GROWTH AND YIELD OF TRANSPLANT AUS RICE AS INFLUENCED BY VARIETY AND NUMBER OF SEEDLINGS PER HILL

BY

NIAZ MORSHED

REG. NO. 08-03266

MASTER OF SCIENCE (MS)
IN
AGRONOMY

DEPARTMENT OF AGRONOMY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA

JUNE, 2010

GROWTH AND YIELD OF TRANSPLANT AUS RICE AS INFLUENCED BY VARIETY AND NUMBER OF SEEDLINGS PER HILL

BY

NIAZ MORSHED

REG. NO. 08-03266

A Thesis
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 (MS)
IN
AGRONOMY
SEMESTER: JANUARY- JUNE, 2010

APPROVED BY:

…….
Dr. H. M. M. Tariq Hossain
Associat Professor
Supervisor

……
Dr. Md. Shahidul Islam
Associat Professor
Co-supervisor

……..…..……
Prof. Dr. Md. Fazlul Karim
Chairman
Examination Committee

DEDICATED TO

MY

BELOVED PARENTS

Sher-e-Bangla Agricultural University

Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the research work entitled ,**"GROWTH AND YIELD OF TRANSPLANT AUS RICE AS INFLUENCED BY VARIETY AND NUMBER OF SEEDLINGS PER HILL**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment the requirements for the degree of **MASTER OF SCIENCE IN AGRONOMY,** embodies the result of a piece of bona-fide research work successfully carried out by **NIAZ MORSHED** bearing Registration No. 08- 3266 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, as has been availed of during the course of this investigation has duly been acknowledged.

. . . . . .

Dr. H. M. M. Tariq Hossain

Associat Professor

Department of Agronomy

Sher-e-Bangla Agricultural University

Dated:

Place:Dhaka,Bangladesh

ACKNOWLEDGEMENT

All praises are devoted to Almighty Allah, who is the supreme authority of this universe, and who enabled the author to complete the research work and submit the thesis for the degree of Master of Science (MS) in Agronomy.

The author would like to acknowledge the untiring inspiration, encouragement and invaluable guidance provided by his respected teacher and supervisor, Associate Professor Dr. H. M. M. Tariq Hossain, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka. His constructive criticism, continuous supervision and valuable suggestions were helpful in completing the research and writing up the manuscript.

The author would like to express his heartiest appreciation, ever indebtedness and deep sense of gratitude to his Co-supervisor, Associate Professor Dr. Md. Shahidul Islum, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, for his sincere advice, constant supervision, valuable suggestions and factual comments on upgrading the quality of the research work and preparing the manuscript.

The author would like to express his heartiest appreciation, ever indebtedness and deep sense of gratitude to Professor Dr. Md. Fazlul Karim, Chairman, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka for his kind permission to allow the departmental and laboratory facilities.

The author expresses his thanks to all other staff and members of the farm of Sher-e-Bangla Agricultural University, Dhaka for their help in conducting the experiment.

The author feel proud to express his unreserved gratitude to Md. Saiful Islum, Md. Nazrul Islam, Md. Maruf Al Hasan, A. F. M. Mamun and Md. Shahidulllah for their heartfelt cooperation during research period and writing up the manuscript.

The author expresses his boundless, gratitude and deepest appreciation to his beloved father "Kazi Moslem Uddin", mother "Begum Samsoonnahar", elder brother "kazi Meftaful Alam", and elder sister "Ferdaus Ara" for their unlimited prayer, support, sacrifice and inspiration to educate him up to this level.

ABSTRACT

An experiment was conducted at the Agronomy Farm of Sher-e-Bangla Agricultural University, Dhaka to evaluate 'the growth and yield of transplanted aus rice as influenced by variety and number of seedling per hill'. The experiment comprised two factors; (1) four varieties viz. V_1 (BRRI dhan 48), V_2 (BRRI dhan 43), V_3 (BRRI dhan 42) and V_4 (ACI hybrid-2) and (2) four seedling treatments viz, H_1 (1 seedling per hill), H_2 (2 seedlings per hill), H_3 (3 seedlings per hill) and H_4 (4 seedlings per hill). Data were collected on plant height (cm), number of tillers per hill, number of leaves per hill, number of panicles per hill, number of grains per panicle, 1000-seed weight, grain yield, stover yield and harvest index (%). Three effects have been considered to evaluate the experiment such as (i) Effect of variety, (ii) Effect of seedling per hill and (iii) Interaction effect of variety and seedling per hill. Results showed that The variety, V_3 (BRRI dhan 42), showed the highest plant height (94.95 cm) but the highest number of tillers per hill (23.62), number of leaves per hill (161.50), number of panicles per hill (16.67), number of grains per panicle (104.40), 1000- seed weight (20.82 g), grain yield (3.743 t/ha), stover yield (5.55 t/ha) and harvest index (40.13%) was obtained from V_4 (ACI hybrid-2). In terms of seedling per hill, H_4 (4 seedlings per hill) showed the highest plant height (94.53 cm) but the highest number of tillers per hill (24.65), number of leaves per hill (161.70), number of panicles per hill (17.22), number of grains per panicle (105.6), 1000-seed weight (22.00 g), grain yield (3.92 t/ha), stover yield (5.77 t/ha) and harvest index (40.37%) was obtained from H_1 (1 seedling per hill). With the interaction effect of different variety and seedling per hill the highest plant height (99.40 cm) was recorded in V_3H_4 but the highest number of tillers per hill (25.07), number of leaves per hill (356.60), number of panicles per hill (19.13), number of grains per panicle (121.70), 1000-seed weight (24.67 g), grain yield (4.42 t/ha), stover yield (6.02 t/ha) and harvest index (42.33%) was obtained from V_4H_1. It may be stated that the best variety was V_4 (ACI hybrid-2) and 1 seedling per hill under the present study. The combination of V_4H_1 (ACI hybrid-2 with 1 seedling per hill) performed the best in producing higher yield than other treatments comprised with other variety and number of seedling per hill under the present study.

CONTENTS

CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AEZ	: Agro Ecological Zone
BRRI	: Bangladesh Rice Research Institute
SAU	: Sher-e-Bangla Agricultural University
BAU	: Bangladesh Agriculture University
BARI	: Bangladesh Agriculture Research Institute
BINA	: Bangladesh Institute of Nuclear Agriculture
BBS	: Bangladesh Bureau of Statistics
DAT	: Days After Transplanting
FAO	: Food and Agricultural Organization
UNDP	: United Nations Development programme
RCBD	: Randomized Complete Block Design
t ha^{-1}	: Ton per hectare
AIS	: Agriculture Information System

CHAPTER I

INTRODUCTION

Rice is a major food crop in the world. It is the most important food grain in the diet of billions of people of Asia, Africa and Latin America and will also continue to be so in the future. Asia contributes about 92% of the world rice harvest (IRRI, 1995).

Bangladesh occupies the third position in rice area and fourth position in rice production among the rice growing countries of the world (BRRI, 2009). Rice is the most extensively cultivated crop of Bangladesh and the staple food of her people. It plays a dominant role in Bangladesh agriculture as it covers 74 per cent of total cultivable area (AIS, 2001) and is the principal commodity in our domestic market. The total area under rice cultivation in Bangladesh is about 10.80 million hectares and total production is 25.08 million tons (BBS, 2001). The average yield of rice in Bangladesh is around 2.3 t ha^{-1}, whereas, the average yield of rice in other countries is quite high such as 6.5 t ha^{-1} in Korea, 6.4 t ha^{-1} in Australia, 6.3 t ha^{-1} in Janan (Karim, 1992).

Rice is grown in Bangladesh under diverse ecosystems like irrigate rain fed and deep water conditions in three distinct seasons aus, aman and boro. Among the three rice groups, aus rice covers only 12.27% of the rice growing area. The average yield of rice in aus, aman and boro season are 1.45, 1.97 and 3.17 t ha^{-1}, respectively (BBS, 2001). The rice yield in the aus season is low as compared to the other growing seasons, which should be improved.

In Bangladesh, food deficit is increasing day by day at an alarming rate. To meet this challenge, food production needs to be increased. But the horizontal expansion

of crop land in Bangladesh is not possible due to heavy population pressure. So the only avenue left is to increase the production per unit area. For achieving higher yield per unit area, use of high yielding varieties along with appropriate production technology like number of seedlings per hill for transplant aus rice may be important.

Yield is the product of several components such as number of effective tillers per hill, number of grains per panicle and weight of individual grain. These components are influenced by variety and environment in which the crop grows. Bangladesh Rice Research Institute (BRRI) has released more than 55 modern varieties (MV) of rice suitable for cultivation in one or more of the three rice growing seasons of Bangladesh. The present study was under taken to evaluate the growth and yield of released popular variety BRRI dhan 42, BRRI dhan 43, BRRI dhan 48 and a fairly recently released variety ACI hybrid-2 as transplant aus rice.

Number of seedlings per hill is an important factor among the management practices. It influences the plant population per unit area and availability of sunlight, nutrient and other growth factors which ultimately influence the yield and field contributing characters of rice (Chowdhury *et al.,* 1993).

Optimum number of seedlings per hill may enable the rice plant to grow properly both by its aerial and underground parts through utilizing maximum radiant energy, nutrient, space and water and also can reduce seedling cost of farmers. Excess number of seedlings per hill may produce higher number of tillers per hill resulting in mutual shading and lodging and thus favouring the production of higher compared to straw grain, while less number of seedlings per hill may cause total number of panicles reduction in per unit area may be reduced resulting in poor yield. Therefore, it may be necessary to determine the optimum number of seedlings per hill for a particular variety or varieties, which may be considered as an important means to increase the

yield of transplant aus rice.

With the above background, an experiment was initiated with the following objectives:

Objectives

1. To study the effect of variety on growth and yield of transplant aus rice.
2. To study the effect of number of seedlings per hill on growth and yield of transplant aus rice.
3. To find out the interaction effect of variety and number of seedlings per hill on growth and yield of transplant aus rice.

CHAPTER II

REVIEW OF LITERATURE

Growth, development and yield of rice are greatly influenced by environmental factors, variety and agronomic practices. The high yielding cultivar of rice plays an important role in producing higher yield per unit area. Among the various agronomic practices influencing crop yield, number of seedlings per hill 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. Effect of variety

Rahman *et al.* (2002) carried out an experiment with 4 varieties of transplant aman rice viz., BR1l, BR22, BR23 and Tui Shimala 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 Tulshirnaia.

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 per hill). 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 per hill and effective tillers per hill 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 (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 (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 per hill, . '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 (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 per panicle. 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 amen rice with cvs, BR23, BR 11 and Kunuagoir. They reported that local Kumragoir statistically out yielded the modem cultivars BR23 and BR11.

Chowdhury *et al*. (2005) 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 and Pajam during the amen season. They reported that the cv. BR23 showed superior performance over Pajam in respect of yield and yield contributing characters i.e. number of productive tillers hill^{-1}, length of panicle, l000-grain weight, grain yield and straw yield. On the other hand, the cultivar Pajam produced significantly the tallest plant, total number of grains per panicle, number of filled grains per panicle and number of unfilled grains per panicle.

B1NA (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.

Hussain *et al.* (1989) observed in an experiment with 9 cultivars that total tillers per hill differed among the 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 per panicle, 1000-grain weight and biological yield were the highest for C-14-8 among the three varieties. Refey *et al.* (1989) conducted an experiment with 3

different rice cultivars and reported that weight of 1000-grain differed among the cultivars studied.

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. Babiker (1986) carried out an experiment with rice cv. Giza and Giza 180 and observed that total tillers $hill^{-1}$ were significantly affected by the cultivars. He also reported that panicle length differed among the varieties. However, grain yield was statistically influenced by cultivars.

BRR1 (1985) conducted an experiment to find out performance of four modern and local varieties BR4, BR16, Rajasail and Kazalsail. In amen season BR4 and BR16 were found to yield better than Rajasail and Kazalsail.

Islam and Ahmed (1981) reported 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. Effect of seedling numbers per hill

Karmakar *et al.* (2002) conducted an experiment with rice cv. BR23 at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. They reported that number of effective tillers per hill and straw yield were the highest with 6 seedlings per hill while panicle length, grains panicle^{-1} and harvest index were the highest with two seedlings hill^{-1} in case of late transplant aman rice.

Obulamma *et al*. (2002) carried out an experiment with hybrid rice DRRH-1 and APHR-2 at Andhra Pradesh, India The treatments were 4 spacing (15 × 10, 20 × 10, 15 × 15 and 20 × 15 cm^2) and 3 seedling, densities (1, 2 and 3 seedling per hill). One seedling per hill recorded the highest grain yield, crop growth rate and net assimilation rate, while 3 seedlings hill^{-1} had the highest dry matter production, leaf area index and leaf area density.

Dongarwar *et al.* (2002) carried out an experiment at Maharashtra, India with hybrid rice. KTTR-1 where 3 spacing (20 × 10, 20 × 1.5 and 20 × 20) cm and 2 levels of seedlings (1 and 2 seedlings hill^{-1}) were tested. Planting of one seedling hill^{-1} was at par with planting of two seedlings hill^{-1}.

Islam *et al*. (2002) inducted an experiment with fine rice cv. Kalizira including three hill densities viz. 25 x 20 cm, 25 x 15 cm, 25 x 10 cm and 2 levels of seedlings hill^{-1} viz. 2 seedlings hill^{-1} and 4 seedlings hill^{-1} at Bangladesh Agricultural University Farm, Mymensingh. The highest grain yield was recorded from 25 x 20 cm spacing and 2 seedlings per hill.

Shrirame *et al*. (2000) carried out a field experiment during the kharif season 1996 in Nagpur, Maharashtra, India on rice cv. TNRH 10, TNRH 13 and TNItH18 grown at 1, 2 or 3 seedlings hill^{-1}. Two seedlings hill^{-1} gave significantly higher number of

tillers hill^{-1} and straw yield than three seedlings hill^{-1}. One seedling per hill gave significantly higher harvest index (HI). Plant height, number of functional leaves, leaf area and grain yield were not affected by seedling number hill^{-1}.

BRRI (1999) conducted an experiment to study the effect of seedling number on panicle production and yield of local variety Kumragoir at 1, 3, 6 and 9 seedlings per hill. The results revealed that panicle and grain yield did not differ significantly with seedling number hill^{-1}.

Rajarathinam and Balasubramaniyan (1999) conducted at Madurai in Tamil Nadu of India- and found that the grain or straw yield of hybrid rice cv. CORH-2 was not changed significantly due to planting at single or double seedling hill^{-1}.

Bisht *et al.* (1999) conducted afield experiment with hybrid variety PRH, transplanting with 1, 2, 3 seedlings hill^{-1} and reported that number of panicles and total spikelets increased with 2 or 3 seedlings hill^{-1}.

Rajendra *et al.* (1998) from a field trial of two hybrid rice cv. Pusa 834 and Pusa HR3 grown at 1, 2 or 3 seedlings hill^{-1} reported the highest grain yields of 3.5 and 5.6 t ha^{-1} with 2 and 3 seedlings hill^{-1}, respectively.

Srivastava and Tripathi (1998) experimented in Madhya Pradesh of India with rice cv. Hybrid 6201 and R 320-300. They were grown with 20 cm x 15 cm or 15 cm x 10 cm spacing at 1, 2 or 3 seedlings hill^{-1}. The cv. R 320-300 grown at l5 cm x 10 cm spacing with 2 seedlings hill^{-1} produced the highest grain yield of 7.59 t ha^{-1}.

Banik *et al.* (1997) conducted in a field experiment in 1993-95 in Bihar with 30; 40; 50; or 60 day old rice cv. Pankaj and planting seedlings at 2, 4, 6 or 8 hill^{-1}. Results showed no significant variation in yield between the cultivars. However, mean grain

yield was the highest (4.74 t ha^{-1}) from plots transplanted with 40 days old seedlings while yield of 4 seedlings hill plots was 4.22 t ha^{-1}.

Asif *et al.* (1997) conducted an experiment with rice cv. Basmati-385grown at 1, 2 or 3 seedlings per hill and observed that grain yield was the highest at 2 seedlings $hill^{-1}$ but grain quality parameters in terms of percentage of sterility and number of aborted kernels were not significantly affected by planting density.

Ahmed and Rao (1995) stated that yield obtained from 3 seedlings $hill^{-1}$ during June to October was the highest, while during December to April, 23 seedlings $hill^{-1}$ produced the highest yields.

Bali *et al.* (1995) conducted an experiment in 1988-89 in Jammu and Kashmir in India and reported that 5 and 7 week old rice seedlings were transplanted on 5 June, 20 June and 5 July @ 3, 6 and 9 seedlings $hill^{-1}$. Mean grain yield was highest with 6 seedlings $hill^{-1}$.

Rao and Reddy (1993) conducted a field experiment at Hyderabad in India 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 spacing from 33 to 200 hills m 2 with l seedling $hill^{-1}$, when 10 seedlings $hill^{-1}$ were planted yield decreased at the widest spacing.

Chowdhury *et al.* (1993) conducted an experiment at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh with 2, 4 and 6 seedlings $hill^{-1}$ to study their effect on the yield and yield components of rice cv. BR23 and Pajam during the aman season. They reported that 6 seedlings $hill^{-1}$ gave the highest grain and straw yields.

BINA (1993) observed the effect of number of seedlings hill^{-1} on the performance of three rice varieties viz. IRATOM 24, BRl4 and BR3 in the boro season. Three seedlings hill^{-1} produced significant effect on filled grains panicle^{-1}, grain and straw yields. Increased seedling number hill^{-1} produced significantly higher grain and straw yields with higher harvest index but other characters did not differed significantly.

Prasad *et al.* (1992) conducted an experiment with 2, 3, 4 and 5 seedlings per hill 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.

BRRI (l992a) reported that local transplanted aman variety Kumragoir with planting 2-3 seedlings hill^{-1} at 25 x 15 cm spacing appeared to be better in terms of yield than the local farmer's practices of planting at a wider spacing and with more seedlings hill^{-1}.

BRRI (1992b) conducted an experiment on rice including B1222, BR23 and Nazirshail transplanted at mid-September with 16, 20, 27, 33, 44 and 66 hills m^{-2} using 2-4 seedlings hill^{-1} to find out the effect of plant population density on the yield of late transplant aman rice. Results revealed that grain yield increased with the increase in plant population density irrespective of varieties.

Wen and Yang (1991) reported that late rice yields in a double cropping system were the highest with 1 seedling per hill than with 4 seedlings hill^{-1}. The proportion of effective panicles, number of grains per panicle and 1000-grain weight were also higher with 1 seedling hill^{-1}. In trial with 6 cultivars differing in maturity date, a very early maturing cultivar gave a lower yield with l seedling hill^{-1} than with 4 seedlings hill^{-1} and another early cultivar gave similar yields at both plant densities; however, the other 4 cultivars gave higher yields with 1 seedling hill^{-1}. In the early maturing

cultivars, early sowing and transplanting gave higher yield with 4 seedlings hill^{-1} than with 1 seedling hill^{-1}.

Shah *et al*. (1991) carried out a field trail in 1987 at Kashmir, India with rice cv. K39, grown at 15 x 15 cm or 10 x 10 cm plant spacing and 3, 4, 5 or 6 seedlings hill^{-1} that number of panicles per plant and spikelets, per panicle, 1000 grain weight, grain yield, straw yield and harvest index were influenced by the treatments. Plant height and number of grains panicle' increased with decrease in seedling number hill^{-1}. Plant height and harvest index were the greatest with 15 x 15 cm spacing and tiller number m^2 and straw yield were the highest at 10 x 10 cm spacing. The highest grain yield of 2.70 t ha^{-1} was obtained from 6 seedlings hill^{-1} at 15 x 15 cm spacing.

BRRI (1991b) conducted an experiment at Barisal to study the effect of seedling number (2, 3, 4 and 5 seedlings per hill) on the yield, and yield components of BR3, BR9 and BRl4. The results showed that there was no significant effect of seedling number on the yield of BR3 and BR14. Planting 4-5 seedlings hill^{-1} gave significantly higher yield of BR9 than 2-3 seedlings hill^{-1} although such differences were not apparent in yield components.

Zhang and Huang (1990) observed that 5 seedlings hill^{-1} of rice cv. Ewan 5 gave the highest yields when transplanted at 1-5 seedlings hill^{-1}. Hossain and Haque (1990) reported that deep water rice cvs. Habiganj aman II and Habiganj aman IV were transplanted when 30 or 60 days old at 1, 2 or 3 seedlings hill^{-1} in deep water tanks. The number of basal tillers per plot increased with increasing seedling number. Flooding survival decreased with increased seedling hill^{-1}. Grain yield was the highest with 2 seedlings hill^{-1} when 60 days old seedlings were transplanted.

BRRI (1990) studied to find out the optimum plant population required for a satisfactory grain yield of rice both at Joydebpur and Habiganj at combination of

different plant spacing with 2-3 and 5-6 seedlings hill^{-1}. At Habiganj the highest grain yield was obtained using 5-6 seedlings hill^{-1} in 30 x 10 cm spacing. Increase in seedling number from 2-3 to 5-6 seedlings hill^{-1} produced higher grain yield in most cases.

Das *et al.* (1989) observed that 5 seedlings hill^{-1} of rice cv. Parijat gave the highest yields when transplanted at 2-5 seedlings hill^{-1}. Budhar *et al.* (1989) found from their experiment that the early maturing rice cv. 66618 grown at a spacing of 10 x 10 cm with 2 and 4 seedlings hill^{-1} (250 and 500 plants m^2) gave rice yields of 3.8 and 4.4 t ha^{-1}, respectively.

Singh *et al.* (1987) conducted an experiment with seed rate in nursery and seedlings hill^{-1}, on yield of transplanted rice. They found that the increasing sowing rates decreased number of panicles hill^{-1} and of gains per panicle and the number of seedlings hill^{-1} had no significant effect Setty *et al.* (1987) observed that the grain yield decreased significantly when single seedling hill^{-1} was transplanted as compared with 2 and 4 seedlings hill^{-1}.

BINA (1987) studied four varieties of aus rice viz., IRATOM24, IRATOM38, BR3 and Pajam using 1, 2, 3 and 4 number of seedlings hill^{-1}. It was found that the number of effective tillers hill^{-1} increased progressively from 1 seedling hill^{-1}, seedling number 2, 3 and 4 hill^{-1} gave statistically same of effective tillers hill^{-1} the yield was highest from 4 seedlings hill^{-1}, although it was statistically similar with 3 seedlings hill^{-1}. The lowest yield was obtained from 1 seedling hill^{-1}.

Rameswamy *et al.* (1987) investigated 50, 66 or 80 hills per m^2 with 2, 4, 6 or 8 seedlings hill^{-1}. The results showed that spacing at 80 hills gave the highest grain yield of 4.0 t per hill. Yield decreased with more than 2 seedlings.

Pande *et al.* (1987)) conducted an experiment in Madhya Prodesh of India and found that 4 rice cultivars transplanted at 1, 2, 3 or 4 seedlings per hill gave average paddy yields of 3.78, 5.09, 5.00 and 4.94 t ha^{-1}, respectively.

Mohammad *et al.* (1987) reported that when rice cv. Basmati 370 was grown at 2 seedlings $hill^{-1}$ and at 6, 11, 25 or 44 hills m^{-2} then the number of tillers $hill^{-1}$, the number of panicle bearing tillers $hill^{-1}$ and 1000 grain weight decreased with increasing plant density, but plant height, number of grains m^{-2} and grain yield remained unaffected.

Karim *et al.* (1987) observed that highest, grain and straw yields (2748 and 4574 kg ha^{-1}) were produced by 4 seedlings $hill^{-1}$ while 1 seedling $hill^{-1}$ yielded the lowest.

Reddy and Mitra (1984) investigated the effect of time of planting age and number of seedlings $hill^{-1}$ on the yield of rice varieties in flood prone situation. From their pot trials stimulated with flash flood situation they found that grain yields, were the highest at earlier transplanting dates (in main kharif) and were unaffected by number of seedlings $hill^{-1}$.

Reddy and Ghosh (1984)) conducted an experiment with seedling and hill density on the performance of rice under intermediate deep water condition. They showed that transplanting with 6-8 seedlings per hill at 20-25 hills m^{-2} gave grain yields as high as with 3 seedlings $hill^{-1}$ at 50 hills m^{-2}.

CHAPTER III

MATERIALS AND METHODS

The experiment was undertaken during March 2010 to August 2010 to study the growth and yield of transplanted aus rice as influenced by variety and number of seedling per hill. The materials used and the methodologies followed are described in this chapter.

3.1. Experimental Site

The present experiment was conducted in the Agronomy farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is $23^0 74^/$N latitude and $90^0 35^/$E longitude and at an elevation of 8.2 m from sea level.

3.2. Climate

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

3.3. Characteristics of the Soil of Experimental Site

The soil of the experimental area is medium high land having red brown terrace soil, which belongs to the Modhupur Tract (UNDP, 1988) under AEZ no. 28 and the Tejgaon soil series (FAO, 1988). The soil of the experimental plot were analyzed in the Soil Testing Laboratory, SRDI, Khamarbari, Dhaka and details of the recorded soil characteristics are presented in Appendix II.

3.4. Materials

3.4.1. Seed

Three high yielding variety (HYV) and one hybrid variety of rice were used as planting materials named (i) BRRI dhan 48, (ii) BRRI dhan 43, (iii) BRRI dhan 42 and (iv) ACI hybrid -2.

3.5. Methods

3.5.1. Treatments

Two treatment factors were used in the present experiment to get 16 treatment combinations which were as follows:

Factor A: Variety - 4

V_1 = BRRI dhan 48

V_2 = BRRI dhan 43

V_3 = BRRI dhan 42

V_4 = ACI hybrid-2

Factor B: Seedling number per hill

H_1 = 1 seedling per hill

H_2 = 2 seedlings per hill

H_3 = 3 seedlings per hill

H_4 = 4 seedling s per hill

3.5.2. Experimental design and layout

The experiment was laid out in a randomized complete block design with three replications. Each block, representing a replication, was divided into 16 unit plots where the 16 treatment combinations were allocated at random. The total number of unit plots was 48. The size of each unit plot was 2 m × 2 m. The distance maintained between the unit plots and blocks were 0.50 m and 1.0 m, respectively.

3.6. Management of the crop

3.6.1. Raising of seedlings

Healthy seeds of BRRI dhan 48, BRRI dhan 43, BRRI dhan 42 and ACI hybrid-2 were used. Seeds of the four varieties were separately immersed in water in buckets for 24 hours and then kept in thick layer under gunny bags for another 48 hours for sprouting. A small piece of high land was selected for seedbed where sprouted seeds were sown in well puddled condition by broadcast method on 11 March, 2010. Proper care was taken to protect the seeds in the seedbed and raise healthy seedlings as necessary.

3.6.2. Land preparation

The selected land for the experiment was first open on 10 April, 2010 by a power tiller. Later on, the land was irrigated. For puddling, the land was ploughed and cross ploughed three times with a bullock drawn country plough followed by laddering in order to level the land. The corners of the land were spaded well. Weeds and stubbles were removed from the field as much as possible for transplanting of seedlings. The layout of the experimental field was done according to the design adopted. Finally, individual plots were prepared before transplantation.

3.6.3. Fertilizer application

For inbreed variety, the field was fertilized with urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate @ 150, 120, 80, 70 and 10 kg/ha in order to supply nitrogen, phosphorus, potassium, sulphur and zinc, respectively. Urea was applied in three times, during land preparation, after 15 DAT first weeding and after 30 DAT second weeding. For hybrid variety, the field was fertilized with urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate @ 250, 200, 200, 50 and 12 kg/ha in order to supply nitrogen, phosphorus, potassium, sulphur and zinc, respectively except urea, the whole amount of other fertilizers were applied before final land preparation. Urea was top dressed in three equal splits at 15, 30 and 50 days after transplanting. (Adhunik Dhaner chash, June, 2010)

3.6.4. Uprooting and transplanting of seedlings

Thirty three days old seedlings were uprooted carefully from the nursery bed and then transplanted in the main field according to experimental requirement on 14 April, 2010. The maintaining distance between raw was 20 cm and hills 15 cm respectively. The number of seedlings per hill was maintained as per treatment.

3.7. Intercultural operations

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

3.7.1. Gap filling

After one week of transplantation, dead seedlings were replaced by planting new healthy seedlings from the same source.

3.7.2. Irrigation

There was no insufficient rainfall during the growing period. To ensure sufficient water in the experimental plots they were irrigated at 20, 40, 55 and 70 days after transplanting (DAT).

3.7.3. Weed control

Weeding was done thrice with Japanese rice weeder followed by hand pulling at 25, 40, and 55 days after transplanting (DAT).

3.7.4. Plant protection measures

The crop was infested at active tillering stage by rice stem borer, which was successfully controlled by applying Diazinon 10G @ 16.80 kg per ha.

3.8. Sampling, harvesting and post harvest processing

The crop was harvested just above ground level at full maturity. Five hills were randomly selected from each unit plot; plants were uprooted before harvesting and properly tagged, for recording of necessary data. After sampling the harvested crop of each plot was separately bundled, properly tagged, brought to the threshing floor and threshed by pedal thresher. Fresh weight of grain and straw per plot were recorded. After drying the grains and straw properly in the sun the weight of grains and straw were adjusted to 12% moisture content. Finally the grain and the straw yields were converted to ton per ha.

3.9. Recording of data

Five hills were randomly selected from each plot and marked with bamboo sticks for recording data at 30, 50, 70 DAT and at harvest.

3.9.1. Data recording at different growth stages

The data on growth characters were collected from 30 DAT to at harvest at 20 days interval. The procedure of growth data collection is given below:

(i) **Plant height:** Plant height was recorded from the base of the plant to the tip of the longest leaf or panicle and was expressed in cm.

(ii) **Number of leaves per hill:** Total number of leaves were counted from five hills and then averaged to leaves per hill

(iii) **Number of tillers per hill:** Tillers having at least one leaf visible were counted from the selected hills.

(iv) **Number of panicles per hill:** Total number of panicles were counted from five hills and then averaged to panicles per hill.

3.9.2. Data recording at harvest

Five hills randomly selected in previous, were used to collect data collection to study on various plant characters and yield components at harvest.

The procedure of recording data at harvest is given below:

(i) **Plant height:** Plant height was measured from the base of the plant to the tip of the longest panicle. Plant height was measured from five selected hills and then averaged.

(ii) **Number of tillers per hill:** Tillers which had at least one visible leaf were recorded. It included both effective and non-effective tillers. Average tillers per hill were counted from five hills.

(iii) **Number of leaves per hill:** Total number of leaves were counted from five hills and then averaged to leaves per hill.

(iv) **Number of panicle per hill:** Total number of panicle were counted from five hills and then averaged to panicles per hill.

(v) **Number of grains per panicle:** Total numbers of grains were counted from randomly selected 10 panicles from each plot and then averaged to grains per panicle.

(vi) **1000-seed weight:** One thousand clean dried grains were counted from the seed stock obtained from five samples of each plot and weighed by using an electrical balance.

(vii) **Grain yield:** Gains obtained from each unit plot was sun dried and the weight was taken. The dry weight of grains of five sample plants was also added to the respective unit plot yield to record the final grain yield plot^{-1} and then it is converted to t ha^{-1}.

(viii) **Stover yield:** Straw obtained from each unit plot including the straw of five sample plants of respective unit plot were sun dried and weighed to record the final straw yield per plot. It was finally converted to t ha^{-1}.

(ix) **Biological yield:** The sum total of grain yield and straw yield are together regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield +.Straw yield

(x) Harvest index: It denotes the ratio of grain yield to biological yield and is expressed in percentage. The following formula was used to calculate harvest index:

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

3.10. Statistical analysis

Data recorded for different parameters were tabulated in proper form. The analyses of variance were done following randomized complete block design (RCBD) with the help of a computer package programme MSTAT. The mean differences among the treatments of a parameter were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experimental results regarding the 'growth and yield of transplant aus rice as influenced by variety and number of seedling per hill' have been presented and discussed in this chapter. The effect of variety and number of seedling per hill and their interaction on growth, yield and yield contributing characters have been shown below.

4.1. Growth parameters

4.1.1. Plant height

4.1.1.1. Effect of variety

Variety exhibited significant influence on plant height at all the growth stages studied except 30 (Fig. 1 and Appendix III). Results showed that V_3 (BRRI dhan 42) was evidence for highest plant height at 50, 70 days after transplanting (DAT) and harvest (64.49, 94.95 and 94.95 cm, respectively). The competition in accordance with plant height among the varieties, the smallest plant was observed in V_1 (BRRI dhan 48) at 50, 70 days after transplanting (DAT) and at harvest that were 63.37, 92.62 and 92.62 cm, respectively. The results obtained from V_2 (BRRI dhan 43) and V_4 (ACI hybrid-2) showed intermediate results compared to highest and lowest results. Similar result was also found by BINA (1993).

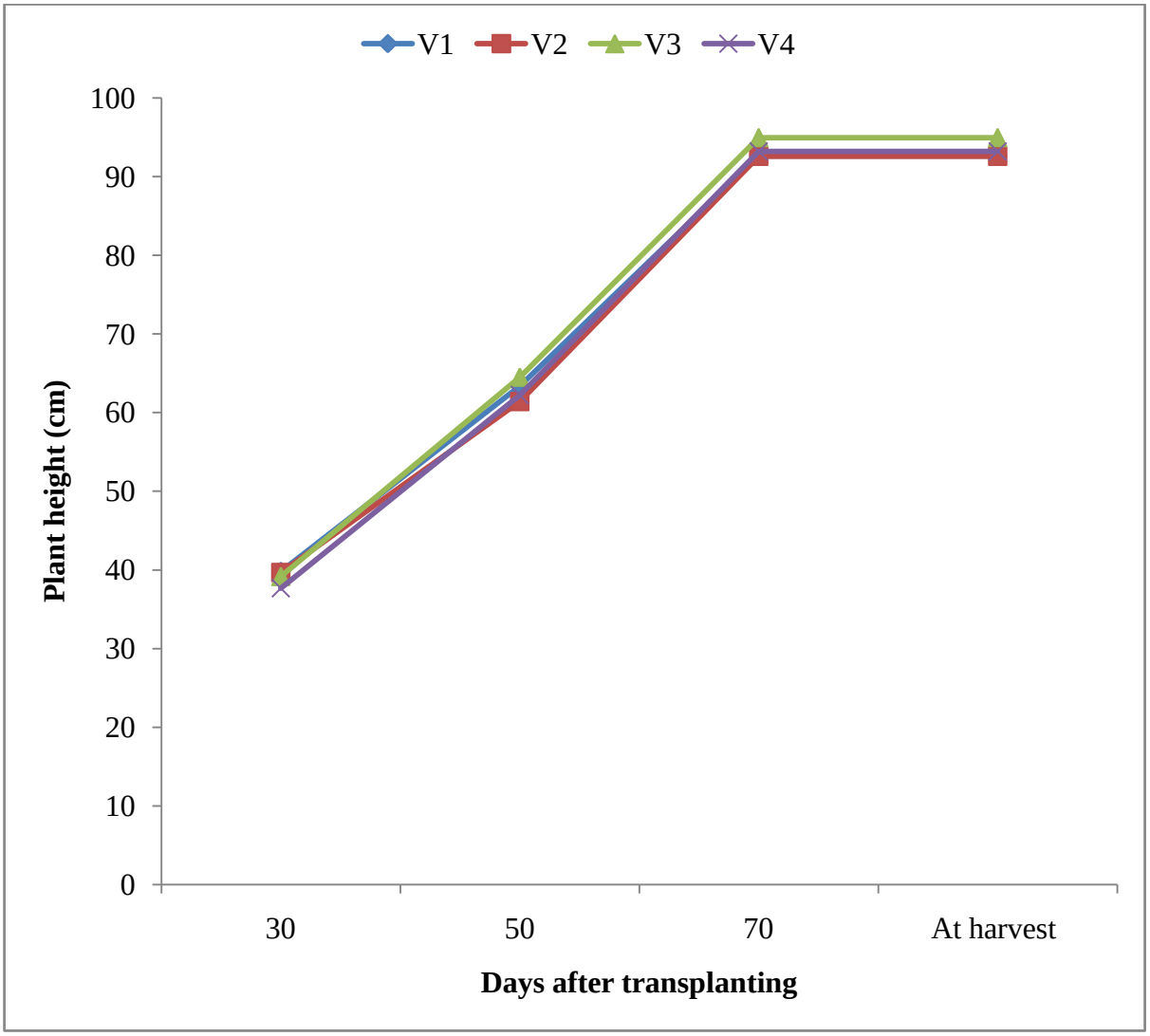

Fig 1: Plant height of transplant aus rice as influenced by variety.

Here,

V_1	=	BRRI dhan 48	H_1	=	1 seedling per hill
V_2	=	BRRI dhan 43	H_2	=	2 seedlings per hill
V_3	=	BRRI dhan 42	H_3	=	3 seedlings per hill
V_4	=	ACI hybrid-2	H_4	=	4 seedlings per hill

4.1.1.2. Effect of seedling per hill

Plant height as influenced by different seedling per hill of transplant aus rice was significant at different growth stages except 30 DAT (Fig. 2 and Appendix III). It was mentioned that at 50, 70 DAT and at harvest H_4 (4 seedlings per hill) showed the longest plant (64.33, 94.53 and 94.53 cm, respectively at 50, 70 and at harvest). On the other hand, results obtained by H_1 (1 seedling per hill) showed shortest plant (61.87, 92.67 and 92.67 cm at 50, 70 DAT and at harvest, respectively). The result under the present study was similar with the findings of Shrirame *et al*. (2000) and Shah *et al*. (1991).

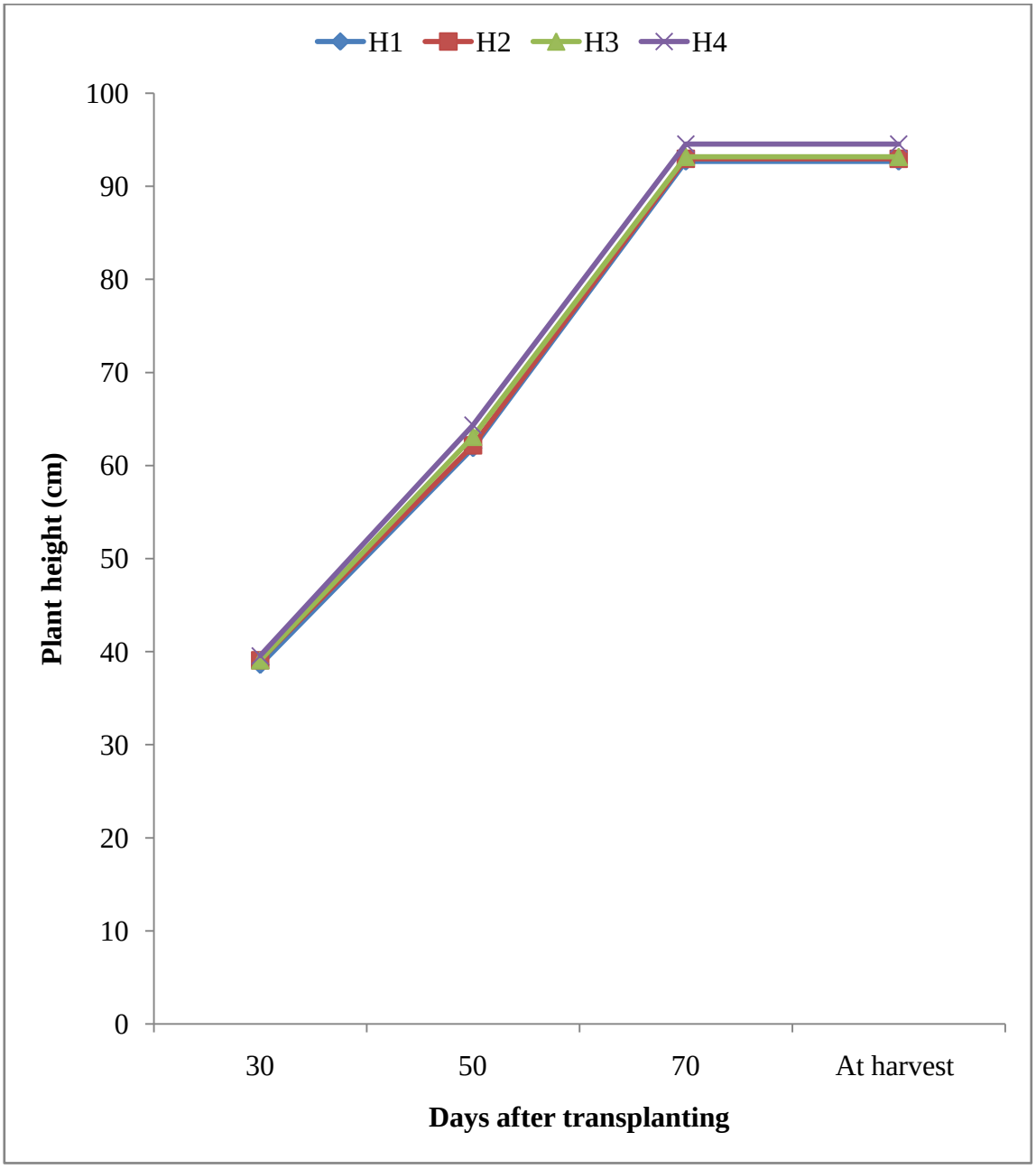

Fig 2: Plant height of transplant aus rice as influenced by seedling per hill.

Here,

V_1	=	BRRI dhan 48	H_1	=	1 seedling per hill
V_2	=	BRRI dhan 43	H_2	=	2 seedlings per hill
V_3	=	BRRI dhan 42	H_3	=	3 seedlings per hill
V_4	=	ACI hybrid-2	H_4	=	4 seedlings per hill

4.1.1.3. Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill had significantly influence on plant height at different growth stages of transplant aus rice (Fig. 3 and Appendix III). Results indicated that the longest plant (41.07, 68.29, 99.40 and 99.40 cm at 30, 50, 70 DAT and at harvest, respectively) was found in V_3H_4, which was significantly different from all other treatments. The treatment combination of V_1H_1, V_2H_4, V_3H_3, V_4H_2, and V_4H_3 also showed higher plant height but significantly different from V_3H_4. On the other hand, V_2H_1 showed the lowest plant height (35.60, 56.91, 91.07 and 91.07 cm at 30, 50, 70 DAT and at harvest, respectively), which was closely followed by V_1H_4 and at 70 DAT and at harvest.

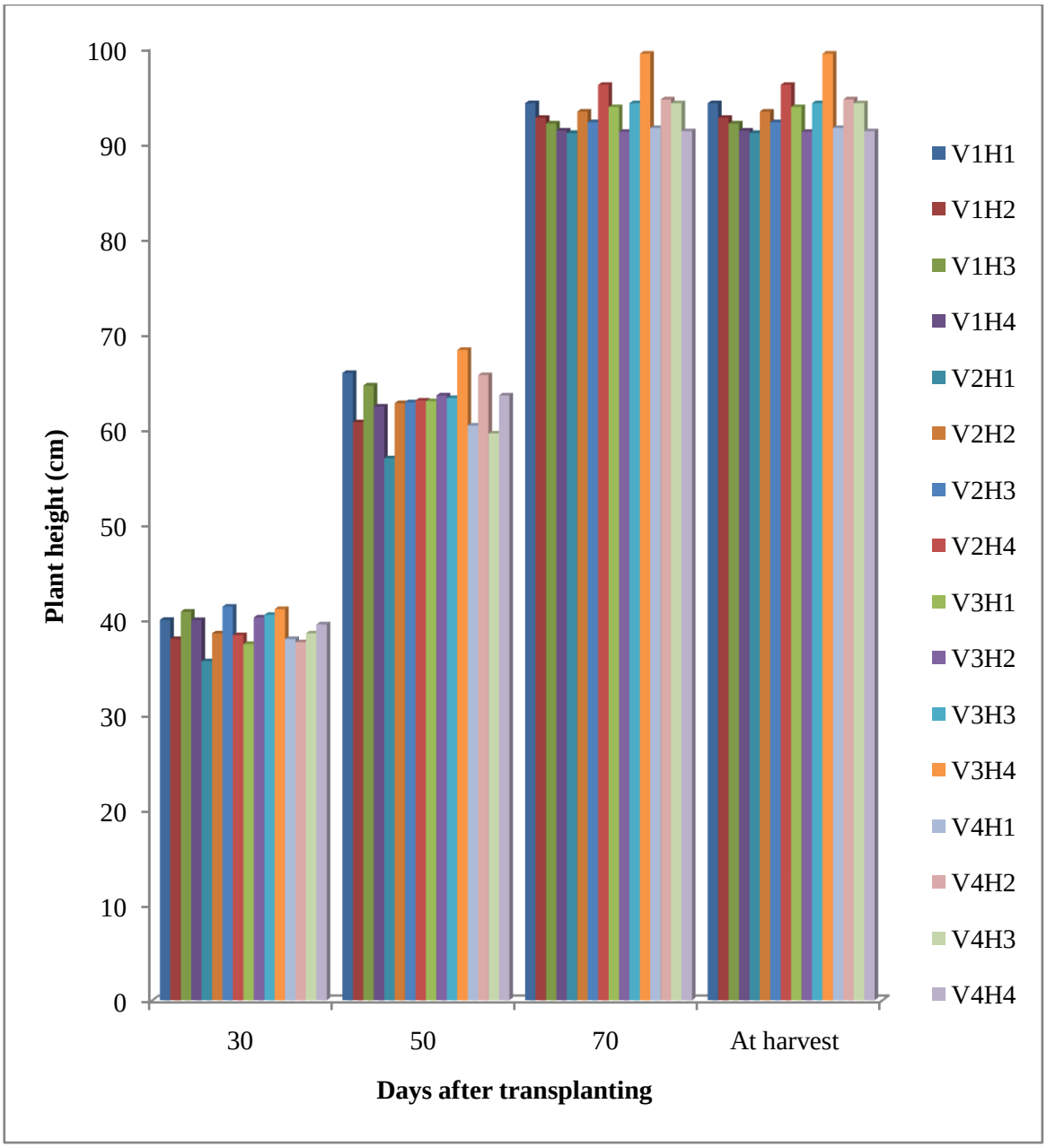

Fig 3: Plant height of transplant aus rice as influenced by interaction of variety and number of seedling per hill. Mentioning LSD value at different stages

Here,

V_1 = BRRI dhan 48
V_2 = BRRI dhan 43
V_3 = BRRI dhan 42
V_4 = ACI hybrid-2

H_1 = 1 seedling per hill
H_2 = 2 seedlings per hill
H_3 = 3 seedlings per hill
H_4 = 4 seedlings per hill

4.1.2. Number of tillers per hill

4.1.2.1. Effect of variety

Differences in number of tillers per hill as influenced by different variety of transplant aus rice were found significant (Fig. 4 and Appendix IV). Results showed that at 30, 50, 70 DAT and at harvest V_4 (ACI hybrid-2) was evidence for highest number of tillers per hill (11.65, 14.37, 23.62 and 23.62, respectively). Comparing among the varieties, the lowest number of tillers per hill was observed with V_2 (BRRI dhan 43) at 30, 50, 70 DAT and at harvest, and that were 9.18, 13.10, 21.83 and 21.83, respectively. The results obtained from V_1 (BRRI dhan 48) and V_3 (BRRI dhan 42) showed intermediate results compared to highest and lowest results. Differences in tiller numbers per hill were found by Chowdhury *et al*. (2005), BINA (1998) and BINA (1993).

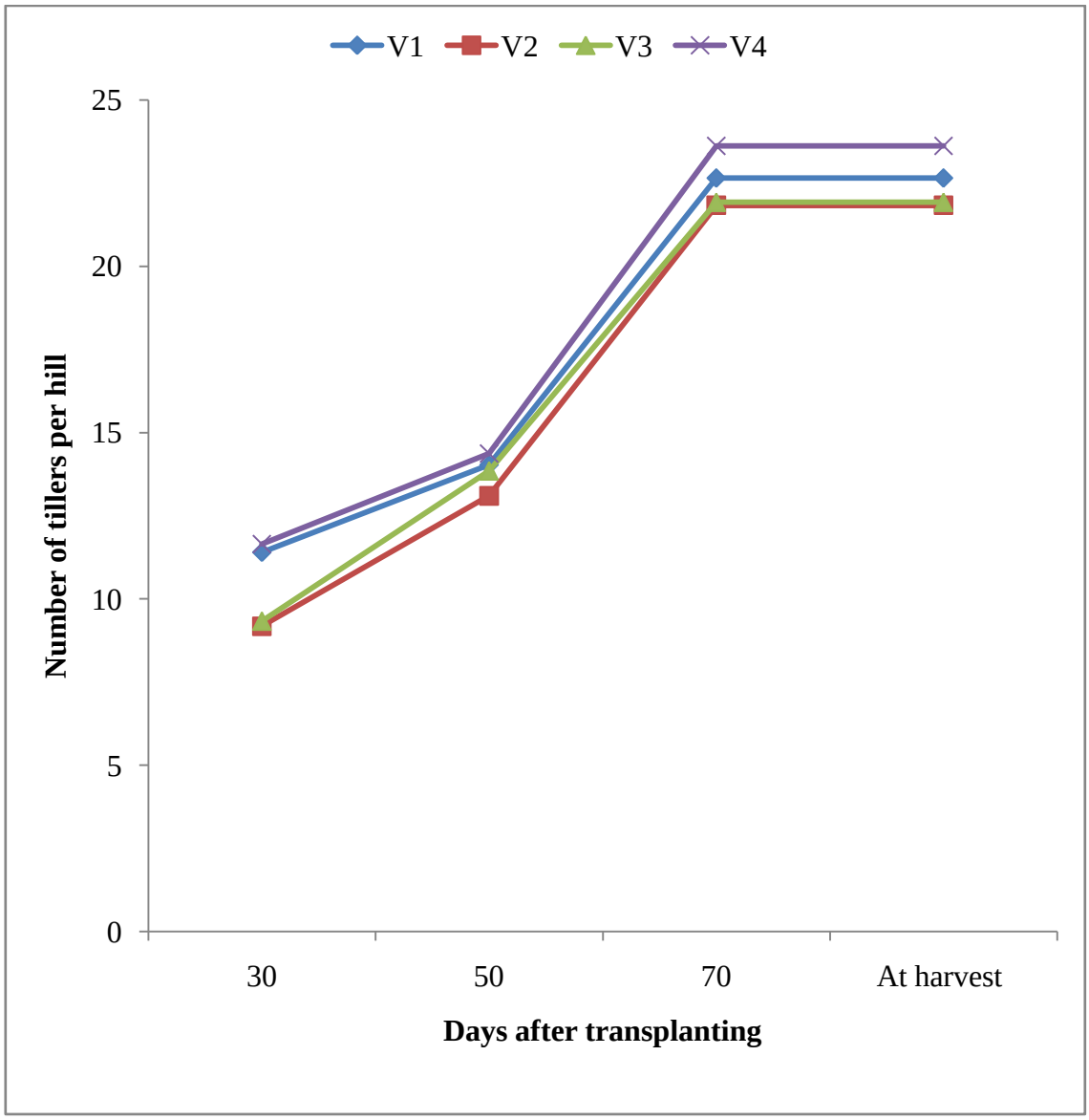

Fig 4: Tillers per hill of transplant aus rice as influenced by variety.

Here,

V_1	=	BRRI dhan 48	H_1	=	1 seedling per hill
V_2	=	BRRI dhan 43	H_2	=	2 seedlings per hill
V_3	=	BRRI dhan 42	H_3	=	3 seedlings per hill
V_4	=	ACI hybrid-2	H_4	=	4 seedlings per hill

4.1.2.2. Effect of seedling number per hill

Tillers per hill as influenced by different seedling number per hill of transplant aus rice was significant at different growth stages after transplantation (Fig. 5 and Appendix IV). It was mentioned that there was no significant effect on number of tillers per hill at 30 DAT, but at 50, 70 DAT and at harvest H_1 (1 seedling per hill) showed the highest number of tillers per hill (14.32, 24.65 and 24.65, respectively). On the other hand, results obtained by H_4 (4 seedlings per hill) showed the lowest number of tillers per hill (13.02, 21.02 and 21.02 at 50, 70 DAT and at harvest, respectively). Intermediate results were obtained from H_2 (2 seedlings per hill) and H_3 (3 seedlings per hill) at all the growth stages. The results achieved by Karmakar *et al.* (2002), Shrirame *et al*. (2000) and BINA (1987) were in conformity with the present findings.

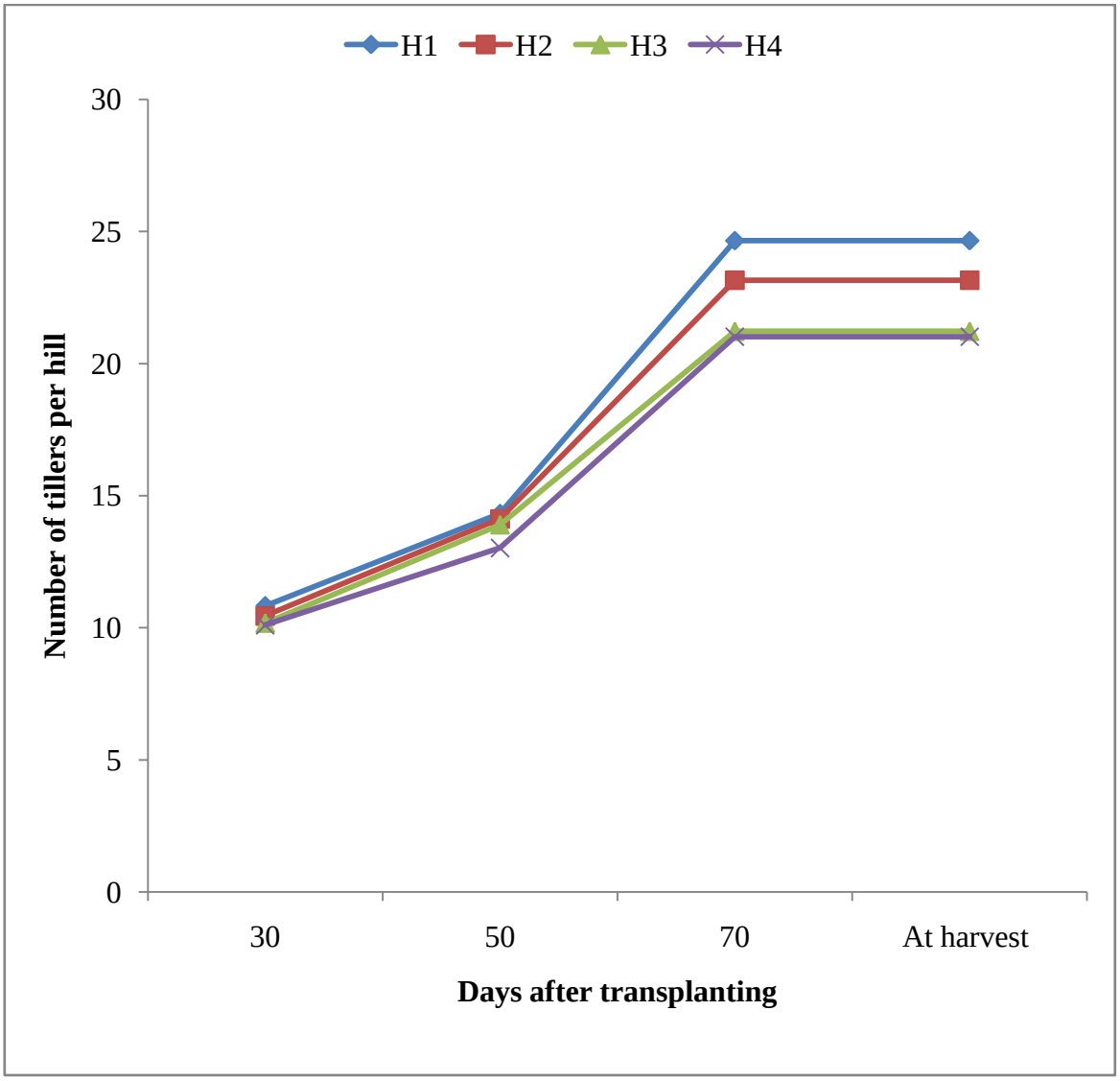

Fig 5: Tillers per hill of transplant aus rice as influenced by seedling per hill. Mentioning LSD value

Here,

V_1	=	BRRI dhan 48	H_1	=	1 seedling per hill
V_2	=	BRRI dhan 43	H_2	=	2 seedling per hill
V_3	=	BRRI dhan 42	H_3	=	3 seedling per hill
V_4	=	ACI hybrid-2	H_4	=	4 seedling per hill

4.1.2.3. Interaction effect of variety and seedling per hill

Interaction effect of variety and seedling per hill had significantly influence on number of tillers per hill at different growth stages of transplant aus rice (Fig. 6 and Appendix IV). Results indicated that the highest number of tillers per hill (13.13, 16.13, 25.07 and 25.07 at 30, 50, 70 DAT and at harvest, respectively) was with $V_4H_{1,}$ which was closely followed by V_1H_1 at all growth stages and also with V_3H_1 at 30, 70 DAT and at harvest. V_1H_2, V_3H_2, V_3H_3 also showed higher number of tillers per hill but significantly different from V_4H_1. On the other hand, V_2H_4 showed the lowest number of tillers per hill (7.00, 12.33, 19.40 and 19.40 at 30, 50, 70 DAT and at harvest, respectively) which was significantly different from all other treatments. These results also indicated that 1 seedling per hill produced the highest tillers per hill in all the transplant aus rice varieties studied.

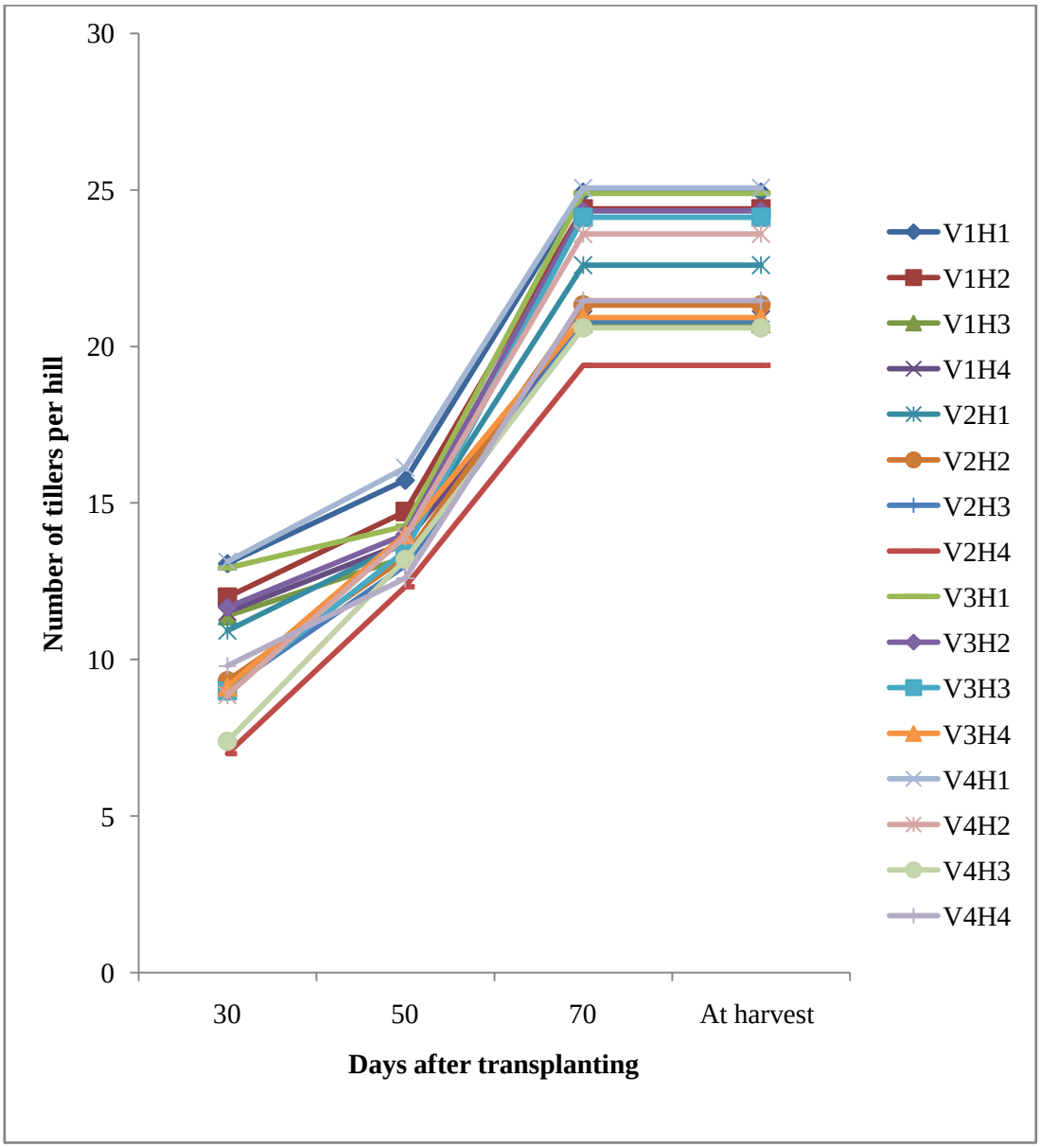

Fig 6: Tillers per hill of transplant aus rice as influenced by interaction of variety and number of seedling per hill.

Here,

V_1	=	BRRI dhan 48	H_1	=	1 seedling per hill
V_2	=	BRRI dhan 43	H_2	=	2 seedlings per hill
V_3	=	BRRI dhan 42	H_3	=	3 seedlings per hill
V_4	=	ACI hybrid-2	H_4	=	4 seedlings per hill

4.1.3. Number of leaves per hill

4.1.3.1. Effect of variety

Significant variations were observed in number of leaves per hill study as influenced due to variety of transplant aus rice (Table 3 and Appendix V). Results showed that at 30, 50, 70 DAT and at harvest V_4 (ACI hybrid-2) was evidence for the highest number of leaves per hill (32.28, 42.63, 161.50 and 161.50, respectively) and the lowest (29.25, 40.00, 90.70 and 90.70, respectively) in V_2 (BRRI dhan 43). The results obtained from V_1 (BRRI dhan 48) and V_3 (BRRI dhan 42) showed intermediate results compared to the highest and the lowest producer. The production of higher number of leaves per hill may be caused due to its genetical characters, varietal performance, proper management etc.

4.1.3.2. Effect of seedling number per hill

Leaves per hill as influenced by different seedling number per hill of transplant aus rice was significant at different growth stages after transplantation (Table 3 and Appendix V). It was observed that at 30, 50, 70 DAT and at harvest H_1 (1 seedling per hill) showed highest number of leaves per hill (31.65, 44.18, 161.70 and 161.70, respectively). On the other hand, results obtained by H_4 (4 seedlings per hill) showed the lowest number of leaves per hill (29.62, 38.18, 90.43 and 90.43 at 50, 70 DAT and at harvest, respectively). Intermediate results were obtained from H_2 (2 seedlings per hill) and H_3 (3 seedlings per hill) at all the growth stages. Similar result was observed by Shrirame *et al*. (2000).

4.1.3.3. Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill had significantly influence on number of leaves per hill at different growth stages of transplant aus rice (Table 3 and Appendix V). Results indicated that the highest number of leaves per hill (35.60, 47.67, 356.30 and 356.60 at 30, 50, 70 DAT and at harvest, respectively) was found V_4H_1. The results from V_1H_1, V_2H_1, V_2H_2 and V_3H_3 also showed higher number of leaves per hill but significantly different from V_4H_1. On the other hand, V_2H_4 showed the lowest number of leaves per hill (26.80, 35.93, 82.47 and 82.47 at 30, 50, 70 DAT and at harvest, respectively), which was statistically identical with V_3H_4 at 70 DAT and harvest.

Table 1. Leaves per hill of transplant aus rice as influenced by variety, number of seedling per hill and their interaction

Treatment	Number of leaves per hill			
	30 DAT	50 DAT	70 DAT	At harvest
Variety				
V_1	30.05 b	41.73 ab	99.67 b	99.67 b
V_2	29.25 c	40.00 c	90.70 c	90.70 c
V_3	30.02 b	40.83 bc	91.68 c	91.68 c
V_4	32.28 a	42.63 a	161.5 a	161.5 a
SE	0.1196	0.0845	0.0938	0.0938
$LSD_{(0.05)}$	0.6885	1.028	1.729	1.729
Seedling per hill				
H_1	31.65 a	44.18 a	161.7 a	161.7 a
H_2	30.40 b	41.52 b	99.08 b	99.08 b
H_3	29.93 bc	41.32 b	92.30 c	92.30 c
H_4	29.62 c	38.18 c	90.43 d	90.43 d
SE	0.1196	0.0845	0.0938	0.0938
$LSD_{(0.05)}$	0.6885	1.324	1.729	1.729
Interaction				
V_1H_1	32.60 b	47.53 a	104.7 b	104.7 b
V_1H_2	31.40 cd	40.67 cd	96.53 de	96.53 de
V_1H_3	29.53 f	39.00 de	89.27 f	89.27 f
V_1H_4	29.40 f	36.73 ef	88.07 f	88.07 f
V_2H_1	29.00 fg	40.73 cd	103.0 bc	103.0 bc
V_2H_2	27.67 hi	38.47 d-f	100.9 bc	100.9 bc
V_2H_3	31.87 bc	39.00 de	99.60 cd	99.60 cd
V_2H_4	26.80 i	35.93 f	82.47 g	82.47 g
V_3H_1	31.67 c	47.40 a	94.13 e	94.13 e
V_3H_2	29.67 ef	41.33 cd	95.13 e	95.13 e
V_3H_3	30.47 de	42.53 bc	101.7 bc	101.7 bc
V_3H_4	30.67 d	40.07 cd	82.87 g	82.87 g
V_4H_1	35.60 a	47.67 a	356.3 a	356.3 a
V_4H_2	28.47 gh	44.80 ab	88.87 f	88.87 f
V_4H_3	30.53 de	36.27 ef	94.53 e	94.53 e
V_4H_4	31.07 cd	42.67 bc	96.07 de	96.07 de
SE	0.2392	0.169	0.1876	0.1876
$LSD_{(0.05)}$	0.8855	2.647	3.457	3.457
CV(%)	8.78	9.36	7.44	8.15

Here,

V_1 = BRRI dhan 48
V_2 = BRRI dhan 43
V_3 = BRRI dhan 42
V_4 = ACI hybrid-2

H_1 = 1 seedling per hill
H_2 = 2 seedlings per hill
H_3 = 3 seedlings per hill
H_4 = 4 seedlings per hill

4.1.4. Number of panicle per hill

4.1.4.1. Effect of variety

Number of panicles per hill was significantly influenced by as influenced by variety of transplant aus rice (Table 4 and Appendix VI). Results showed that at 50, 70 DAT and at harvest V_4 (ACI hybrid-2) demonstrated the highest number of panicles per hill (6.38, 11.93 and 16.67, respectively) which was statistically identical to that of V_1 (BRRI dhan 48) at 50 DAT and at harvest. On the other hand, the lowest number of panicles per hill (5.97, 10.95 and 15.47 at 50, 70 DAT and at harvest, respectively) was observed in V_2 (BRRI dhan 43). The results obtained from V_3 (BRRI dhan 42) showed intermediate results compared to the highest and the lowest results. The production of higher number of panicle per hill may be caused due to its genetical characters, varietal performance, proper management etc.

4.1.4.2. Effect of seedling number per hill

Panicle per hill as influenced by different seedling number per hill of transplant aus rice was significant at different growth stages after transplantation (Table 4 and Appendix VI). It was evident that at 50, 70 DAT and at harvest H_1 (1 seedling per hill) showed the highest number of panicles per hill (9.02, 12.80 and 17.22, respectively) which was closely followed by H_2 (2 seedlings per hill) at 70 DAT and at harvest. On the other hand, results obtained by H_4 (4 seedlings per hill) showed the lowest number of panicles per hill (4.62, 10.20 and 15.32 at 50, 70 DAT and at harvest, respectively). Intermediate results were obtained from H_3 (3 seedlings per hill) at all growth stages. This result under the present study may obtain due to higher space and less nutrient competition and more availability of nutrient, light, water, air etc.

4.1.4.3. Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill had significantly influence on number of panicles per hill at different growth stages of transplant aus rice (Table 4 and Appendix VI). Results indicated that the highest number of panicles per hill (12.47, 14.47 and 19.13 at 50, 70 DAT and at harvest, respectively) was with V_4H_1, which was closely followed by V_1H_1 at harvest. The combination of V_1H_2, V_3H_1, and V_3H_4 also showed higher number of panicles per hill but significantly different from that of V_4H_1. On the other hand, V_2H_4 produced the lowest number of panicles per hill (2.80, 9.73 and 12.93 at 50, 70 DAT and at harvest, respectively), which was significantly different from that of all other treatments.

Table 2. Panicle per hill of transplant aus rice as influenced by variety number of seedling per hill and their interaction

Treatment	Number of panicle per hill		
	50 DAT	70 DAT	At harvest
Variety			
V_1	6.367 a	11.68 b	16.64 a
V_2	5.967 b	10.95 d	15.47 c
V_3	6.067 b	11.10 c	16.02 b
V_4	6.383 a	11.93 a	16.67 a
SE	0.0815	0.0612	0.0149
$LSD_{(0.05)}$	0.2314	0.0913	0.2702
Seedling per hill			
H_1	9.017 a	12.80 a	17.22 a
H_2	5.717 b	11.88 ab	16.77 ab
H_3	5.433 b	10.78 bc	15.52 b
H_4	4.617 b	10.20 c	15.32 b
SE	0.0815	0.0612	0.0149
$LSD_{(0.05)}$	1.620	1.153	1.469
Interaction			
V_1H_1	8.333 b	14.40 a	18.47 ab
V_1H_2	7.067 bc	10.93 cd	18.13 b
V_1H_3	6.867 b-d	11.07 cd	13.93 h
V_1H_4	3.333 fg	11.73 bc	15.47 fg
V_2H_1	7.467 bc	10.20 cd	15.73 ef
V_2H_2	6.534 b-d	11.27 cd	16.13 d-f
V_2H_3	5.600 c-e	10.80 cd	13.93 h
V_2H_4	2.800 g	9.733 d	12.93 i
V_3H_1	8.200 b	13.27 ab	17.87 b
V_3H_2	5.000 d-f	10.13 cd	14.60 gh
V_3H_3	8.200 b	11.27 cd	15.27 fg
V_3H_4	4.200 e-g	10.80 cd	17.53 bc
V_4H_1	12.47 a	14.47 a	19.13 a
V_4H_2	6.867 b-d	10.80 cd	16.73 cd
V_4H_3	2.933 g	10.07 cd	16.60 c-e
V_4H_4	3.267 fg	11.73 bc	16.80 cd
SE	0.163	0.1224	0.0298
$LSD_{(0.05)}$	1.731	1.592	0.9209
CV(%)	9.42	10.36	8.87

Here,

V_1 = BRRI dhan 48
V_2 = BRRI dhan 43
V_3 = BRRI dhan 42
V_4 = ACI hybrid-2

H_1 = 1 seedling per hill
H_2 = 2 seedlings per hill
H_3 = 3 seedlings per hill
H_4 = 4 seedlings per hill

4.2. Yield contributing parameters

4.2.1. Grains per panicle

4.2.1.1. Effect of variety

Number of grains per panicle was significantly influenced by different varieties of transplant aus rice (Table 5 and Appendix VII). Results showed that the highest number of grains per panicle (104.40) was achieved from V_4 (ACI hybrid-2). On the other hand, the lowest number of grains per panicle (93.18) was observed in V_2 (BRRI dhan 43). The results obtained from V_1 (BRRI dhan 48) and V_3 (BRRI dhan 42) showed intermediate results compared to that of the highest and the lowest producers. Similar results were also reported by Chowdhury *et al*. (2005) and Hussain *et al*. (1989).

4.2.1.2. Effect of seedling number per hill

Number of grains per panicle was significantly influenced by different seedling number per hill of transplant aus rice (Table 5 and Appendix VII). It was found that H_1 (1 seedling per hill) showed the highest number of grains per panicle (105.6) while, H_4 (4 seedling per hill) showed the lowest (90.92). Intermediate results were obtained from H_2 (2 seedling per hill) and H_3 (3 seedling per hill) in terms of number of grains per panicle. Similar findings were also observed by Karmakar *et al*. (2002) and BINA (1993).

4.2.1.3 Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill on number of grains per panicle was significant for transplant aus rice (Table 5 and Appendix VII). Results indicated that the highest number of grains per panicle (121.70) was found in V_4H_1. The results from V_1H_1, V_3H_1, V_2H_1 and V_4H_4 also showed higher number of grains per panicle but significantly different from V_4H_1. On the other hand, V_2H_4 showed

the lowest number of grains per panicle (78.20), which was significantly different from that of all other treatments.

4.2.2. Weight of 1000 seeds

4.2.1.1. Effect of variety

Weight of 1000 seeds was significantly influenced by different varieties of transplanted aus rice (Table 5 and Appendix VII). Results showed that the highest 1000 seeds weight (20.82 g) was achieved from V_4 (ACI hybrid-2), which was statistically identical with V_1 (BRRI dhan 48). On the other hand, the lowest 1000 seeds weight (20.38 g) was observed in V_2 (BRRI dhan 43), which was also statistically identical to V_3 (BRRI dhan 42). Supporting results were found by Rahman *et at.* (2002), and Singh and Gongwer (1989).

4.2.2.2. Effect of seedling number per hill

Different seedling number per hill of transplant aus rice had significant influence on 1000 seeds weight (Table 5 and Appendix VII). Result revealed that H_1 (1 seedling per hill) showed highest 1000 seed weight (22.00 g), which was statistically identical to H_2 (2 seedlings per hill). On the other hand, results obtained from H_4 (4 seedlings per hill) showed the lowest 1000 seeds weight (18.83 g) which was also statistically identical with H_3 (3 seedlings per hill. Supported results with the present findings were observed by Wen and Yang (1991).

4.2.2.3. Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill on 1000 seeds weight was significant for transplant aus rice (Table 5 and Appendix VII). Results indicated that the highest 1000 seeds weight (24.67 g) was found in V_4H_1 which was closely followed by V_1H_1. On the other hand, V_2H_4 showed the lowest 1000 seeds weight (15.87 g), which was significantly different from that of all other treatments.

Table 3. Different yield contributing characters of transplanted aus rice as influenced by variety, number of seedling per hill and their interaction

Treatment	Number of grain per panicle	1000 seed-weight (g)
variety		
V_1	99.10 b	20.78 a
V_2	93.18 d	20.38 b
V_3	97.47 c	20.44 b
V_4	104.4 a	20.82 a
SE	0.0126	0.1152
$LSD_{(0.05)}$	2.422	0.1769
Seedling number per hill		
H_1	105.6 a	22.00 a
H_2	101.2 b	21.80 a
H_3	96.63 c	19.79 b
H_4	90.92 d	18.83 b
SE	0.0126	0.1152
$LSD_{(0.05)}$	2.422	1.277
Interaction		
V_1H_1	115.9 b	23.73 ab
V_1H_2	83.87 f	20.63 de
V_1H_3	102.9 d	22.70 bc
V_1H_4	106.9 cd	18.93 fg
V_2H_1	108.7 c	21.77 cd
V_2H_2	91.13 e	19.93 ef
V_2H_3	94.67 e	16.10 h
V_2H_4	78.20 g	15.87 h
V_3H_1	114.3 b	22.07 c
V_3H_2	92.27 e	18.63 g
V_3H_3	83.20 f	20.67 de
V_3H_4	92.53 e	21.90 c
V_4H_1	121.7 a	24.67 a
V_4H_2	96.40 e	19.97 ef
V_4H_3	96.00 e	19.50 e-g
V_4H_4	105.3 cd	22.63 bc
SE	0.0252	0.2304
$LSD_{(0.05)}$	4.844	1.112
CV(%)	8.36	9.14

Here,

V_1 = BRRI dhan 48
V_2 = BRRI dhan 43
V_3 = BRRI dhan 42
V_4 = ACI hybrid-2

H_1 = 1 seedling per hill
H_2 = 2 seedlings per hill
H_3 = 3 seedlings per hill
H_4 = 4 seedlings per hill

4.3. Yield parameters

4.3.1. Grain yield

4.2.1.1. Effect of variety

Grain yield (t/ha) was significantly influenced by different varieties of transplant aus rice (Table 6 and Appendix VIII). Results showed that the highest grain yield (3.743 t/ha) was achieved from V_4 (ACI hybrid-2). On the other hand, the lowest grain yield (2.963 t/ha) was observed in V_2 (BRRI dhan 43). The variety V_1 (BRRI dhan 48) and V_3 (BRRI dhan 42) showed intermediate results compared to highest and lowest grain yield. Similar results were also found by Rahman *et al*. (2002), Chowdhury *et al*. (2005) and Dwivedi (1997).

4.2.2.2. Effect of seedling number per hill

Different seedling number per hill of transplant aus rice had significant influence on grain yield (Table 6 and Appendix VIII). Result revealed that H_1 (1 seedling per hill) showed the highest grain yield (3.918 t/ha) where the lowest grain yield (2.785 t/ha) was achieved with H_4 (4 seedling per hill). The results obtained from H_2 (2 seedling per hill) and H_3 (3 seedling per hill) showed medium grain yield compared to that of the highest and the lowest grain yielder. Similar results were also found by Islam *et al*. (2002), Obulamma *et al*. (2002) and Shrirame *et al*. (2000).

4.2.2.3. Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill on grain yield for transplant aus rice was significant (Table 6 and Appendix VIII). Results indicated that the highest grain yield (4.42 t/ha) was found in V_4H_1, which was significantly different from that of all other treatments. The other combined effect, V_1H_1, V_2H_1 and V_4H_2 showed higher grain yield but significantly different from V_4H_1. On the other hand, V_2H_4 showed the lowest grain yield (2.41 t/ha), which was identical to that of V_3H_3.

4.3.2. Stover yield

4.3.2.1. Effect of variety

Stover yield (t/ha) was significantly influenced by different varieties of transplant aus rice (Table 6 and Appendix VIII). Results showed that the highest stover yield (5.55 t/ha) was achieved from V_4 (ACI hybrid-2), the lowest stover yield (4.99 t/ha) was observed in V_2 (BRRI dhan 43). The variety V_1 (BRRI dhan 48) and V_3 (BRRI dhan 42) showed intermediate results compared to that of the highest and the lowest yielder. The results found by Chowdhury *et al*. (2005) and Dwivedi (1997) were similar with the present findings.

4.3.2.2. Effect of seedling number per hill

Different seedling number per hill of transplant aus rice had significant influence on stover yield (Table 6 and Appendix VIII). Result revealed that H_1 (1 seedling per hill) showed highest stover yield (5.77 t/ha), where the lowest stover yield (4.753 t/ha) was achieved with H_4 (4 seedling per hill). The results obtained from H_2 (2 seedling per hill) and H_3 (3 seedling per hill) showed intermediate stover yield compared to the highest and the lowest yielder. The results found by Karmakar *et al.* (2002), Shrirame *et al*. (2000), and Rajarathinam and Balasubramaniyan (1999) were similar with the present findings.

4.3.2.3. Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill had significantly influence on stover yield for transplant aus rice (Table 6 and Appendix VIII). Results indicated that the highest stover yield (6.02 t/ha) was found in V_4H_1, which was closely followed by V_4H_2. The other combined effect, V_1H_1, and V_2H_1 showed higher stover yield but significantly different from V_4H_1. On the other hand, V_2H_4 showed the lowest stover yield (4.52 t/ha), which was identical to V_3H_3 and closely followed by V_1H_4, and V_2H_3.

4.3.3. Harvest index

4.3.3.1. Effect of variety

Harvest index (%) was significantly influenced by different varieties of transplant aus rice (Table 6 and Appendix VIII). Results showed that the highest harvest index (40.13%) was achieved from V_4 (ACI hybrid-2), whereas the lowest (37.04%) was observed in V_2 (BRRI dhan 43). The variety V_1 (BRRI dhan 48) and V_3 (BRRI dhan 42) showed intermediate results compared to that of the highest and the lowest harvest index. The result reported by Karmakar *et al.* (2002) was similar with the present findings.

4.3.3.2. Effect of seedling per hill

Different seedling per hill of transplant aus rice had significant influence on harvest index (Table 6 and Appendix VIII). Result revealed that H_1 (1 seedling per hill) showed the highest harvest index (40.37%) where the lowest (36.86 %) was achieved with H_4 (4 seedling per hill). The results obtained from H_2 (2 seedling per hill) and H_3 (3 seedling per hill) showed intermediate harvest index compared to that of the highest and the lowest values. The findings in supported with the present study were achieved by Karmakar *et al.* (2002), Shrirame *et al*. (2000) and BINA (1993).

4.3.3.3. Interaction effect of variety and seedling number per hill

Interaction effect of variety and seedling number per hill had significantly influence on harvest index for transplant aus rice (Table 6 and Appendix VIII). Results indicated that the highest harvest index (42.33%) was found in V_4H_1, which was significantly different from that of all other treatments. The other combined effect, V_1H_1, V_2H_1 and V_4H_2 showed higher harvest index but significantly different from V_4H_1. On the other hand, V_2H_4 showed the lowest harvest index (36.67%), which was significantly different from that of all other treatments.

Table 4. Different yields and harvest index of transplant aus rice as influenced by variety, number of seedling number per hill and their interaction

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Harvest index (%)
Effect of variety				
V_1	3.368 b	5.283 b	8.650 b	38.79 b
V_2	2.963 c	4.990 c	7.952 c	37.04 d
V_3	3.265 b	5.202 b	8.467 b	38.41 c
V_4	3.743 a	5.550 a	9.291 a	40.13 a
SE	0.0072	0.0086	0.0169	0.0069
$LSD_{(0.05)}$	0.1149	0.1344	0.2283	0.1087
Effect of seedling per hill				
H_1	3.918 a	5.770 a	9.686 a	40.37 a
H_2	3.703 b	5.622 b	9.325 b	39.67 b
H_3	2.932 c	4.880 c	7.813 c	37.47 c
H_4	2.785 d	4.753 c	7.537 d	36.86 d
SE	0.0072	0.0086	0.0169	0.0069
$LSD_{(0.05)}$	0.1149	0.1344	0.2283	0.1087
Interaction effect of variety and seedling number per hill				
V_1H_1	3.920 bc	5.840 a-c	9.760 bc	40.16 bc
V_1H_2	3.740 cd	5.640 b-d	9.380 b-d	39.87 cd
V_1H_3	3.010 hi	4.920 gh	7.930 gh	37.96 f
V_1H_4	2.800 ij	4.730 hi	7.530 hi	37.18 gh
V_2H_1	3.850 b-d	5.760 a-c	9.610 bc	40.06 c
V_2H_2	3.620 de	5.580 cd	9.200 cd	39.35 de
V_2H_3	2.880 ij	4.790 hi	7.670 hi	37.55 fg
V_2H_4	2.410 l	4.520 i	6.930 j	34.78 j
V_3H_1	3.480 ef	5.460 de	8.940 de	38.93 e
V_3H_2	3.420 e-g	5.390 de	8.810 d-f	38.82 e
V_3H_3	2.540 kl	4.590 i	7.130 ij	35.62 i
V_3H_4	2.710 jk	4.680 hi	7.390 h-j	36.67 h
V_4H_1	4.420 a	6.020 a	10.43 a	42.33 a
V_4H_2	4.030 b	5.880 ab	9.910 ab	40.66 b
V_4H_3	3.300 fg	5.220 ef	8.520 ef	38.73 e
V_4H_4	3.220 gh	5.080 fg	8.300 fg	38.79 e
SE	0.0144	0.0171	0.0338	0.0138
$LSD_{(0.05)}$	0.2299	0.2689	0.5378	0.5704
CV(%)	8.54	7.16	9.42	7.79

Here,

V_1 = BRRI dhan 48
V_2 = BRRI dhan 43
V_3 = BRRI dhan 42
V_4 = ACI hybrid-2

H_1 = 1 seedling per hill
H_2 = 2 seedlings per hill
H_3 = 3 seedlings per hill
H_4 = 4 seedlings per hill

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was conducted at the Agronomy Farm of Sher-e-Bangla Agricultural University, Dhaka to evaluate 'growth and yield of transplant aus rice as influenced by variety and number of seedlings per hill'. The experiment comprised two different factors; (1) four varieties viz. V_1 (BRRI dhan 48), V_2 (BRRI dhan 43), V_3 (BRRI dhan 42) and V_4 (ACI hybrid-2) and (2) four seedling treatments Viz. H_1 (1 seedling per hill), H_2 (2 seedling per hill), H_3 (3 seedling per hill) and H_4 (4 seedling per hill).

The experiment was set up in Randomized Complete Block Design (factorial) with three replications. There were 16 treatment combinations. The experimental plots were fertilized with recommended fertilizer doses of urea, TSP and MOP. Data on different growth, yield and yield parameters were recorded and analyzed statistically.

Data were collected on plant height, number of tillers per hill, number of leaves per hill, number of panicles per hill, number of grain per panicle, 1000 seed-weight, grain yield, stover yield and harvest index. Three effects have been considered to evaluate the experiment such as (i) Effect of variety, (ii) Effect of seedling per hill and (iii) Interaction effect of variety and seedling number per hill.

Considerable effect was observed on growth, yield and yield contributing characters of transplant aus rice by different varieties. The variety, V_3 (BRRI dhan 42), showed the highest plant height (64.49, 94.95 and 94.95 cm at 50, 70 DAT and at harvest, respectively) where the lowest (63.37, 92.62 and 92.62 cm at 50, 70 DAT and at harvest, respectively) was obtained by V_2 (BRRI dhan 43). The other parameters; the highest number of tillers per hill (11.65, 14.37, 23.62 and 23.62 at 30, 50, 70 DAT and at harvest, respectively), number of leaves per hill (32.28, 42.63, 161.50 and 161.50 at 30, 50, 70 DAT and at harvest, respectively), number of panicles per hill (6.38, 11.93 and 16.67 at 50, 70 DAT and at harvest, respectively), number of grains

per panicle (104.40), 1000-seed weight (20.82 g), grain yield (3.743 t ha^{-1}), stover yield (5.55 t ha^{-1}) and harvest index (40.13%) was obtained from V_4 (ACI hybrid-2) where the lowest number of tillers per hill (9.18, 13.10, 21.83 and 21.83 at 30, 50, 70 DAT and at harvest, respectively), number of leaves per hill (29.25, 40.00, 90.70 and 90.70 at 30, 50, 70 DAT and at harvest, respectively), number of panicles per hill (5.97, 10.95 and 15.47 at 50, 70 DAT and at harvest respectively), number of grains per panicle (93.18), 1000-seed weight (20.38 g), grain yield (2.963 t ha^{-1}), stover yield (4.99 t ha^{-1}) and harvest index (37.04%) was obtained from V_2 (BRRI dhan 43).

For successful crop production, number of seedling per hill is very important. The results under the present study showed that growth, yield and yield contributing characters of transplanted aus rice were significantly influenced by different number of seedling per hill. The higher number seedling per hill, H_4 (4 seedlings per hill) showed the highest plant height (64.33, 94.53 and 94.53 cm at 50, 70 DAT and at harvest respectively) where the lower number of seedling per hill, H_1 (1 seedling per hill) showed the lowest plant height (61.87, 92.67 and 92.67 cm at 50, 70 DAT and at harvest, respectively). But in terms of other parameters; the highest number of tillers per hill (14.32, 24.65 and 24.65 at 50, 70 DAT and at harvest, respectively), number of leaves per hill (31.65, 44.18, 161.70 and 161.70 at 30, 50, 70 DAT and at harvest, respectively), number of panicle per hill (9.02, 12.80 and 17.22 at 50, 70 DAT and at harvest, respectively), number of grain per panicle (105.6), 1000 seed weight (22.00 g), grain yield (3.918 t ha^{-1}), stover yield (5.77 t/ha) and harvest index (40.37%) was obtained from H_1 (1 seedling per hill) where the lowest number of tillers per hill (13.02, 21.02 and 21.02 at 50, 70 DAT and at harvest, respectively), number of leaves per hill (29.62, 38.18, 90.43 and 90.43 at 50, 70 DAT and at harvest, respectively), number of panicle per hill (4.62, 10.20 and 15.32 at 50, 70 DAT and at harvest, respectively), number of grain per panicle (90.92), 1000-seed weight (18.83 g), grain yield (2.785 t ha^{-1}), stover yield (4.753 t ha^{-1}) and harvest index (36.86 %) was obtained from H_4 (4 seedlings per hill).

The growth, yield and yield contributing parameters of transplant aus rice were also significantly influenced by different variety along with different seedling per hill treatment. The highest plant height (41.07, 68.29, 99.40 and 99.40 cm at 30, 50, 70 DAT and at harvest, respectively) was with V_3H_4 where the lowest (35.60, 56.91, 91.07 and 91.07 cm at 30, 50, 70 DAT and at harvest, respectively) was by V_2H_1. But the parameters; the highest number of tillers per hill (13.13, 16.13, 25.07 and 25.07 at 30, 50, 70 DAT and at harvest, respectively), number of leaves per hill (35.60, 47.67, 356.30 and 356.60 at 30, 50, 70 DAT and at harvest, respectively), number of panicles per hill (12.47, 14.47 and 19.13 at 50, 70 DAT and at harvest, respectively), number of grains per panicle (121.70), 1000- seed weight (24.67 g), grain yield (4.42 t/ha), stover yield (6.02 t ha^{-1}) and harvest index (42.33%) was obtained from V_4H_1, where the lowest number of tillers per hill (7.00, 12.33, 19.40 and 19.40 at 30, 50, 70 DAT and at harvest, respectively), number of leaves per hill (26.80, 35.93, 82.47 and 82.47 at 30, 50, 70 DAT and at harvest, respectively), number of panicles per hill (2.80, 9.73 and 12.93 at 50, 70 DAT and at harvest, respectively), number of grains per panicle (78.20), 1000- seed weight (15.87 g), grain yield (2.41 t ha^{-1}), stover yield (4.52 t ha^{-1}) and harvest index (36.67%) was obtained from V_2H_4.

It may be concluded from the results that variety and number of seedling per hill is very much promising for higher rice yield. However, the best variety was V_4 (ACI hybrid-2) and best seedling number was 1 seedling per hill under the present study. The combination of V_4H_1 (ACI hybrid-2 with 1 seedling per hill) performed best in producing higher yield than other treatments comprised with other variety and number of seedling per hill under the present study. On the other hand interactions of ACI hybrid-2 and 1 seedling per hill showed its superiority in producing higher rice yield.

The present research work was carried out at the Sher-e-Bangla Agricultural University and in one season only. Further trial of this work in different locations of the country is needed to justify the result for higher return of yield.

REFERENCES

Ahmed. M.K. and Rao, R.S. (1995). Studies on the effect of spacing with varying number of seedlings planted per hill on grain and straw yields of Japonica x HR 103. *Andhra Agric. J.* **11**(1) - 1-9.

AIS. (2001). Krishi Diary. Agricultural Information Service, Khamarbari, New Airport Road, Farmgate, Dhaka, Bangladesh. pp. 20-22.

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.

Asif, M., Chowdhury, F.M. and Saeed, M. (1997). Panicle structure, kernel quality and yield of fine rice as influenced by different NPK levels and per hill seedling density. *Pakistan J. Agril. Sci.* **34**(l-4): 73-77.

Babiker, F.S.H. (1986). The effect of zinc sulphate levels on the rice growth and productivity. *Alexandria J. Agril. Res***. 31**(2): 480-481.

Bali, A.S., Singh, K.N., Balli, A.S., Ganai, B.A. and Hasan, B. (1995). Effect of transplanting date, number and age of seedling on rice (*Oryza sativa*). *Indian J. Agron.* **40**(3): 504-507.

Banik, P., Sarker, B., Samsel, T., Ghosal, P.K. and Bagohi, D.K. (1997). Effect of different number and age of seedlings on rice cultivars in lowland plateau region of Bihar. *Indain J. Agron*. **42**(2): 265-268.

BBS. (2001). Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics. Stat. Div. Minis. Plann., Govt. People's Rep. Bangladesh. Dhaka. p. 138.

BINA. (1987). Annual Report (1986-87). Bangladesh Inst. Nucl. Agric. P.O. Box No. 4. Mymensingh. p. 165.

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.

Bisht, P.S., Pandey, P.C. and Lal, P. (1999). Plant population requirement of hybrid rice in the Tarsi Region of Uttar Pradesh, India Int. Rice Res. Notes **24**(2)-38.

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

BRRI. (1990). Annual Report for (1987). Bangladesh Rice Research Institute. Joydebpur. Gazipur, Bangladesh. p. 9.

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

BRRI (1991b). Annual Report for 1989. Bangladesh Rice Research Institute. Joydebpur, Gazipur, Bangladesh. pp. 82-84, 294-300.

BRRI. (1992a). Annual Report for 1990. Bangladesh Rice Research Institute. Joydebpur, Gazipur, Bangladesh. pp. 11, 278-289.

BRRI. (1992b). Annual Report for 1990. Bangladesh Rice Research Institute. Joydebpur, Gazipur, Bangladesh. pp. 28-33.

BRRI. (1994), Annual Report for 1993. Bangladesh Rice Res. Inst. Joydebpur, Gazipur. pp. 8-9.

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

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

BRRI. (1999). Annual Report for 1998. Bangladesh Rice Research Institute. Pub. No. 207. Joydebpur, Gazipur, Bangladesh. pp. 152-158.

BRRI. (2000). Annual Report for 1999. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh. pp. 88-256.

BRRI. (2009). Annual report for 2008. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh. Anonymous. 2009. p. 175

Budhar, A.M.. Palanipalan, S.P. and Rangasamy, A. (1989). Effect of plant population on productivity of early duration rice. *Madras Agric. J.* **26**(3). 310-311.

Chowdhury, M.J.U., Sarker, A.U., Sarkar, M.A.R. and Kashem, M.A. (2005). Effect of variety and number of seedlings per hill on the yield and its components on late transplanted aman rice. *Bangladesh J. Agril. Sci.* **20**(2): 311-316.

Das, K., Biswal, D. and Pradhan, T. (1989). Effect of plant density and age of seedling on the groivth and yield of rice variety. Oryza. **25**(2): 191194.

Dongarwar, UK, Patankar, M.N. and Pawar, W.S. (2002). Response of hybrid rice to spacing and number of seedlings per hill and their effects on growth and yield. *J. Soils and Crops.* **12**(2): 248-249.

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

FAO and UNDP. (1988). Land Resources Appraisal . of Bangladesh for Agricultural Development. Report 2. Agro-ecological Regions of Bangladesh. Food and Agric. Org. and United Nations Dev. Prog. pp. 212-221.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. (2^{nd} edn.) John Wiley and Sons. New York, Chickester, Brishane. Toronto, Singapore. p. 680.

Hossain, M.M. and Haque, M.Z. (1990). Seedling age and density effects on basal tiller survival and yield of transplant deep water rice. Bangladesh J. Agril. Sci. 12(2): 67-72.

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.

Hossain. T., Jilani. G. and Gaffar, M.A. (1989). Influence of rate and time of N application on growth and yield of rice in Pakistan. Intl. Rice Res. Newsl. 14: 18.

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.

IRRI. (1995). Annual Report for 1994. Intl. Rice Res. Inst. Los Banos, Laguna. Philippines. pp. 179-181.

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.R., Salam, M.A., Harman, M.A. and Sarkar, M.A.R. (2002). Effect of hill density and number of seedlings hill^{-1} on the yield and yield

components of fine rice cv. Kalizira. *Bangladesh J. Agril. Sci.* **29**(2): 325-328.

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.

Karim, M.A. (1992). Krishi Diary. Agricultural Information Service. Kharnarbari, Farmgate, Dhaka. p. 130.

Karirn, M.A., Gaffer, M.A., Maniruzzaman, A.F.M. and Islam, M.A. (1987). Effect of spacing, number of seedling hill^{-1} and planting depth on the yield of aman rice. *Bangladesh J. Agril*. *Sci*. **14**(2): 99-103.

Karmakar, B.. Sarkar, M.A.R., Uddin, M.R. and Biswas, M. (2002). Effect of row arrangements, number of seedlings hill^{-1} and nitrogen rates on yield and yield components of late transplant aman rice. *Bangladesh. J. Agri1*. *Sci.* **29**(2):275-281.

Muhammad, A.U.S., Sharkar, 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.

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.

Pandey, R.C., Pandey, R.P., Vyas, O.P, and Pandey, A. (1987). Effect of number of seedlings hill^{-1} on grain yield of rice. *Indian J. Agron.* **32**(l): 106-107.

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

Rafey. A., Khan, P.A. and Srivastava, V.C. (1989). Effect of N on growth, yield and nutrient uptake of upland rice. *Indian J. Agron*. **30**(1): 133-135.

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.

Rajarathinam, P. and Balasubramaniyan, P. (1999). Optimum plant population, seedling density and N levels for medium duration hybrid rice. *Indian J. Agril. Sci*. **69**(8): 583-585.

Rajendra, P., Sharma, S.N., Surendra, S., Zaman, F.U., Prasad, R. and Singh, S. (1998). Productivity of hybrid rice Pusa HR3 under late planting conditions. *Annals Agril. Res*. **19**(l): 92-93.

Rameswamy. S., Chandrasekaran, B. and Sandaran, S. (1987). Effect of spacing and seedlings per hill. *Int. Rice Res. Newsl*. **12**(4): 49.

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

Reddy. K.S. and Ghosh, B.C. (1984). Effect of seeding and hill density on the performance of rice under intermediate deep water conditions. Div. Agron. Cent. Rice Res. *Inst. Orissa, India,* **21**(4): 233 - 237.

Reddy, M.D. and Mitra, B.N. (1984). Effect of time of planting, age and number of seedlings hill-' on yield and yield components of rice varieties in flood prone situations. *Thai J. Agric. Sci*. **17**(1): 41- 49.

Setty. R.A., Veereswaran, M.L., Kumar, B.P., Hayaradang, P.V., Ulanjunath, S., Seetharam, B.A., Ligaraje, S., Devaraju, K.M. and Ralcijcr. (1987). Influence of seedlnig age, number of seedlings hill and nitrogen fertilization on grain yield of transplanted paddy. *Regional Res. Station and lndo-Japanese Agricultural Training Centre, Mandya, Japan* **24**(2): 172-173.

Shah, M.H. Khushu, M.K., Khanday, B.A. and Bali, A.S. (1991). Effect of spacing and seedlings per hill on transplanted rice under late sown condition. *Indian J. Agron*. **36**(2): 274-275.

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.

Shikder, F.S.,Salam, M.A., Haque . A.K.G. and Kashem. M.A. (2010). Adhunik Dhaner chash, Bangladesh Rice Research Institute, Joyebpur, Gazipur.

Singh, R.D., Verma, B.S. and Rajput, *O.P* (1992). Effect of age and number of seedling per hill on yield and yield attributes of rice under rain fed lowland. *Crop Res.* **53**(1): 417- 419.

Singh, O.P. and Pal, D. and Om, H. (1987). Ropai Ke Liye Dhan Ki Nursery. Haryana Kheti, **19**(5): 22.

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.

Wen, H.N. and Yang, Z.G. (1991). Studies on the cultivation method with transplanting single seedlings $hill^{-1}$ in late rice. Zhejiang Nongye Kexue, 6:264-268 .

Zhang, X.G. and Huang, Y.K. (1990). Effect of seedlings per hill on individual rice plant yield and yield components. *Int. Rice Res. Newsl*. **15**(4): 21-22.

APPENDICES

Appendix I. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from March, 2010 to August, 2010

Month	***RH (%)***	***Air temperature (^oC)***			***Rainfall (mm)***
		Max.	***Min.***	***Mean***	
March	46.13	36.2	22	29.1	0
April	61.40	33.74	23.81	28.77	185
May	64.27	32.5	24.95	28.72	180
June	66.24	28.28	25.34	26.81	184
July	81	31.4	25.8	28.6	542
August	82	32.0	26.6	29.3	361

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

Appendix II. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

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

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

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

Source: Soil Resource Development Institute (SRDI)

Appendix III. Plant height of transplant aus rice as influenced by variety, number of seedling per hill and their interaction

Source of variation	Degrees of Freedom	Plant height			
		Mean square value			
		30 DAT	50 DAT	70 DAT	At harvest
Replication	2	0.001	0.027	1.461	1.461
Factor A	3	NS	2.846**	14.95*	14.95*
Factor B	3	NS	4.679*	8.236*	8.236*
AB	9	1.035*	1.852*	16.61*	16.61*
Error	30	0.832	14.516	4.770	4.770

Appendix IV. Tillers per hill of transplant aus rice as influenced by variety, number of seedling per hill and their interaction

Source of variation	Degrees of Freedom	Number of tillers per hill			
		Mean square value			
		30 DAT	50 DAT	70 DAT	At harvest
Replication	2	0.004	0.002	0.006	0.006
Factor A	3	2.721*	3.450*	4.139*	4.139*
Factor B	3	NS	3.941*	5.568*	5.568*
AB	9	1.818**	2.745*	4.121*	4.121*
Error	30	0.012	0.936	1.982	1.982

Appendix V. Leaves per hill of transplant aus rice as influenced by variety, number of seedling per hill and their interaction

Source of variation	Degrees of Freedom	Number of leaves per hill			
		Mean square value			
		30 DAT	50 DAT	70 DAT	At harvest
Replication	2	0.016	0.001	0.044	0.044
Factor A	3	6.556*	5.493*	3.723*	3.723*
Factor B	3	9.576*	7.298*	7.243*	7.243*
AB	9	11.82*	12.76*	12.75*	12.75*
Error	30	0.389	1.384	2.477	2.477

Appendix VI. Panicle per hill of transplant aus rice as influenced by variety, number of seedling per hill and their interaction

Source of variation	Degrees of Freedom	Number of panicle per hill		
		Mean square value		
		50 DAT	70 DAT	At harvest
Replication	2	0.112	0.018	1.101
Factor A	3	0.534**	2.624*	4.028*
Factor B	3	5.047*	16.051*	10.407*
AB	9	8.150*	4.159*	11.181*
Error	30	3.359	3.597	3.437

Appendix VII. Different yield contributing characters of transplant aus rice as influenced by variety, number of seedling per hill and their interaction

Source of variation	Degrees of Freedom	Mean square value of	
		Number of grain per panicle	1000 - seed weight (g)
Replication	2	0.008	0.011
Factor A	3	0.571**	0.610**
Factor B	3	5.155*	28.697*
AB	9	10.810*	20.719*
Error	30	2.615	30.812

Appendix VIII. Different yield characters of transplant aus rice as influenced by variety, number of seedling per hill and their interaction

Source of variation	Degrees of Freedom	Mean square value			
		Grain yield	Straw yield	Biological yield	Harvest index
Replication	2	0.001	0.006	0.002	0.004
Factor A	3	1.243*	0.643*	3.665*	19.457*
Factor B	3	3.755*	3.174*	13.81*	34.460*
AB	9	4.011*	6.007*	8.020*	0.649*
Error	30	0.301	1.421	3.003	3.012