1}$ had a significant effect on number of total tillers $hill^{-1}$ of rice during aman season (Table 22). Results showed that, the maximum number of total tillers $hill^{-1}$ (15.17) was observed from the treatment combination when rice transplanted on 21st August (T_2) with 3 seedling $hill^{-1}$ (S_2), which was statistically similar with $T_3S_{2,}$ T_2S_1 and the minimum total number of tiller $hill^{-1}$ (12.08) was observed from the treatment combination when transplanted on 14th August (T_1) with 2 seedling $hill^{-1}$ (S_1), which was statistically similar with T_4S_2 and T_1S_2.

4.2.5.7 Interaction effect of variety, transplanting date and seedling number $hill^{-1}$ on total tillers $hill^{-1}$

Interaction effect of variety, transplanting date and seedling number $hill^{-1}$ had a significant effect on number of total tillers $hill^{-1}$ of rice during aman season (Table 23). Results showed that, the maximum number of total tillers $hill^{-1}$ (17.51) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) with 3 seedling $hill^{-1}$ (S_2) and the minimum number of total tillers $hill^{-1}$ (10.08) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 14th August (T_1) with 2 seedling $hill^{-1}$ (S_1), which was similar with $V_2T_3S_3$.

4.2.6 Effective tillers hill^{-1}

4.2.6.1 Effect of aromatic rice varieties on effective tillers hill^{-1}

Significant variation was recorded on effective tillers hill^{-1} due to rice varieties (Table 19). The result of the experiment revealed that, the HYV variety- BRRI dhan34 produced the maximum number of effective tillers hill^{-1} (13.42) and the minimum number of effective tillers hill^{-1} (11.40) was recorded from Tulsimala (V_2). Khalifa (2009) reported that H_1 hybrid rice variety surpassed other varieties in consideration of effective tillers hill^{-1}.

4.2.6.2 Effect of transplanting date on effective tillers hill^{-1}

Effective tillers hill^{-1} showed statistically significant differences due to different Date of transplanting (Table 19). Maximum number of effective tillers hill^{-1} (13.42) was recorded when rice transplanted on 21st August (T_2) and the minimum number of effective tillers hill^{-1} was recorded from T_1 (14th August).

4.2.6.3 Effect of seedling number hill^{-1} on effective tillers hill^{-1}

Effective tillers hill^{-1} also showed significant differences due to number of seedlings hill^{-1} (Table 19). The maximum number of effective tillers hill^{-1} was recorded from S_1 (12.57) which were statistically similar to S_2 (12.57). On the other hand, the minimum number of effective tillers hill^{-1} was found from S_3 (12.37). This result is in agreement with Alam (2006) who found the highest number of effective tillers hill^{-1} from 2 seedlings hill^{-1}.

4.2.6.4 Interaction effect of variety and transplanting date on effective tillers hill^{-1}

Interaction effect of variety and transplanting date had a significant effect on the number of effective tillers hill^{-1} of rice during aman season (Table 20). Results showed that, maximum number of effective tillers hill^{-1} (14.67) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3), which was statistically similar with V_1T_2 and the minimum number of effective tillers hill^{-1} (10.85) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4).

4.2.6.6 Interaction effect of variety and seedling number hill^{-1} on effective tillers hill^{-1}

Interaction effect of variety and seedling number hill^{-1} had a significant effect on the number of effective tillers hill^{-1} of rice during aman season (Table 21). Results showed that, the maximum number of effective tillers hill^{-1} (13.77) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted with 2 seedling hill^{-1} (S_1). On the other hand the minimum number of effective tillers hill^{-1} (11.25) was observed from the treatment combination with local Tulsimala (V_2) when transplanted with 4 seedling hill^{-1} (S_3).

4.2.6.6 Interaction effect of transplanting date and seedling number hill^{-1} on effective tillers hill^{-1}

Interaction effect of transplanting date and seedling number hill^{-1} had a significant effect on number of effective tillers hill^{-1} of rice during aman season (Table 22). Results showed that, the maximum number of effective tillers hill^{-1} (13.83) was observed from the treatment combination when rice transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2), which was statistically similar with T_2S_2 and T_2S_1 and the minimum effective number of tiller hill^{-1} (12.11) was observed from the treatment combination when rice transplanted on 14th August (T_1) with 3 seedling hill^{-1} (S_2).

4.2.6.7 Interaction effect of variety and transplanting date and seedling number hill^{-1} on effective tillers hill^{-1}

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on number of effective tillers hill^{-1} of rice during aman season (Table 23). Results showed that, the maximum number of effective tillers hill^{-1} (16.33) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2) and the minimum number of effective tillers hill^{-1} (9.63) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 14th August (T_1) with 2 seedling hill^{-1} (S_1).

4.2.7 Ineffective tillers hill^{-1}

4.2.7.1 Effect of aromatic rice varieties on ineffective tillers hill^{-1}

The number of ineffective tillers hill^{-1} was not significantly influenced by varieties (Table 19). Numerically The result of the experiment revealed that, the HYV variety- BRRI dhan34 produced the maximum number of effective tillers hill^{-1} (1.08) and the minimum number of ineffective tillers hill^{-1} (1.01) was recorded from Tulsimala (V_2).

4.2.7.2 Effect of transplanting date on ineffective tillers hill^{-1}

Ineffective tillers hill^{-1} showed statistically significant differences due to different Date of transplanting (Table 19). Maximum number of ineffective tillers hill^{-1} (1.30) was recorded when rice transplanted on 4th September (T_4), which were statistically similar to T_2 (1.25) and the minimum number of ineffective tillers hill^{-1} (0.70) was recorded from T_1 (14th August), which were statistically similar to T_3 (0.93)

4.2.7.3 Effect of seedling number hill^{-1} on ineffective tillers hill^{-1}

Ineffective tillers hill^{-1} did not showed significant differences due to number of seedlings hill^{-1} (Table 19). Numerically the maximum number of ineffective tillers hill^{-1} was recorded from S_2 (1.15) and the minimum number of ineffective tillers hill^{-1} was found from S_3 (0.98).

4.2.7.4 Interaction effect of variety and transplanting date on ineffective tillers hill^{-1}

Interaction effect of variety and transplanting date had a significant effect on the number of ineffective tillers hill^{-1} of rice during aman season (Table 20). Results showed that, maximum number of ineffective tillers hill^{-1} (1.63) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 4th September (T_4), which was statistically similar with V_2T_2 and the minimum number of ineffective tillers hill^{-1} (0.67) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 14th August (T_1), which was statistically similar with V_2T_1, V_2T_3, V_2T_4, V_1T_2 and V_1T_4.

4.2.7.5 Interaction effect of variety and seedling number hill^{-1} on ineffective tillers hill^{-1}

Interaction effect of variety and seedling number hill^{-1} had no significant effect on the number of ineffective tillers hill^{-1} of rice during aman season (Table 21). Results showed that, numerically the maximum number of ineffective tillers hill^{-1} (1.17) was observed from the treatment combination of V_2S_2. On the other hand the minimum number of ineffective tillers hill^{-1} (0.92) was observed from the treatment combination with local Tulsimala (V_2) when transplanted with 2 seedling hill^{-1} (S_1).

4.2.7.6 Interaction effect of transplanting date and seedling number hill^{-1} on ineffective tillers hill^{-1}

Interaction effect of transplanting date and seedling number hill^{-1} had a significant effect on number of ineffective tillers hill^{-1} of rice during aman season (Table 22). Results showed that, the maximum number of effective tillers hill^{-1} (1.33) was observed from the treatment combination when rice transplanted on 21st August (T_2) with 3 seedling hill^{-1} (S_2), which was statistically similar with T_4S_3, T_4S_1, T_2S_1, T_4S_2, T_2S_3, T_3S_2, T_3S_1, T_1S_2 and T_3S_3 and the minimum ineffective number of tiller hill^{-1} (0.50) was observed from the treatment combination when rice transplanted on 14th August (T_1) with 2 seedling hill^{-1} (S_1), which was statistically similar with T_1S_3.

4.2.7.7 Interaction effect of variety, transplanting date and seedling number hill^{-1} on ineffective tillers hill^{-1}

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on number of ineffective tillers hill^{-1} of rice during aman season (Table 23). Results showed that, the maximum number of ineffective tillers hill^{-1} (1.89) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_1), which is statistically similar with $V_2T_2S_1$ and the minimum number of ineffective tillers hill^{-1} (0.44) was observed from the treatment combination with local Tulsimala (V_2) when transplanted on 14th August (T_1) with 2 seedling hill^{-1} (S_1).

4.2.8 Weight of 1000-grain (g)

4.2.8.1 Effect of aromatic rice varieties on weight of 1000-grain (g)

Rice varieties showed significant variation on weight of 1000-grain (Table 19). The result of the experiment revealed that, the maximum weight of 1000-grain (11.60 g) was found from Tulsimala and the minimum weight of 1000-grain was observed from the HYV variety- BRRI dhan34 (10.51 g).

4.2.8.2 Effect of transplanting date on weight of 1000-grain (g)

Date of transplanting had no significant effect on weight of 1000-grain (g) of rice during aman season (Table 19). Numerically the highest weight of 1000-grain were recorded when rice transplanted on 21st August (T_2) (11.15 g) and the lowest weight of 1000-grain were recorded from 4th September (T_4) (10.96 g).

4.2.8.3 Effect of seedling number hill^{-1} on weight of 1000-grain (g)

Seedling number hill^{-1} had no significant effect on weight of 1000-grain (g) of rice during aman season (Table 19). Results showed that, numerically the highest weight of 1000-grain (11.12 g) was observed from S_3 (3 seedling hill^{-1}) and the lowest weight of 1000-grain (11.00) was observed from S_1 (2 seedling hill^{-1}).

4.2.8.4 Interaction effect of variety and transplanting date on weight of 1000-grain (g)

Interaction effect of variety and transplanting date had significant effect on weight of 1000-grain (g) of rice during aman season (Table 20). Highest weight of 1000-grain (11.75) was observed from the treatment combination V_2T_2, which were statistically similar with the treatment combination V_2T_3, V_2T_1 and V_2T_4 and the lowest weight of 1000-grain (1.61 g) was observed from the treatment combination of V_1T_4, which was statistically similar with V_1T_1, V_1T_3 and V_1T_2.

4.2.8.5 Interaction effect of variety and seedling number hill^{-1} on weight of 1000-grain (g)

Interaction effect of variety and seedling number hill^{-1} had a significant effect on weight of 1000-grain (g) of rice (Table 21). Results showed that, highest weight of 1000-grain

(11.73 g) was observed from the treatment combination with local Tulsimala (V_2) when transplanted with 4 seedling hill^{-1} (S_3), which was statistically similar with V_2S_1 and V_2S_2. On the other hand the lowest weight of 1000-grain (11.41 g) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted with 2 seedling hill^{-1} (S_1), which was statistically similar with V_1S_3 and V_1S_2.

4.2.8.6 Interaction effect of transplanting date and seedling number hill^{-1} on weight of 1000-grain (g)

Interaction effect of transplanting date and seedling number hill^{-1} had a significant effect on weight of 1000-grain (g) of rice during aman season (Table 22). Results showed that, highest weight of 1000-grain (11.29 g) was observed from the treatment combination when rice transplanted on 21st August (T_2) with 3 seedlings hill^{-1} (S_2), which were statistically similar with all other treatment combination, except treatment combination T_1S_2 and T_4S_1.

4.2.8.7 Interaction effect of variety, transplanting date and seedling number hill^{-1} on weight of 1000-grain (g)

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on weight of 1000-grain (g) of rice during aman season (Table 23). Results showed that, highest weight of 1000-grain (12.01 g) was observed from the treatment combination of $V_2T_2S_3$, which were statistically similar with $V_2T_1S_3$, $V_2T_3S_3$, $V_2T_1S_1$, $V_2T_3S_2$, $V_2T_2S_2$, $V_2T_2S_1$, $V_2T_4S_2$, $V_2T_3S_3$ and $V_2T_4S_3$ and the lowest weight of 1000-grain (10.2 g) was observed from the treatment combination of $V_1T_2S_3$, which was similar with $V_1T_1S_1$.

Table 19. Effect of variety, transplanting date, and number of seedlings hill^{-1} on yield contributing characters of aromatic rice

Treatment	Total tillers hill^{-1}(no.)	Effective tillers hill^{-1} (no.)	Ineffective tillers hill^{-1} (no.)	1000-seeds weight (g)
Effect of Variety				
V_1	14.64 a	13.56 a	1.08 a	10.51 b
V_2	12.41 b	11.40 b	1.01 a	11.59 a
LSD (0.05)	0.28	0.14	0.26	1.17
Effect of Transplanting date				
T_1	12.396 d	11.70 c	0.70 c	10.99 a
T_2	14.672 a	13.42 a	1.25 ab	11.16 a
T_3	13.929 b	13.00 b	0.93 bc	11.10 a
T_4	13.092 c	11.80 c	1.30 a	10.96 a
LSD (0.05)	0.04	0.20	0.36	0.24
Effect of Seedling number hill^{-1}				
S_1	13.569 a	12.57 a	1.00 a	11.00 a
S_2	13.652 a	12.51 ab	1.15 a	11.04 a
S_3	13.346 a	12.37 b	0.98 a	11.12 a
LSD (0.05)	0.35	0.17	0.32	0.21
CV (%)	**4.41**	**2.40**	**52.01**	**3.29**

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

V_1: BRRI dhan34
V_2: Tulsimala

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

Table 20. Interaction effect of variety and transplanting date on yield contributing characters of aromatic rice

Treatment	Total tillers hill^{-1}(no.)	Effective tillers hill^{-1} (no.)	Ineffective tillers hill^{-1} (no.)	1000-seeds weight (g)
V_1 T_1	12.893 d	12.226 c	0.67 c	10.48 b
V_2 T_1	11.900 e	11.175 d	0.73 c	11.50 a
V_1 T_2	15.568 a	14.605 a	0.96 c	10.58 b
V_2 T_2	13.777 c	12.244 c	1.53 ab	11.74 a
V_1 T_3	15.710 a	14.666 a	1.04 bc	10.53 b
V_2 T_3	12.148 e	11.333 d	0.82 c	11.67 a
V_1 T_4	14.370 b	12.741 b	1.63 a	10.47 b
V_2 T_4	11.814 e	10.852 e	0.96 c	11.46 a
LSD (0.05**)**	**0.57**	**0.28**	**0.51**	**0.35**
CV (%)	**4.41**	**2.40**	**52.01**	**3.29**

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

V_1: BRRI dhan34 T_1: 14th August T_3: 28th August
V_2: Tulsimala T_2: 21st August T_4: 4th September

Table 21. Interaction effect of variety and seedling number hill^{-1} on yield contributing characters of aromatic rice

Treatment	Total tillers hill^{-1}(no.)	Effective tillers hill^{-1} (no.)	Ineffective tillers hill^{-1} (no.)	1000-seeds weight (g)
V_1 S_1	14.85 a	13.77 a	1.08 a	10.41 b
V_2 S_1	12.27 bc	11.37 cd	0.92a	11.59 a
V_1 S_2	14.55 a	13.44 b	1.13 a	10.62 b
V_2 S_2	12.75 b	11.58 c	1.17 a	11.46 a
V_1 S_3	14.50 a	13.48 b	1.02 a	10.52 b
V_2 S_3	12.19 c	11.25 d	0.94 a	11.73 a
LSD (0.05**)**	**0.49**	**0.25**	**0.45**	**0.30**
CV (%)	**4.41**	**2.40**	**52.01**	**3.29**

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

V_1: BRRI dhan34 S_1: 2 Seedling hill^{-1}
V_2: Tulsimala S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

Table 22. Interaction effect of transplanting date and seedling number hill^{-1} on yield contributing characters of aromatic rice

Treatment	Total tillers hill^{-1}(no.)	Effective tillers hill^{-1} (no.)	Ineffective tillers hill^{-1} (no.)	1000-seeds weight (g)
T_1 S_1	12.08 f	11.58 d	0.50 c	10.99 a-c
T_1 S_2	12.30 ef	11.41 d	0.89 a-c	10.70 c
T_1 S_3	12.81 de	12.11 c	0.70 bc	11.29 a
T_2 S_1	14.92 a	13.64 a	1.28 ab	11.06 a-c
T_2 S_2	15.17 a	13.83 a	1.33 a	11.31 a
T_2 S_3	13.93 b	12.80 b	1.13 ab	11.11 a-c
T_3 S_1	13.78 bc	12.83 b	0.94 a-c	11.11 a-c
T_3 S_2	14.92 a	13.83 a	1.09 a-c	11.14 ab
T_3 S_3	13.09 cd	12.33 c	0.76 a-c	11.05 a-c
T_4 S_1	13.50 b-d	12.22 c	1.28 ab	10.84 bc
T_4 S_2	12.22 ef	10.94 e	1.28 ab	11.00 a-c
T_4 S_3	13.56 bc	12.22 c	1.33 a	11.05 a-c
LSD (0.05)	**0.49**	**0.35**	**0.63**	**0.42**
CV (%)	**4.41**	**2.40**	**52.01**	**3.29**

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

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September
S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

Table 23. Interaction effect of variety and transplanting date and seedling number hill^{-1} on yield contributing characters of aromatic rice

Treatment	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Ineffective tillers hill^{-1} (no.)	1000-seeds weight (g)
$V_1T_1S_1$	14.08 e-g	13.53 d	0.56 cd	10.22 f
$V_2T_1S_1$	10.08 n	9.63 i	0.44 d	11.75 ab
$V_1T_1S_2$	12.26 j-l	11.48 f	0.78 b-d	10.45 ef
$V_2T_1S_2$	12.34 i-l	11.34 fg	1.00 a-d	10.95 de
$V_1T_1S_3$	12.33 i-l	11.67 f	0.67 b-d	10.77 d-f
$V_2T_1S_3$	13.29 g-i	12.56 e	0.73 b-d	11.81 ab
$V_1T_2S_1$	15.89 b	15.11 b	0.78 bcd	10.57 ef
$V_2T_2S_1$	13.95 f-h	12.18 e	1.78 a	11.56 a-c
$V_1T_2S_2$	15.44 bc	14.33 c	1.11 a-d	10.98 c-e
$V_2T_2S_2$	14.89 c-f	13.33 d	1.56 ab	11.63 ab
$V_1T_2S_3$	15.37 b-d	14.37 c	1.00 a-d	10.20 f
$V_2T_2S_3$	12.49 i-k	11.22 fg	1.27 a-d	12.01 a
$V_1T_3S_1$	14.44 d-f	13.33 d	1.11 a-d	10.45 ef
$V_2T_3S_1$	13.11 g-j	12.33 e	0.78 b-d	11.77 ab
$V_1T_3S_2$	17.51 a	16.33 a	1.18 abcd	10.59 ef
$V_2T_3S_2$	12.33 i-l	11.33 fg	1.00 a-d	11.69 ab
$V_1T_3S_3$	15.18 b-d	14.33 c	0.84 b-d	10.54 ef
$V_2T_3S_3$	11.00 mn	10.33 h	0.67 bcd	11.55 abc
$V_1T_4S_1$	15.00 b-e	13.11 d	1.89 a	10.41 ef
$V_2T_4S_1$	12.00 kl	11.33 fg	0.67 b-d	11.27 b-d
$V_1T_4S_2$	13.00 h-j	11.56 f	1.44 a-c	10.45 ef
$V_2T_4S_2$	11.44 lm	10.33 h	1.11 a-d	11.56 a-c
$V_1T_4S_3$	15.11 b-d	13.56 d	1.56 ab	10.55 ef
$V_2T_4S_3$	12.00 kl	10.89 g	1.11 a-d	11.55 a-c
LSD (0.05)	**0.98**	**0.49**	**0.44**	**0.60**
CV (%)	**4.41**	**2.40**	**52.01**	**3.29**

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

V_1: BRRI dhan34
V_2: Tulsimala

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

4.3 Yield (t ha^{-1})

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

4.3.1.1 Effect of aromatic rice varieties on grain yield (t ha^{-1})

In present study variety had significant effect on the grain yield (t ha^{-1}) of rice (Table 24). The highest grain yield of rice was recorded from BRRI dhan34 (3.99 t ha^{-1}). In contrast the lowest grain yield of rice was recorded from Tulsimala (2.88 t ha^{-1}). Grain yield differed due to varieties were reported by Suprithatno and Sutaryo (1992), Singh and Singh (1992) who recorded variable grain yield among tested varieties. Grain yield is a function of interplay of various yield components such as number of productive tillers hill^{-1}, number of filled grains panicl^{-1} and 1000-grain weight (Hassan *et al.* 2003).

4.3.1.2 Effect of transplanting date on grain yield (t ha^{-1})

Date of transplanting had a significant effect on grain yield (t ha^{-1}) of rice during aman season (Table 24). Transplanting date 21st august (T_2) produced significantly the highest grain yield (3.92 t ha^{-1}). On the other hand, the lowest grain yield (2.76 t ha^{-1}) was produced by transplanting date 4th September (T_4). The results agreed with the findings of Chandra and Manna (1988), Ali *et al* (1999) and Ghosh and Ganguly (1994) who stated that delayed transplanting reduces grain yield of rice due to shorter vegetative phase.

4.3.1.3 Effect of seedling number hill^{-1} on grain yield (t ha^{-1})

Number of seedlings hill^{-1} showed significant differences on grain yield (t ha^{-1}) (Table 24). Data revealed that the highest grain yield was found from S_2 (3.79 t ha^{-1}). On the other hand, the lowest grain yield was recorded from S_1 (3.17 t ha^{-1}). Similar results were also found by Islam *et al*. (2012), Obulamma *et al*. (2002) and Shrirame *et al*. (2000).

4.3.1.4 Interaction effect of variety and transplanting date on grain yield (t ha^{-1})

Interaction between variety and transplanting date played an important role for promoting the yield. Grain yield was significantly influenced by the interaction effect of variety and transplanting date (Table 25). Among the treatments, the highest grain yield was observed in BRRI dhan34 which was transplanted on 28th August (4.57 t ha^{-1}) followed by V_1T_2 (4.00 t ha^{-1}), whereas the lowest grain yield (2.26) was observed in local variety Tulsimala which was transplanted on 4th September.

4.3.1.5 Interaction effect of variety and seedling number hill^{-1} on grain yield (t ha^{-1})

Significant variation was recorded due to the interaction effect of rice varieties and number of seedlings hill^{-1} on grain yield of rice (Table 26). The highest grain yield was recorded from the combination of V_1S_2 (4.43 t ha^{-1}) which was statistically different from others and the lowest grain yield was found from V_2S_1 (2.71 t ha^{-1}), which was statistically similar with V_2S_3.

4.3.1.6 Interaction effect of transplanting date and seedling number hill^{-1} on grain yield (t ha^{-1})

Interaction effect of transplanting date and seedling number hill^{-1} had a significant effect on grain yield (t ha^{-1}) of rice during aman season (Table 27). Results showed that, highest grain yield (4.36 t ha^{-1}) was observed from the treatment combination when rice transplanted on 21st August (T_2) with 3 seedling hill^{-1} (S_2) and the lowest grain yield (2.45 t ha^{-1}) was observed from the treatment combination when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_2), which was statistically similar with T_4S_3.

4.3.1.7 Interaction effect of variety and transplanting date and seedling number hill^{-1} on grain yield (t ha^{-1})

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on grain yield (t ha^{-1}) of rice during aman season (Table 28). Results showed that, highest grain yield (5.01 t ha^{-1}) was observed from the treatment combination with BRRI dhan34 (V_1) when transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2), which were statistically similar with $V_1T_2S_2$ and $V_1T_2S_{2,}$ whereas the lowest grain yield (2.09 t ha^{-1}) were observed from the treatment combination with local Tulsimala (V_2) when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_1), which was statistically similar with $V_2T_4S_2$.

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

4.3.2.1 Effect of aromatic rice varieties on straw yield (t ha^{-1})

In present study variety had significant effect on the straw yield (t ha^{-1}) of rice (Table 24). The highest straw yield of rice was recorded from local variety Tulsimala (7.55 t ha^{-1}) compared to the other variety BRRI dhan34 (7.00 t ha^{-1}). This result was similar with the findings of Mohammad *et al.* (2014) who reported that, the highest straw yield (5.90 t ha^{-1}) was produced by BR11 while the lowest straw yield (3.99 t ha^{-1}) was recorded from Pajam. Similar results also obtained by Patel (2000) and Chowdhury *et al*.(1993).

4.3.2.2 Effect of transplanting date on straw yield (t ha^{-1})

Date of transplanting had a significant effect on straw yield (t ha^{-1}) of rice during aman season (Table 24). Transplanting date 21st august (T_2) produced significantly the highest straw yield (7.71 t ha^{-1}). On the other hand, the lowest straw yield (6.63 t ha^{-1}) was produced by transplanting date 4th September (T_4). Too much early planted crop (1 July) also gave lower straw yield, this might be due to lower sun shine hour, cloudy weather in the standing field which reduce the photosynthetic potentiality of plant. These results are in conformity with the results of Mannan *et al.* (2009), Chopra and Chopra (2004) and Salam *et al.* (2004). Islam *et al.* (2008) confirmed that, the highest straw yield was obtained (5.84 t ha^{-1}) in transplanting date 10 August and the lowest straw yield (5.58 t ha^{-1}) was obtained at 4 September.

4.3.2.3 Effect of seedling number hill^{-1} on straw yield (t ha^{-1})

Straw yield varied significantly due to number of seedlings hill^{-1} under the present trial (Table 24). The highest straw yield was found from S_2 (7.52 t ha^{-1}) while the lowest straw yield was recorded from S_1 (6.99 t ha^{-1}). Faruk *et al*. (2009) reported that different levels of number of seedlings hill^{-1} significantly influenced straw yields.

4.3.2.4 Interaction effect of variety and transplanting date on straw yield (t ha^{-1})

Interaction between variety and transplanting date played an important role for promoting the yield. Straw yield was significantly influenced by the interaction effect of variety and transplanting date (Table 25). Among the treatments, the highest straw yield was observed in local variety Tulsimala which was transplanted on 21st August (8.25 t ha^{-1}), whereas the lowest straw yield (6.46 t ha^{-1}) was observed in BRRI dhan34 which was transplanted on 4th September.

4.3.2.5 Interaction effect of variety and seedling number hill^{-1} on straw yield (t ha^{-1})

Significant variation was recorded due to the interaction effect of rice varieties and number of seedlings hill^{-1} on straw yield (t ha^{-1}) of rice (Table 26). The highest straw yield was recorded from the combination of V_2S_3 (7.85 t ha^{-1}) which was statistically different from others and the lowest straw yield was found from V_1S_1 (6.77 t ha^{-1}), which was statistically similar with V_1S_3.

4.3.2.6 Interaction effect of transplanting date and seedling number hill^{-1} on straw yield (t ha^{-1})

Interaction effect of transplanting date and seedling number hill^{-1} had a significant effect on straw yield (t ha^{-1}) of rice during aman season (Table 27). Results showed that, highest straw yield (8.66 t ha^{-1}) was observed from the treatment combination when rice transplanted on 14th August (T_1) with 4 seedling hill^{-1} (S_3), which was statistically similar with T_2S_1 and the lowest straw yield (5.94 t ha^{-1}) was observed from the treatment combination when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_1), which was statistically similar with T_4S_3.

4.3.2.7 Interaction effect of variety and transplanting date and seedling number hill^{-1} on straw yield (t ha^{-1})

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on straw yield (t ha^{-1}) of rice during aman season (Table 28). Results showed that, highest straw yield (10.23 t ha^{-1}) was observed from the treatment combination with local variety Tulsimala (V_2) which was transplanted on 14th August (T_1) with 4 seedling hill^{-1} (S_3) and the straw yield (5.18 t ha^{-1}) was observed from the treatment combination with BRRI dhan34 (V_1) which transplanted on 4th September (T_4) with 4 seedling hill^{-1} (S_3), which was statistically similar with $V_2T_4S_1$.

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

4.3.3.1 Effect of aromatic rice varieties on biological yield (t ha^{-1})

Variety had significantly effect on biological yield of aromatic rice (Table 24). The result of the study revealed that, the maximum biological yield (10.96 t ha^{-1}) was found from the high yielding variety BRRI dhan34 and the lowest biological yield (4.43 t ha^{-1}) was found from the local variety Tulsimala. This result was in line with the findings of Mohammad *et al.* (2014) who found that the highest biological yield (11.04 t ha^{-1}) due to highest grain and straw yield was recorded from BR11and the lowest biological yield (7.53 t ha^{-1}) was obtained from Pajam.

4.3.3.2 Effect of transplanting date on biological yield (t ha^{-1})

There was significant difference among the transplanting dates observed in respect of biological yield (Table 24). Transplanting date 21st august (T_2) produced significantly the highest biological yield (11.63 t ha^{-1}). On the other hand, the lowest biological yield (2.76 t ha^{-1}) was produced by transplanting date 4th September (T_4). The results agreed with the findings of Chandra and Manna (1988), Ali *et al* (1993) and Ghosh and Ganguly (1994) who stated that delayed transplanting reduces biological yield of rice due to shorter vegetative phase.

4.3.3.3 Effect of seedling number $hill^{-1}$ on biological yield (t ha^{-1})

Number of seedlings $hill^{-1}$ showed significant differences on biological yield (t ha^{-1}) (Table 24). Data exposed that the highest biological yield was found from S_2 (11.25 t ha^{-1}). On the other hand, the lowest biological yield was recorded from S_1 (10.16 t ha^{-1}). Similar results were also found by Islam *et al*. (2002), Obulamma *et al*. (2002) and Shrirame *et al*. (2000).

4.3.3.4 Interaction effect of variety and transplanting date on biological yield (t ha^{-1})

Interaction effect between variety and transplanting date was significant in respect of biological yield (t ha^{-1}) (Table 25). Among the treatments, the highest biological yield was observed in BRRI dhan34 which was transplanted on 28th August (12.28 t ha^{-1}), whereas the lowest biological yield (9.06 t ha^{-1}) was observed in local variety Tulsimala which was transplanted on 4th September.

4.3.3.5 Interaction effect of variety and seedling number hill^{-1} on biological yield (t ha^{-1})

Significant variation was recorded due to the interaction effect of rice varieties and number of seedlings hill^{-1} on biological yield of rice (Table 26). The highest biological yield (11.77 t ha^{-1}) was documented from the combination of where BRRI dhan34 (V_1) transplanted with 3 seedling hill^{-1}(S_2) and the lowest biological yield was found from V_2S_1 (2.71 t ha^{-1}).

4.3.3.6 Interaction effect of transplanting date and seedling number hill^{-1} on biological yield (t ha^{-1})

Interaction effect between transplanting date and seedling number hill^{-1} had a significant effect on biological yield (t ha^{-1}) of rice during aman season (Table 27). Results showed that, highest biological yield (12.46 t ha^{-1}) was observed from the treatment combination when rice transplanted on 21st August (T_2) with 3 seedling hill^{-1} (S_2), which was statistically similar with T_3S_2 and T_1S_3 and the lowest biological yield (8.39 t ha^{-1}) was observed from the treatment combination when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_1).

4.3.3.7 Interaction effect of variety, transplanting date and seedling number hill^{-1} on biological yield (t ha^{-1})

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on biological yield (t ha^{-1}) of rice during aman season (Table 28). Results showed that, highest biological yield (13.88 t ha^{-1}) was observed from the treatment combination with BRRI dhan34 (V_1) which transplanted on 28th August (T_3) with 3 seedling hill^{-1} (S_2), which were statistically similar with $V_2T_1S_3$, whereas the lowest biological yield (7.55 t ha^{-1}) were observed from the treatment combination with local Tulsimala (V_2) which transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_2), which was statistically similar with $V_1T_4S_3$.

4.3.4 Harvest index

4.3.4.1 Effect of aromatic rice varieties on harvest index

Harvest index was significantly influenced by the variety (Table 24). The result of the study revealed that, the highest harvest index (35.97 %) was found from the high yielding variety BRRI dhan34 and the lowest harvest index (27.64 %) was found from the local variety Tulsimala. The harvest index was (30.34%) higher in the HYV variety compared to the local variety. Similar findings was also reported by Mohammad *et al.* (2014) who concluded that, the highest harvest index (50.06%) was recorded from BRRI dhan40. The lowest one (46.94 %) was obtained from Pajam.

4.3.3.2 Effect of transplanting date on harvest index

There was significant difference among the transplanting dates observed in respect of harvest index (%) (Table 24). Transplanting date 21st august (T_2) produced significantly the highest harvest index (33.70 %). On the other hand, the lowest harvest index (29.33 %) was produced by transplanting date 4th September (T_4).

4.3.3.3 Effect of seedling number hill^{-1} on harvest index

Number of seedlings hill^{-1} showed significant differences on harvest index (%) (Table 24). Data exposed that the highest harvest index was found from S_2 (32.93 %). On the other hand, the lowest harvest index was recorded from S_1 (31.05%), which was statistically similar with S_3 (4 seedling hill^{-1}). Sarkar *et al*. (2011) reported that the highest harvest index was found when 3 tiller seedlings were transplanted hill^{-1}.

4.3.3.4 Interaction effect of variety and transplanting date on harvest index

Interaction effect between variety and transplanting date was significant in respect of harvest index (%) (Table 25). Among the treatments, the highest harvest index was observed in BRRI dhan34 which was transplanted on 21st August (38.73 %), whereas the lowest harvest index (25.15%) was observed in local variety Tulsimala which was transplanted on 4th September.

4.3.3.5 Interaction effect of variety and seedling number hill^{-1} on harvest index

Significant variation was recorded due to the interaction effect of rice varieties and number of seedlings hill^{-1} on harvest index (%) of rice (Table 26). The highest harvest index (36.69%) was recognized from the combination of where BRRI dhan34 (V_1) transplanted with 3 seedling hill^{-1}(S_2) and the lowest harvest index was found from V_2S_3 (26.39%).

4.3.3.6 Interaction effect of transplanting date and seedling number hill^{-1} on harvest index

Interaction effect between transplanting date and seedling number hill^{-1} had a significant effect on harvest index (%) of rice during aman season (Table 27). Results showed that, highest harvest index (36.12 %) was observed from the treatment combination when rice transplanted on 21st August (T_2) with 3 seedling hill^{-1} (S_2), and the lowest harvest index (28.77 %) was observed from the treatment combination when transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_1), which was statistically similar with T_4S_1 and T_1S_3.

4.3.3.7 Interaction effect of variety, transplanting date and seedling number hill^{-1} on harvest index

Interaction effect of variety, transplanting date and seedling number hill^{-1} had a significant effect on harvest index (%) of rice during aman season (Table 28). Results showed that, highest harvest index (41.70 %) was observed from the treatment combination with BRRI dhan34 (V_1) which transplanted on 21st August (T_2) with 3 seedling hill^{-1} (S_2), whereas the lowest harvest index (23.01 %) were observed from the treatment combination with local variety Tulsimala (V_2) which transplanted on 4th September (T_4) with 2 seedling hill^{-1} (S_2), which was statistically similar with $V_2T_1S_3$.

Table 24. Effect of variety, transplanting date, and number of seedlings hill^{-1} on yield of aromatic rice

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Effect of Variety				
V_1	3.99 a	7.00 b	10.96 a	35.97 a
V_2	2.88 b	7.55 a	10.43 b	35.97 a
LSD (0.05)	0.07	0.12	0.15	0.46
Effect of Transplanting date				
T_1	3.33 c	7.25 c	10.52 c	31.41 c
T_2	3.92 a	7.71 a	11.63 a	33.70 a
T_3	3.73 b	7.51 b	11.24 b	32.79 b
T_4	2.76 d	6.63 d	9.39 d	29.33 d
LSD (0.05)	**0.07**	**9.10**	**7.74**	**3.48**
Effect of Seedling number hill^{-1}				
S_1	3.17 c	6.99 c	10.16 c	31.05 b
S_2	3.79 a	7.52 a	11.25 a	32.93 a
S_3	3.35 b	7.32 b	10.68 b	31.44 b
LSD (0.05)	0.09	0.15	0.18	0.57
CV (%)	4.54	3.47	2.96	3.06

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

V_1: BRRI dhan34
V_2: Tulsimala

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

Table 25. Interaction effect of variety and transplanting date on yield of aromatic rice

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest index (%)
V_1 T_1	3.62 b	6.66 de	10.15 d	34.35 c
V_2 T_1	3.04 d	7.85 b	10.89 c	28.46 d
V_1 T_2	4.53 a	7.17 c	11.70 b	38.73 a
V_2 T_2	3.32 c	8.25 a	11.56 b	28.67 d
V_1 T_3	4.57 a	7.71 b	12.28 a	37.30 b
V_2 T_3	2.89 e	7.31 c	10.20 d	28.28 d
V_1 T_4	3.26 c	6.46 e	9.71 e	33.51 c
V_2 T_4	2.26 f	6.80 d	9.06 f	25.15 e
LSD (0.05)	0.15	0.24	0.30	0.92
CV (%)	4.54	3.47	2.96	3.06

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

V_1: BRRI dhan34 | T_1: 14th August | T_3: 28th August
V_2: Tulsimala | T_2: 21st August | T_4: 4th September

Table 26. Interaction effect of variety and seedling number hill^{-1} on yield of aromatic rice

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest index (%)
V_1 S_1	3.63 c	6.77 d	10.40 c	34.73 b
V_2 S_1	2.71 e	7.21 c	9.92 d	27.37 d
V_1 S_2	4.43 a	7.44 b	11.77 a	36.69 a
V_2 S_2	3.14 d	7.60 b	10.73 b	29.17 c
V_1 S_3	3.92 b	6.79 d	10.72 b	36.50 a
V_2 S_3	2.78 e	7.85 a	10.63 bc	26.39 e
LSD (0.05)	0.13	0.21	0.26	0.80
CV (%)	4.54	3.47	2.96	3.06

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

V_1: BRRI dhan34 | S_1: 2 Seedling hill^{-1}
V_2: Tulsimala | S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

Table 27. Interaction effect of transplanting date and seedling number hill^{-1} on yield of aromatic rice

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest index (%)
T_1 S_1	3.10 e	6.76 d	9.86 f	31.31 d
T_1 S_2	3.43 d	6.34 e	9.57 f	33.76 b
T_1 S_3	3.47 d	8.66 a	12.13 ab	29.16 ef
T_2 S_1	3.94 c	8.53 ab	12.46 a	31.74 d
T_2 S_2	4.36 a	7.74 c	12.09 b	36.12 a
T_2 S_3	3.47 d	6.87 d	10.33 e	33.24 b
T_3 S_1	3.18 e	6.73 d	9.91 f	32.06 cd
T_3 S_2	4.16 b	8.28 b	12.44 ab	33.07 bc
T_3 S_3	3.86 c	7.53 c	11.38 c	33.24 b
T_4 S_1	2.45 f	5.94 f	8.39 h	29.08 ef
T_4 S_2	3.20 e	7.72 c	10.92 d	28.77 f
T_4 S_3	2.62 f	6.23 ef	8.85 g	30.14 e
LSD (0.05)	0.18	0.29	0.37	1.13
CV (%)	4.54	3.47	2.96	3.06

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

T_1: 14th August　　T_3: 28th August　　S_1: 2 Seedling hill^{-1}

T_2: 21st August　　T_4: 4th September　　S_2: 3 Seedling hill^{-1}

S_3: 4 Seedling hill^{-1}

Table 28. Interaction effect of variety and transplanting date and seedling number hill^{-1} on yield of aromatic rice

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest Index (%)
$V_1T_1S_1$	3.45 ef	6.72 ij	10.17 g	33.95 g
$V_2T_1S_1$	2.74 hi	6.81 ij	9.54 h-j	28.66 j-l
$V_1T_1S_2$	3.64 de	6.17 k	9.42 ij	34.44 fg
$V_2T_1S_2$	3.21 fg	6.50 jk	9.72 g-j	33.08 g
$V_1T_1S_3$	3.76 d	7.09 hi	10.86 f	34.66 e-g
$V_2T_1S_3$	3.17 g	10.23 a	13.40 ab	23.65 op
$V_1T_2S_1$	4.44 b	7.78 ef	12.22 de	36.39 cd
$V_2T_2S_1$	3.45 ef	9.28 b	12.73 cd	27.09 lm
$V_1T_2S_2$	4.97 a	6.95 hi	11.92 e	41.70 a
$V_2T_2S_2$	3.75 d	8.52 cd	12.27 de	30.55 h
$V_1T_2S_3$	4.18 c	6.79 ij	10.97 f	38.11 b
$V_2T_2S_3$	2.75 hi	6.95 hi	9.70 g-j	28.38 kl
$V_1T_3S_1$	3.80 d	6.16 k	9.96 gh	38.13 b
$V_2T_3S_1$	2.56 ij	7.30 gh	9.86 g-i	25.98 mn
$V_1T_3S_2$	5.01 a	8.87 bc	13.88 a	36.11 c-e
$V_2T_3S_2$	3.30 fg	7.69 fg	10.99 f	30.04 h-j
$V_1T_3S_3$	4.90 a	8.11 de	13.01 bc	37.65 bc
$V_2T_3S_3$	2.81 hi	6.96 hi	9.76 g-i	28.83 i-k
$V_1T_4S_1$	2.81 hi	6.42 jk	9.23 j	30.43 hi
$V_2T_4S_1$	2.09 l	5.45 l	7.55 k	27.73 kl
$V_1T_4S_2$	4.10 c	7.77 ef	11.87 e	34.53 e-g
$V_2T_4S_2$	2.30 kl	7.67 fg	9.96 gh	23.01 p
$V_1T_4S_3$	2.86 h	5.18 l	8.03 k	35.57 def
$V_2T_4S_3$	2.39 jk	7.28 gh	9.67 g-j	24.71 no
LSD (0.05)	**0.26**	**0.42**	**0.52**	**1.60**
CV (%)	**4.54**	**3.47**	**2.96**	**3.06**

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

V_1: BRRI dhan34
V_2: Tulsimala

T_1: 14th August
T_2: 21st August
T_3: 28th August
T_4: 4th September

S_1: 2 Seedling hill^{-1}
S_2: 3 Seedling hill^{-1}
S_3: 4 Seedling hill^{-1}

CHAPTER V

SUMMARY AND CONCLUSION

During the period of aman season from July to December 2018, a field experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University (SAU), Dhaka, to find out the effect of transplanting dates and seedling number hill^{-1} on growth and yield of aromatic rice varieties. The experiment comprised of three factors. Factor A: Rice variety (2) –V_1: BRRI dhan34, V_2: Local aromatic rice Tulsimala; Factor B: Four transplanting dates viz. 14th August (T_1), 21st August (T_2), 28th August (T_3) and 4th September and Factor C: Three number of seedlings hill^{-1} viz. 2 seedling hill^{-1} (S_1), 3 seedling hill^{-1} (S_2) and 4 seedlings hill^{-1} (S_3). The experiment was laid out in a Randomized Complete Block Design (Factorial) with three replications. There were 24 treatment combinations. The total number of plots were 72. The size of the unit plot was 2m x 2.5m. The distance between each plot was 0.5 m. The crop of each plot was harvested separately on different dates at full maturity when 80% of the grains become golden yellow in color. Data on different growth characters, yield and yield components were recorded and analyzed.

Results of the experiment showed that growth parameters viz. plant height was significantly affected by varieties and the maximum values was obtained from Tulsimala (V_2) for plant height while maximum number of tillers and dry mater production were shown at BRRI dhan34 (V_1). It revealed that Tulsimala showed significantly taller plant throughout the growth stage while BRRI dhan34 showed lowest result in relation to plant height. The highest plant height was 141.03 cm which obtained from Tulsimala (V_2) and lowest plant height was 121.31 cm which obtained from BRRI dhan34 (V_1). BRRI dhan34 produce the highest number of total tiller hill^{-1} while Tulsimala (V_2) produced the lowest. Maximum total grain penical^{-1} was found in BRRI dhan34 (V_1) and minimum was found in Tulsimala (V_2). The maximum number of filled grain and unfilled grain were found also in BRRI dhan34 (V_1) variety and lowest on Tulsimala (V_2). For panicle weight, result showed that weight of the panicle was highest in BRRI dhan34 (V_1). On the other hand, lowest value of panicle weight was found Tulsimala (V_2). Tulsimala (V_2) produced maximum (11.59 g) 1000-grain weight while BRRI dhan 34 (V_1) produced the lowest (10.51 g) which are statistically different from each other. BRRI dhan34 produced the highest grain yield (3.99 t ha^{-1}) and lowest grain yield (2.88 t ha^{-1}) recorded from Tulsimala (V_2). Straw yield was the highest (7.55 t ha^{-1}) in Tulsimala (V_2) and lowest (7.00 t ha^{-1}) in BRRI dhan34 (V_1). Like grain yield, BRRl dhan34 (V_1) maintained its superiority by producing highest biological yield (10.96 t ha^{-1}) over the promising Tulsimala (V_2) (10.43 t ha^{-1}). BRRl dhan34 maintained its preeminence by producing highest harvest index (35.97%) over Tulsimala (27.64%)

Results of the experiment showed that growth parameters viz. plant height and dry matter production, were significantly affected by transplanting dates. Numerical values of these characters were the highest for early transplanting and the lowest for late transplanting. Highest plant height (136.96 cm) was found T_2 transplanting and lowest height (118.25 cm) was obtained from T_4. Number of tillers $hill^{-1}$ (14.67) was maximum at T_2 transplanting dates and the minimum (12.4) was found in T_1 transplanting date. Effective and ineffective tillers $hill^{-1}$ was affected significantly by the transplanting dates. The highest effective tillers $hill^{-1}$ (13.42) was obtained from T_2 transplanting date and lowest from T_4 transplanting. On the other hand, the highest ineffective tillers $hill^{-1}$ (1.30) was obtained from T_3 transplanting date and lowest from T_1 transplanting. From the result, it can be said that production of total tillers $hill^{-1}$ was the highest in early transplanting dates than delayed transplanting dates with decreasing trends. Weight of panicle was significantly affected by transplanting dates and T_2 produced highest panicle weight (1.97 g) of panicle which was statistically similar with T_3 (1.95 g). In contrast, T_4 transplanting showed lowest weight (1.72 g) which was statistically similar with T_1 (1.73 g). T_2 also produced maximum number of filled grains $panicle^{-1}$ (152.66) while T_1 produced lowest number of unfilled grains (41.06). In contrast, T_4 produced lowest number (124.72) of filled grain and highest number (47.33) of unfilled grain. There 1000 grain weight was not significantly affected by transplanting dates. T_2 transplanting produced the highest grain yield (3.92 t ha^{-1}) and lowest grain yield (2.76 t ha^{-1}) recorded from T_4. Straw yield was the highest (7.71 t ha^{-1}) in T_2 and lowest (6.63 t ha^{-1}) at T_4 transplanting dates. Late transplanting reduced grain and straw yield. T_2 transplanting date produced highest biological yield (11.63 t ha^{-1}) over T_4 (9.39 t ha^{-1}). Like grain yield, T_2 maintained its dominance by producing highest harvest index (33.70%) while T_4 produced lowest (29.33%) harvest index.

Results of the experiment showed that growth parameters viz. plant height and dry matter production were significantly affected by number of seedlings hill^{-1}. Highest plant height (132.07 cm) was found S_2 that was statistically similar to S_1 (131.38 cm), and lowest height (130.06 cm) was obtained from S_3. Number of total tillers hill^{-1} was not significantly affected by number of seedlings hill^{-1}. Effective and ineffective tillers hill^{-1} was affected significantly by number of seedlings hill^{-1}. The highest effective tillers hill^{-1} (12.57) was obtained from S_1 and lowest from S_3. On the other hand, the highest ineffective tillers hill^{-1} was not significantly affected by number of seedlings hill^{-1}. From the result, it can be said that for higher production of effective tillers hill^{-1} did not need extra seedling hell^{-1}. Weight of panicle was significantly affected by number of seedlings hill^{-1} and S_2 produced highest panicle weight (1.89 g) of panicle. In contrast, S_1 seedlings hill^{-1} showed lowest weight (1.80 g) which was statistically similar with S_3 (1.83 g). S_2 also produced maximum number of filled grains panicle^{-1} (144.65) while S_3 produced highest number of unfilled grains (45.65). S_1 produced lowest number (131.02) of filled grain and S_2 produce lowest number (42.79) of unfilled grain which was statistically similar with S_1. There 1000 grain weight was not significantly affected by number of seedlings hill^{-1}. S_2 seedlings hill^{-1} produced the highest grain yield (3.79 t ha^{-1}) and lowest grain yield (3.17 t ha^{-1}) recorded from S_1. Straw yield was the highest (7.52 t ha^{-1}) in S_2 and lowest (6.99 t ha^{-1}) at S_1 seedlings hill^{-1}. Less number of seedlings hill^{-1} reduced grain and straw yield. S_2 seedlings hill^{-1} produced highest biological yield (11.52 t ha^{-1}) over S_1 (10.16 t ha^{-1}). Like grain yield, S_2 maintained its supremacy by producing highest harvest index (32.93%) while S_1 produced lowest (31.05%) harvest index.

Interaction between varieties and transplanting dates significantly affects in plant height, dry matter production and total tiller hill^{-1}. The highest values of these characters were observed in early transplanting with all varieties and the lowest was recorded from delayed transplanting. Interaction effect of V_2T_2 was provided highest plant height (148.40 cm) and V_1T_4 was provided lowest plant height (108.40 cm). Plant produced highest dry matter was recorded from interaction of V_1T_2 (32.63 g), which was similar with the interaction of V_1T_3 and lowest dry matter was recorded from V_2T_4 (21.89 g). Interaction effect of varieties and transplanting dates are significantly affected total number of tillers hill^{-1}. Highest number of tiller hill^{-1} (15.71) was obtained from $V_1T_{3,}$ which was statistically similar with V_1T_2 (15.56) and lowest number of tiller hill^{-1} (12.14) from V_2T_3 which was statistically similar with V_2T_3 and V_2T_4. For effective tiller hill^{-1} V_1T_3 produced the highest (14.67) which was statistically similar with V_1T_2. V_2T_4 produced the lowest (10.85) number of effective tiller hill^{-1}. For ineffective tiller, V_1T_4 and V_2T_2 statistically produced the highest (1.63, and 1.53) and all other statistically produced lower ineffective tiller. Panicle weight was affected significantly by the interaction of varieties and transplanting dates. V_1T_3 showed the highest panicle weight (2.20 g) while V_2T_4 showed lowest panicle weight (1.61 g). So, it can be said that weight of panicle was reduced at late transplanting. Maximum total grain penical^{-1} was found in V_1T_3 (223.38) and minimum was found in V_2T_4 (152.89) and maximum filled grain penicle^{-1} (169.53) was found in V_1T_3 which was statistically similar with V_1T_2 (164.00) and minimum was recorded in V_2T_4 (115.55), which was statistically similar with V_2T_3 and V_1T_1. Number of filled grains panicle also showed decreasing trends from early transplanting to delayed transplanting. Maximum (57.32) number of unfilled grains was obtained from V_1T_4, which was statistically similar with V_1T_3 and lowest (37.34) at V_2T_3, which was statistically similar with $V_2T_{3.}$ 1000 seed weight was affected significantly by the interaction of varieties and transplanting dates. Highest 1000 grain weight (11.74 g) was found in V_2T_2 which was statistically similar with V_2T_3, V_2T_1 and V_2T_4 and lowest (10.47 g) was found V_1T_4, which was statistically similar with V_1T_2, V_1T_3 and V_1T_1. Grain yield was highest (4.57 t ha^{-1}) in the interaction of $V_1T_{3,}$ which was statistically similar with V_1T_2 and the lowest grain yield (2.26 t ha^{-1}) was observed from V_2T_4 interaction treatment. Straw yield was the highest (8.25 t ha^{-1}) in V_2T_2 and highest biological yield (12.28 t ha^{-1}) produced in V_1T_3 interaction. On the other hand, straw yield and biological yield was lowest in V_1T_4 and V_2T_4, respectively. Harvest Index was also significantly affected by transplanting date and variety. Harvest index was the highest (38.73%) in V_1T_2 interaction and lowest in V_2T_4 interaction.

Interaction between varieties and number of seedlings hill^{-1} significantly affects in plant height, dry matter production and total tiller hill^{-1}. Interaction effect of V_2S_2 was provided highest plant height (144.61 cm) and V_1S_2 was provided lowest plant height (119.53 cm). Plant produced highest dry matter at 60 DAT was recorded from interaction of V_2S_3 (31.43 g), which was similar with the interaction of V_1S_2 and lowest dry matter was recorded from V_2S_1 (25.06 g). Interaction effect of varieties and number of seedlings hill^{-1} are significantly affected total number of tillers hill^{-1}. Highest number of tiller hill^{-1} (14.55) was obtained from V_1S_2, which was statistically similar with V_1S_3 (14.50) and lowest number of tiller hill^{-1} (12.19) from V_2S_3 which was statistically similar with V_2S_3. For effective tiller hill^{-1} V_1S_1 produced the highest (13.77). V_2S_3 produced the lowest (11.25) number of effective tiller hill^{-1}, which was statistically similar with V_2S_1. For ineffective tiller, there had no affected significant different between the interaction. Panicle weight was affected significantly by the interaction of varieties and number of seedling hill^{-1}. V_1S_2 showed the highest panicle weight (1.98 g) which was statistically similar with V_1S_1 and V_1S_3, while V_2S_1 showed lowest panicle weight (1.65 g). So, it can be said that weight of panicle was differ mostly because of variety. Maximum total grain penical^{-1} was found in V_1S_2 (202.65), which was statistically similar with V_1S_3 (194.79) and minimum was found in V_2S_1 (142.87) and maximum filled grain penicle^{-1} (153.00) was found in V_1S_2 and minimum was recorded in V_2S_1 (117.87). Maximum (49.64) number of unfilled grains was obtained from V_1S_2 and lowest (35.93) at V_2S_2. 1000 seed weight was affected significantly by the interaction of varieties and number of seedling hill^{-1}. Highest 1000 grain weight (11.59 g) was found in V_2S_3 which was statistically similar with V_2S_1 and V_2S_2 and lowest (10.41 g) was found V_1S_1, which was statistically similar with V_1S_3 and V_1S_2. Grain yield was highest (4.43 t ha^{-1}) in the interaction of V_1S_2 and the lowest grain yield (2.71 t ha^{-1}) was observed from V_2S_1 interaction treatment, which was statistically similar with V_2S_3. Straw yield was the highest (7.85 t ha^{-1}) in V_2S_3 and lowest in V_1S_1 which was statistically similar with V_1S_3. Highest biological yield (11.77 t ha^{-1}) produced in V_1S_2 interaction. On the other hand, biological yield was lowest in V_2S_1 (9.92 t ha^{-1}). Harvest Index was also significantly affected by variety and number of seedling hill^{-1}. Harvest index was the highest (36.69%) in V_1S_2 interaction, which was statistically similar with V_1S_2 and lowest (26.39%) in V_2T_3 interaction.

Interaction between transplanting dates and number of seedlings hill^{-1} significantly affects in plant height, dry matter production and total tiller hill^{-1}. Interaction effect of T_2S_1 was provided highest plant height (139.13 cm), which was statistically similar with T_1S_2 and T_4S_3 was provided lowest plant height (116.44 cm). Plant produced highest dry matter at 60 DAT was recorded from interaction of T_2S_2 (35.89 g) and lowest dry matter was recorded from T_4S_1 (20.62 g). Interaction effect of transplanting dates and number of seedlings hill^{-1} are significantly affected total number of tillers hill^{-1}. Highest tiller number hill^{-1} (15.17) was obtained from T_2S_2, which was statistically similar with T_3S_2 and T_2S_1 and lowest tiller number hill^{-1} (12.08) from T_1S_1 which was statistically similar with T_4S_2 and T_1S_2. For effective tiller hill^{-1} T_3S_2 produced the highest (13.83), which was statistically similar with T_2S_2 and T_2S_1. T_4S_2 produced the lowest (10.94) number of effective tiller hill^{-1}. For ineffective tiller, there had no affected significant different between the interaction. Panicle weight was affected significantly by the interaction of transplanting dates and number of seedling hill^{-1}. T_3S_2 showed the highest panicle weight (2.14 g) while T_1S_1 showed lowest panicle weight (1.54 g) which was statistically similar with T_4S_2 and T_1S_3. So, it can be said that weight of panicle was differ mostly because of early and late transplanting. Maximum total grain penical^{-1} was found in T_3S_2 (220.20) and minimum was found in T_1S_1 (148.00) and maximum filled grain penicle^{-1} (172.18) was found in T_3S_2 and minimum was recorded in T_1S_1 (108.98). Maximum (50.05) number of unfilled grains was obtained from T_4S_3 and lowest (38.53) at T_1S_2. 1000 seed weight was not significantly different by the interaction of transplanting dates and number of seedling hill^{-1}. Grain yield was highest (4.36 t ha^{-1}) in the interaction of T_2S_2 and the lowest grain yield (2.45 t ha^{-1}) was observed from T_4S_1 interaction treatment, which was statistically similar with T_4S_3. Straw yield was the highest (8.66 t ha^{-1}) in T_1S_3, which was statistically similar with T_2S_1 and lowest in T_4S_1 which was statistically similar with T_4S_3. Highest biological yield (12.46 t ha^{-1}) produced in T_2S_1 interaction. On the other hand, biological yield was lowest in T_4S_1 (8.39). Harvest Index was also significantly affected by variety and number of seedling hill^{-1}. Harvest index was the highest (36.12%) in T_2S_2 interaction and lowest (28.77%) in T_4T_2 interaction.

Interaction between variety, transplanting dates and number of seedlings hill^{-1} significantly affects in plant height, dry matter production and total tiller hill^{-1}. Interaction effect of $V_2T_1S_2$ was provided highest plant height (153.60 cm) and $V_1T_4S_2$ was provided lowest plant height (107.44 cm), which was statistically similar with the interaction

$V_1T_4S_3$ and $V_1T_4S_1$. Plant produced highest dry matter at 60 DAT was recorded from interaction of $V_1T_2S_2$ (36.28 g), which was statistically similar with the interaction $V_2T_2S_2$ and lowest dry matter was recorded from $V_2T_4S_1$ (18.40 g). Interaction effect of variety, transplanting dates and number of seedlings hill^{-1} are significantly affected total number of tillers hill^{-1}. Highest tiller number hill^{-1} (17.51) was obtained from $V_1T_3S_2$ and lowest tiller number hill^{-1} (10.08) from $V_2T_1S_1$ which was statistically similar with $V_2T_3S_3$. For effective tiller hill^{-1} $V_1T_3S_2$ produced the highest (16.33). $V_2T_1S_1$ produced the lowest (9.63) number of effective tiller hill^{-1}. For ineffective tiller, there had no affected significant different between the interaction. Panicle weight was affected significantly by the interaction of variety, transplanting dates and number of seedling hill^{-1}. $V_1T_3S_2$ showed the highest panicle weight (2.42 g) while $V_2T_4S_1$ showed lowest panicle weight (1.44 g) which was statistically similar with $V_1T_4S_2$, $V_2T_3S_3$ and $V_1T_1S_1$. Maximum total grain penical^{-1} was found in $V_1T_3S_2$ (263.20) and minimum grain penical^{-1} was found in $V_1T_1S_1$ (148.00), which was statistically similar with $V_2T_4S_1$, $V_2T_3S_3$ and $V_2T_3S_1$ and maximum filled grain penicle^{-1} (206.33) was found in $V_1T_3S_2$ and minimum was recorded in $V_2T_4S_1$ (99.98), which was statistically similar with $V_1T_1S_1$, $V_2T_3S_3$, $V_1T_4S_2$ and $V_2T_3S_1$. Maximum (62.05) number of unfilled grains was obtained from $V_1T_4S_3$, which was statistically similar with $V_1T_3S_2$ and $V_1T_4S_2$ and lowest (34.11) at $V_2T_4S_2$. 1000 seeds weight was significantly different by the interaction of variety, transplanting dates and number of seedling hill^{-1}. $V_2T_2S_3$ showed highest 1000 seeds weight and lowest at $V_1T_2S_3$ interaction. Grain yield was highest (5.01 t ha^{-1}) in the interaction of $V_1T_3S_2$, which was statistically similar with $V_1T_2S_2$ and the lowest grain yield (2.09 t ha^{-1}) was observed from $V_2T_4S_1$ interaction treatment, which was statistically similar with $V_2T_4S_2$. Straw yield was the highest (10.23 t ha^{-1}) in $V_2T_1S_3$ and lowest (5.18 t ha^{-1}) in $V_1T_4S_3$ which was statistically similar with $V_2T_4S_1$. Highest biological yield (13.88 t ha^{-1}) produced in $V_1T_3S_2$ interaction, which was statistically similar with $V_2T_1S_3$. On the other hand, biological yield was lowest in $V_2T_4S_1$ (7.55 t ha^{-1}), which was statistically similar with $V_1T_4S_3$. Harvest Index was also significantly affected by the interaction of variety, transplanting dates and number of seedling hill^{-1}. Harvest index was the highest (41.70%) in $V_1T_2S_2$ interaction and lowest (23.01%) in $V_2T_4T_2$ interaction, which was statistically similar with $V_2T_1S_3$.

From the above results it can be concluded that between two aromatic variety BRRI dhan34 provided the best yield and between 4 transplanting dates 21st August provided best yield and between 3 number of seedling hill^{-1}, 3 seedling hill^{-1} provided best yield. In interaction BRRI dhan34 transplanted at 21st august and 28th august gave statistically similar grain yield and BRRI dhan34 transplanted with 3 seedling hill^{-1} gave higher yield. In interaction with transplanting dates and seedling number per hill^{-1} rice transplanted at 21st August with 3 seedlings hill^{-1} provided best yield. In 3 factors interaction BRRI dhan34 transplanted on 28th August with 3 seedling hill^{-1} and BRRI dhan34 transplanted on 21st August with 3 seedling hill^{-1} provided statistically same grain yield.

Recommendation

Bearing in mind the above observation of the present study further investigation in the following areas may be recommended:

- Further study may be required in changed Agro-Ecological Zones (AEZ) of Bangladesh for rational adaptability.

- More number of treatments with different transplanting dates, number of seedling number and other aromatic rice varieties may be chosen to study such effect.

CHAPTER VI

REFFERANCE

Ahmad, Z., Alim, S., Dil, R. and Tahir, M. (1996). Rice genotypes responses to environment stresses in term of Yield and yield components in sub-mountainous region of swat. *Sarhad J. Agril*. **12**: 619-624.

AICRIP (All India Co-coordinate Rice Improvement Project). (1992). Progress report. **3**: 120-124.

Alam, F. (2006). Effect of spacing, number of seedlings hill^{-1} and fertilizer management on the performance of *Boro* rice cv. BRRI dhan29. M. S. Thesis, Dept. Agron., Bangladesh Agril. Univ., Mymensingh. pp. 24-27.

Alam, M.S., Baki, M.A., Sultana, M.S., Ali, K.J. and Islam, M.S. (2012). Effect of variety, spacing and number of seedlings per hill on the yield potentials of transplant aman rice. *Intl. J. Agron. Agril. Res.* **2**(12): 10-15.

Ali, H. (2008). Effect of spacing and number of seedling per hill on the performance of BRRI dhan41. Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Ali, M.Y. and Murshid, M.G. (1993). Effect of age of seedlings on yield and economic performance of late transplant aman rice. *Bangladesh J. Agril. Sci.* **20**(2): 345-349.

Ali, M.Y., Rahman, M. M., and Haq, M.R. 1999. Effect of time of transplanting age of seedling on the performance of late planted aman rice. *Bangladesh J. Sci. Indus. Res*. **30**(1): 45-53.

Alim, A., Zaman, S. M. H., Sen, J. L., Ullah, M. T. and Chowdhry, M. A. (1962). Review of Half a Century of Rich Research in East Pakistan. *Agril. Dept., Govt. East Pakistan.* pp. 33-63.

Amin, M.R., Hamid, A., Choudhury, R.U., Raquibullah, S.M. and Asaduzzaman M. (2006). Nitrogen Fertilizer Effect on Tillering, Dry Matter Production and Yield of Traditional Varieties of Rice. *Intl. J. Sustain*. *Crop Prod*., **1**(1): 17-20.

Asbur, Y. (2013). Effect of seedling number per hill and seedling age on plant growth and grain yield ciherang rice. The 2nd International Conference on Multidisciplinary Research (ICMR). October 2-4, 2013, Banda Aceh, Indonesia. pp. 9-15.

Asif, M., Chudhury, F.M. and Saeed, M. (1998). Panicle structure, kernel quality and yield of fine rice as influenced by different NPK levels and per hill seedlings density. *Pakistan J. Agril. Sci*., **34**(1-40):73-77.

Babu, A. M. (1987). Effect of planting date and variety on growth and yield of rice. *Oryza*, **25**(3): 319-322.

Banik, P., Sarkar, B., Sasmel, T., Ghosol, P.K. and Bagohi, D.K. (1997). Effect of different numbers and age of seedlings on rice cultivars in low land plateau region of Bihar. *Indian J. Agron*., **42**(2): 265-268.

Baqui, M. A., Harun M. E., Jones, D. and Straingfellow, R. (1997). The export potential of traditional varieties of rice from Bangladesh. Bangladesh Rice Research Institute, Gazipur, Bangladesh.

BBS (Bangladesh Bureau of Statistics). (2018). 45 years Agriculture Statistics of Major Crops (Aus, Amon, Boro, Jute, Potato & Wheat). Stat. Div. Min. Planning, Dhaka, Bangladesh. pp. 19-20.

BBS (Bangladesh Bureau of Statistics). (2014). Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Govt. of Peoples Republic of Bangladesh. Dhaka, Bangladesh. p. 64.

Bhowmick, N. and Nayak, R.L. (2000). Response of hybrid rice (*Oryza sativa*) varieties to nitrogen, phosphorus and potassium fertilizers during dry (boro) season in West Bengal. *Indian J. Agron.*, **45**(2): 323-326.

Bhowmik, S.K., Sarkar, M.A.R. and Zaman, F. (2012). Effect of spacing and number of seedlings per hill on the performance of *aus* rice cv. NERICA 1 under dry direct seeded rice (DDSR) system of cultivation. *J. Bangladesh Agril. Univ*., **10**(2): 191-195.

Bhuiyan, M.S.H., Zahan, A., Khatun, H., Iqbal, M., Alam, F. and Manir, M.R. (2014). Yield performance of newly developed test crossed hybrid rice variety. *Intl. J. Agron. Agril. Res*. **5**(4): 48-54.

BINA. (1992). Annual Report (1990-91). Bangladesh Inst. Nucl. Agric. P.O. Box No. 4. Mymensingh. p. 6.

BINA. (1993). Annual Report (1992-93). Bangladesh Inst. Nucl. Agric. P.O. Box No. 4. Mymensingh. pp. 143-147.

BINA. (1998). Technical report on hybrid rice. Alok 6201. Div. Agron., Bangladesh Inst. Nuc. Agric., P.O. Box No. 4. Mymensingh.

Biswas, K.K., Hussain, I.A.S.M., Abuyusuf, M., Hassan, M.Z. and Noor-A-Jannat. (2015). Hill spacing and number of seedlings per hill on the yield of T. *aman* rice (var. BRRI dhan52) in the tidal ecosystem. *American Res. Thoughts*. **1**(11): 2727-2744.

BRRI (Bangladesh Rice Research Institute) (1990).Annual Report for 1987. Bangladesh Rice Res. Inst. Gazipur. Pub no. 92. pp. 94-100.

BRRI (Bangladesh Rice Research Institute). (1988). Annual report for 1985. Bangladesh Rice Research Institute. Gazipur. Bangladesh. Pub. no.89. pp. 52-56.

BRRI (Bangladesh Rice Research Institute). (1991a), Annual Report for 1988. Bangladesh Rice Research Institute. pp. 82-300.

BRRI (Bangladesh Rice Research Institute). (1994). Annual Report for 1993. Bangladesh Rice Research Institute, Jodebpur, Gazipur. pp. 8-9.

BRRI (Bangladesh Rice Research Institute). (1995a). Annual Report for 1992. Bangladesh Rice Research Institute. Pub. No. 113. Joydebpur, Gazipur, Bangladesh. pp. 226-252.

BRRI (Bangladesh Rice Research Institute). (1995b). Annual Report for 1992. Bangladesh Rice Research Institute. Pub. No. 113. Joydebpur, Gazipur, Bangladesh. pp. 237.

BRRI (Bangladesh Rice Research Institute). (2003). Annual Internal Review, held on 19-23 October, 2003. Grain Quality and Nutrition Division. Bangladesh Rice Research Institute. pp. 1-20.

BRRI (Bangladesh Rice Research Institute) (1985). Annual Report for 1983. Bangladesh Rice Research Institute. Joydebpur, Gazipur, Bangladesh. p. 34.

Chandra, S. and Manna, J. (1988). Effect of date of planting and spacing on grain yield and grain quality of scented rice (*Oryza sativa*) varieties in wet season in costal Orisssa. *Indian J. Agric. Sci*. **67**: pp. 93-97.

Chopra, N. K. and Chopra, N. (2004). Seed yield and quality of "Pusa 44" rice (*Oryza sativa*) as influenced by nitrogen fertilizer and row spacing. *Indian J. Agril. Sci*. **74**(3): 144-146.

Chowdhury, M.J.U., Sarker, A.U., Sarkar. M.A.R. and Kashem, M.A. (1993). Effect of variety and number of seedlings hill^{-1} on the yield and its components of late transplant *Aman* rice. *Bangladesh J. Agril. Sci*., **20**(2): 311-316.

Das, T. and Baqui, M. A. (2000). Aromatic rices of Bangladesh. In: *Aromatic rices,* pp.184-187. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.

Dinesh, C., Lodh. S. B., Sahoo. K.M., Nanda, B.B. and Chandra, D. (1997). Effect of date of planting and spacing on grain yield and quality of scented rice (*Oryza sativa*) varieties in wet season in coastal Orissa. *Indian J. Agril. Sci.* **67**(3):93-97.

Dowling, N. G., Greenfield, S. M. and Fisher, K. S. (1998). Sustain ability of rice in the global food system. International Rice Research Institute. Los Banos, Philippines. p. 404.

Dwivedi, D.K. (1997). Response of scented rice (*Oryza sativa*) genotypes of nitrogen under midupland situation. *Indian J. Agron*. **43**(1.): 74-76.

Edris, K.M., Islam, A.T.M.T., Chowdhury, M.S. and Haque, A.K.M.M. (1979). Detailed Soil Survey of Bangladesh, Dept. Soil Survey, Govt. People's Republic of Bangladesh. p.118.

FAO (Food and Agriculture Organization). (2006). Retrieved from: http// www.fao.org.

Faruk M.O., Rahman M.A. and Hasan M.A. (2009). Effect of seedling age and number of seedling per hill on the yield and yield contributing characters of BRRI dhan33. *Intl. J. Sustain. Crop Prod.*, **4**(1): 58-61.

Gangwar, K. S. and Sharma, S. K. (1997). Influence of planting dates on productivity of traditional scented rice varieties. *IRRN*. **22**(1): 42.

Ghosh, D. C. and Ganguly, S. (1994). Cultural factors affecting growth, lodging and productivity of wet land rice. *Indian Agril.* **38**(2): 99-103.

Gohain, T. and Saikia, L. (1996). Effect of date of transplanting on growth and yield of rain fed lowland rice (*Oryza sativa*). *Indian J. Agron.* **41**(3): 488-490.

Haque, M.S. and Nasiruddin, M. (1988). Effect of population density on yield and agronomic traits of deep water rice. In Proc. 1987. Intl. Deep Water Rice Workshop, Manila, Philippines. *Intl. Rice Res. Inst*. pp. 449-453.

Haque, Z. (1997). Photoperiodism and thermo sensitivity of transplant Aman rice & in Bangladesh. *In. Proc. Intl. Sem.* Photoperiod-sensitive Transplant Rice. October. 1997. pp-18-25.

Hassan, G., Khan, N. U. and Khan, Q. N. (2003). Effect of transplanting date on the yield and yield components of different rice cultivars under high temperature of D.I. Khan. *Sci. Res.* **16**(2): 129-137.

Hossain, M. and Haque, M.S. (1990). Effect of population density on yield and agronomic traits of deep water rice. In Proc. 1987. Intl. Deep Water Rice Workshop, Manila, Philippines. *Intl. Rice Res. Inst*. pp. 449-453.

Hossain, S.M.A., Alam, A.B.M. and Kashem, M.A. (1991a). Performance of different varieties of boro rice. In- Fact Searching and Intervention in Two FSRDP Sites. Activities 1989-90. Farming Syst. Res. Dev.

Hossain. S.M.A., Alam, A.B.M. and Kashem, M.A. (1991b). Status of crop production technology. In: Fact Searching and Intervention in Two FSRDP Sites. Activities 1989-90. Farming Syst. Res. and Dev. Prop., Bangladesh Agril. Univ., Mymensingh. pp. 150-154.

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

Idris, M. and Matin, M.A. (1990). Response of four exotic strains of *aman* rice to urea. *Bangladesh J. Agric. Assoc.*, **118**: 48-61.

Ingale, M.S., Luis, B.K. and Brod, M.A. (2005). Effect of number of seedlings per hill (one or two) and nitrogen rates (50,100,150 kg per ha) on the yield of Sahydri rice hybrid. *Japan J. Sci. Ind. Res.* **41**(4):205-2007.

IRRI (International Rice Research Institute). (2009). Rough rice production by country and geographical region-USDA. Trend in the rice economy. In: world rice statistics. Retrieved from: www.irri.org/science/ricestat.

Islam, A. J. M. A. (1986). Review of agronomic research on rice and its future strategy. Advance Agronomic Research. In Bangladesh. *Bangladesh soc. Agron.* **3**: pp.7-19

Islam, M. R., Rahman, M. S., Rahman, M.H., Awal, M. A. and Hossain, S. M. G. (1999). Effect of date of transplanting on yield and yield attributes of two advanced mutants of rice on *aman* season. *Bangladesh J. Nuclear. Agril*. **15**(1): 34-40.

Islam, M. R., Salam, M. A., Hannan, M. A. and Sarker, M. A. R. 2002. Effect of hill density and number of seedlings per hill on the yield and yield components of fine rice cv. Kalizira. *Bangladesh J. Agril. Sci.* **29**(2): 325-328.

Islam, M. S., Hossain, M. A., Chowdhury, M. A. H. and Hannan, M. A. (2008). Effect of nitrogen and transplanting date on yield and yield components of aromatic rice. *J. Bangladesh Agril. Univ*. **6**(2): 291-296.

Islam, M.A. and Ahamed, J.U. (1981). Effect of age of seedlings on the yield of transplant aman cultivars. *Bangladesh J. Agril. Sci*. **8**(2): 175-179.

Islam, M.A., Khan, M.N. and Rahman, M.M. (1980). Effects of cultural weed control practice on aus (summer) rice. *Bangladesh J. Agril. Sci*., **7**(1): 43-46.

Islam, M.R., Khan, M.A.H., Rahman, M.S., Alam, M.S. and Afrin, S. (2012). Effect of spacing and number of seedlings per hill on the yield performance of fine rice cv. Kalizira. *J. Agrofor. Environ*., **6**(1): 79-82.

Islam, M.S., Sarkar, M.A.R., Uddin, S. and Parvin, S. (2012).Yield of fine rice varieties as influenced by integrated management of poultry manure, urea super granules and prilled urea. *J. Environ. Sci. Natural Res.* **5**(1):129-132.

Islam, M.Z. (1986). Effect of weeding regime on the growth and yield of BRRI dhan31 under varying seedlings number. M.S. Thesis, Dept. Agron. Bangladesh Agril. Univ., Mymensingh. pp. 76-77.

Joseph, K. and Havanagi, G. V. (1987). Effect of dates of planting and irrigation on yield and yield attributes of rice varieties. *Indian J. Agron.* **32** (4):411-413.

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

Khalifa, A.A.B.A. (2009). Physiological evaluation of some hybrid rice varieties under different sowing dates. *Australian J. Crop Sci.,* **3**(3):178-183.

Khisha, K. (2002). An evaluating of Madagascar system of rice production in aman season with three high potential rice varieties. MS Thesis, Dept. Agron., Bangladesh Agril., Univ., Mymensingh. p. 98.

Kilshnan, P. and Nayak. S. K. (1998). Development rate and growth duration of rice (Oryza saliva) in response to delayed transplanting. *Indian J. Agric. Sci.* **68** (9): 593-595.

Mandavi, F., Eamaili, M.A., Pirdashti, H. and Fallah, A. (2004). Study on the physiological and morphological indices among the modern and old rice (*Oryza sativa* L.) genotypes: New directions for a diverse planet. Proc. 4th Int. Crop Sci. Congress; Brisbane, Australia**.**

Mannan, M. A., Bhuiya, M. S. U., Hossain, S. M. A. and Akhand, M. I. M. (2009). Study on phenology and yielding ability of basmati fine rice genotypes as influenced by planting date in aman season. *Bangladesh J. Agril. Res.* **34**(3): 373-384.

Masum, S.M., Ali, M.H. and Ullah, J. (2008). Growth and yield of two T. aman rice varieties as affected by seedling number per hill and urea supper granules. *J. Agric. Educ. Technol*. **11**(1&2): 51-58.

Miah, M. H. N., Karim, M. A., Rahman, M. S. and Islam, M. S. (1990). Performance of nitrogen nutrients under different row spacing. *Bangladesh J. Train. Dev.* **3**(2): 31-34.

Mohammad, N., Islam, N., Ziauddin, A. T. M. and Hossain, M. M. (2014). Effect of variety and method of USG placement on the yield performance of transplanted aman rice. *J. Bangladesh Agril. Univ.* **12**(1): 7-12.

Mohapatra, A.K. (1989). Effect of dates of planting, age of seedling and levels of nitrogen on biological yield and harvest index of rice. *Environ. Ecol*. 7(4): 896-898.

Muhammad, A.U.B., Sharker, M.S. and Nazir, M.S. (1987). The yield and yield components of fine rice as influenced by different spacings. *Pakistan J. Sci. Indust. Res*. **30**(7): 523-525.

Murthy, K.N.K., Shankaranarayana, V., Murali, K. and Jayakumar, B.V. (2004). Effect of different dates of planting on spikelet sterility in rice genotypes (*Oryza sativa* L.). *Res. Crops.* **5**(2/3): 143-147.

Narayanaswamy, S., Yoogeshwar, R.Y., Ramsheshaiash, K. and Sivasankaan, R.V. (1982). Effect of time and method of sowing rice varieties in puddled soil during wet season. *Oryza.* **19**: 47-52.

Obulamma, U., Reddeppa, R. and Reddy, R. (2002). Effect of spacing and seedling number on growth and yield of hybrid rice. *J. Res. Agron*. **30**(1): 76-78.

Om, M. R. and Desai, N. D. (1998). Sources and methods of N application for irrigated wetland rice. *Intl. Rice Res. Newsl*.**12** (2): 43.

Patel, S. R. (2000). Effect of different forms of urea and levels of nitrogen on the yield and nitrogen uptake of rice. *Adv. Plant Sci.* **7**(2): 297-401.

Paliwal, A. K., Kandalkar, V. S., Paraye, P. M. and Tomar. N. S. (1996). Effect of transplanting time on grain yield and its attributes in dwarf scented rice varieties. *Indian J. Agril.* Sci. **66**(1): 48-50.

Prasad, K., Room, S. and Sher, S. (1992). Effect of seedling age and number of seedlings hill^{-1} on the yield of rice in a sodic soil. *Current Agric*. **16**(2): 67-70.

Rahman, M.A., Hossain, S.M.A., Sarkar, N.A.R., Hossain, M.S. and Islam, M.S. (2002). Effect of variety and structural arrangement of rows on the yield and yield components of transplant aman rice. *Bangladesh .J. Agril. Sci.* **29**(2): 303-307.

Rao, S.P. and Reddy, C.K. (1993). High density grain and yield in rice as influenced by number of seedlings hill^{-1} at varied population pressures. *Indian J. Plant Physiol*., **36**(3): 163-165.

Reddy, M.D. and Mittra, B.N. (1984). Effect of time of planting age and number of seedling hill^{-1} on yield and yield components of rice varieties in flood prone situations. *Thailand J. Agric. Sci*., **17**(1): 41-49.

Relwani, I.L. (1982). Studies on the effect of spacing, number of seedlings hill^{-1} and levels of nitrogen on paddy yields. *Indian J. Agron*., **6**(4): 279-288.

Salam, M. A., Ali, F., Anwar, M. P. and Bhuiya, M. S. U. (2004). Effect of level nitrogen and date of transplanting on the yield and yield attributes of transplanted aman rice under SRI method. *J. Bangladesh Agril. Univ*. **2**(1): 31-36.

Sarkar, M.A.R., Paul, S.K. and Hossain, M.A. (2011). Effect of row arrangement, age of tiller seedling and number of tiller seedlings per hill on performance of transplant aman rice. *J. Agril. Sci.,* **6**(2): 59-68.

Shah, M. L. and Yadav, R. (2001). Response of rice varieties to age of seedlings and transplanting dates. *Nepal Agric. Res. J.* 4 and 5: 14-17.

Shamsuddin. A.M.. Islam, M.A. and Hossain, A. (1988). Comparative study on the yield and agronomic characters of nine cultivars of aus rice. *Bangladesh J. Agri1. Sci*. **15**(1): 121-124.

Shrirame, M.D., Rajgire, H.J. and Rajgire, A.H. (2000). Effect of spacing and seedling number per hill on growth attributes and yield of rice hybrids under lowland condition. *Indian J. Soils Crops.* **10**(l): 109-113.

Singh, A.K. Manibhushan, M.K. and Upadhyaya, A. (2012). Effect of Sulphur and Zinc on Rice Performance and Nutrient Dynamics in Plants and Soil of Indo Gangetic Plains. *J. Agril. Sci*., **4**(11): 162-170.

Singh, G. and Singh, O.P. (1992). Effect of age and number of seedlings hill^{-1} on yield and yield attributes of rice under rain fed lowland. *Indian J. Crop. Res*. **5**(3): 417-419.

Singh, G. and Singh, O.P. (1992). Effect of age and number of seedlings hill^{-1} on yield and yield attributes of rice under rainfed lowland. *Indian J. Crop. Res*., **5**(3): 417-419.

Singh, K. M., Pal, S. K., Verma, U. N., Thakur, R. and Singh, M. K. (1997). Effect of time and methods of planting on performance of rice cultivars under medium land of Bihar Plateau. *Indian J. Agron*. **42**(3): 443-445.

Singh, R. K., Singh, U. S., Khush, G. S. and Rohilla, R. (2000). Genetics and biotechnology of quality traits in aromatic rices In: Aromatic rices, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, p.58.

Singh, S. and Gongwer, B. (1989). Comparative studies on production potentials in traditional tall and improved rice cultivars. *J. Andaman Sci. Assoc*. **5**(l): 81-82.

Srivastava, G.K. and Tripathi, R.S. (1998). Response of hybrid and composite rice to number of seedling and planting geometry. *Annals Agril. Res*.**19**(2): 235-236.

Subbain, P., Gopalasundararn, P. and Palaniappan, S. P. (1995). Energetic and water use efficiency of intensive cropping system. *Indian J. Agron*. **40**(3): 398-401.

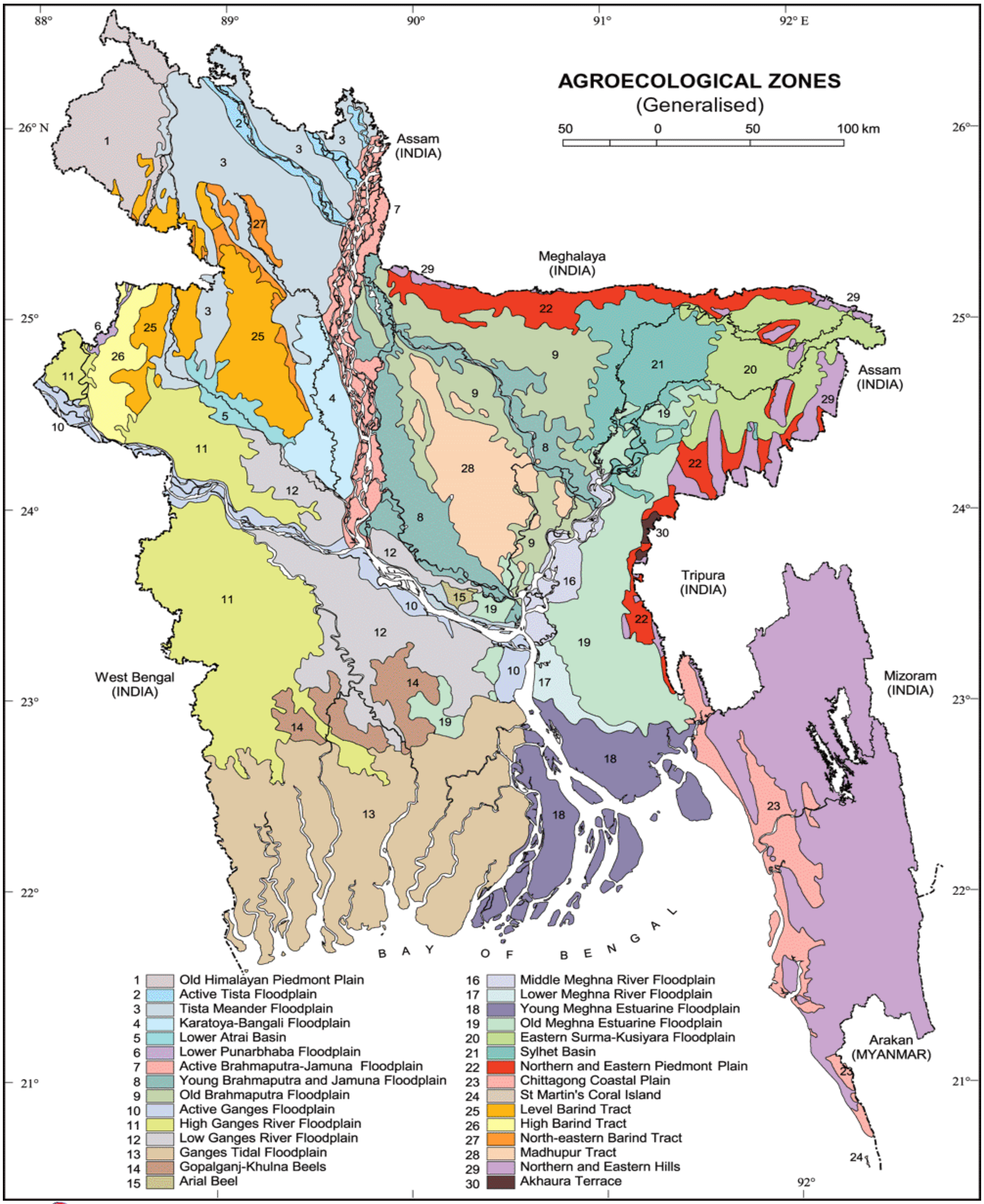
Suprihatno, B. and Sutaryo, B. (1992). Yield performance of some new rice hybrids varieties in Indonesia. *Intl. Rice Res. Newsl*., **17**(3): 12.

Yoshida,S. (1981). Fundamentals of Rice Crop Science.Intl. Rice Res.Inst.Los Bannos. Philippines. pp 41-58

Zaman, S. M. H. (1980). Simple techniques of rice production. *In:* Proc. of the workshop on modern rice cultivation in Bangladesh. Feb, 1980. Bangladesh Rice Res. Inst. Gazipur. pp. 31-39.

APPENDICES

Appendix I. Map showing the experimental site under the study



The experimental site under the study

Appendix II. Monthly average temperature, average relative humidity and total rainfall and average sunshine of the experimental site during the period from June, 2018 to December, 2018

Month	Average Temperature (ºC)		Average Relative Humidity (%)	Rainfall (mm)	Average sunshine (hr)
	Minimum	**Maximum**			
June, 2018	23.2	35.5	78	312	5.4
July, 2018	24.5	36.0	83	563	5.1
August, 2018	23.5	36.0	81	319	5.0
September, 2018	24.4	34.5	81	279	4.4
October, 2018	25	32	79	175	6
November, 2018	21	30	65	35	8
December, 2018	15	29	74	15	9

Source: Bangladesh Meteorological Department (Climate & Weather Division), Agargoan, Dhaka-1212.

Appendix III: Characteristics of soil of experimental field analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of soil of the experimental field

Morphological features	Characteristics
Location	Agronomy field, SAU, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Land type	Medium-high land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical composition of the soil

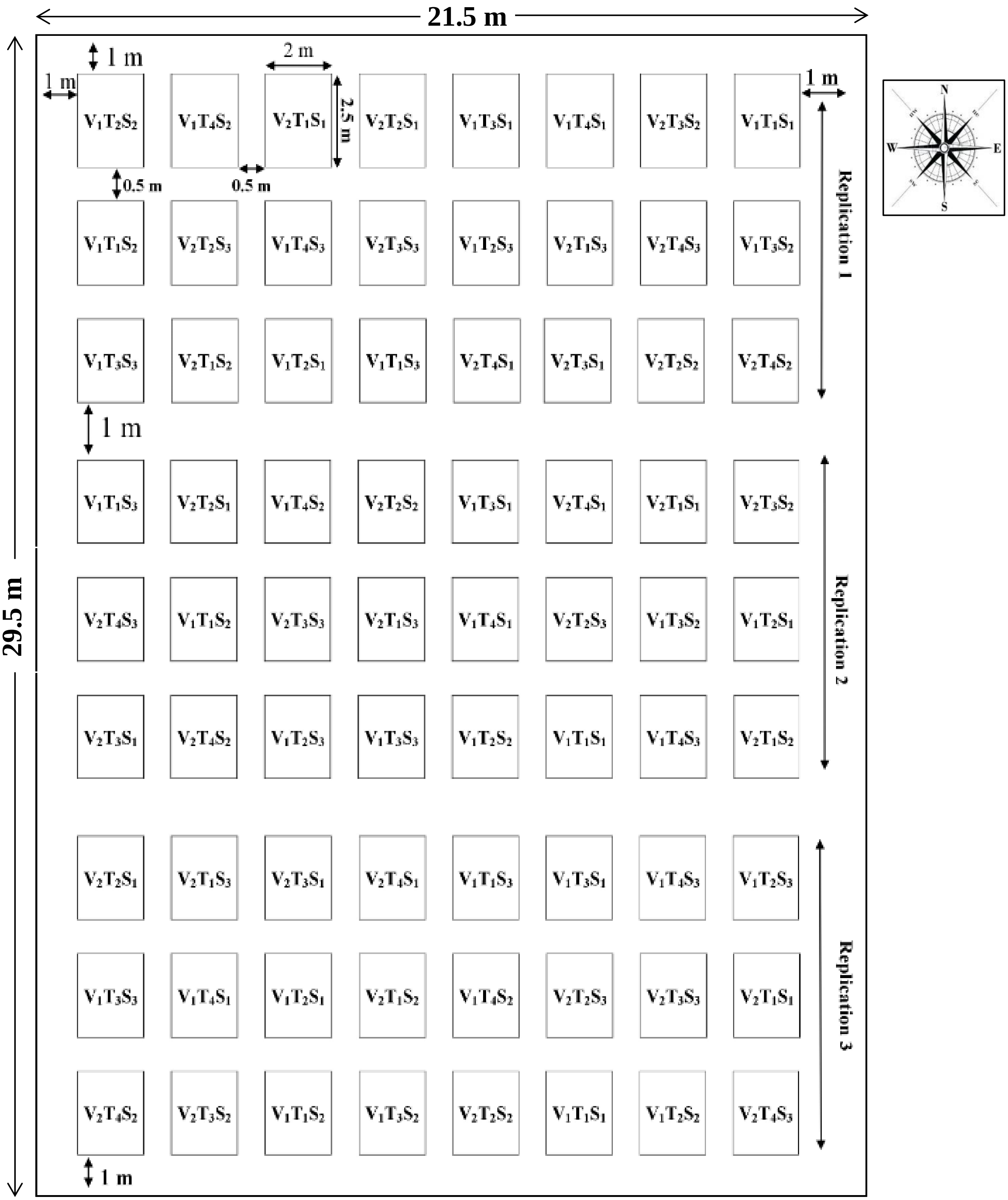
Soil separates	%	Methods employed
Sand	26	Hydrometer method (Day, 1915)
Silt	45	Do
Clay	29	Do
Texture class	Silty loam	Do

C. Chemical composition of the soil

Sl. No.	Soil characteristics	Analytical data	Methods employed
1	Organic carbon (%)	0.45	Walkley and Black, 1947
2	Total N (%)	0.03	Bremner and Mulvaney, 1965
3	Total S (ppm)	225.00	Bardsley and Lanester, 1965
4	Total P (ppm)	840.00	Olsen and Sommers, 1982
5	Available N (kg/ha)	54.00	Bremner, 1965
6	Available P (ppm)	20.54	Olsen and Dean, 1965
7	Exchangeable K (me/100 g soil)	0.10	Pratt, 1965
8	Available S (ppm)	16.00	Hunter, 1984
9	pH (1:2.5 soil to water)	5.6	Jackson, 1958
10	CEC	11.23	Chapman, 1965

Source: Soil Resource and Development Institute (SRDI), Farmgate, Dhaka

Appendix IV: Layout of the design of the experiment



Appendix V. Analysis of variance (ANOVA) of plant height at different days after Transplanting date for aromatic rice

ANOVA for plant height at 30 DAT

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	2	3.22	1.612		
Variety	1	396.45	396.446	633.13	0.0000
Transplanting date	3	723.07	241.025	384.92	0.0000
Seedling hill^{-1}	2	12.73	6.364	10.16	0.0002
Variety*Transplanting date	3	600.79	200.263	319.82	0.0000
Variety*Seedling hill^{-1}	2	119.35	59.677	95.31	0.0000
Transplanting date*Seedling hill^{-1}	6	150.32	25.053	40.01	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	131.72	21.953	35.06	0.0000
Error	46	28.80	0.626		
Total	71	2166.45			
Grand Mean	**61.95**				
CV	**1.28**				

ANOVA for plant height at 40 DAT

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	2	0.96	0.482		
Variety	1	196.42	196.416	217.88	0.0000
Transplanting date	3	686.84	228.945	253.97	0.0000
Seedling hill^{-1}	2	8.96	4.479	4.97	0.0111
Variety*Transplanting date	3	286.06	95.354	105.78	0.0000
Variety*Seedling hill^{-1}	2	176.71	88.355	98.01	0.0000
Transplanting date*Seedling hill^{-1}	6	262.37	43.729	48.51	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	167.50	27.916	30.97	0.0000
Error	46	41.47	0.901		
Total	71	1827.28			
Grand Mean	**74.54**				
CV	**1.27**				

ANOVA for plant height at 50 DAT

Source	DF	SS	MS	F	P
Replication	2	4.84	2.419		
Variety	1	535.19	535.190	262.53	0.0000
Transplanting date	3	1105.17	368.388	180.71	0.0000
Seedling hill-1	2	57.48	28.739	14.10	0.0000
Variety*Transplanting date	3	217.17	72.391	35.51	0.0000
Variety*Seedling hill^{-1}	2	459.90	229.952	112.80	0.0000
Transplanting date*Seedling hill^{-1}	6	217.80	36.299	17.81	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	81.88	13.647	6.69	0.0000
Error	46	93.78	2.039		
Total	71	2773.20			
Grand Mean	**86.508**				
CV	**1.65**				

ANOVA for plant height at 60 DAT

Source	DF	SS	MS	F	P
Replication	2	7.94	3.97		
Variety	1	1435.23	1435.23	579.48	0.0000
Transplanting date	3	620.51	206.84	83.51	0.0000
Seedling hill^{-1}	2	192.41	96.21	38.84	0.0000
Variety*Transplanting date	3	501.77	167.26	67.53	0.0000
Variety*Seedling hill^{-1}	2	448.63	224.32	90.57	0.0000
Transplanting date*Seedling hill^{-1}	6	274.75	45.79	18.49	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	147.76	24.63	9.94	0.0000
Error	46	113.93	2.48		
Total	71	3742.93			
Grand Mean	**98.169**				
CV	**1.60**				

ANOVA for plant height at Harvest

Source	DF	SS	MS	F	P
Replication	2	0.6	0.32		
Variety	1	7005.5	7005.47	4301.07	0.0000
Transplanting date	3	4105.5	1368.51	840.21	0.0000
Seedling hill^{-1}	2	50.0	24.99	15.34	0.0000
Variety*Transplanting date	3	221.2	73.73	45.27	0.0000
Variety*Seedling hill^{-1}	2	266.7	133.36	81.88	0.0000
Transplanting date*Seedling hill^{-1}	6	175.0	29.16	17.90	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	87.8	14.63	8.98	0.0000
Error	46	74.9	1.63		
Total	71	11987.2			
Grand Mean	**131.17**				
CV	**0.97**				

Appendix VI. Analysis of variance (ANOVA) of number of tiller hill^{-1} at different days after Transplanting date for aromatic rice varieties

ANOVA for number of tiller at 30 DAT

Source	DF	SS	MS	F	P
Replication	2	0.166	0.0829		
Variety	1	34.648	34.6482	95.52	0.0000
Transplanting date	3	44.361	14.7871	40.77	0.0000
Seedling hill^{-1}	2	7.436	3.7182	10.25	0.0002
Variety*Transplanting date	3	13.758	4.5859	12.64	0.0000
Variety*Seedling hill^{-1}	2	8.558	4.2791	11.80	0.0001
Transplanting date*Seedling hill^{-1}	6	5.766	0.9610	2.65	0.0272
Variety*Transplanting date*Seedling hill^{-1}	6	20.943	3.4905	9.62	0.0000
Error	46	16.685	0.3627		
Total	71	152.322			
Grand Mean	**10.999**				
CV	**5.48**				

ANOVA for number of tiller at 40 DAT

Source	DF	SS	MS	F	P
Replication	2	0.647	0.3234		
Variety	1	38.053	38.0531	234.68	0.0000
Transplanting date	3	37.948	12.6494	78.01	0.0000
Seedling $hill^{-1}$	2	11.127	5.5635	34.31	0.0000
Variety*Transplanting date	3	9.719	3.2398	19.98	0.0000
Variety*Seedling $hill^{-1}$	2	5.217	2.6084	16.09	0.0000
Transplanting date*Seedling $hill^{-1}$	6	7.799	1.2998	8.02	0.0000
Variety*Transplanting date*Seedling $hill^{-1}$	6	13.293	2.2155	13.66	0.0000
Error	46	7.459	0.1621		
Total	71	131.263			
Grand Mean	**12.798**				
CV	**3.15**				

ANOVA for number of tiller at 50 DAT

Source	DF	SS	MS	F	P
Replication	2	0.504	0.2518		
Variety	1	34.183	34.1827	121.97	0.0000
Transplanting date	3	49.721	16.5737	59.14	0.0000
Seedling $hill^{-1}$	2	7.201	3.6006	12.85	0.0000
Variety*Transplanting date	3	15.773	5.2575	18.76	0.0000
Variety*Seedling $hill^{-1}$	2	7.404	3.7020	13.21	0.0000
Transplanting date*Seedling $hill^{-1}$	6	6.793	1.1322	4.04	0.0025
Variety*Transplanting date*Seedling $hill^{-1}$	6	18.822	3.1370	11.19	0.0000
Error	46	12.892	0.2803		
Total	71	153.292			
Grand Mean	**15.094**				
CV	**3.51**				

ANOVA for number of tiller at 60 DAT

Source	DF	SS	MS	F	P
Replication	2	0.515	0.2576		
Variety	1	33.857	33.8573	117.79	0.0000
Transplanting date	3	47.950	15.9834	55.60	0.0000
Seedling hill^{-1}	2	7.369	3.6846	12.82	0.0000
Variety*Transplanting date	3	14.570	4.8568	16.90	0.0000
Variety*Seedling hill^{-1}	2	8.170	4.0852	14.21	0.0000
Transplanting date*Seedling hill^{-1}	6	6.801	1.1335	3.94	0.0029
Variety*Transplanting date*Seedling hill^{-1}	6	18.486	3.0809	10.72	0.0000
Error	46	13.223	0.2874		
Total	71	150.942			
Grand Mean	**16.491**				
CV	**3.25**				

Appendix VII. Analysis of variance (ANOVA) of plant Dry matter production at different days after Transplanting date for aromatic rice varieties

ANOVA for dry matter weight at 30 DAT

Source	DF	SS	MS	F	P
Replication	2	0.0150	0.00749		
Variety	1	0.5185	0.51850	55.48	0.0000
Transplanting date	3	11.4957	3.83191	410.03	0.0000
Seedling hill^{-1}	2	0.5451	0.27254	29.16	0.0000
Variety*Transplanting date	3	0.1659	0.05530	5.92	0.0017
Variety*Seedling hill^{-1}	2	0.1150	0.05752	6.15	0.0043
Transplanting date*Seedling hill^{-1}	6	2.6491	0.44152	47.24	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	2.0990	0.34983	37.43	0.0000
Error	46	0.4299	0.00935		
Total	71	18.0332			
Grand Mean	**3.3365**				
CV	**2.90**				

ANOVA for dry matter weight at 40 DAT

Source	DF	SS	MS	F	P
Replication	2	0.0097	0.0048		
Variety	1	0.0005	0.0005	0.03	0.8531
Transplanting date	3	33.8610	11.2870	870.09	0.0000
Seedling hill^{-1}	2	1.1618	0.5809	44.78	0.0000
Variety*Transplanting date	3	0.5262	0.1754	13.52	0.0000
Variety*Seedling hill^{-1}	2	0.1944	0.0972	7.49	0.0015
Transplanting date*Seedling hill^{-1}	6	8.8742	1.4790	114.02	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	4.1201	0.6867	52.93	0.0000
Error	46	0.5967	0.0130		
Total	71	49.3445			
Grand Mean	**7.4681**				
CV	**1.53**				

ANOVA for dry matter weight at 50 DAT

Source	DF	SS	MS	F	P
Replication	2	0.179	0.0896		
Variety	1	9.812	9.8125	171.99	0.0000
Transplanting date	3	256.639	85.5463	1499.45	0.0000
Seedling hill^{-1}	2	6.743	3.3717	59.10	0.0000
Variety*Transplanting date	3	4.635	1.5449	27.08	0.0000
Variety*Seedling hill^{-1}	2	1.635	0.8173	14.33	0.0000
Transplanting date*Seedling hill^{-1}	6	46.741	7.7902	136.55	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	22.124	3.6873	64.63	0.0000
Error	46	2.624	0.0571		
Total	71	351.132			
Grand Mean	**14.027**				
CV	**1.70**				

ANOVA for dry matter weight at 60 DAT

Source	DF	SS	MS	F	P
Replication	2	0.66	0.328		
Variety	1	34.29	34.293	116.40	0.0000
Transplanting date	3	949.38	316.459	1074.14	0.0000
Seedling hill^{-1}	2	269.66	134.831	457.65	0.0000
Variety*Transplanting date	3	15.26	5.085	17.26	0.0000
Variety*Seedling hill^{-1}	2	49.93	24.966	84.74	0.0000
Transplanting date*Seedling hill^{-1}	6	229.11	38.185	129.61	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	51.76	8.626	29.28	0.0000
Error	46	13.55	0.295		
Total	71	1613.59			
Grand Mean	**29.528**				
CV	**1.84**				

Appendix VIII. Analysis of variance (ANOVA) of yield data

A. ANOVA for Panicle weight (g)

Source	DF	SS	MS	F	P
Replication	2	0.00954	0.00477		
Variety	1	0.91013	0.91013	188.04	0.0000
Transplanting date	3	1.05030	0.35010	72.33	0.0000
Seedling hill^{-1}	2	0.09964	0.04982	10.29	0.0002
Variety*Transplanting date	3	0.91086	0.30362	62.73	0.0000
Variety*Seedling hill^{-1}	2	0.04771	0.02386	4.93	0.0115
Transplanting date*Seedling hill^{-1}	6	1.01341	0.16890	34.90	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	0.66820	0.11137	23.01	0.0000
Error	46	0.22264	0.00484		
Total	71	4.93243			
Grand Mean	**1.8420**				
CV	**3.78**				

B. **ANOVA for total grains panicle^{-1}**

Source	DF	SS	MS	F	P
Replication	2	267.3	133.7		
Variety	1	15189.0	15189.0	165.33	0.0000
Transplanting date	3	7676.1	2558.7	27.85	0.0000
Seedling hill-1 Hill^{-1}	2	2200.5	1100.2	11.98	0.0001
Variety*Transplanting date	3	16630.9	5543.6	60.34	0.0000
Variety*Seedling hill^{-1}	2	203.2	101.6	1.11	0.3395
Transplanting date*Seedling hill^{-1}	6	13551.4	2258.6	24.58	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	5549.0	924.8	10.07	0.0000
Error	46	4226.0	91.9		
Total	71	65493.3			
Grand Mean	**181.36**				
CV	**5.29**				

C. **ANOVA for filled grains panicle^{-1}**

Source	DF	SS	MS	F	P
Replication	2	423.2	211.60		
Variety	1	6310.4	6310.45	94.70	0.0000
Transplanting date	3	8935.4	2978.47	44.70	0.0000
Seedling hill^{-1}	2	2244.2	1122.08	16.84	0.0000
Variety*Transplanting date	3	11245.2	3748.42	56.25	0.0000
Variety*Seedling hill^{-1}	2	555.1	277.57	4.17	0.0217
Transplanting date*Seedling hill^{-1}	6	10739.0	1789.83	26.86	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	5398.5	899.75	13.50	0.0000
Error	46	3065.2	66.63		
Total	71	48916.3			
Grand Mean	**137.53**				
CV	**5.94**				

D. ANOVA for unfilled grain panicle^{-1}

Source	DF	SS	MS	F	P
Replication	2	104.95	52.48		
Variety	1	1918.90	1918.90	142.57	0.0000
Transplanting date	3	538.39	179.46	13.33	0.0000
Seedling hill^{-1}	2	120.86	60.43	4.49	0.0166
Variety*Transplanting date	3	1140.31	380.10	28.24	0.0000
Variety*Seedling hill^{-1}	2	186.24	93.12	6.92	0.0024
Transplanting date*Seedling hill^{-1}	6	283.17	47.20	3.51	0.0061
Variety*Transplanting date*Seedling hill^{-1}	6	128.06	21.34	1.59	0.1729
Error	46	619.14	13.46		
Total	71	5040.03			
Grand Mean	**43.827**				
CV	**8.37**				

E. ANOVA for total tiller hill^{-1}

Source	DF	SS	MS	F	P
Replication	2	0.169	0.0847		
Variety	1	89.126	89.1261	250.92	0.0000
Transplanting date	3	52.929	17.6429	49.67	0.0000
Seedling hill^{-1}	2	1.204	0.6020	1.69	0.1949
Variety*Transplanting date	3	16.223	5.4075	15.22	0.0000
Variety*Seedling hill^{-1}	2	1.807	0.9036	2.54	0.0896
Transplanting date*Seedling hill^{-1}	6	22.764	3.7940	10.68	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	37.536	6.2560	17.61	0.0000
Error	46	16.339	0.3552		
Total	71	238.097			
Grand Mean	**13.523**				
CV	**4.41**				

F. ANOVA for effective tiller hill^{-1}

Source	DF	SS	MS	F	P
Replication	2	0.217	0.1086		
Variety	1	83.866	83.8656	932.51	0.0000
Transplanting date	3	40.279	13.4265	149.29	0.0000
Seedling hill^{-1}	2	0.520	0.2601	2.89	0.0656
Variety*Transplanting date	3	12.242	4.0806	45.37	0.0000
Variety*Seedling hill^{-1}	2	0.983	0.4917	5.47	0.0074
Transplanting date*Seedling hill^{-1}	6	18.293	3.0489	33.90	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	36.810	6.1351	68.22	0.0000
Error	46	4.137	0.0899		
Total	71	197.348			
Grand Mean	**12.480**				
CV	**2.40**				

G. ANOVA for ineffective tiller hill^{-1}

Source	DF	SS	MS	F	P
Replication	2	0.2864	0.14320		
Variety	1	0.0800	0.08000	0.27	0.6044
Transplanting date	3	4.3059	1.43528	4.88	0.0050
Seedling hill^{-1}	2	0.3991	0.19953	0.68	0.5122
Variety*Transplanting date	3	3.6392	1.21308	4.13	0.0113
Variety*Seedling hill^{-1}	2	0.1271	0.06355	0.22	0.8064
Transplanting date*Seedling hill^{-1}	6	0.5280	0.08800	0.30	0.9340
Variety*Transplanting date*Seedling hill^{-1}	6	1.1220	0.18700	0.64	0.7006
Error	46	13.5208	0.29393		
Total	71	24.0084			
Grand Mean	**1.0424**				
CV	**52.01**				

H. ANOVA for 1000 seeds weight (g)

Source	DF	SS	MS	F	P
Replication	2	0.1499	0.0750		
Variety	1	21.1250	21.1250	159.40	0.0000
Transplanting date	3	0.4232	0.1411	1.06	0.3734
Seedling hill^{-1}	2	0.1912	0.0956	0.72	0.4914
Variety*Transplanting date	3	0.0956	0.0319	0.24	0.8677
Variety*Seedling hill^{-1}	2	0.4672	0.2336	1.76	0.1830
Transplanting date*Seedling hill^{-1}	6	1.1614	0.1936	1.46	0.2129
Variety*Transplanting date*Seedling hill^{-1}	6	1.4401	0.2400	1.81	0.1179
Error	46	6.0965	0.1325		
Total	71	31.1501			
Grand Mean	**11.054**				
CV	**3.29**				

I. ANOVA for grain yield (t. ha^{-1})

Source	DF	SS	MS	F	P
Replication	2	0.0476	0.0238		
Variety	1	22.4562	22.4562	923.20	0.0000
Transplanting date	3	14.3029	4.7676	196.00	0.0000
Seedling hill^{-1}	2	4.8191	2.4095	99.06	0.0000
Variety*Transplanting date	3	2.8219	0.9406	38.67	0.0000
Variety*Seedling hill^{-1}	2	0.4353	0.2176	8.95	0.0005
Transplanting date*Seedling hill^{-1}	6	2.8991	0.4832	19.86	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	1.8280	0.3047	12.53	0.0000
Error	46	1.1189	0.0243		
Total	71	50.7290			
Grand Mean	**3.4351**				
CV	**4.54**				

J. ANOVA for straw yield (t. ha^{-1})

Source	DF	SS	MS	F	P
Replication	2	0.3654	0.18271		
Variety	1	5.4670	5.46702	85.72	0.0000
Transplanting date	3	11.9675	3.98918	62.55	0.0000
Seedling hill^{-1}	2	3.4216	1.71082	26.82	0.0000
Variety*Transplanting date	3	7.3225	2.44083	38.27	0.0000
Variety*Seedling hill^{-1}	2	2.5744	1.28719	20.18	0.0000
Transplanting date*Seedling hill^{-1}	6	41.4946	6.91576	108.43	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	20.8174	3.46957	54.40	0.0000
Error	46	2.9338	0.06378		
Total	71	96.3643			
Grand Mean	**7.2769**				
CV	**3.47**				

K. ANOVA for biological yield (t. ha^{-1})

Source	DF	SS	MS	F	P
Replication	2	0.506	0.2529		
Variety	1	5.104	5.1040	51.00	0.0000
Transplanting date	3	52.656	17.5519	175.39	0.0000
Seedling hill^{-1}	2	14.426	7.2129	72.07	0.0000
Variety*Transplanting date	3	18.795	6.2650	62.60	0.0000
Variety*Seedling hill^{-1}	2	2.775	1.3873	13.86	0.0000
Transplanting date*Seedling hill^{-1}	6	65.962	10.9936	109.85	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	28.885	4.8141	48.10	0.0000
Error	46	4.604	0.1001		
Total	71	193.711			
Grand Mean	**10.695**				
CV	**2.96**				

L. ANOVA for harvest index (%)

Source	DF	SS	MS	F	P
Replication	2	1.20	0.60		
Variety	1	1248.93	1248.93	1316.11	0.0000
Transplanting date	3	195.15	65.05	68.55	0.0000
Seedling hill^{-1}	2	47.45	23.72	25.00	0.0000
Variety*Transplanting date	3	42.49	14.16	14.92	0.0000
Variety*Seedling hill^{-1}	2	28.43	14.22	14.98	0.0000
Transplanting date*Seedling hill^{-1}	6	86.89	14.48	15.26	0.0000
Variety*Transplanting date*Seedling hill^{-1}	6	145.22	24.20	25.51	0.0000
Error	46	43.65	0.95		
Total	71	1839.40			
Grand Mean	**31.807**				
CV	**3.06**				

PLATES

Plate 1. Raising seedling in seed bed

Plate 2. Transplanting of seedlings

Plate 3. Transplanted seedling at different date of transplanting

Plate 4. Intercultural operation

Plate 5. Drainage for irrigation

Plate 6. Collected sample for drying

Plate 7. Crop at ripening stage

Plate 8. Overhead crop netting at ripening stage

Plate 9. Sun drying the harvest grains