EFFECT OF TRANSPLANTING DEPTHS ON TILLERING AND YIELD OF HYBRID AND INBRED RICE

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CERTIFICATE

This is to certify that the thesis entitled ***"EFFECT OF TRANSPLANTING DEPTHS ON TILLERING AND YIELD OF HYBRID AND INBRED RICE"*** *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,*** *embodies the results of a piece of bona fide research work carried out by* ***MD. ALI RUBEL,*** *Registration. No.* ***12-04889*** *under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

Dated:

Dhaka, Bangladesh

(Prof. Dr. H. M. M. Tariq Hossain)
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DEDICATED TO

MY

BELOVED PARENTS

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EFFECT OF TRANSPLANTING DEPTHS ON TILLERING AND YIELD OF HYBRID AND INBRED RICE

ABSTRACT

A field experiment was conducted in medium fertile soil at Sher-e-Bangla Agricultural University (90º37´ E longitude and 23º77´ N latitude), Dhaka, Bangladesh during November 2017 to April 2018 in *Boro* season with a view to evaluating the performance of rice varieties under different transplanting depths. The experiment was carried out with three varieties i.e. BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 in the main plot and four levels of transplanting depth *viz.* (2, 4, 6 and 8 cm) in the sub-plots. The experiment was laid out in a split-plot design with three replications. The combination of variety and transplanting depth had significant effects on most of the growth and yield contributing parameters. At 30, 50, 80 DAT and at harvest, the longest plant (18.20 cm, 25.72 cm, 79.86 cm, and 102.9 cm) was found from the treatment combination of V_1D_1 (BRRI hybrid dhan3 × transplanting at 2 cm depth), whereas the shortest (22.86 cm, 29.14 cm, 77.64 cm, and 87.55 cm) was observed from the treatment combination of V_3D_1 (BRRI dhan63 × transplanting at 2 cm depth). At 30, 50, 80 DAT and at harvest, the maximum number of tillers hill^{-1} (1.73, 9.80, 17.29, and 13.22) was recorded from the treatment combination of V_1D_2 (BRRI hybrid dhan3 × transplanting at 4 cm depth), again the minimum number (1.20, 9.80, 14.53 and 11.00) was obtained from the treatment combination of V_2D_2 (BRRI dhan45 × transplanting at 4 cm depth) at 30, 50, 80 DAT and at harvest. The longest panicle (24.49 cm) was found from the treatment combination of V_1D_4, while the shortest panicle length (21.48 cm) was observed from V_3D_3. The highest weight of 1000 grains (30.02 g) was recorded from the treatment combination of V_1D_4 and the lowest weight (23.54 g) from V_3D_1. The highest grain yield (8.55 t ha^{-1}) was recorded from the treatment combination of V_1D_2 and the combination of V_1D_4 also produced statistically similar yield (8.09 t ha^{-1}) whereas the lowest (5.75 t ha^{-1}) from V_2D_1. It may be concluded that growth, yield and yield contributing characters of *Boro* rice were greatly influenced by varieties and transplanting depth. Variety V_1 (BRRI hybrid dhan3) at transplanting depth 4 cm produced longest panicle, maximum number of filled grains panicle^{-1} and highest 1000 grains weight and ultimately provided maximum yields of BRRI hybrid dhan3.

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LIST OF ACRONYMS

%	=	Percent
µg	=	Micro gram
^0C	=	Degree Celsius
AEZ	=	Agro-Ecological Zone
AIS	=	Agriculture Information Service
B:C	=	Benefit Cost ratio
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centi-meter
CV%	=	Percentage of coefficient of variance
cv.	=	Cultivar
cv.	=	Cultivar
DAS	=	Days after sowing
DF	=	Degree of freedom
EC	=	Emulsifiable Concentrate
et al.	=	And others
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram
ha^{-1}	=	Per hectare
HI	=	Harvest Index
hr	=	Hour
Kg	=	Kilogram
LAI	=	Leaf area index
LSD	=	Least significant difference
LSD	=	Least Significant Difference
m	=	Meter
Max	=	Maximum
Min	=	Minimum
mm	=	Millimeter
MP	=	Muriate of Potash
N	=	Nitrogen
No.	=	Number
NPK	=	Nitrogen, Phosphorus and Potassium
NS	=	Non-significant
ppm	=	Parts per million
RCBD	=	Randomized complete block design
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
T	=	Ton
TSP	=	Triple Super Phosphate
viz.	=	Videlicet (namely)
WCE	=	Weed Control Efficiency
WP	=	Wettable Powder
Wt.	=	Weight

CHAPTER I

INTRODUCTION

Bangladesh is a densely populated agricultural country where rice is the most extensively cultivated cereal crop. Increased rice production in this country is essential to meet the food demand of the teeming population. In Bangladesh, there is 8.65 million hectares of arable land of which 75% is devoted to rice cultivation (BBS, 2004). Although, the climate and soil of Bangladesh are favorable for year round rice cultivation, unfortunately the yield of rice is very low in Bangladesh. The average yield of rice is 4.3 t ha^{-1} (BBS, 2014); which is quite lower compared to that of many other rice growing countries like China, Japan, Korea and the USA where yields are 6.23, 6.79, 6.59 and 7.04 t ha^{-1}, respectively (FAO, 2014). The total yield of rice in *Aus*, *Aman* and *Boro* season was 2.71, 13.99 and 19.58 million metric tons, respectively (BRRI, 2018).

Rice is extensively grown in Bangladesh in three seasons namely, *Aus, Aman* and *Boro*, which covers 80% of the total cultivable area of the country (AIS, 2011). During the year 2014-2015 rice covered an area of 28209 thousand acres with a production of 34710 thousand m. tons (BBS, 2016). The yield of rice may be increased through improved agronomic management practices. Variety is the key component to produce higher yield of rice depending upon their differences in genotypic characters, input requirements and response, growth process and off course the prevailing environmental conditions during the growing season.

Variety is an important factor which contributes a lot for producing higher yield and yield components of a particular crop. Yield components are directly related to the variety and the neighboring environments on which it grows. Rice variety has tremendous impact on the growth and yield of rice. Yield components such as number of effective tillers $hill^{-1}$, number of grains $panicle^{-1}$ and weight of individual grain contribute to increase or decrease the yield. Each cultivar has certain tiller producing capacity. Adequate number of effective tillers $unit^{-1}$ area exerts a role in producing panicle number and the spikelet number. Panicle number $unit^{-1}$ area and the fertile spikelet per panicle are the most important yield components in rice. Optimum number of tillers $unit^{-1}$ area is a prerequisite for obtaining maximum yield from a rice variety and rice yield increases with increased number of panicles unit^{-1} area. Among the different agronomic practices, planting management, depth of planting and planting methods play a vital role in achieving higher yield levels of hybrid and inbred rice. Appropriate transplanting depth is one of the most important cultural practices for *Boro* rice, it may have a positive effect on the number of tillers hill^{-1}, grains panicle^{-1} and ultimately this can increase the yield of rice (Grist, 1965). In rice cultivation, both the planting depth and rice cultivar are the two most important cultural practices (Amir *et al*., 1984). Improper planting depth and haphazard plant spacing may have deleterious effect on the number of tillers hill^{-1}, grains panicle^{-1} and ultimately may affect the yield of rice. The chemical and mineralogical compositions, biotic activities, organic matter contents, availability of nutrient elements such as nitrogen, phosphorus and sulphur vary with the depth of soil (Millar *et al*., 1965). Besides, low temperature at deeper root zone retards the availability of nutrient elements resulting in the restricted development of the root system and tillers (Matsushima, l976). Moreover, a reduction in grain yield and its components is caused due to the increase in depth of transplanting (Sarker *et al.*, 1986 and Karinal 1985). Ahmed and Faiz (1972) reported that transplanting depth can play an important role for achieving higher yield of rice because chemical and mineralogical composition, biotic activities, organic matter content and plant nutrients such as N, P, K, S etc., differ significantly with the depths of soil (Miller *et al.*, 1965). Therefore, proper transplanting depth provides adequate root zone area and sufficient moisture level for having proper growth and development of the crop. As for example, greater transplanting depth of rice seedlings hampers normal root development and a new root system develops from the upper nodes. This phenomenon retards plant growth which ultimately affects the yield (Grist, 1965). However, there are reports that increasing transplanting depth results in the decrease in grain yield and its components (BRRI, 1979; Karim, 1985 and Sarker *et al*., 1986). Indeed, shallow sowing is a traditional practice in some countries (Tully and Rassam, 1985). In Syria, for example, farmers usually commence sowing after rain when the surface soil is moist and hence, do not need to sow more deeply than 3 cm. Thus, planting must be delayed until significant rainfall occurs; in some cases planting is incomplete if the rain is excessive, restricting access to the field as it happens in particularly wet years (Mahdi *et al*., 1998).

A suitable depth of transplanting for a cultivar of rice under question may play a remarkable role for the improvement in yield of *Boro* rice. So, adjustment of transplanting depth is necessary depending upon variety, location, season and cultural conditions to eliminate measurable interspace competition and to create suitable micro-climate for obtaining the maximum grain yield of rice.

Therefore, the present study was undertaken to find out the effect of transplanting depth on tillering and yield of transplanted *Boro* rice with the following objectives.

a. To find out the effects of variety on tillering and yield of hybrid and inbred rice.
b. To find out the effects of transplanting depth on tillering and yield of hybrid and inbred rice.
c. To find out the interaction effects of different variety and transplanting depths on tillering and yield of hybrid and inbred rice.

CHAPTER II

REVIEW OF LITERATURE

Yield and yield contributing characters of rice are considerably dependent on manipulation of basic ingredients of agriculture. The basic ingredients include variety, environment and agronomic practices (transplanting depth, density & time, fertilizer, irrigation, weeding etc.). Among the above factors transplanting depth are more responsible for the growth and yield of rice. High yielding varieties (HYV) are generally more adaptive to appropriate transplanting depth and they produce higher yield with optimum transplanting depth. The available relevant reviews of related transplanting depth in the recent past have been presented and discussed under the following headings:

2.1 Effect of transplanting depth on rice

Among the factors that are responsible for tillering, yield and yield contributing characters of rice, transplanting depth is very important for the production of modern varieties of *Boro* rice. Some information regarding effect of transplanting depth are reviewed under the following headings:

2.1.1 Growth parameters

Plant height

Plant height is significantly influenced by the interaction effect between cultivar and depth of transplanting. Karim (1985) observed that plant height was not significantly affected by various planting depth though the tallest plants (112.23 cm) were produced from 2.5 cm planting depth and the shortest plants (110.18 cm) from 7.5 cm planting depth. Maximum plant height (110.20 cm) was found where depth was kept 3.0 cm at the time of mechanical rice transplanting. The minimum plant height (102.30 cm) was observed during 2011 where depth was kept 7.5 cm at the time of transplanting which ultimately reduce the plant growth slightly. These results are in conformity with that of Junego *et al* (2001) and Talpur *et al.* (2013). They also observed decrease in plant height with increasing depth at transplanting. It was concluded from their study that the maximum plant survival and tallest average plant height were recorded in 5 cm depth (minimum) from cultivaton till to mid stage of growth (Talpur *et al.* 2013). But in another study Enyi

(1963) found that seedlings transplanted to a depth of 9.0 cm produced plants significantly taller than those of transplanted to 3.0 cm and 6.0 depths, respectively at 30 days after transplanting. BAU-63 produced taller plants when planted at 8 cm depth than BR3 cultivar with similar depth of transplanting (Sarker *et al*., 1986).

Total tillers hill^{-1}

With the increase in depth of transplanting the tiller production gradually decreased due to restricted growth and low nutrient availability (Matsushima, 1976) though more total tillers were produced at the soil surface but all of these tillers could not bear panicles at harvest. Mahapatra and Padalia (1971) reported an increase in the production of effective tillers hill^{-1} with the increase in transplanting depth. The number of grains panicle^{-1} was found to be drastically reduced in plants transplanted at soil surface and at 12 cm depth. This was probably due to translocation of more photosynthates to the non-bearing late tillers formed at both conditions (Karim, 1985). Rao *et al*. (1986) found that planting depth did not influence the poorly or moderately tillering varieties Visaya and Kanagi but shallow planting resulted in a better response than deeper planting in pro functional tillering Kalinga-11. Karim (1985) reported that there was a reduction in tiller number with increase in depth of transplanting beyond 5.0 cm.

Likewise, the grain yield was severely curtailed at the same conditions due to the production of fewer effective tillers with less number of grains per panicle. Besides, the reduction in grain yield due to deep transplanting of rice has been observed by various authors (Sarker *et al*., 1986). However, the production of more tillers at shallower depth was the main reason for the maximum straw yield at the puddle soil surface. Maximum number of productive tillers plant^{-1} (20.55 tillers) were found in case where depth at transplanting was kept 2.5 cm whereas minimum number of productive tillers per plant (15.11 tillers) were found in case where depth at transplanting was kept 7.5 cm. Therefore, it may be concluded that increasing depth at the time of mechanical transplanting reduced number of productive tillers. These results are in line with Singh *et al* (1985). Matsushima (1976) got the similar result that shallow transplanting of 1 cm depth promoted the emergence of tillers in the early growth period in comparison to deep transplanting of 5 cm depth. Rice seedlings planted deeper than 2-4 cm delayed and reduced tiller formation.

BRRI (1979) carried out a research on the depth of planting with BR7 rice variety using different depths of transplanting and found a progressive deterioration of tillering rate with an increase in transplanting depth. When the seedlings were shallowly planted 1.0-5.0 cm they reported that the total number of tillers hill^{-1} did not differ significantly.

Generally, no standard depth of transplanting of rice is followed in Bangladesh. But the depth of transplanting influences total tillers hill^{-1} which ultimately affect the grain yield of rice plant. Kawasima and Tanabe (1970) observed that shallow planting of 20 days old seedlings produced higher number of tillers hill^{-1}. In terms of tillering nature, the majority of available research findings indicated that shallow planting was better than deep planting. But Enyi (1963) stated that deep transplanting increased the tiller number and reduced the tiller mortality.

Effective tillers hill^{-1}

More effective tillers hill^{-1} were produced in plants when planting depths ranged from farmers' depth to 9 cm depth, In a depth of planting study with BR7 rice BRRI (1979) indicated that the effective tillers differed between planting depth except in 3.0 cm where higher numbers of panicles were attained. Matsushima (1976) stated that shallow depth of transplanting promotes the emergence of tillers in the early growth period resulting in increase effective tillers. Karim (1985) reported that 5.0 cm planting depth produced higher number of effective tillers hill^{-1} which was significantly superior to 1.0 cm and 7.5 cm planting depths, respectively.

Mahapatra and Padalia (1971) reported an increase in the production of effective tillers hill^{-1} with the increase in transplanting depth. There are contradictory reports regarding the production of effective tillers hill^{-1} due to different planting depths. Padalia and Mahpatra (1965) carried out an experiment with depths of 1.0, 3.0, 7.0 and 15.0 cm and in presence of NPK alone or in combination at different rates and they found that shallow planting increased slightly the number of effective tillers hill^{-1}.

Panicle length

Duraisamy *et al*. (2011) carried out a field experiment during March-June 2008 at wetland in Tamil Nadu Agricultural University to optimize the spacing and depth of transplanting in rice cultivation using a self-propelled rice transplanter (Yanmar 6 row). The treatment consisted of 4 levels of hill spacing in the main plot and depth of planting (manual: 2 cm and 4 cm depth) in the sub plot. Among the depth of planting, panicle length (22 cm) were produced in 4 cm depth. Panicle of *Boro* rice is influenced by the depth of the planting density. From a study of Mahapatra and Padalia (1971) regarding the various depths of transplanting of rice seedlings it was revealed that the panicle length in plants increased with the increase of planting depth.

Total spikelet panicle^{-1}

Karim (1985) reported that an increase in depth of planting beyond 2.5 cm increased the total number of spikelet per panicle. Depth of planting and age of seedlings interacted to cause a marked variation in the number of total spikelet panicle^{-1}. Kawashima and Tanabe (1970) found that shallow planting of 20 day old seedlings produced higher number of spikelet per panicle than 40 day old seedlings.

Filled grains panicle^{-1}

Duraisamy *et al*. (2011) conducted a field experiment during March-June 2008 at wetland in Tamil Nadu Agricultural University to optimize the spacing and depth of transplanting in rice cultivation using a self-propelled rice transplanter (Yanmar 6 row). The treatment consisted of 4 levels of hill spacing in the main plot and depth of planting (manual, 2 cm and 4 cm depth) in the sub plot. Among the depth of planting, filled grains panicle^{-1} (113) were produced in 4 cm depth. Results showed that 2.5 cm depth at transplanting time produced more number of fertile grains per panicle (113.26 grains). Whilst the other three treatments produced significantly less number of fertile grains per panicle. The least number of grains (105.89 grains) per panicle were obtained in case of 7.5 cm depth at transplanting.

The number of grains panicle^{-1} was found to be drastically reduced in plants transplanted at soil surface and at 12 cm depth. This was probably due to translocation of more photosynthates to the non-bearing late tillers formed at both conditions (Karim, 1985). The number of filled grains per panicle is influenced significantly by the depth of planting. In a field experiment Karim (1985) observed that 5.0 cm planting depth produced the maximum number of grains per panicle which was identical to 2.5 cm planting depth whereas transplanting at 1.0 cm depth produced the minimum number of grains per panicle which was identical to 7.5 cm planting depth.

2.1.2 Yield parameters

Grain yield

A field experiment was conducted by Duraisamy *et al*. (2011) at wetland in Tamil Nadu Agricultural University to optimize the spacing and depth of transplanting in rice cultivation using a self-propelled rice transplanter (Yanmar 6 row). The treatment consisted of 4 levels of hill spacing in the main plot and depth of planting (manual: 2 cm and 4 cm depth) in the sub plot. Among the depth of planting, the highest grain yield (7,667 kg ha^{-1}) was produced in 4 cm depth. Patel *et al. (*1983) showed that the grain yield increased by transplanting 24 day old seedling to a depth 3.0 to 4.0 cm than transplanting of 36 or 45 day old seedlings at a depth of 3.0 to 4.0 cm or 5.0 to 7.0 cm. Sarker *et al.* (1986) repotted that by sing variety BAU-63 and BR3 in *Boro* rice reported that the depth of transplanting below 6 cm produced significantly lower grain yield. Karim (1985) found similar results that shallow planting produced lower gain yield than deeper planting.

In an experiment, BRRI (1979) used 2 age group of seedlings (20 and 30 day) of BR4 transplanted at various depths ranging from 0 to 8 cm and concluded that overall planting depths and grain yields were higher with 20 day old seedlings than that of 30 day of old seedlings. Grain yield did not differ widely between planting depths except in a few cases which could not be explained. The increased active vegetative growth period thereby increased leaf area index which are responsible to manufacture higher food through photosynthesis for the growth and development of plants reported by Azhiri *et al.,* (2005) and Hossain *et al.,* (2003). Significantly higher values of yield attributing characters under shallow depth of planting than deeper planting depth was viewed by Zhao *et al.,* (1999). Though 3.0 and 4.5 cm depth produced higher yield than 1.5, 6.0 or 7.5 cm depths of transplanting, they did not differ significantly (Nair *et al.*, 1978). Similarly Ahmed *et al.* (1972) got the higher yield for 4 seedlings $hill^{-1}$ than 1, 2 or 6 seedlings at a depth of 5.08 than 2.5 and 7.62 cm, respectively.

The grain yield was severely curtailed at the same conditions due to the production of fewer effective tillers with less number of grains panicle^{-1}. Besides, the reduction in grain yield due to deep transplanting of rice has been observed by various authors (Sarker *et al*., 1986). Kawasima and Tanabe (1970) observed shallow planting of 20 day old seedlings produced higher yield per hectare of rice than that of 40 day old seedlings with increasing the depth of transplanting. There is a seasonal variation in depth of transplanting like the number of seedlings hill^{-1}. Mahapatra and Padalia (1971) conducted separate experiments in two seasons and found that in Rabi season, 1.0 and 3.0 cm depth of transplanting produced higher grain yield than transplanting at 5.0 cm and 7.0 cm depth. But in *Kharif* season, 5.0 cm depth gave the highest yield compared to 1.0, 3.0 and 7.0 cm depths, respectively. The shallow depth of planting did not show significant effect on straw yield and harvest index (HI) during 2010 but during 2011 significantly higher straw yield was obtained under shallow depth of planting (9.61 t ha^{-1}) as compared to normal depth of planting (9.17 t ha^{-1}). The results are on line with those of Kumar *et al.* (2016) and Sarwar *et al.* (2014).

Rice MR-219 variety was markedly superior in various all yield attributing characters viz; effective tillers m^2, weight of panicle, grains panicle^{-1}, test weight, healthy grains panicle^{-1} more harvest index with wider spacing under shallow depth of planting. Dahal and Khadka (2012) also reported that the crop planted in the shallow depth produced significantly higher effective tiller per m^2 (328), higher 1000 grain weight (21.50 g) and grain yield (8.54mt ha^{-1}). The cumulative effects of superior growth and yield attributes were finally reflected in terms of higher grain yield. The increased active vegetative growth period thereby increased leaf area index which are responsible to manufacture higher food through photosynthesis for the growth and development of plants reported by Azhiri *et al.*, (2005) and Hossain *et al.*, (2003). Significantly higher values of yield attributing characters under shallow depth of planting than deeper planting depth was viewed by Zhao *et al.*, (1999).

In case of various depth of transplanting there is a significant difference in grain yield per hectare. Shallow transplanting permits greater advantages over deep transplanting in respect of grain yield. With the increase in depth of transplanting the root formation is delayed and at the same time plant growth is retarded and finally the gain yield is decreased when compared to shallow transplanting (Padalia and Mahapatra, 1965).

From the literature cited above it may be concluded that the yield and yield Components of rice vary with various depths of transplanting. Responses of rice to different depths of transplanting vary in different seasons of the year and rice cultivars response differently to different depths of transplanting. Variation in rice yield has also been found in different countries of the world due to different depths of transplanting. Therefore, the present research work has been planned and conducted to determine the influence of depth of transplanting on the growth and yield of rice under Bangladesh condition.

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out under field conditions during *Boro* season 2017-18 at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207.The details of the research work carried out, materials used and methodologies adopted in this research are described below:

3.1 Experimental site

The farm is geographically located at $23^0 77'$ N latitude and $90^0 35'$ E longitude at an altitude of 8.6 m above mean sea level under the Agro-ecological zone of Modhupur Tract, AEZ-28. Location of the experimental site is presented in Appendix I.

3.1.1 Weather during the crop growth period

The climate of the experimental site is subtropical. It receives rainfall mainly from South West monsoon (May-October) and winter season from November to February. The weather data during experimental period was collected from the Meteorological Station of Bangladesh, Sher-e Bangla Nagar, presented in Appendix II.

The maximum temperature during the crop growth period ranged from 15^0C to 35^0 C with an average of 28.5^0 C during 2018, while the minimum temperature 10^0 C to 24^0 C with an average 17.33^0 C. The mean relative humidity ranged from 57 percent to 74 percent. The total rainfall received during the crop growth period was 302 mm received in 27 rainy days.

3.1.2 Soil

The soil of the research field belongs to "The Modhupur Tract", AEZ – 28 is slightly acidic in reaction with low organic matter content. The experimental area was above flood level and sufficient sunshine with having available irrigation and drainage system during the experimental period. The experimental plot was high land having pH 5.6. The physical properties and nutritional status of soil of the experimental plot are given in Appendix III.

3.2 Plant materials and features

BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 were used as plant materials for the present study. These three varieties are recommended for *Boro* season. The features of these three varieties are presented below:

3.2.1 BRRI dhan45: BRRI dhan45 variety is grown in *Boro* season. This variety is recommended for cultivation in medium high land and medium low land. The life cycle of the variety is 140-145 days. It attains a plant height 95-100 cm. It gives an average yield of 6-6.5 t ha^{-1}.

3.2.2 BRRI dhan63: BRRI dhan63 is a good variety to cultivate in *Boro* season. Average plant height is 100-105 cm. Its life cycle about 148-150 days. The average yield is 6.5-7 t ha^{1}.

3.2.3 BRRI hybrid dhan3: BRRI hybrid dhan3 variety is grown in *Boro* season. This variety is recommended for cultivation in medium high land and medium low land. The cultivar matures at 145 days of planting. It attains a plant height 110 cm. Average yield of the variety is 9 t ha^{-1}.

3.3 Experimental details

3.3.1 Treatments:

Two sets of treatments included in the experiment were as follows:

Factor A: Variety

i. V_1 = BRRI hybrid dhan3

ii. V_2 = BRRI dhan45

iii.V_3= BRRI dhan63

Factor B: Transplanting depth

i. D_1: Transplanting at 2 cm depth ii. D_2: Transplanting at 4 cm depth

iii. D_3: Transplanting at 6 cm depth iv. D_4: Transplanting at 8 cm depth

3.3.2 Experimental design

The experiment was laid out in a split-plot design with three replications having variety in the main plots and methods of transplanting depths in the sub-plot. There were 12 treatment combinations. The total numbers of unit plots were 36.

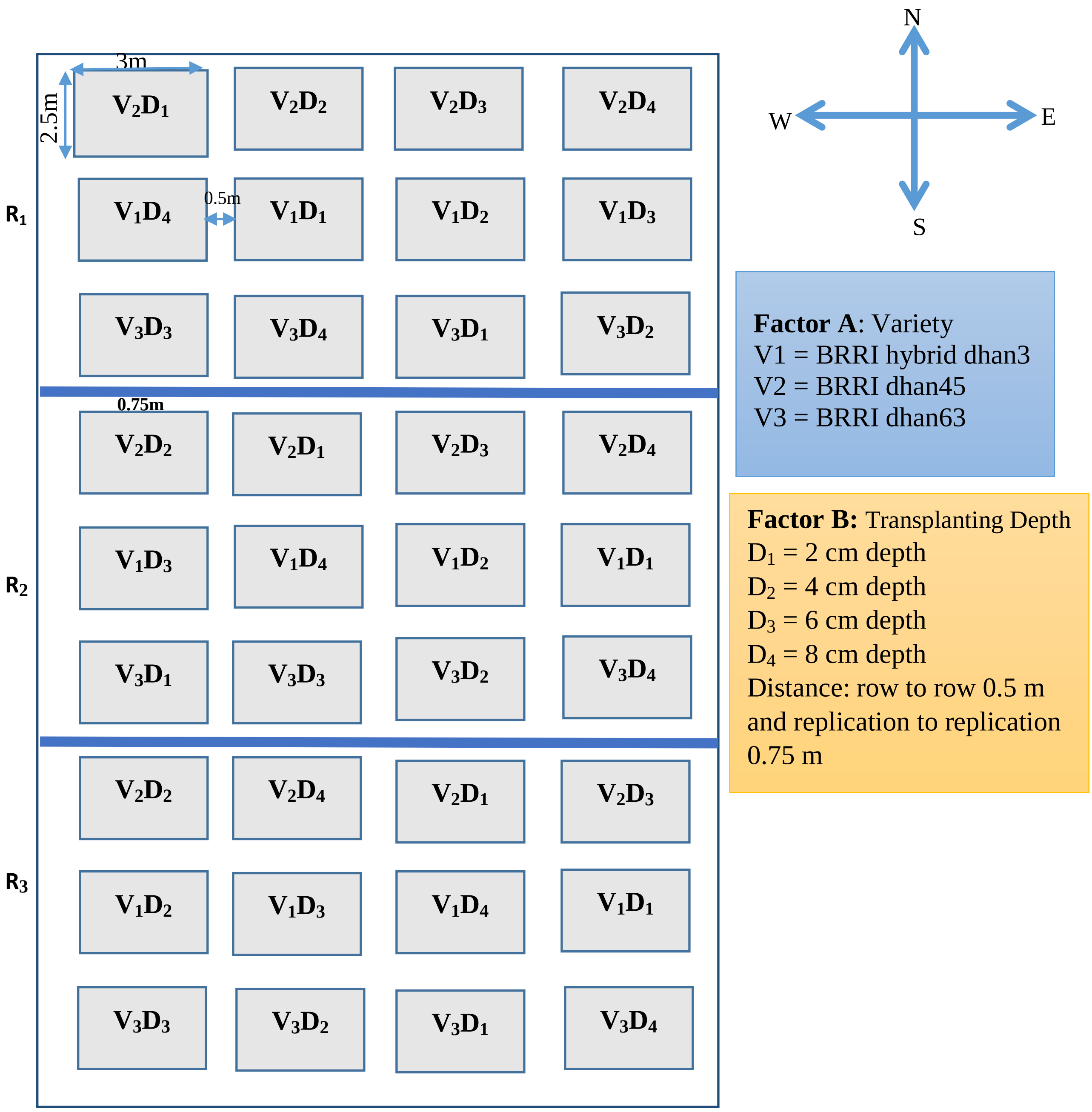


Fig.1: Layout of the experimental plot

3.4 CULTIVATION DETAILS

Details of cultivation practices are presented here under.

3.4.1 Growing of crops

3.4.2 Raising seedlings

3.4.3 Seed collection

The seeds of the test crop i.e. BRRI dhan45, BRRI dhan63 and BRRI hybrid dhan3 were collected from Bangladesh Rice Research Institute (BRRI), Joydevpur, Gazipur.

3.4.4 Seed sprouting

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

3.4.5 Nursery

The field selected for nursery was thoroughly ploughed. Seed rate was calculated based on test weight and germination percentage. Sprouted seed was sown uniformly in the nursery bed on 24-11-2017. All the three test varieties were sown in an area of 1 m^2 each on the same day i.e. 24-11-2017. Later, the seed was covered immediately and then a light irrigation was given. The nursery of $3m^2$ was fertilized with a basal dose of 65g urea, 95g of single super phosphate and 25g of muriate of potash as BRRI recommended dose. Weeding and plant protection measures were taken up as and when necessary. Top dressing of urea @ 25g m^{-2} was given 10 days after sowing.

3.4.6 Main field preparation

The experimental plot was ploughed twice with a tractor drawn rotavator to obtain the required puddle under 5 cm of standing water in the field. Prior to perform the layout of the plot it was leveled by a ladder. The layout of the plot is shown in Fig.1.

3.4.7 Manures

A well decomposed farmyard manure was applied at the time of final land preparation.

3.4.8 Fertilizer Application

A recommended dose of urea, TSP, MoP and gypsum @ 180 kg, 165 kg, 180 kg and 90 kg, respectively were applied for N, P_2O_5, K_2O and S. The one third amount of urea and entire amount of TSP, MoP and Gypsum were applied during the final preparation of land. Rest urea was applied in two equal installments at tillering and panicle initiation stage.

3.4.9 Transplanting

Seedlings of 40 day old were transplanted on the well puddled experimental plots on 2 January 2018 in the main field at the rate of 2 seedlings $hill^{-1}$ with 20 × 15 cm spacing. Planting depth was maintained by measuring scale as per treatments.

3.5 Intercultural operation

3.5.1 Gap Filling

Some seedlings from the nursery were transplanted alongside of the irrigation channels at the time of transplanting for the purpose of gap filling. Gap filling was done at the tenth day by using seedlings planted alongside the channels which were also lifted along with the intact soil in order to maintain uniform population.

3.5.2 Irrigation

A thin film of water was maintained at the time of transplanting for better establishment of the seedlings. From the third day onwards, 2 to 3 cm depth of water was maintained up to the panicle initiation stage except at the time of top dressing of nitrogen, where the water was drained out and re-flooded after 48 hours to maintain 5 cm depth of water up to physiological maturity. After dough stage, water was gradually drained out to facilitate easy harvesting of the crop.

3.5.3 Weeding

Weeds were removed from the plots manually from four weeks after transplanting and the plots were kept weed free as and when necessary. Second weeding was taken up at 40-45 DAT.

3.5.4 Plant Protection

No major incidence of pests and diseases were observed except minor incidence of leaf folder, observed at 40 days after planting, which was controlled by spraying Chlorpyriphos @ 3 ml L^{-1} of water.

3.5.5 Harvesting and Threshing

The crop harvested from $1m^2$ each treatment was bundled separately and sun dried and later threshed individually plot-wise by manual labour. Before harvesting net plots, the plants selected for recording data for yield component were harvested separately. Threshing was done by manual labour and the grain was cleaned and sun dried. Grain and straw yields were recorded plot wise after drying to constant weight. The grain weights from sample plants were also added to the net plot yields.

3.6 SAMPLING

3.6.1 Destructive Sampling

For destructive sampling, five random hills were sampled at each time from the second row from the border on each side to record dry matter production. The destructive samples taken were shade dried and then oven dried at 72^0C for 72 hours till a constant weight was obtained. Sampling was done at 30, 50, 80 DAT and at harvest to study the dry matter production.

3.6.2 Non-destructive Sampling

For non-destructive sampling, 5 representative hills were selected randomly and tagged in each plot second rows opposite from destructive sample from each side of the plot.

3.7 Data recording

The following data were collected during the study period:

A. Crop growth characters

i. Plant height (cm) at 30, 50, 80 DAT and harvest

ii. Leaf area (cm^2) at 30, 50, 80 DAT and harvest

The leaf area was calculated using the following factor.

Leaf area = Leaf length × Leaf breath × 0.75 (here, 0.75 = Correction factor)

iii. Number of tillers $hill^{-1}$ at 30, 50, 80 DAT and harvest

iv. Dry weight $hill^{-1}$ of plant at 30, 50, 80 DAT and harvest

B. Yield and other crop characters

i. Number of effective tillers $hill^{-1}$

ii. Number of noneffective tillers $hill^{-1}$

iii. Length of panicle (cm)

iv. Number of filled grains $panicle^{-1}$

v. Number of unfilled grains $panicle^{-1}$

vi. Weight of 1000 grains (g)

vii. Grain yield (t ha^{-1})

viii. Straw yield (t ha^{-1})

ix. Biological yield (t ha^{-1})

x. Harvest index (%)

3.7.1 Pre-harvest data recording

3.7.1.1 Plant height (cm)

Plant height was recorded for the five randomly tagged hills in each treatment in all the three replications. Plant height was measured from the base of the plant to tip of the top most leaf of every labeled hill at each sampling at 30, 50, 80 days after transplanting and at harvest. The plant height was expressed in centimeters (cm).

3.7.1.2 Number of tillers hill^{-1}.

Total number of tillers hill^{-1} from the labeled plants at 30, 50, 80 DAT and at harvest was counted and expressed as total number of tillers hill^{-1}.

3.7.1.3 Number of effective tillers hill^{-1}.

Number of panicle bearing tillers from the labeled plants at harvest were counted and expressed as effective tillers hill^{-1}.

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

Number of without panicle bearing tillers from the labeled plants at harvest were counted and expressed as non-effective tillers hill^{-1}.

3.7.1.5 Dry matter accumulation hill^{-1}.

Three successive hills were sampled, as mentioned earlier, at 30, 50, 80 DAT and at harvest. The samples were dried in shade first and then dried in hot-air oven at 72^{0}C for 72 hours till to attain constant weight. Sample dry weights were summed up to arrive at mean dry matter hill^{-1} in individual treatment. The mean dry weight was expressed in g hill^{-1}.

3.7.2 Post–harvest observation

3.7.2.1 Panicle length (cm)

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

3.7.2.2 Filled grains panicle^{-1} (no.)

Grain was considered to be filled if any kernel was present there in. The number of total filled grains present total panicles of two hill were recorded and finally averaged.

3.7.2.3 Unfilled grains panicle^{-1} (no.)

Unfilled grains means the absence of any kernel inside in and such grains total panicles of two hill were counted and finally averaged.

3.7.2.4 1000 seed weight (g)

One thousand grains were counted from harvested grains of sampled plants and recorded the weight accordingly and expressed as 1000 seed weight (g).

3.7.2.5 Grains yield (t ha^{-1})

The crop harvested from 1m^2 each treatment was bundled separately and sun dried and later threshed individually plot-wise by manual labour. Cleaning of the grain was done after threshing followed by sun drying to a constant weight to record the final yield. Expressing the final grain yield in t ha^{-1}.

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

Straw from 1m^2 each of each plot was dried in sun to a constant weight. Straw yield finally express as t ha^{-1}.

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

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

Biological yield (t ha^{-1}) = Grain yield (t ha^{-1}) + Straw yield (t ha^{-1})

3.7.2.8 Harvest index (%)

Harvest index is the ratio of grain yield to the total biological yield (grain + straw) and expressed in percent. It was calculated using the formula given hereunder as suggested by Yoshida (1981).

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (t ha}^{-1}\text{)}}{\text{Biological yield (t ha}^{-1}\text{)}} \times 100$$

3.8 STATISTICAL ANALYSIS

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program MSTAT-C and the mean differences were adjusted by Least Significance Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

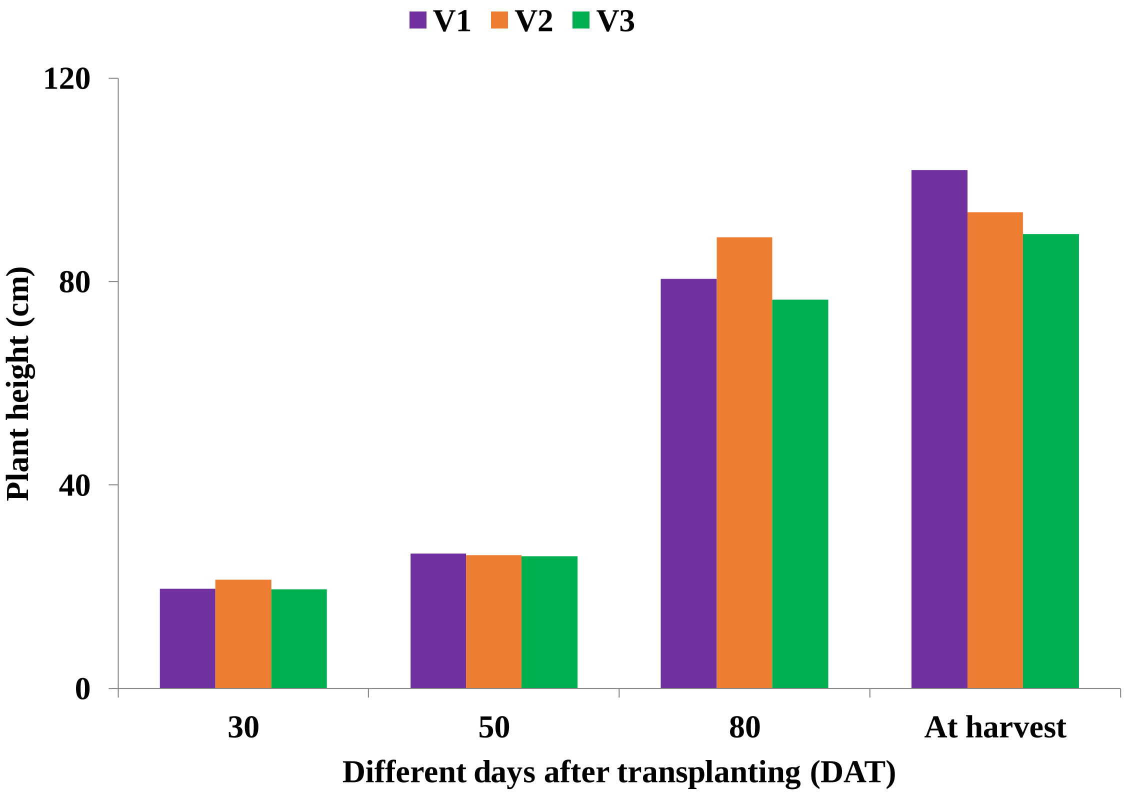
RESULTS AND DISCUSSION

The experimental results have been presented and possible interpretations given under the following headings:

4.1 Plant height (cm)

4.1.1 Effect of variety

A significant variation on plant height was observed among varieties BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix V and Fig. 2). At 30 DAT, the longest plant (21.30 cm) was observed in V_2 (BRRI dhan45) which was statistically similar (19.54 cm) with V_1 (BRRI hybrid dhan3) and the shortest plant (19.46 cm) was recorded in V_3 (BRRI dhan63). The longest plant (26.48 cm) was found in V_1 which was statistically similar (26.20 cm) with V_2 while the shortest plant was obtained in V_3 (25.92 cm) at 50 DAT. At 80 DAT, the longest plant was found in V_2 (88.69 cm) which was statistically similar with V_1 (80.50 cm), whereas the shortest plant was recorded in V_3 (76.43 cm). At harvest, the longest plant was recorded in V_1 (101.90 cm) which was closely followed by V_2 (93.64 cm). On the other hand, the shortest plant was obtained in V_3 (89.36 cm).

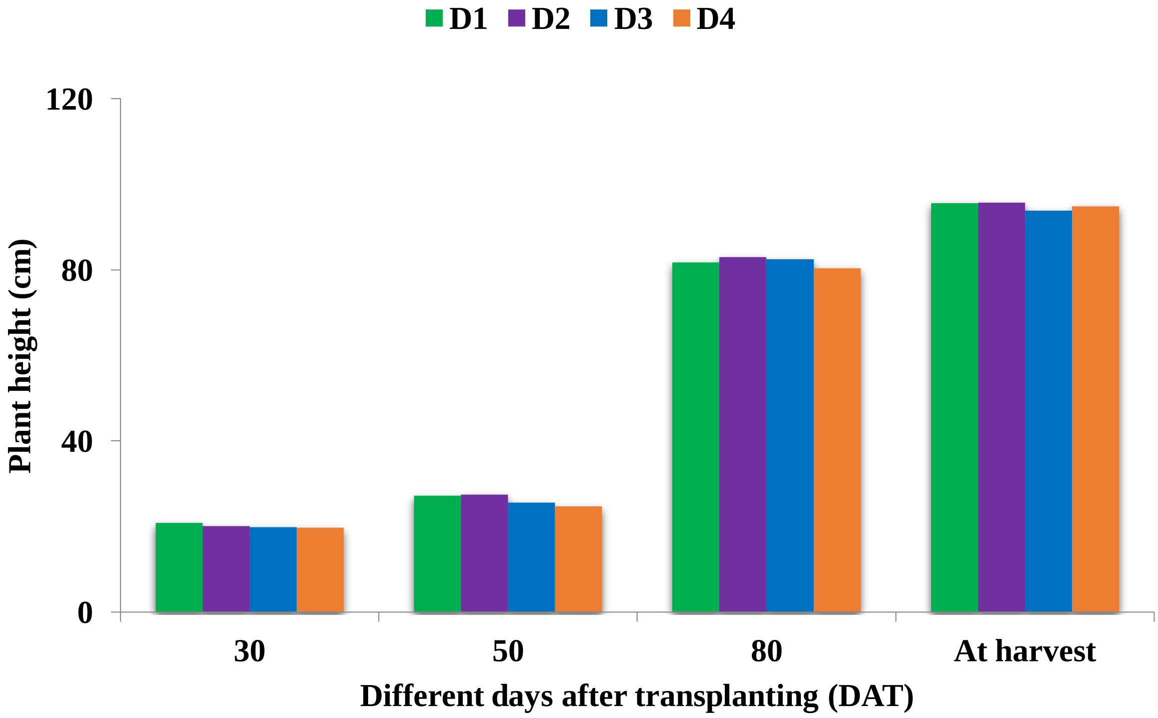


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 2. Effect of variety on the plant height of rice at different days after transplanting (LSD $_{0.05}$ = 1.90, 2.96, 13.13, 13.73 at 30, 50, 80 DAT and harvest, respectively)

4.1.2 Effect of transplanting depth

Different transplanting depth showed statistically significant differences for Plant height of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix V and Fig.3). At 30 DAT, the longest plant (20.85 cm) was recorded in D_1 (transplanting at 2 cm depth) which was statistically similar (20.08 cm) with D_2 (transplanting at 4 cm depth) and followed (19.76 cm) by D_3 (transplanting at 6 cm depth), while the shortest plant (19.72 cm) was observed in D_4 (transplanting at 8 cm depth). The longest plant (27.43 cm) was found in D_2 which was statistically similar (27.18 cm) with D_1 and followed (25.57 cm) by D_3, while the shortest plant was obtained in D_4 (24.36 cm) at 50 DAT. At 80 DAT, the longest plant was found in D_2 (82.96 cm) which was statistically similar with D_3 (82.41 cm) and followed by D_1 (81.77 cm), whereas the shortest plant was recorded in D_4 (80.35 cm). At harvest, the longest plant was recorded in D_2 (95.66 cm) which was closely followed by D_1 (95.52 cm) and D_4 (94.85 cm). On the other hand, the shortest plant was obtained in D_3 (93.78 cm).



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 3. Effect of transplanting depth on the plant height of rice at different days after transplanting (LSD $_{0.05}$ = 1.29, 1.65, 2.96, 3.72 at 30, 50, 80 DAT and harvest, respectively)

4.1.3 Interaction effect of variety and transplanting depth

Interaction effect of variety and transplanting depth showed significant differences for plant height of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix V and Table 1). At 30 DAT, the longest plant (22.86 cm) was found in the treatment combination of V_3D_1 (BRRI dhan63 × transplanting at 2 cm depth) and the shortest plant height (18.20 cm) was observed in the treatment combination of V_1D_1 (BRRI hybrid dhan3× transplanting at 2 cm depth). The longest plant (29.14 cm) was recorded in the treatment combination of V_3D_1, while the shortest (23.41 cm) was found in the treatment combination of V_3D_4 at 50 DAT. At 80 DAT, the longest plant (91.20 cm) was obtained in the treatment combination of V_2D_2 and the shortest plant (73.00 cm) was recorded in the treatment combination of V_3D_4. At harvest, the longest plant (102.9 cm) was obtained in the treatment combination of V_1D_1 whereas the shortest (87.55 cm) was recorded in the treatment combination of $V_3D_{1.}$

Table1. Interaction effect of variety and transplanting depths on plant height (cm) of rice

Treatment combinations	Plant height (cm) at different days after transplanting (DAT)			
	30	50	80	At harvest
V_1D_1	18.20 d	25.72 b-d	79.86 b	102.9 a
V_1D_2	20.34 b-d	28.53 ab	81.05 b	101.6 ab
V_1D_3	19.15 cd	25.45 cd	79.82 b	101.3 ab
V_1D_4	20.49 bc	26.22 b-d	81.26 b	101.7 ab
V_2D_1	21.47 ab	26.67 a-c	87.82 a	96.11 bc
V_2D_2	21.66 ab	28.51 ab	91.20 a	93.54 cd
V_2D_3	21.77 ab	25.38 cd	88.96 a	91.33 cd
V_2D_4	20.27 b-d	24.26 cd	86.79 a	93.55 cd
V_3D_1	22.86 a	29.14 a	77.64 bc	87.55 d
V_3D_2	18.25 cd	25.25 cd	76.62 bc	91.88 cd
V_3D_3	18.35 cd	25.89 b-d	78.46 b	88.67 d
V_3D_4	18.39 cd	23.41 d	73.00 c	89.34 d
LSD(0.05)	**2.245**	**2.852**	**5.132**	**6.44**
CV (%)	**6.51**	**6.34**	**3.65**	**3.95**

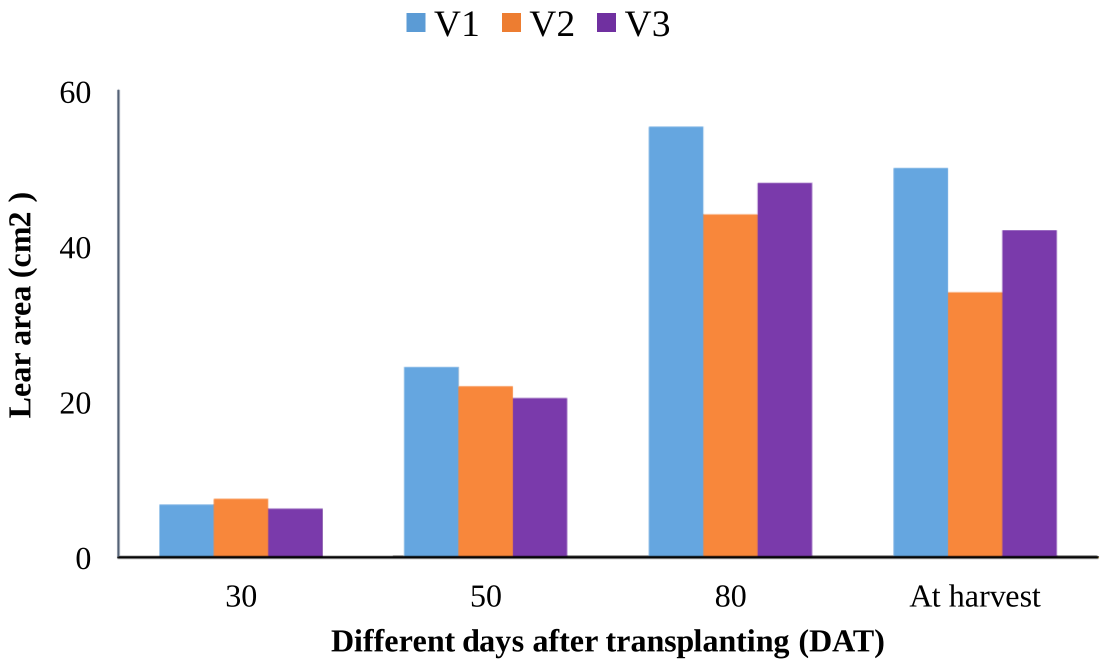
In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63; D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth, D_4: Transplanting at 8 cm depth.

4.2 Leaf area (cm^2)

4.2.1 Effect of variety

A significant variation on leaf area was observed among varieties BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix VI and Fig.4). At 30 DAT, the maximum leaf area (7.50 cm^2) was observed in V_2 (BRRI dhan45) which was statistically similar (6.78 cm^2) with V_1 (BRRI hybrid dhan3) and where the minimum leaf are (6.24 cm^2) was recorded in V_3 (BRRI dhan63). The maximum leaf area (24.46 cm^2) was found in V_1 while the minimum leaf area was obtained in V_3 (20.46 cm^2) which was statistically similar (21.98 cm^2) with V_2 at 50 DAT. At 80 DAT, the maximum leaf area was found in V_1 (55.39 cm^2), whereas the minimum leaf area was recorded in V_2 (44.09 cm^2) which was statistically similar with V_3 (48.13 cm^2). At harvest, the maximum leaf area recorded in V_1 (50.07 cm^2). On the other hand, the minimum leaf area was obtained in V_2 (34.06 cm^2) which was followed by V_3 (42.04 cm^2).

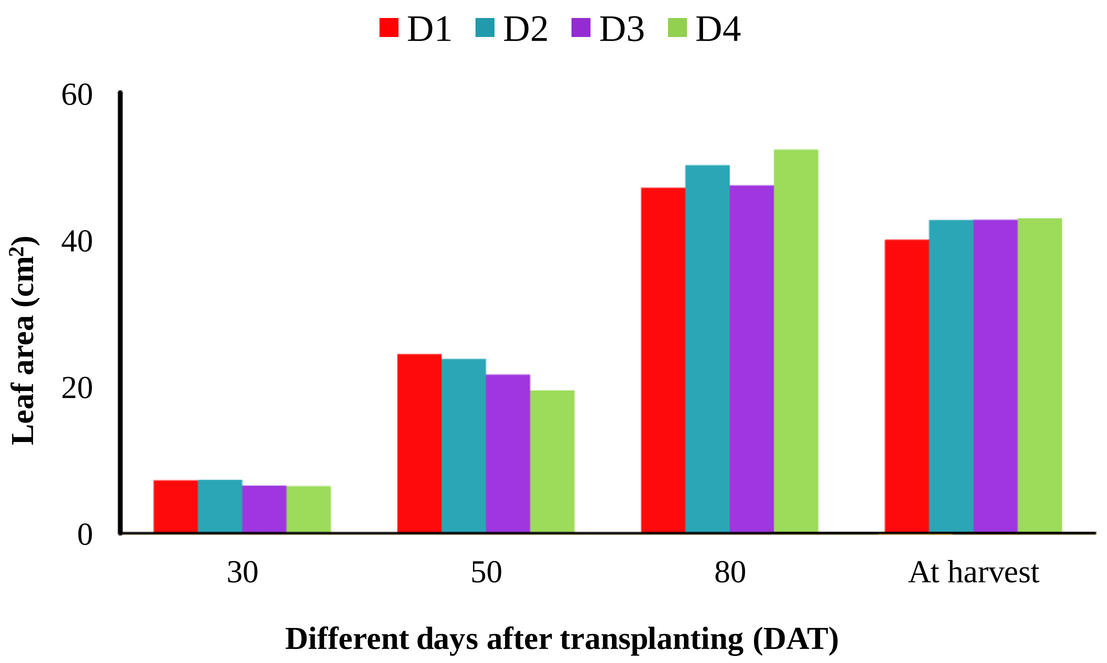


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 4. Effect of variety on leaf area of rice at different days after transplanting (LSD $_{0.05}$ = 1.58, 3.26, 7.22, 8.17 at 30, 50, 80 DAT and harvest, respectively

4.2.2 Effect of transplanting depth

Different transplanting depth showed statistically significant differences for Leaf area of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix VI and Fig.5). At 30 DAT, the maximum leaf area (7.26 cm^2) was recorded in D_2 (transplanting at 4 cm depth) which was statistically similar (7.20 cm^2) with D_1 (transplanting at 2 cm depth), while the minimum leaf area (6.42 cm^2) was observed in D_4 (transplanting at 8 cm depth) and followed (6.47 cm^2) by D_3 (transplanting at 6 cm depth). The maximum leaf area (24.40 cm^2) was found in D_1 which was statistically similar (23.72 cm^2) with D_2 and followed (21.62 cm^2) by D_3, while the minimum leaf area was obtained in D_4 (19.46 cm^2) at 50 DAT. At 80 DAT, the maximum leaf area was found in D_4 (52.25 cm^2) which was statistically similar with D_2 (50.14 cm^2) and followed by D_3 (47.37 cm^2), whereas the minimum leaf area was recorded in D_1 (47.05 cm^2). At harvest, the maximum leaf area was recorded in D_4 (42.88 cm^2) which was closely followed by D_3 (42.71 cm^2) and D_2 (42.65 cm^2). On the other hand, the minimum leaf area was obtained in D_1 (39.98 cm^2).



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 5. Effect of transplanting depth on leaf area of rice at different days after transplanting (LSD $_{0.05}$ = 0.71, 2.72, 5.57, 4.88 at 30, 50, 80 DAT and harvest, respectively)

4.2.3 Interaction effect of variety and transplanting depth

Interaction effect of variety and transplanting depth showed significant differences for plant height of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix VI and Table 2). At 30 DAT, the maximum leaf area (8.70 cm^2) was found in the treatment combination of V_2D_2 (BRRI dhan45 × transplanting at 4 cm depth) and the minimum leaf area (4.96 cm^2) was observed in the treatment combination of V_3D_4 (BRRI dhan63× transplanting at 6 cm depth). The maximum leaf area (26.41 cm^2) was recorded in the treatment combination of V_1D_2, while the minimum leaf area (15.82 cm^2) was found in the treatment combination of V_3D_4 at 50 DAT. At 80 DAT, the maximum leaf area (63.64 cm^2) was obtained in the treatment combination of V_1D_4 and the minimum leaf area (42.83 cm^2) was recorded in the treatment combination of V_2D_4. At harvest, the maximum leaf area (54.12 cm^2) was obtained in the treatment combination of V_1D_4 whereas the minimum leaf area (31.69 cm^2) was recorded in the treatment combination of $V_2D_{2.}$

Table2. Interaction effect of variety and transplanting depths on leaf area (cm^2) of rice

Treatment combinations	Leaf area (cm) at different days after transplanting (DAT)			
	30	**50**	**80**	**At harvest**
V_1D_1	6.33 de	25.61 ab	50.41 bc	45.87 ab
V_1D_2	7.57 a-c	26.41 a	58.42 ab	53.74 a
V_1D_3	5.99 d-f	23.81 a-c	49.08 bc	46.55 ab
V_1D_4	7.19 b-d	22.00 a-c	63.64 a	54.12 a
V_2D_1	7.21 b-d	21.93 a-c	44.76 c	32.60 e
V_2D_2	8.70 a	24.45 a-c	44.10 c	31.69 e
V_2D_3	6.97 b-d	20.98 bc	44.65 c	37.16 c-e
V_2D_4	7.12 b-d	20.55 c	42.83 c	34.77 de
V_3D_1	8.05 ab	25.67 ab	45.99 c	41.47 b-d
V_3D_2	5.52 ef	20.31 cd	47.90 c	42.52 b-d
V_3D_3	6.46 c-e	20.05 cd	48.38 c	44.43 bc
V_3D_4	4.96 f	15.82 d	50.26 bc	39.75 b-e
LSD(0.05)	**1.225**	**4.713**	**9.647**	**8.448**
CV (%)	**10.45**	**12.32**	**11.43**	**11.71**

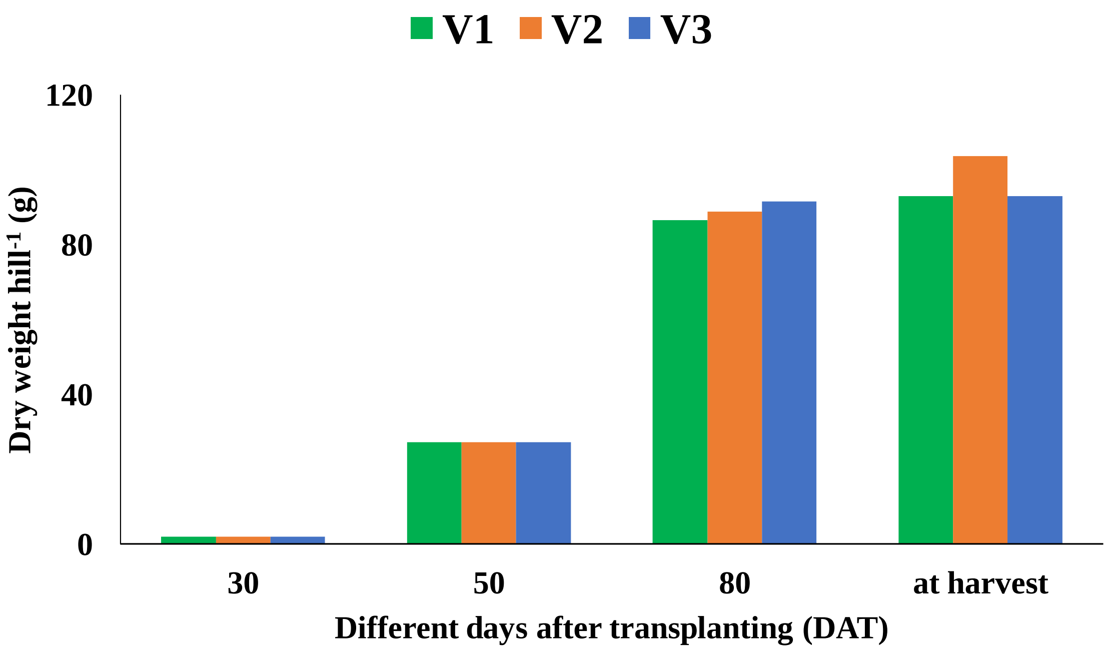
In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63; D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth, D_4: Transplanting at 8 cm depth.

4.3 Dry weight hill^{-1}

4.3.1 Effect of variety

Different variety showed significant differences in dry matter hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix VII and Fig.6). At 30 DAT, the highest dry matter hill^{-1} (1.97 g) was produced in V_3 (BRRI dhan63) which was statistically similar (1.96 g) with V_1 (BRRI hybrid dhan3) and again the lowest (1.93 g) was recorded in V_2 (BRRI dhan45). The highest dry matter hill^{-1} (27.26 g) was found in V_2 which was closely followed (27.25 g) by V_1, while the lowest (27.18 g) was recorded in V_3 at 50 DAT. At 80 DAT, the highest dry matter hill^{-1} (91.54 g) was found in V_3, whereas the lowest (86.53 g) was recorded in V_1 which was followed (88.76 g) by V_2. At harvest, the highest dry matter hill^{-1} (103.7 g) was observed in V_2, whereas the lowest (92.90 g) was recorded in V_1 which was statistically similar (92.92 g) with V_3.

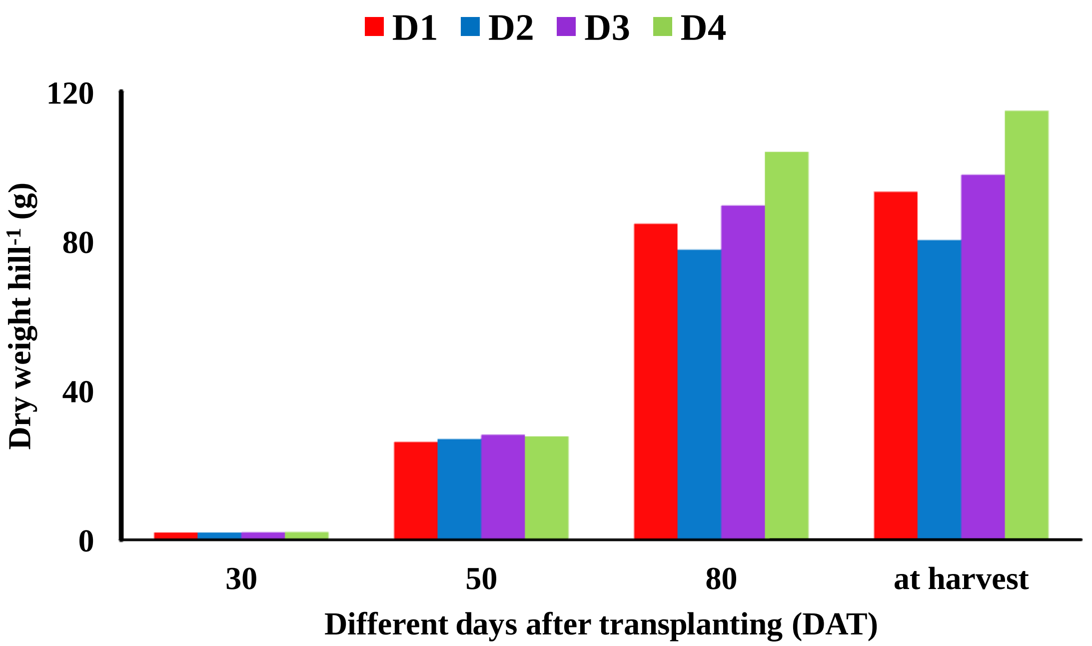


V_1 = BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 6. Effect of variety on dry weight hill^{-1}of rice at different days after transplanting (LSD $_{0.05}$ = 0.22, 3.23, 6.99, 13.2 at 30, 50, 80 DAT and harvest, respectively)

4.3.2 Effect of transplanting depth

Different transplanting depths showed statistically significant differences for dry matter hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix VII and Fig. 7). At 30 DAT, the highest dry matter hill^{-1} (2.04 g) was recorded in D_4 (transplanting at 4 cm depth) which was closely followed (1.97 g) by D_3 (transplanting at 6 cm depth), whereas the lowest dry matter (1.88 g) was observed in D_2 (transplanting at 4 cm depth) which was closely followed (1.93 g) by D_1 (transplanting at 2 cm depth). The highest dry matter hill^{-1} (28.11 g) was found in D_3 which was closely followed (27.69 g) with D_4, while the lowest (26.20 g) was recorded in D_1 which was followed (26.93 g) by D_2 at 50 DAT. At 80 DAT, the highest dry matter hill^{-1} (103.9 g) was found in D_4, whereas the minimum dry matter hill^{-1} (89.54 g) was recorded by D_3, again the lowest (77.67 g) was observed in D_2 which was closely followed (84.66 g) by D_1. At harvest, the highest dry matter hill^{-1} (114.9 g) was found in $D_{4,}$ whereas (97.77 g) was recorded by D_3, while the lowest (80.25 g) was obtained in D_2 which was followed (93.18 g) by D_1.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 7. Effect of transplanting depth on dry weight hill^{-1}of rice at different days after transplanting (LSD $_{0.05}$ = 0.22, 2.59, 7.34, 13.86 at 30, 50, 80 DAT and harvest, respectively)

4.3.3 Interaction effect of variety and transplanting depth

Transplanting depth and variety showed significant differences due to interaction in terms of dry matter hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix VII and Table 3). At 30 DAT, the highest dry matter hill^{-1} (2.13 g) was obtained in the treatment combination of V_3D_4 (BRRI dhan63 × transplanting at 8 cm depth), while the lowest (1.81 g) was found in the treatment combination of V_3D_2 (BRRI dhan63 × transplanting at 4 cm depth). The highest dry matter hill^{-1} (29.47 g) was recorded in the treatment combination of V_1D_4, whereas the lowest (23.64 g) was observed in the treatment combination of V_1D_1 at 50 DAT. At 80 DAT, the highest dry matter hill^{-1} (105.1 g) was obtained in the treatment combination of V_3D_4 and the lowest (72.77 g) was found in the treatment combination of V_2D_2. At harvest, the highest dry matter hill^{-1} (128.8 g) was recorded in the treatment combination of V_2D_4, again the lowest (77.09 g) was observed in the treatment combination of V_1D_2.

Table 3. Interaction effect of variety and transplanting depths on dry matter hill^{-1} of rice

Treatment combinations	Dry weight hill^{-1} (g) at different days after transplanting (DAT)			
	30	**50**	**80**	**At harvest**
V_1D_1	1.93 a	23.64 b	81.91 b-d	100.4 b-d
V_1D_2	1.89 a	26.54 ab	78.29 cd	77.09 d
V_1D_3	1.94 a	29.37 a	81.71 b-d	85.53 cd
V_1D_4	2.10 a	29.47 a	104.2 a	108.5 a-c
V_2D_1	1.89 a	28.33 a	85.92 bc	90.89 b-d
V_2D_2	1.95 a	27.10 ab	72.77 d	82.74 d
V_2D_3	2.00 a	27.57 ab	93.93 ab	112.4 ab
V_2D_4	1.89 a	26.05 ab	102.4 a	128.8 a
V_3D_1	1.97 a	26.62 ab	86.17 bc	88.22 cd
V_3D_2	1.81 a	27.15 ab	81.94 b-d	80.92 d
V_3D_3	1.96 a	27.38 ab	92.97 ab	95.34 b-d
V_3D_4	2.13 a	27.56 ab	105.1 a	107.2 a-c
LSD(0.05)	**0.3758**	**4.495**	**12.77**	**24**
CV (%)	**11.17**	**9.62**	**8.37**	**14.5**

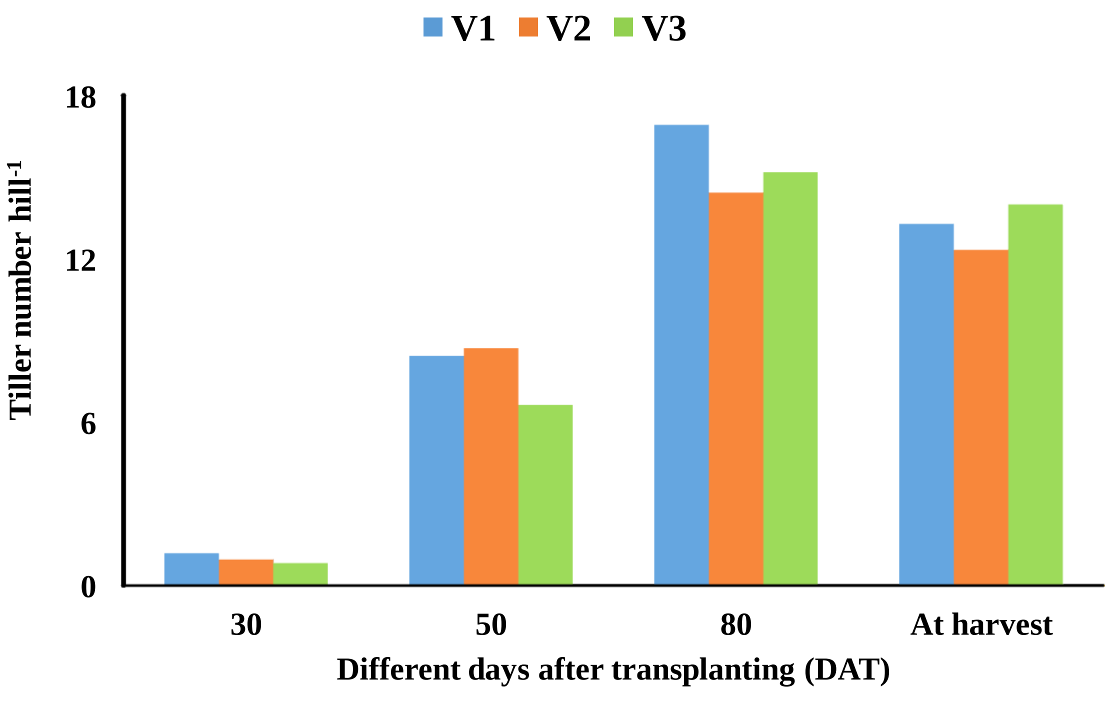
In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63; D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth, D_4: Transplanting at 8 cm depth.

4.4 Number of tillers hill^{-1}

4.4.1 Effect of variety

A significant variation in number of tillers hill^{-1} was observed among variety of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest (Appendix VIII and Figure 8). At 30 DAT, the highest number of tillers hill^{-1} (1.18) was found in V_1 (BRRI hybrid dhan3) which was followed (0.95) with V_2 (BRRI dhan45), while the lowest number (0.82) was obtained in V_3 (BRRI dhan63). The highest number of tillers hill^{-1} (8.71) was found in V_2 which was closely followed by V_1 (8.43), whereas the lowest number (6.63) was found in V_3 at 50 DAT. At 80 DAT, the highest number of tillers hill^{-1} (16.92) was recorded in V_1 which was closely followed (15.18) by V_3 and the lowest number (14.43) was observed in V_2. At harvest, highest number of tillers hill^{-1} (14.00) was recorded in V_3 which was closely followed by V_1 (13.28), whereas the lowest number (12.33) was found in V_2.

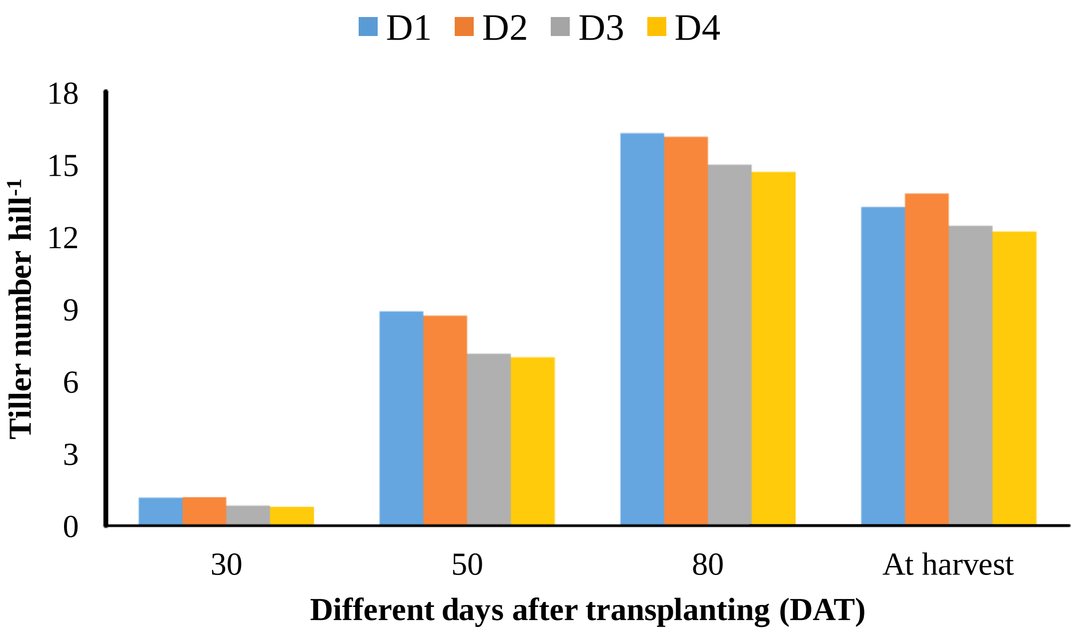


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 8. Effect of variety on number of tiller hill^{-1} of rice at different days after transplanting (LSD $_{0.05}$ = 0.09, 0.87, 3.57, 1.74 at 30, 50, 80 DAT and harvest, respectively)

4.4.2 Effect of transplanting depth

Statistically significant variation was also found for the number of tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest due to the different transplanting depth (Appendix VIII and Figure 9). At 30 DAT, the highest number of tillers hill^{-1} (1.18) was found in D_2 (transplanting at 4 cm depth) which was closely followed (1.16) with D_1 (transplanting at 2 cm depth), while the lowest number (0.78) was obtained in D_4 (transplanting at 8 cm depth) and followed (0.82) by D_3 (transplanting at 6 cm depth). The highest number of tillers hill^{-1} (8.89) was found in D_1 which was closely followed by D_2 (8.71), whereas the lowest number (6.98) found in D_4 which was closely followed (7.13) by D_3 at 50 DAT. At 80 DAT, the highest number of tillers hill^{-1} (16.28) was recorded in D_1 which was closely followed (16.13) by D_2 and the lowest number (14.67) was observed in D_4 which was closely followed (14.97) by D_3. At harvest, highest number of tillers hill^{-1} (13.78) was recorded in D_2 which was closely followed (13.22) by D_1 and the lowest number (12.20) was observed in D_4 which was closely followed (12.44) by D_3.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 9. Effect of transplanting depth on tiller number hill^{-1} of rice at different days after transplanting (LSD $_{0.05}$ = 0.07, 0.78, 1.46, 1.41 at 30, 50, 80 DAT and harvest, respectively)

4.4.3 Interaction effect of variety and transplanting depth

Significant variation was observed for the number of tillers hill^{-1}of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 at 30, 50, 80 DAT and at harvest due to interaction effect of variety and transplanting depth (Appendix VIII and Table 4). At 30 DAT, the highest number of tillers hill^{-1} (1.73) was recorded in the treatment combination of V_1D_2 (BRRI hybrid dhan3× transplanting at 4 cm depth), while the lowest number (0.53) was obtained in the treatment combination of V_2D_4 (BRRI dhan45× transplanting at 8 cm depth). The highest number of tillers hill^{-1} (9.80) was found in the treatment combination of V_2D_2 and the lowest number (6.53) was found in the treatment combination of V_3D_3 at 50 DAT. The highest number of tillers hill^{-1} (15.93) was obtained in the treatment combination of V_1D_1, whereas the lowest number (10.07) was recorded in the treatment combination of V_3D_4 at 80 DAT. At harvest, the highest number of tillers hill^{-1} (15.89) was observed in the treatment combination of V_3D_2 whereas the lowest number (11.00) was found in the treatment combination of V_2D_2.

Table 4. Interaction effect of variety and transplanting depths on number of tillers hill^{-1} of rice

Treatment combinations	Tiller number hill^{-1} at different days after transplanting (DAT)			
	30	50	80	At harvest
V_1D_1	1.20 c	9.67 a	17.76 a	13.44 a-d
V_1D_2	1.73 a	9.80 a	17.29 a	13.22 b-d
V_1D_3	0.80 e	7.07 c-e	16.60 a-c	11.89 cd
V_1D_4	1.00 d	7.20 cd	16.03 a-d	14.56 ab
V_2D_1	1.40 b	9.27 ab	16.99 ab	13.33 b-d
V_2D_2	1.20 c	9.80 a	14.53 b-e	11.00 d
V_2D_3	0.67 f	7.80 cd	13.78 de	12.55 b-d
V_2D_4	0.53 g	8.00 bc	12.43 e	12.44 b-d
V_3D_1	0.87 e	7.73 cd	14.10 c-e	12.89 b-d
V_3D_2	0.60 fg	6.53 de	16.55 a-c	15.89 a
V_3D_3	1.00 d	6.53 de	14.54 b-e	12.89 b-d
V_3D_4	0.80 e	5.73 e	15.53 a-d	14.33 a-c
LSD(0.05)	**0.1213**	**1.351**	**2.523**	**2.447**
CV (%)	**7.02**	**9.93**	**9.48**	**10.8**

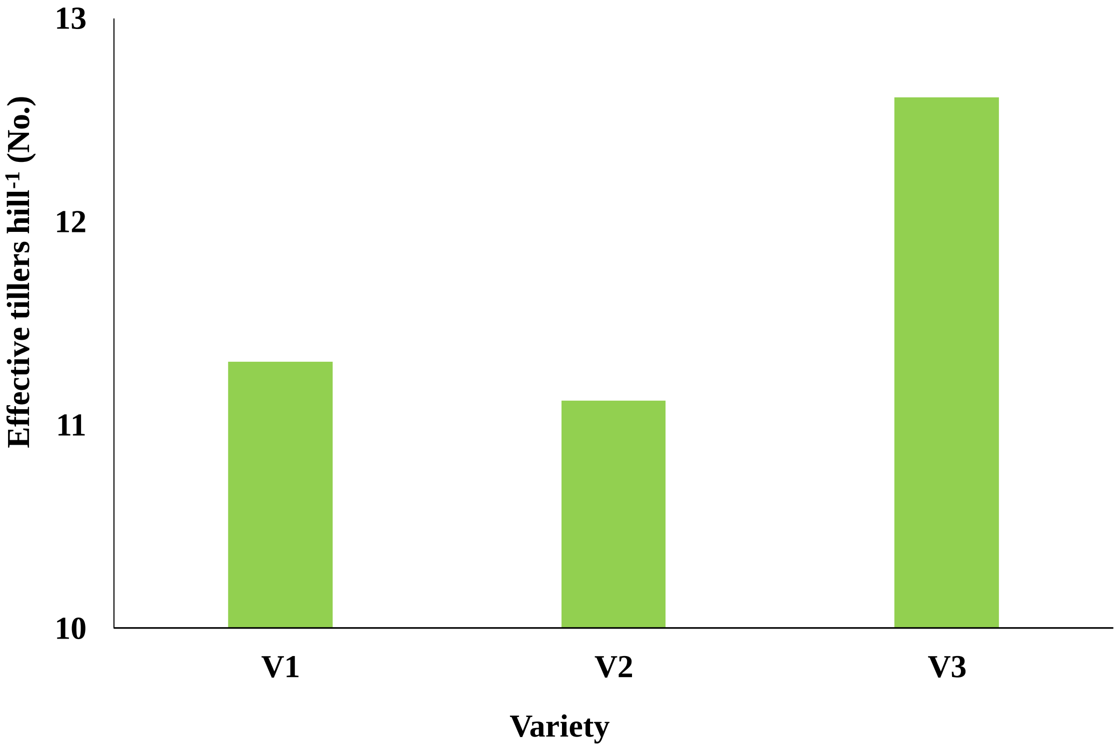
In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63; D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth, D_4: Transplanting at 8 cm depth.

4.5 Number of effective tillers hill^{-1}

4.5.1 Effect of variety

Number of effective tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 showed significant differences for different variety (Appendix IX and Figure 10). The maximum number of effective tillers hill^{-1} (12.61) was found in V_3 (BRRI dhan63) which was closely followed (11.61) by V_1 (BRRI hybrid dhan3), whereas the minimum number (11.12) was obtained in V_2 (BRRI dhan45) treatment.

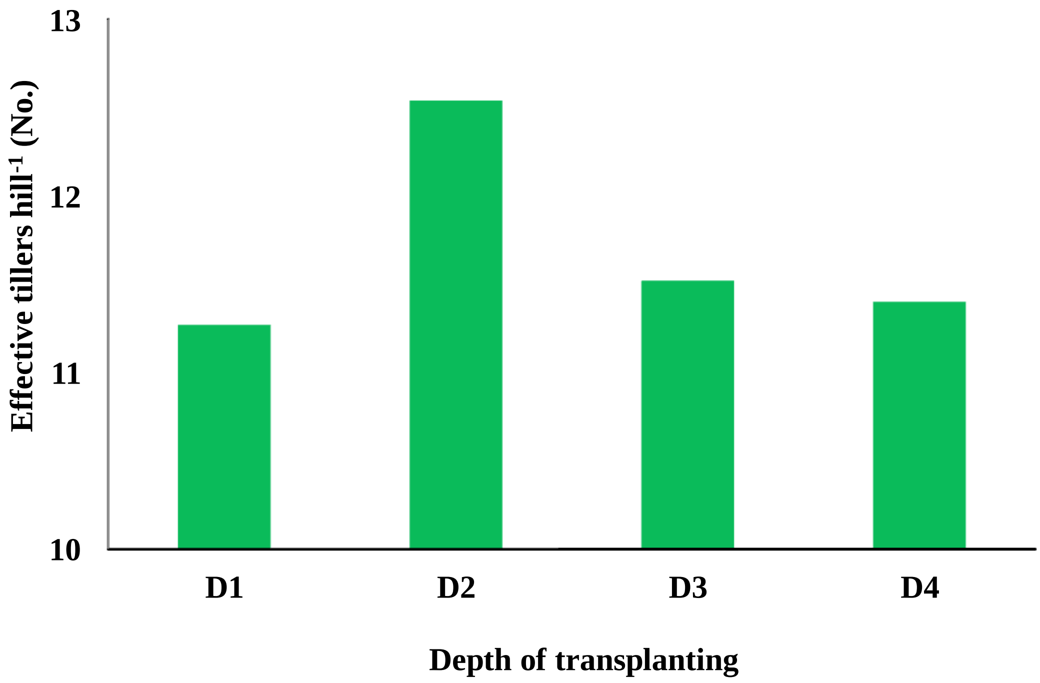


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure10. Effect of variety on effective tiller hill^{-1} at harvest of rice (LSD $_{0.05}$ = 1.43 at harvest)

4.5.2 Effect of transplanting depth

Number of effective tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 varied significantly due to the different transplanting depths (Appendix IX and Figure 11). The maximum number of effective tillers hill^{-1} (12.54) was observed in D_2 (transplanting at 4 cm depth) which was similar (11.52) with D_3 (transplanting at 6 cm depth). On the other hand, the minimum number (11.27) in D_1 (transplanting at 2 cm depth) which was followed (11.40) by D_4 (transplanting at 8 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure11. Effect of transplanting depth on effective tiller hill^{-1} at harvest of rice ($LSD_{0.05}$ = 1.17 at harvest)

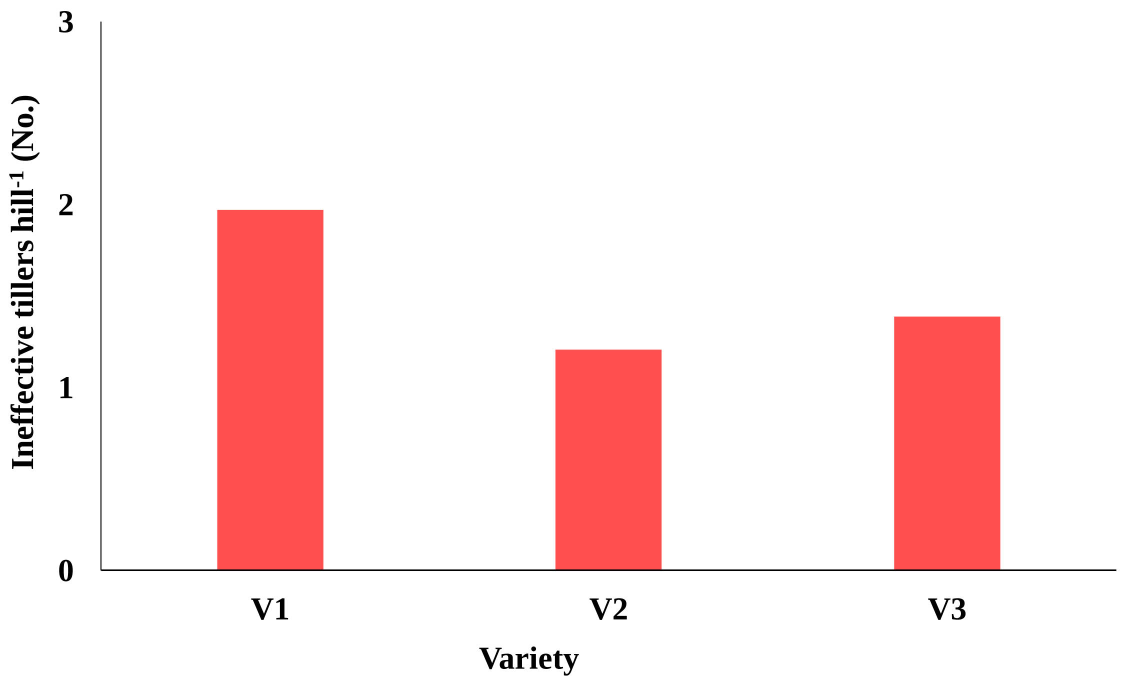
4.5.3 Interaction effect of variety and transplanting depth

Transplanting depth and variety showed significant differences for number of effective tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 due to their interaction effect (Appendix IX and Table 5). The maximum number of effective tillers hill^{-1} (13.69) was recorded in the treatment combination of V_3D_2 (BRRI dhan63 × transplanting at 4 cm depth), again the minimum number (9.94) was found in V_2D_2 (BRRI dhan45 × transplanting at 4 cm depth) treatment combination.

4.6 Number of ineffective tillers hill^{-1}

4.6.1 Effect of variety

Different variety showed significant variation in number of ineffective tillers hill^{-1} of BRRI hybrid dhan3, BRRI dhan45 and BRRI dhan63 (Appendix IX and Figure 12). The maximum number of ineffective tillers hill^{-1} (1.97) was found in V_1 (BRRI hybrid dhan3), whereas the minimum number (1.21) was obtained in V_2 (BRRI dhan45) which was closely followed (1.39) by V_3 (BRRI dhan63) treatment.

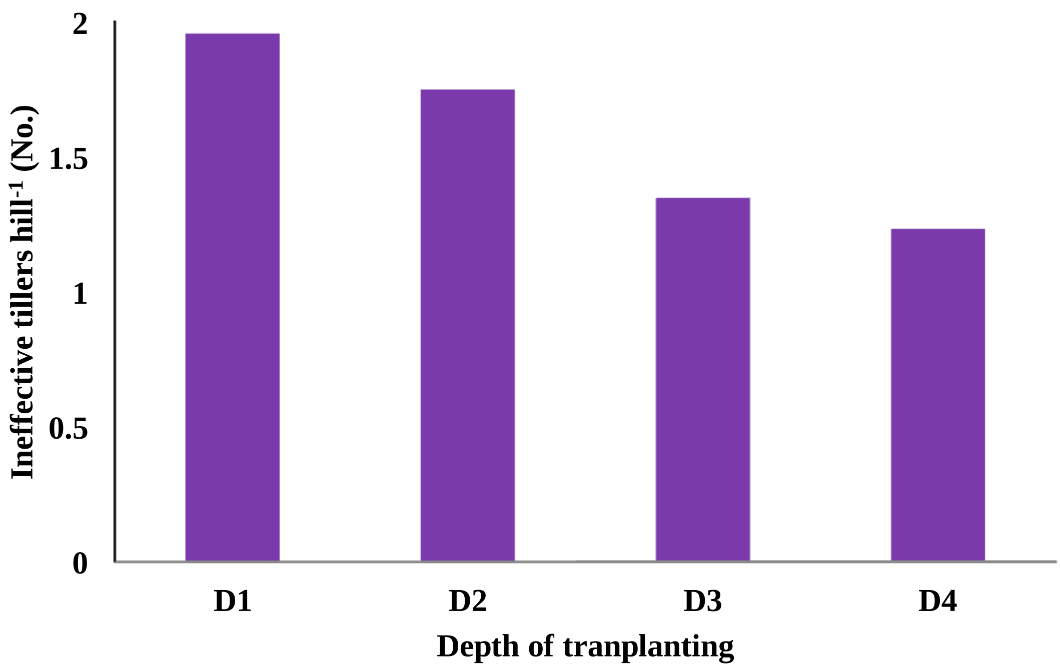


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure12. Effect of variety on ineffective tiller hill^{-1} at harvest of rice (LSD $_{0.05}$ = 0.32 at harvest)

4.6.2 Effect of transplanting depth

Statistically significant variation was recorded for number of ineffective tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 showed due to the different transplanting depth (Appendix IX and Figure 13). The maximum number of ineffective tillers hill^{-1} (1.96) was observed in D_1 (transplanting at 2 cm depth) which was similar (1.75) by D_2 (transplanting at 4 cm depth). On the other hand, the minimum number (1.23) in D_4 (transplanting at 8 cm depth) which was followed (1.35) by D3 (transplanting at 6 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 13. Effect of transplanting depth on ineffective tiller hill^{-1} at harvest of rice (LSD $_{0.05}$ = 0.17 at harvest)

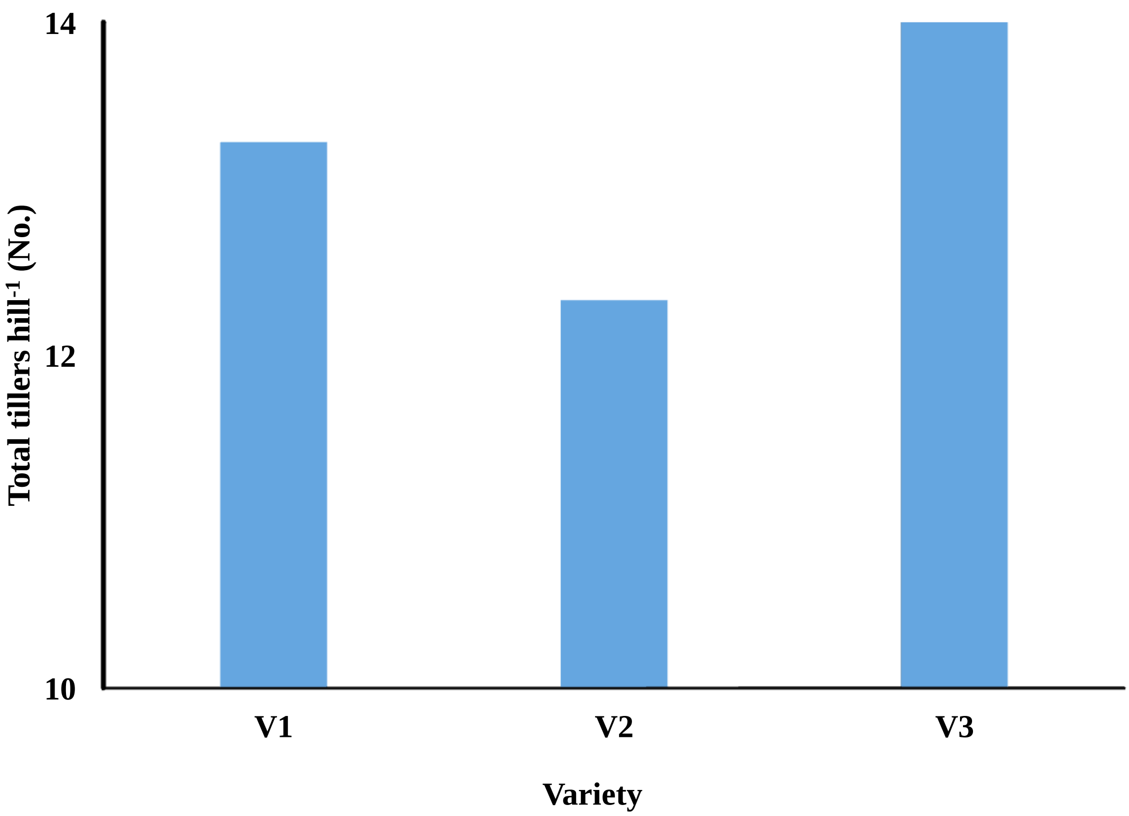
4.6.3 Interaction effect of variety and transplanting depth

Statistically significant variation was recorded for the interaction effect of variety and transplanting depth on number of ineffective tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix IX and Table 5). The minimum number of ineffective tillers $hill^{-1}$ (0.58) was recorded in the treatment combination of V_2D_4 (BRRI dhan45 × transplanting at 8 cm depth), while the maximum number (2.58) was recorded in V_1D_1 (BRRI hybrid dhan3× transplanting at 2 cm depth) treatment combination.

4.7 Number of total tillers $hill^{-1}$

4.7.1 Effect of variety

Statistically significant variation was observed for different varieties in number of total tillers $hill^{-1}$ of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix IX and Figure 14). The maximum number of tillers $hill^{-1}$ (14.00) was found in V_3 (BRRI dhan63), the minimum number (12.33) was recorded in V_2 (BRRI dhan45) which was similar (13.28) to V_1 (BRRI hybrid dhan3) treatment.

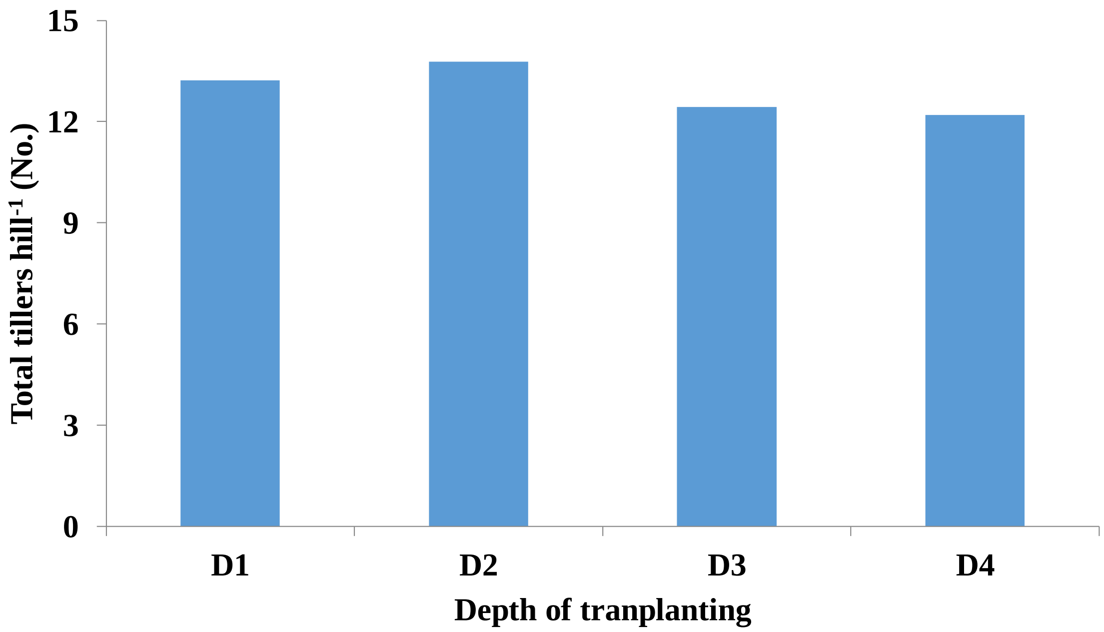


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 14. Effect of variety on total tiller $hill^{-1}$ at harvest of rice (LSD $_{0.05}$ = 1.74 at harvest)

4.7.2 Effect of transplanting depth

Different transplanting depth showed significant differences for number of total tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix IX and Figure 15). The maximum number of tillers hill^{-1} (13.7) was found in D_4 (transplanting at 8 cm depth) which was similar with (13.37) by D_2 (transplanting at 4 cm depth), again the minimum number (12.44) was recorded in D_3 (transplanting at 6 cm depth) which was similar (13.22) to D_1 (transplanting at 2 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 15. Effect of transplanting depth on total tiller hill^{-1} at harvest of rice (LSD $_{0.05}$ = 1.41 at harvest)

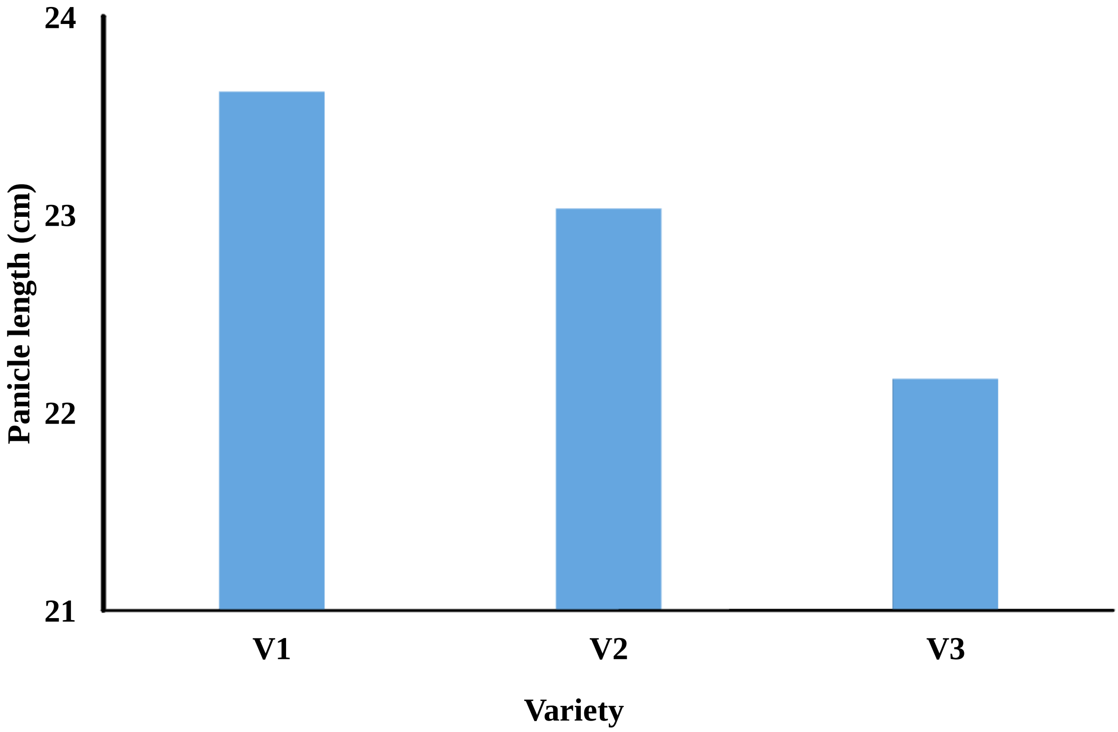
4.7.3 Interaction effect of variety and transplanting depth

Interaction effect of variety and transplanting depth showed significant variation for number of total tillers hill^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 Appendix IX and Table 5). The maximum number of tillers hill^{-1} (15.89) was observed in the treatment combination of V_3D_2 (BRRI dhan63 × transplanting at 4 cm depth). On the other hand the minimum number (11.00) was recorded in V_2D_2 (BRRI dhan45 × transplanting at 4 cm depth) treatment combination.

4.8 Length of panicle (cm)

4.8.1 Effect of variety

Different varieties showed significant difference for length of panicle of BRRI hybrid dhan3, BRRI dhan45 and BRRI dhan63 (Appendix IX and Fig. 16). The longest panicle (23.62 cm) was observed in V_1 (BRRI hybrid dhan3) which was statistically similar (23.03 cm) with V_2 (BRRI dhan45), whereas the shortest panicle (22.17 cm) was found in V_3 (BRRI dhan63).

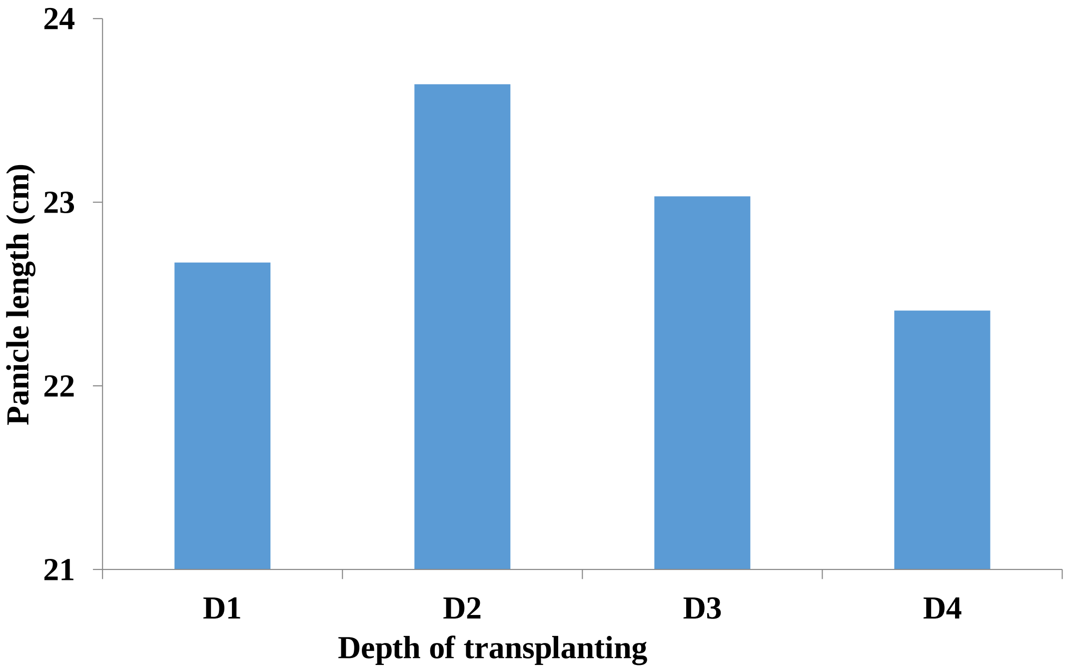


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 16. Effect of variety on panicle length (cm) at harvest of rice (LSD $_{0.05}$ = 1.52 at harvest)

4.8.2 Effect of transplanting depth

Length of panicle of BRRI hybrid dhan3, BRRI dhan45 and BRRI dhan63 showed statistically significant differences due to the different transplanting depths (Appendix IX and Fig. 17). The longest panicle (23.64 cm) was recorded in D_2 (transplanting at 4 cm depth) which was closely followed (23.03 cm) by D_3 (transplanting at 6 cm depth) and the shortest panicle (22.41 cm) was observed in D_4 (transplanting at 8 cm depth) which was statistically similar (22.67 cm) with D_1 treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 17. Effect of transplanting depth on panicle length (cm) at harvest of rice (LSD $_{0.05}$ = 1.37 at harvest)

4.8.3 Interaction effect of variety and transplanting depth

Interaction effect of variety and transplanting depth showed significant differences for panicle length of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix IX and Table 5). The longest panicle (24.49 cm) was found in the treatment combination of V_1D_2 (BRRI hybrid dhan3 × transplanting at 4 cm depth), while the shortest length (21.48 cm) was observed in V_3D_3 (BRRI dhan63 × transplanting at 6 cm depth) treatment combination.

Table 5. Interaction effect of variety and transplanting depths on number of effective tillers hill^{-1}, ineffective tillers hill^{-1}, total tillers hill^{-1} and panicle length (cm) of rice

Treatment combination	Number of effective tillers hill^{-1}	Number of ineffective tillers hill^{-1}	Number of total tillers hill^{-1}	Length of panicle (cm)
V_1D_1	10.87 cd	2.58 a	13.44 a-d	23.17 ab
V_1D_2	10.93 cd	2.29 ab	13.22 b-d	24.49 a
V_1D_3	10.97 cd	0.92 c	11.89 cd	23.16 ab
V_1D_4	12.47 a-c	2.09 b	14.56 ab	23.66 ab
V_2D_1	11.13 cd	2.20 b	13.33 b-d	23.07 ab
V_2D_2	9.940 d	1.06 c	11.00 d	23.13 ab
V_2D_3	11.56 b-d	0.99 c	12.55 b-d	22.60 ab
V_2D_4	11.87 a-d	0.58 d	12.44 b-d	23.30 ab
V_3D_1	11.80 a-d	1.09 c	12.89 b-d	21.76 b
V_3D_2	13.69 a	2.20 b	15.89 a	22.29 ab
V_3D_3	11.67 b-d	1.22 c	12.89 b-d	21.48 b
V_3D_4	13.30 ab	1.03 c	14.33 a-c	23.13 ab
LSD(0.05)	**2.019**	**0.302**	**2.447**	**2.369**
CV (%)	**10.07**	**11.61**	**10.8**	**6.02**

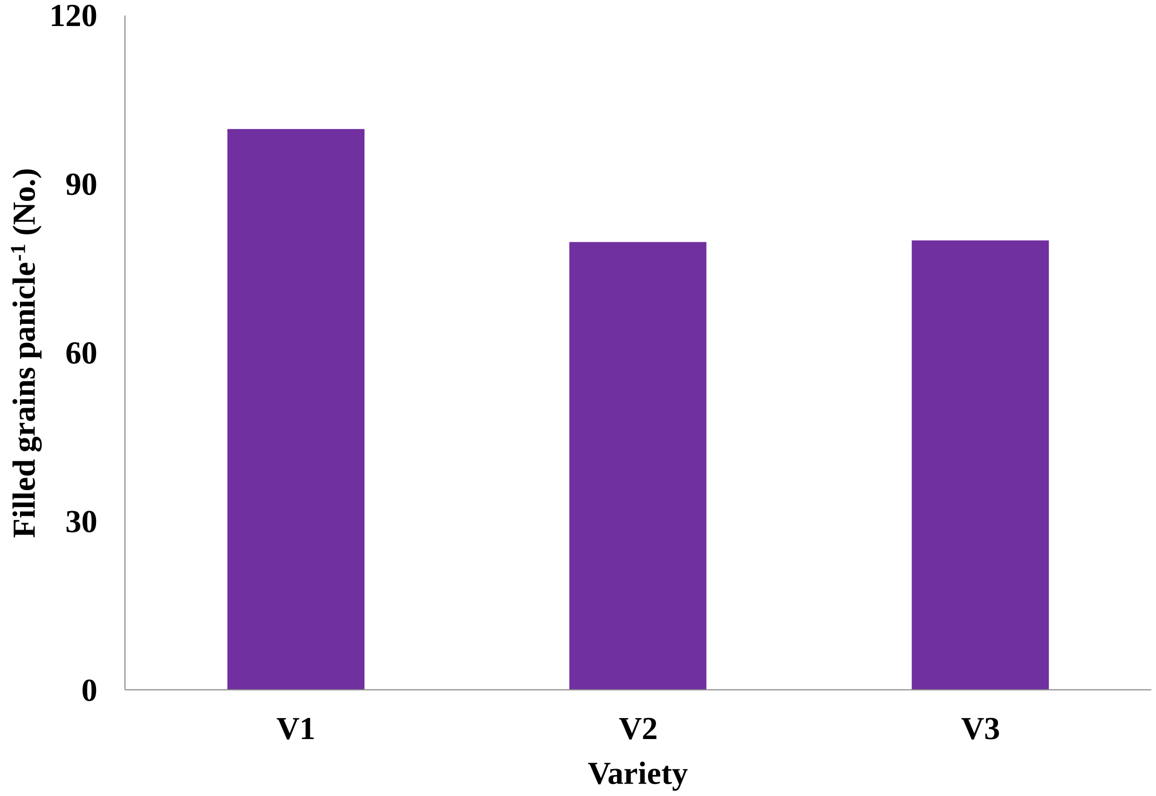
In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63; D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth, D_4: Transplanting at 8 cm depth.

4.9 Number of filled grains panicle^{-1}

4.9.1 Effect of variety

Number of filled grains panicle^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 varied significantly among varieties (Appendix X and Fig. 18). The maximum number of filled grains panicle^{-1} (99.75) was recorded in V_1 (BRRI hybrid dhan3), while the minimum number (79.68) was observed in V_2 (BRRI dhan45) which was closely followed (79.90) by V_3 (BRRI dhan63) treatment.



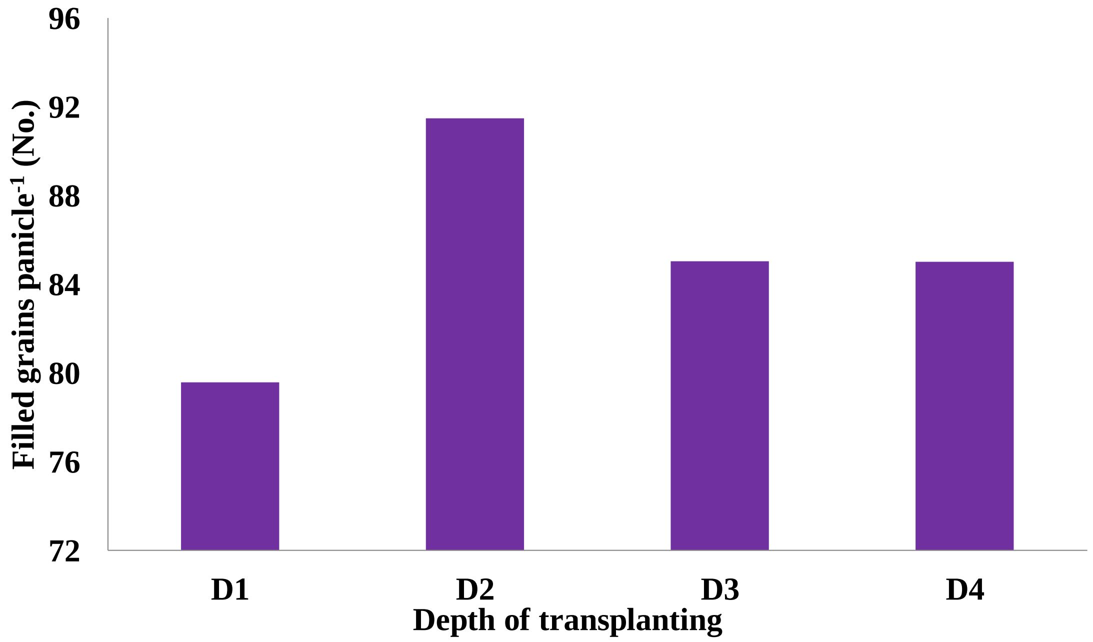
V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 18. Effect of variety on filled grains panicle^{-1} at harvest of rice (LSD $_{0.05}$ = 10.76 at harvest)

4.9.2 Effect of transplanting depth

Statistically significant variation was observed for number of filled grains panicle^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 due to the different transplanting depth (Appendix X and Fig. 19). The maximum number of filled grains panicle^{-1} (91.47) was obtained in D_2 (transplanting at 4 cm depth) which was closely followed (89.73) by

D_3 (transplanting at 6 cm depth), whereas the minimum number (79.56) was attained in D_1 (transplanting at 2 cm depth) which was followed (85.02) by D_4 (transplanting at 8 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 19. Effect of transplanting depth on filled grains panicle^{-1} at harvest of rice (LSD $_{0.05}$ = 7.64 at harvest)

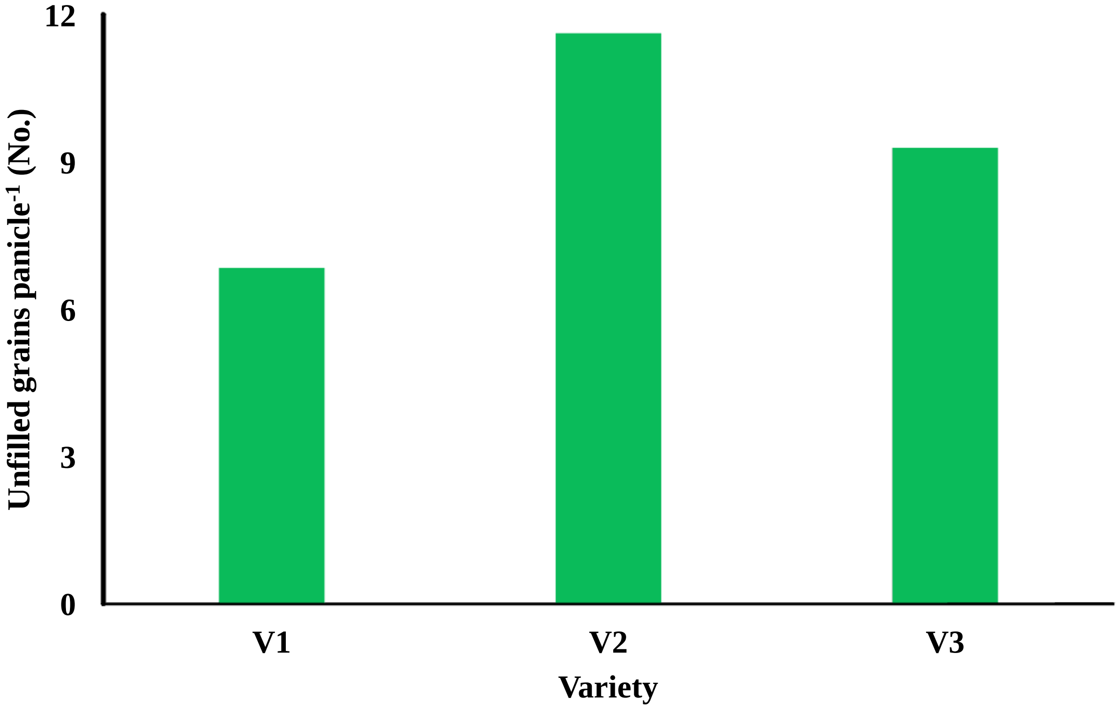
4.9.3 Interaction effect of variety and transplanting depth

Interaction effect of variety and transplanting depth showed significant differences for number of filled grains panicle^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix X and Table 6). The maximum number of filled grains panicle^{-1} (103.8) was found in the treatment combination of V_1D_2 (BRRI hybrid dhan3× transplanting at 4 cm depth), whereas the minimum number (70.86) was recorded in V_3D_1 (BRRI dhan63 × transplanting at 2 cm depth) treatment combination.

4.10 Number of unfilled grains panicle^{-1}

4.10.1 Effect of variety

Number of unfilled grains panicle^{-1} of BRRI hybrid dhan3, BRRI dhan45 and BRRI dhan63 varied significantly for different varieties (Appendix X and Fig. 20). The maximum number of unfilled grains panicle^{-1} (11.62) was recorded in V_2 (BRRI dhan45), which was followed (9.28) by V_3 (BRRI dhan63) while the minimum number (6.84) was observed in V_1 (BRRI hybrid dhan3) treatment.



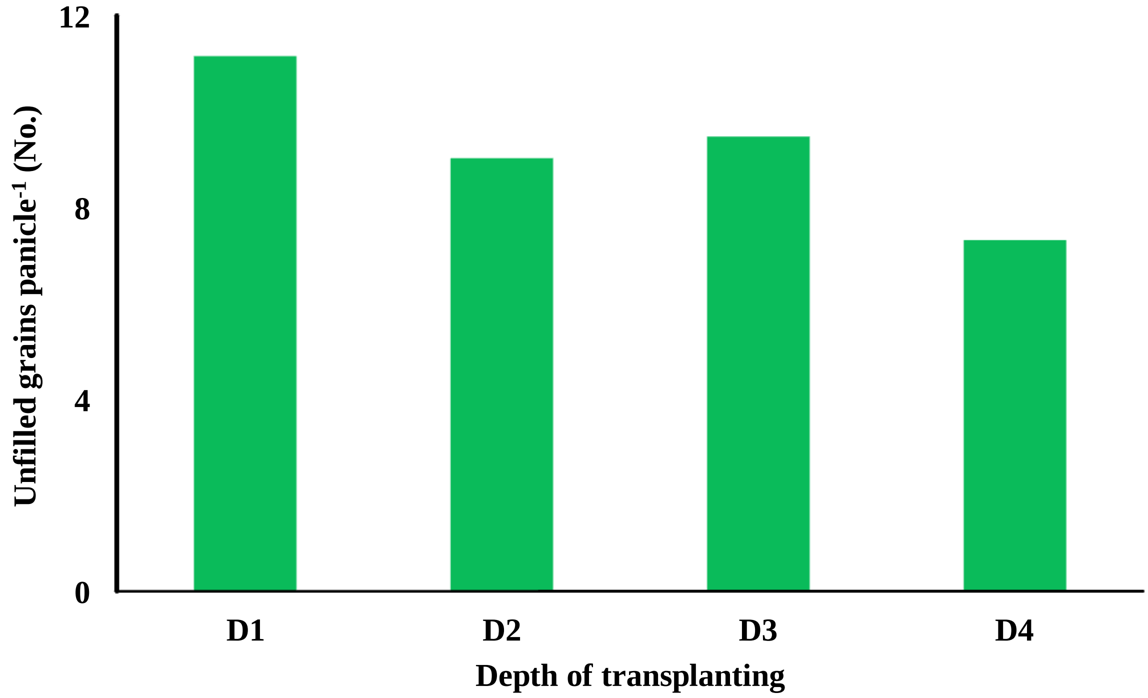
V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 20. Effect of variety on unfilled grains panicle^{-1} at harvest of rice (LSD $_{0.05}$ = 1.09 at harvest)

4.10.2 Effect of transplanting depth

Statistically significant variation was observed for number of unfilled grains panicle^{-1} of BRRI hybrid dhan3, BRRI dhan45 and BRRI dhan63 due to the different transplanting depths (Appendix X and Fig. 21). The maximum number of unfilled grains panicle^{-1} (11.16) was obtained in D_1 (transplanting at 2 cm depth) which was followed (9.48) by D_3 (transplanting at 6 cm depth), whereas the minimum number (7.32) was attained in D_4

(transplanting at 8 cm depth) which was followed (9.03) by D_2 (transplanting at 4 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 21. Effect of transplanting depth on unfilled grains panicle^{-1} at harvest of rice (LSD $_{0.05}$ = 1.08 at harvest)

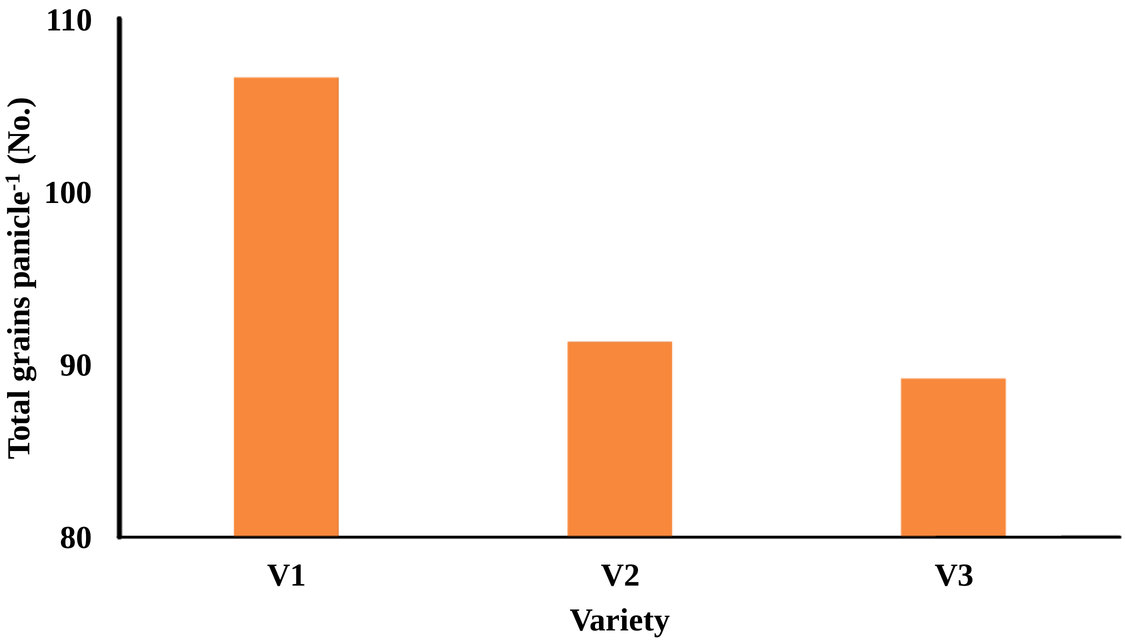
4.10.3 Interaction effect of variety and transplanting depth

Interaction effect of variety and transplanting depth showed significant differences for number of unfilled grains panicle^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix X and Table 6). The maximum number of unfilled grains panicle^{-1} (16.09) was found in the treatment combination of V_2D_1 (BRRI dhan45 × transplanting at 2 cm depth), whereas the minimum number (5.60) was recorded in V_1D_4 (BRRI hybrid dhan3× transplanting at 4 cm depth) treatment combination.

4.11 Number of total grains panicle^{-1}

4.11.1 Effect of variety

Number of total grains panicle^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 varied significantly for different varieties (Appendix X and Fig. 22). The maximum number of total grains panicle^{-1} (106.6) was recorded in V_1 (BRRI hybrid dhan3), while the minimum number (89.18) was observed in V_3 (BRRI dhan63), which was closely followed (91.30) by V_2 (BRRI dhan45) treatment.



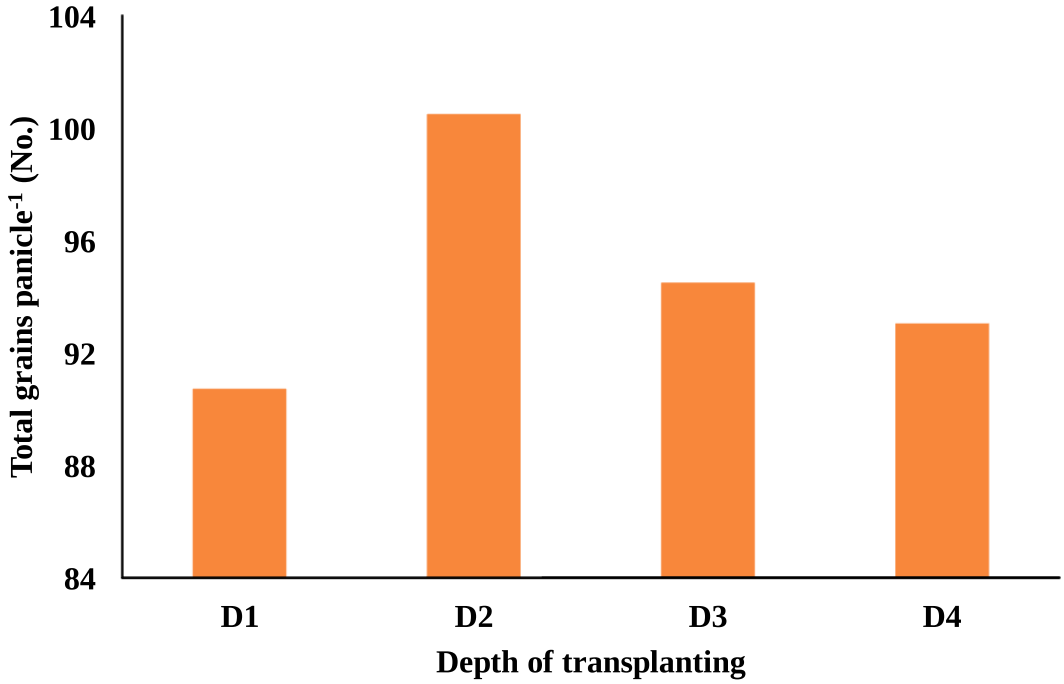
V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 22. Effect of variety on total grains panicle^{-1} at harvest of rice (LSD $_{0.05}$ = 11.67 at harvest)

4.11.2 Effect of transplanting depth

Statistically significant variation was observed for number of total grains panicle^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 due to the different transplanting depth (Appendix X and Fig. 23). The maximum number of total grains panicle^{-1} (100.5) was obtained in D_2 (transplanting at 4 cm depth) which was followed (97.05) by D_4 (transplanting at 8 cm depth), whereas the minimum number (90.72) was attained in D_1

(transplanting at 2 cm depth) which was followed (94.50) by D_3 (transplanting at 6 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 23. Effect of transplanting depth on total grains panicle^{-1} at harvest of rice (LSD $_{0.05}$ = 7.79 at harvest)

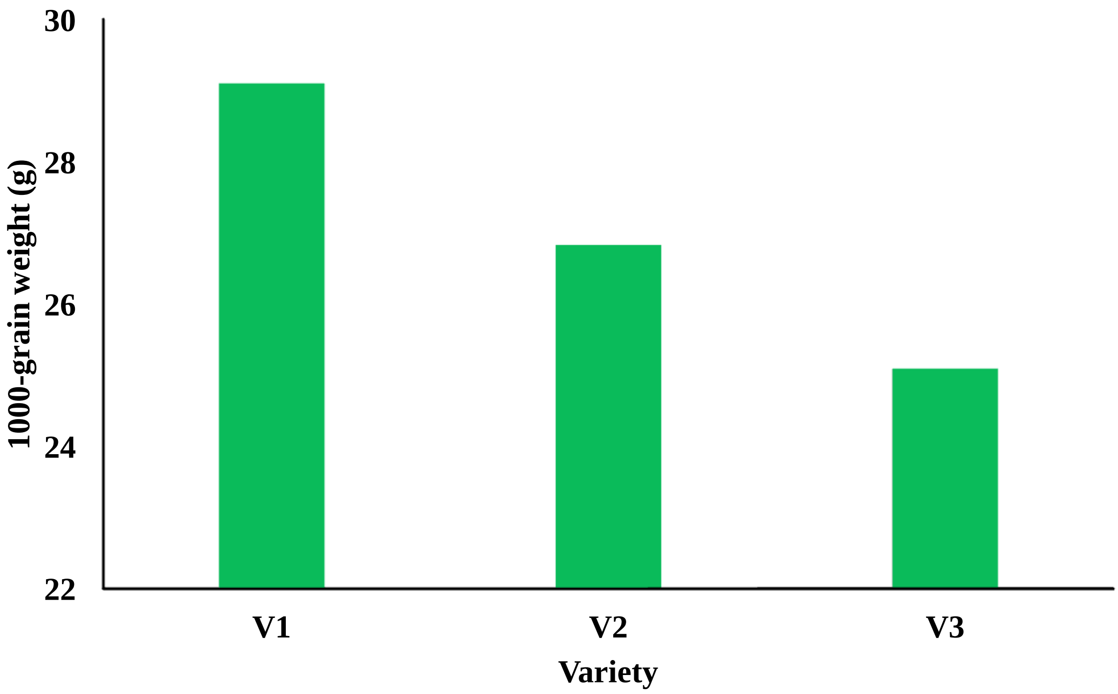
4.11.3 Interaction effect of variety and transplanting depth

Interaction effect of variety and transplanting depth showed significant differences for number of total grains panicle^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix X and Table 6). The maximum number of total grains panicle^{-1} (110.5) was found in the treatment combination of V_1D_2 (BRRI hybrid dhan3× transplanting at 4 cm depth), whereas the minimum number (80.49) was recorded in V_3D_1 (BRRI dhan63 × transplanting at 2 cm depth) treatment combination.

4.12 Weight of 1000-grains (g)

4.12.1 Effect of variety

There was a significant effect of variety on weight of 1000 - grains of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix X and Fig. 24). The highest weight of 1000 - grains (29.10 g) was found in V_1 (BRRI hybrid dhan3) which was statistically similar (26.83 g) with V_2 (BRRI dhan45), whereas the lowest weight (25.09 g) was observed in V_3 (BRRI dhan63) treatment.

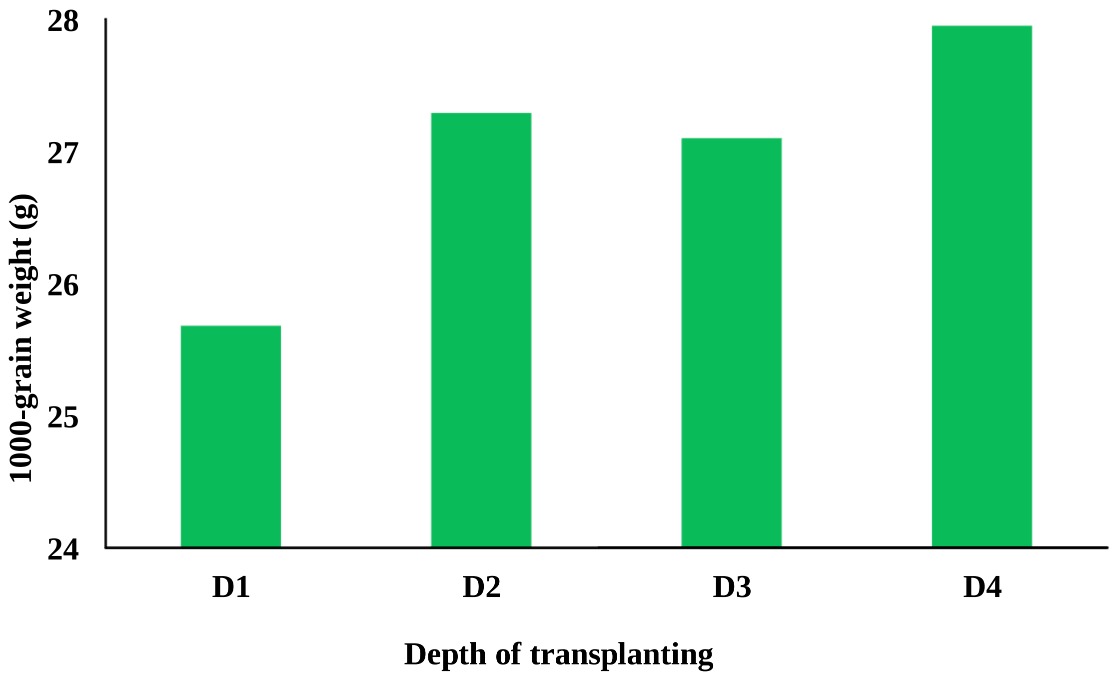


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 24. Effect of variety on weight of thousand grains (g) at harvest of rice (LSD $_{0.05}$ = 2.36 at harvest)

4.12.2 Effect of transplanting depth

Statistically significant difference was recorded for weight of 1000 grains of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 for different transplanting depths (Appendix X and Fig. 25). The highest weight of 1000 grains (27.95 g) was observed in D_4 (transplanting at 8 cm depth) followed (27.29 g) by D_2 (transplanting at 4 cm depth), while the lowest weight (25.68 g) was recorded in D_1 (transplanting at 2 cm depth) which was statistically similar (27.10 g) with D_3 (transplanting at 6 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 25. Effect of transplanting depth on weight of thousand grains (g) at harvest of rice (LSD $_{0.05}$ = 1.76 at harvest)

4.12.3 Interaction effect of variety and transplanting depth

Weight of 1000 grains of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 showed significant differences due to interaction effect of transplanting depth and variety (Appendix X and Table 6). The highest weight of 1000 grains (30.02 g) was recorded in the treatment combination of V_1D_4 (BRRI hybrid dhan3× transplanting at 8 cm depth). On the other hand, the lowest weight (23.54 g) was recorded in V_3D_1 (BRRI dhan63 × transplanting at 2 cm depth) treatment combination.

Table 6. Effect of variety and transplanting depths on number of filled grains panicle-[1], unfilled grains panicle-[1], total grains panicle^{-1} and weight of 1000-grains (g) of rice

Treatment Combination	Filled grains panicle-^{1} (No.)	Unfilled grains panicle-^{1} (No.)	Total grains panicle^{-1} (No.)	Weight of 1000 grains (g)
V_1D_1	91.56 a-c	7.76 e-g	99.33 ab	27.61 ab
V_1D_2	103.8 a	6.69 g-h	110.5 a	29.38 a
V_1D_3	101.0 ab	7.29 f-h	108.3 a	29.39 a
V_1D_4	102.7 a	5.59 h	108.3 a	30.02 a
V_2D_1	76.26 de	16.09 a	92.35 bc	25.90 bc
V_2D_2	81.49 c-e	9.15 d-f	90.64 bc	27.07 ab
V_2D_3	76.01 de	11.52 b	87.53 bc	26.24 bc
V_2D_4	84.99 cd	9.72 b-d	94.71 b	28.11 ab
V_3D_1	70.86 e	9.63 cd	80.49 c	23.54 c
V_3D_2	89.17 b-d	11.24 bc	100.4 ab	25.43 bc
V_3D_3	78.03 de	9.63 c-e	87.66 bc	25.69 bc
V_3D_4	81.54 c-e	6.63 gh	88.18 bc	25.72 bc
LSD(0.05)	**13.22**	**1.863**	**13.48**	**3.045**
CV (%)	**8.92**	**11.74**	**8.21**	**6.57**

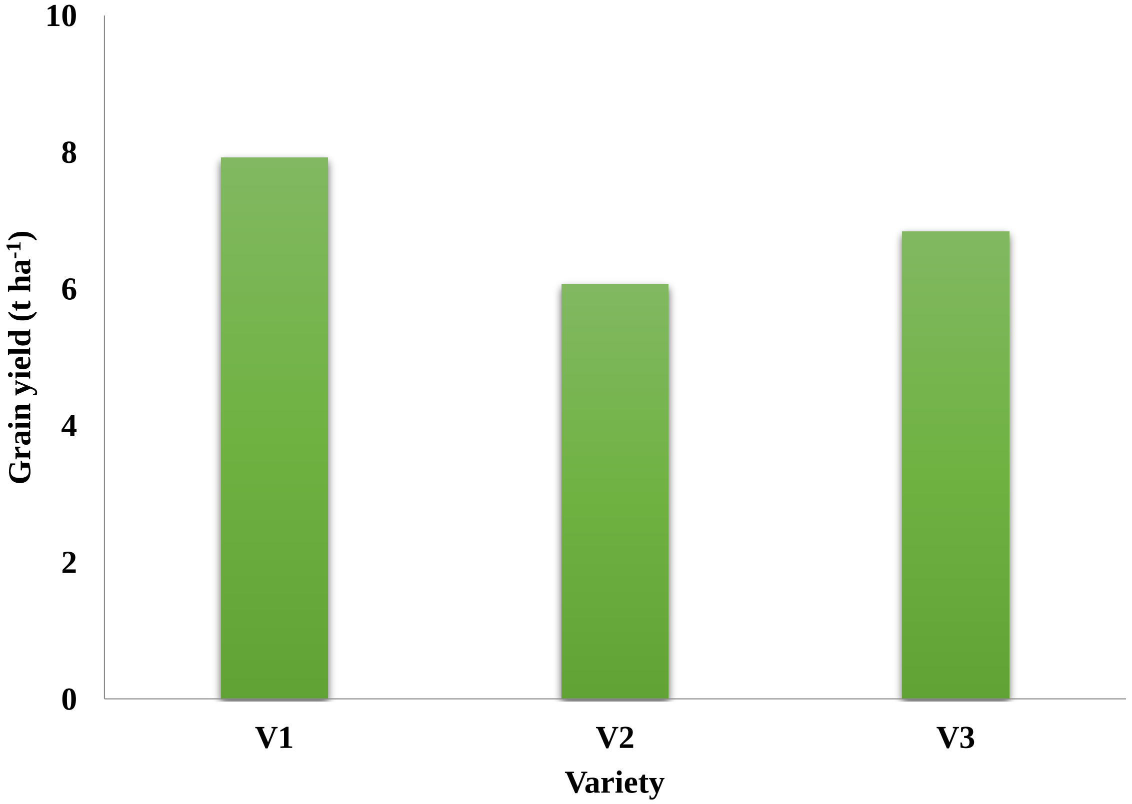
In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63; D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth, D_4: Transplanting at 8 cm depth.

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

4.13.1 Effect of variety

Statistically significant variation was recorded for different variety on grain yield of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix XI and Fig. 26). The highest grain yield (7.92 t ha^{-1}) was obtained in V_1 (BRRI hybrid dhan3) which was closely followed (6.88 t ha^{-1}) by V_3 (BRRI dhan63), while the lowest yield (6.07 t ha^{-1}) was found in V_2 (BRRI dhan45) treatment.

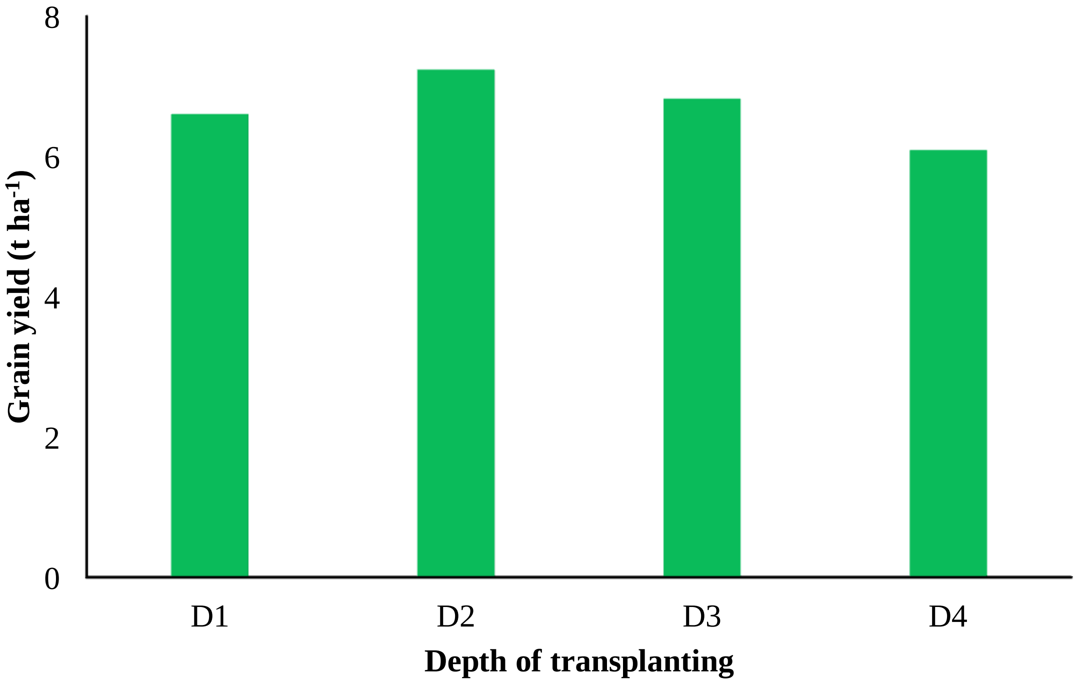


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 26. Effect of variety on grain yield (t ha^{-1}) at harvest of rice (LSD $_{0.05}$ = 1.53)

4.13.2 Effect of transplanting depth

Grain yield ha^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 varied significantly for different transplanting depth (Appendix XI and Fig. 27). The highest grain yield (7.24 t ha^{-1}) was found in D_2 (transplanting at 4 cm depth) which was closely followed (6.82 t ha^{-1}) by D_3 (transplanting at 6 cm depth), whereas the lowest yield (6.09 t ha^{-1}) was recorded in D_4 (transplanting at 8 cm depth) which was closely followed (6.61 t ha^{-1}) by D_1 (transplanting at 2 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 27. Effect of transplanting depth on grain yield (t ha^{-1}) at harvest of rice (LSD $_{0.05}$ = 0.52 at harvest)

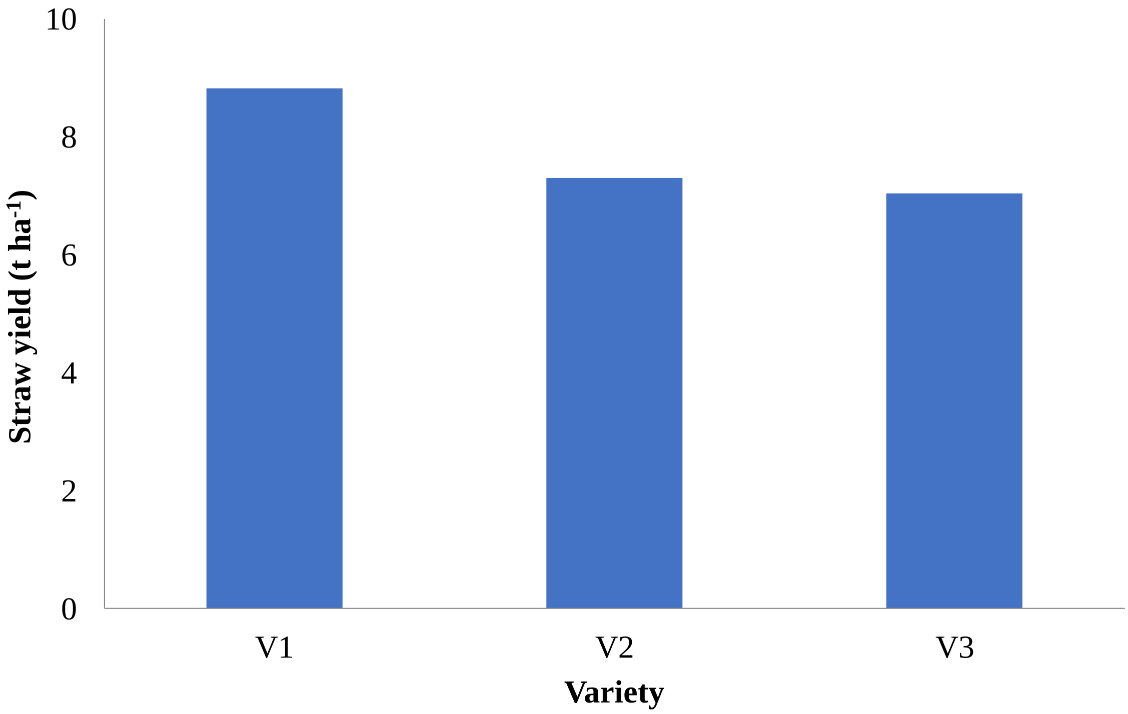
4.13.3 Interaction effect of variety and transplanting depth

Interaction effect of transplanting depth and variety showed significant differences for grain yield ha^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 Appendix XI and Table 7). The highest grain yield (8.55 t ha^{-1}) was recorded in V_1D_2 (BRRI hybrid dhan3× transplanting at 4 cm depth), the similar grain yield (8.09 t ha^{-1}) was also obtained from the combination of V_1D_4 (BRRI hybrid dhan3 × transplanting at 8 cm depth) while the lowest yield (5.75 t ha^{-1}) was observed in V_2D_1 (BRRI dhan45 × transplanting at 2 cm depth) treatment combination.

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

4.14.1 Effect of variety

Statistically significant variation was recorded for different varieties on straw yield of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 Appendix XI and Fig. 28). The highest straw yield (8.82 t ha^{-1}) was obtained in V_1 (BRRI hybrid dhan3), while the lowest yield (7.04 t ha^{-1}) was found in V_3 (BRRI dhan63) which was closely followed (7.30 t ha^{-1}) by V_2 (BRRI dhan45) treatment.

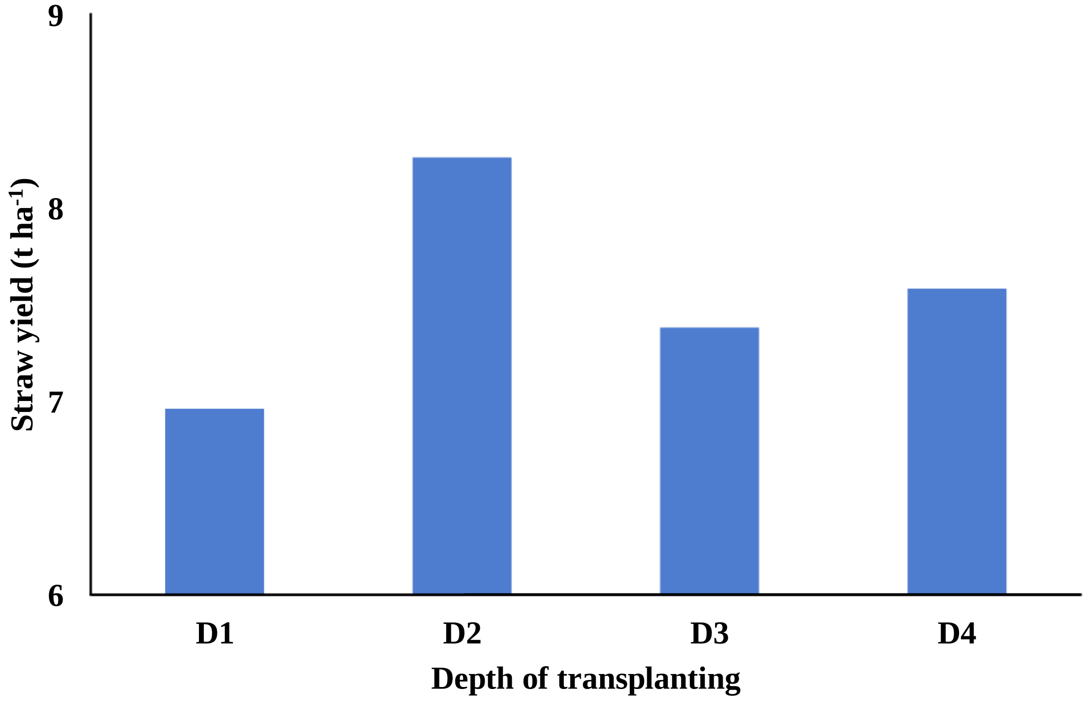


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63

Figure 28. Effect of variety on straw yield (t ha^{-1}) at harvest of rice (LSD $_{0.05}$ = 0.53)

4.14.2 Effect of transplanting depth

Straw yield ha^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 varied significantly for different transplanting depths (Appendix XI and Fig. 29). The highest straw yield (8.26 t ha^{-1}) was found in D_2 (transplanting at 4 cm depth) which was closely followed (7.58 t ha^{-1}) by D_4 (transplanting at 8 cm depth), whereas the lowest yield (6.96 t ha^{-1}) was recorded in D_1 (transplanting at 2 cm depth) which was closely followed (7.38 t ha^{-1}) by D_3 (transplanting at 6 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 29. Effect of transplanting depth on straw yield (t ha^{-1}) at harvest of rice (LSD $_{0.05}$ = 0.60 at harvest)

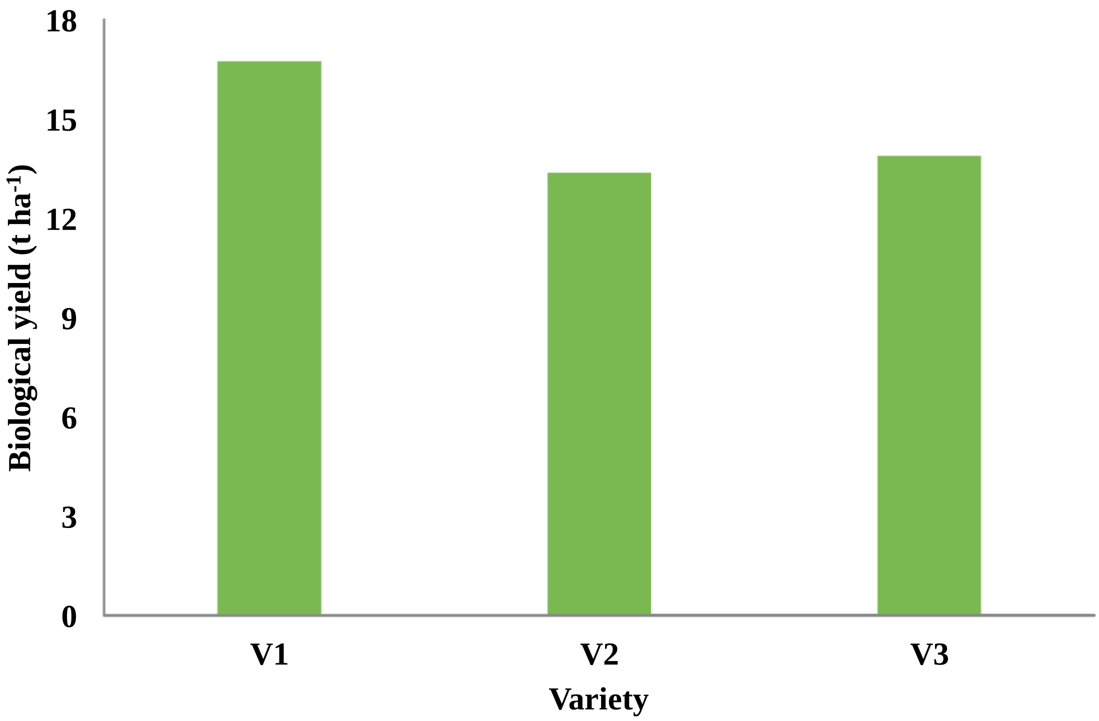
4.14.3 Interaction effect of variety and transplanting depth

Interaction effect of transplanting depth and variety showed significant differences for straw yield ha^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix XI and Table 7). The highest straw yield (9.35 t ha^{-1}) was recorded in V_1D_4 (BRRI hybrid dhan3× transplanting at 8 cm depth), the closely similar grain yield (9.19 t ha^{-1}) was also obtained from the combination of V_1D_2 (BRRI hybrid dhan3 × transplanting at 4 cm depth) while the lowest yield (6.15 t ha^{-1}) was observed in V_2D_1 (BRRI dhan45 × transplanting at 2 cm depth) treatment combination.

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

4.15.1 Effect of variety

Statistically significant variation was recorded for different varieties on biological yield of BRRI hybrid dhan3, BRRI dhan45 and BRRI dhan63 (Appendix XI and Fig. 30). The highest biological yield (16.74 t ha^{-1}) was obtained in V_1 (BRRI hybrid dhan3), while the lowest yield (13.37 t ha^{-1}) was found in V_2 (BRRI dhan45) which was closely followed (13.88 t ha^{-1}) by V_3 (BRRI dhan63) treatment.

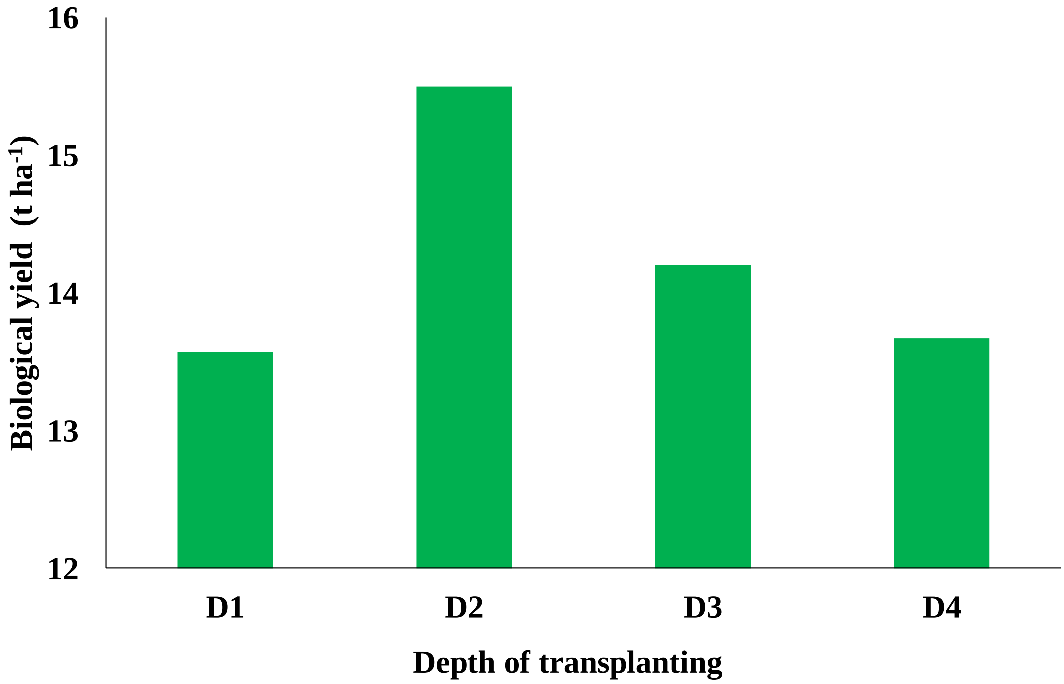


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63.

Figure 30. Effect of variety on biological yield (t ha^{-1}) at harvest of rice (LSD $_{0.05}$ = 1.34 at harvest)

4.15.2 Effect of transplanting depth

Biological yield of BRRI hybrid dhan3, BRRI dhan45 and BRRI dhan63 varied significantly for different transplanting depths (Appendix XI and Fig. 31). The highest biological yield (15.5 t ha^{-1}) was found in D_2 (transplanting at 4 cm depth) which was closely followed (14.2 t ha^{-1}) by D_3 (transplanting at 6 cm depth), whereas the lowest yield (13.57 t ha^{-1}) was recorded in D_1 (transplanting at 2 cm depth) which was closely followed (13.67 t ha^{-1}) by D_4 (transplanting at 8 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 31. Effect of transplanting depth on biological yield (t ha^{-1}) at harvest of rice (LSD $_{0.05}$ = 0.83 at harvest)

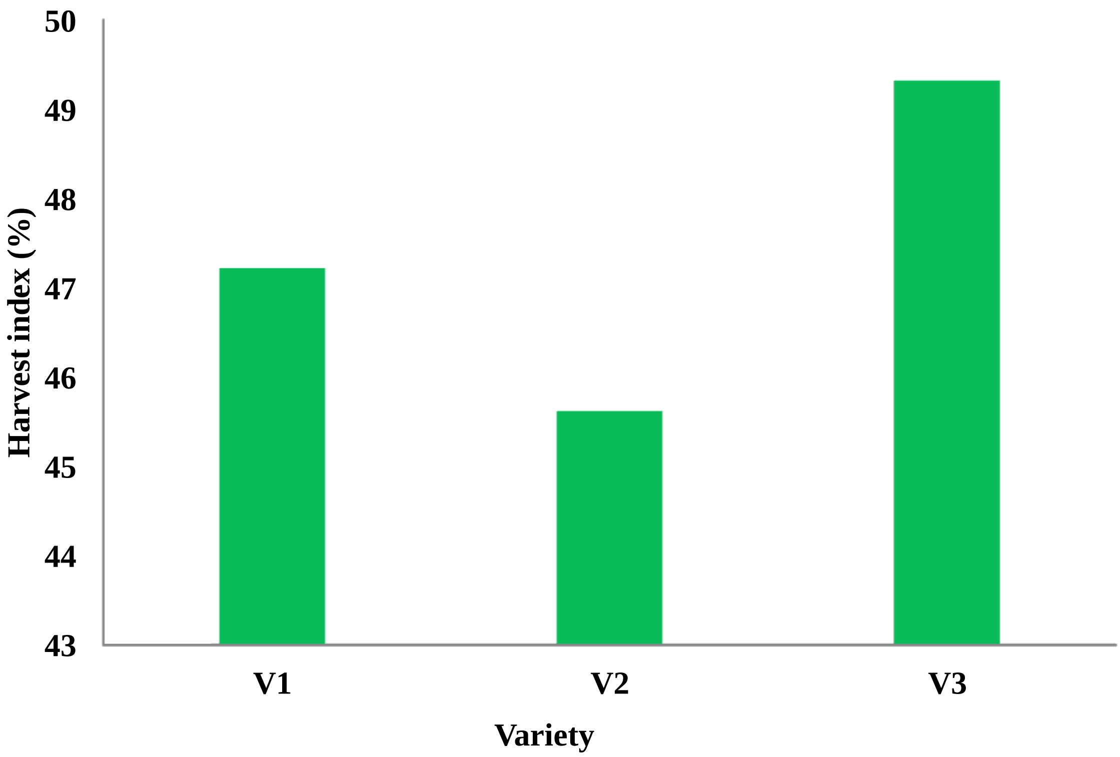
4.15.3 Interaction effect of variety and transplanting depth

Interaction effect of transplanting depth and variety showed significant differences for biological yield ha^{-1} of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix XI and Table 7). The highest biological yield (17.90 t ha^{-1}) was recorded in V_1D_4 (BRRI hybrid dhan3× transplanting at 8 cm depth), the closely similar grain yield (17.28 t ha^{-1}) was also obtained from the combination of V_1D_2 (BRRI hybrid dhan3 × transplanting at 4 cm depth) while the lowest yield (11.90 t ha^{-1}) was observed in V_2D_1 (BRRI dhan45 × transplanting at 2 cm depth) treatment combination.

4.16 Harvest index (%)

4.16.1 Effect of variety

Statistically significant variation was recorded for different varieties on harvest index of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix XI and Fig. 32). The highest harvest index (49.32 %) was obtained in V_3 BRRI dhan63), while the lowest harvest index (45.62 %) was found in V_2 (BRRI dhan45) which was closely followed (47.22 %) by V_1 (BRRI hybrid dhan3) treatment.

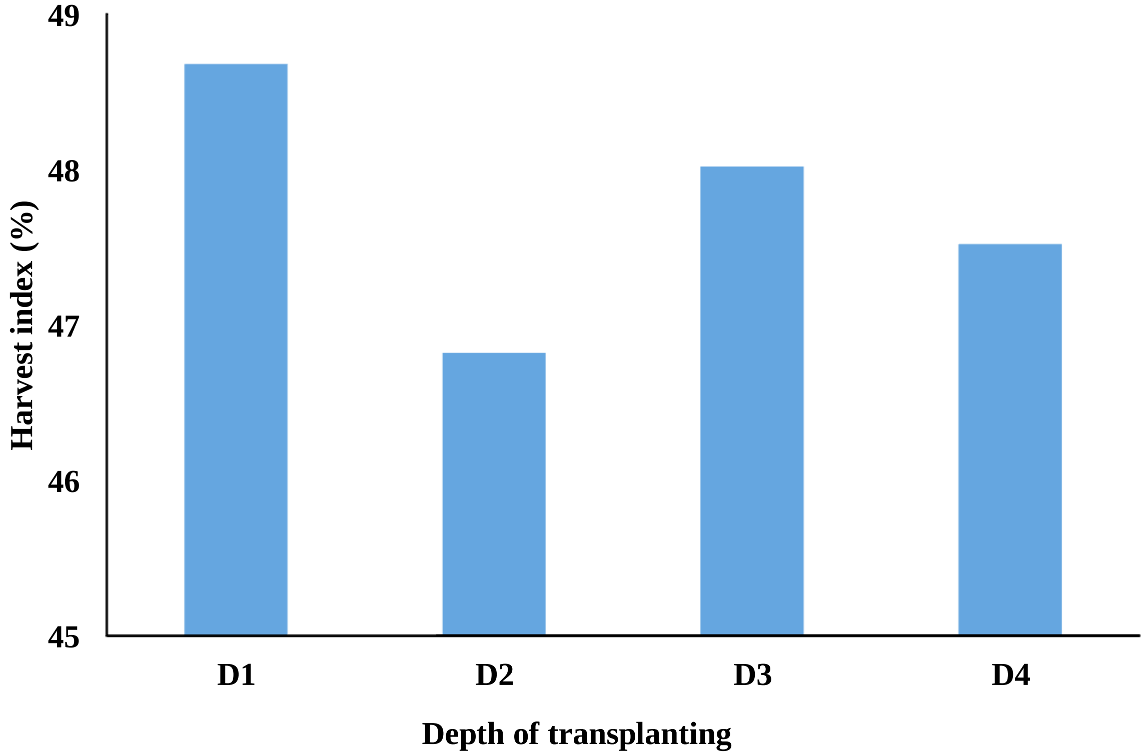


V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63.

Figure 32. Effect of variety on harvest index (%) of rice (LSD $_{0.05}$ = 6.31 at harvest)

4.16.2 Effect of transplanting depth

Harvest index of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 varied significantly for different transplanting depths (Appendix XI and Fig. 33). The highest harvest index (48.77 %) was found in D_1 (transplanting at 2 cm depth) which was closely followed (48.03 %) by D_3 (transplanting at 6 cm depth), whereas the lowest harvest index (46.00 %) was recorded in D_4 (transplanting at 8 cm depth) which was closely followed (46.77 %) by D_2 (transplanting at 4 cm depth) treatment.



D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth and D_4: Transplanting at 8 cm depth.

Figure 33. Effect of transplanting depth on harvest index (%) of rice (LSD $_{0.05}$ = 3.38 at harvest)

4.15.3 Interaction effect of variety and transplanting depth

Interaction effect of transplanting depth and variety showed significant differences for harvest index (%) of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 (Appendix XI and Table 7). The highest harvest index (51.20 %) was recorded in V_3D_1 (BRRI dhan63 × transplanting at 2 cm depth), the closely similar harvest index (50.41 %) was also obtained from the combination of V_3D_2 (BRRI dhan63 × transplanting at 4 cm depth) while the lowest harvest index (43.12 %) was observed in V_2D_2 (BRRI dhan45 × transplanting at 4 cm depth) treatment combination.

Table 7. Interaction effect of variety and transplanting depths on grain yield, straw yield, biological yield and harvest index of rice

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1D_1	7.16 bc	8.15 b	15.31 cd	46.69 a-c
V_1D_2	8.09 a	9.19 a	17.28 a	46.77 a-c
V_1D_3	7.86 ab	8.59 ab	16.45 bc	47.66 a-c
V_1D_4	7.55 ab	8.35 a	16.90 ab	47.77 a-c
V_2D_1	5.75 f	6.15 e	11.90 g	48.42 a-c
V_2D_2	6.43 c-f	8.52 ab	14.95 d	43.12 c
V_2D_3	5.89 ef	6.82 c-e	12.71 fg	46.44 a-c
V_2D_4	6.18 def	7.73 b-d	13.91 d-f	44.52 bc
V_3D_1	6.91 cd	6.59 e	13.50 ef	51.20 a
V_3D_2	7.19 bc	7.07 c-e	14.26 de	50.41 a
V_3D_3	6.72 c-e	6.73 de	13.45 ef	49.98 ab
V_3D_4	6.54 c-f	7.77 bc	14.31 de	45.71 a-c
LSD(0.05)	**0.8946**	**1.035**	**1.444**	**5.858**
CV (%)	**7.52**	**7.82**	**5.74**	**7.21**

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

V_1= BRRI hybrid dhan3, V_2= BRRI dhan45 and V_3= BRRI dhan63; D_1: Transplanting at 2 cm depth, D_2: Transplanting at 4 cm depth, D_3: Transplanting at 6 cm depth, D_4: Transplanting at 8 cm depth.

CHAPTER V

SUMMARY AND CONCLUSION

A field experiment was carried out during Boro season 2017-18 at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207.The experiment consisted of 3 different varieties (BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63) and 4 levels of transplanting depth (2, 4, 6 and 8 cm). The experiment was laid out in a split - plot design with 3 replications. Both varieties and transplanting depths had significant effects on most of the growth and yield contributing characters of hybrid and inbred rice.

At 30, 50, 80 DAT and at harvest, most of the growth and yield contributing parameters viz., plant height, leaf area, number of tillers, effective tillers, dry matter production showed maximum values from the variety of V_1 (BRRI hybrid dhan3), whereas, lower values were recorded in V_3 (BRRI dhan63). The longest panicle, maximum number of filled grains panicle^{-1}, maximum 1000-grains weight, highest grain yield and maximum harvest index were recorded from the variety of V_1 (BRRI hybrid dhan3), while lower values were recorded in V_3 (BRRI dhan63). Most of the growth and yield contributing characters showed maximum values from transplanting at 8 cm whereas the minimum values were recorded in 2 cm transplanting depth.

The combination of variety and transplanting depth had significant effects on most of the growth and yield contributing parameters. At 30, 50, 80 DAT and at harvest, the longest plant (18.20 cm, 25.72 cm, 79.86 cm, and 102.9 cm) was found from the treatment combination of V_1D_1, whereas the shortest (22.86 cm, 29.14 cm, 77.64 cm, and 87.55 cm) was observed from the treatment combination of V_3D_1. At 30, 50, 80 DAT and at harvest, the maximum number of tillers hill^{-1} (1.73, 9.80, 17.29, and 13.22) was recorded from the treatment combination of V_1D_2, again the minimum number (1.20, 9.80, 14.53 and 11.00) was obtained from the treatment combination of V_2D_2. At 30, 50, 80 DAT and at harvest, the highest dry matter plant^{-1} (1.89 g, 26.05 g, 102.4 g, and 128.8 g) was obtained from the treatment combination of V_2D_4, while the lowest (1.89 g, 26.54 g, 78.29 g, and 77.09 g) was found from the treatment combination of V_1D_2. The maximum number of effective tillers hill^{-1} (13.69) was recorded from the treatment combination of V_3D_2, again the minimum number (9.94) was found from V_2D_2. The minimum number of ineffective tillers hill^{-1} (0.58) was recorded from the treatment combination of V_2D_4, while the maximum number (2.58) was recorded from V_1D_1. The maximum number of total tillers hill^{-1} (15.89) was observed from the treatment combination of V_3D_2 and the minimum number (11.00) was recorded from V_2D_2. The longest panicle (24.49 cm) was found from the treatment combination of V_1D_4, while the shortest length (21.48 cm) was observed from V_3D_3. The maximum number of filled grains plant^{-1} (103.8) was found from the treatment combination of V_1D_2, whereas the minimum number (70.86) was recorded in V_3D_1. The minimum number of unfilled grains plant^{-1} (5.59) was found from the treatment combination of V_1D_4, while the maximum number (16.09) was observed from V_2D_1. The maximum number of total grains plant^{-1} (110.5) was recorded from the treatment combination of V_1D_2, while the minimum number (80.49) was attained from V_3D_1. The highest weight of 1000 grains (30.02 g) was recorded from the treatment combination of V_1D_4 and the lowest weight (23.54 g) from V_3D_1. The highest grain yield (8.55 t ha^{-1}) was recorded from the treatment combination of V_1D_4 and the combination of V_1D_2 also produced statistically similar yield (8.09 t ha^{-1}) whereas the lowest (5.75 t ha^{-1}) from V_2D_1. The highest straw yield (9.35 t ha^{-1}) was found from the treatment combination of V_1D_4, whereas the lowest yield (6.15 t ha$^{-1)}$ from V_2D_1. The highest biological yield (17.90 t ha^{-1}) was recorded from the treatment combination of V_1D_4, again the lowest yield (11.90 t ha^{-1}) from V_2D_1. The highest harvest index (51.20%) was recorded from the treatment combination of V_3D_1, again the lowest (43.12%) was found from V_2D_2.

It may be concluded that growth, yield and yield contributing characters of BRRI hybrid dhan3**,** BRRI dhan45 and BRRI dhan63 were greatly influenced by variety and transplanting depth. Variety V_1 (BRRI hybrid dhan3) at transplanting depth 4 cm produced the longest panicle, maximum number of filled grains panicle-^{1} and highest the 1000 grains weight and ultimately provided maximum yields of BRRI hybrid dhan3. Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.

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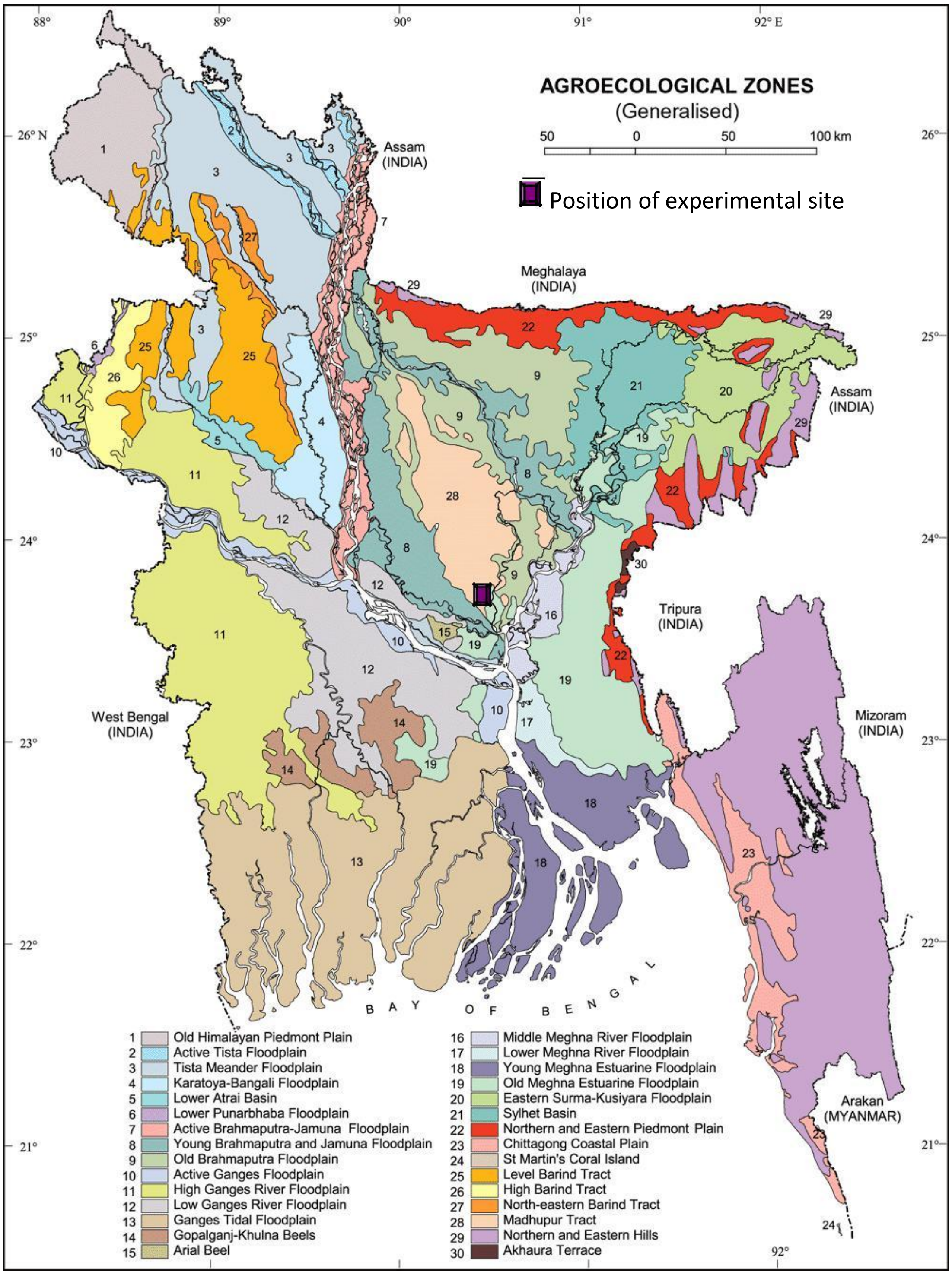
APPENDICES

Appendix I. Map showing the experimental sites under study



Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from November 2017 to April 2018.

Month	RH (%)	Air temperature (C)			Rainfall (mm)
		Max.	Min.	Mean	
November	65	32.0	19.0	26.0	35
December	74	29	15	22	15
January	68	26	10	18	7
February	57	15	24	25.42	25
March	57	34	16	28	65
April	66	35	20	28	155

(Source: timeanddate.com)

Appendix III. Morphophysiological and chemical characteristics of experimental soil

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), Farmgate, Dhaka.

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
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

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

Appendix IV. Calendar of operations

Field operation	Date
Initial soil sample collection from main field	19-11-2017
Preparation of nursery bed	23-11-2017
Sowing of sprouted seeds in nursery	24-11-2017
Puddling of main field	26-12-2017
Layout of main field	30-12-2018
Basal treatment application (Urea, TSP, MoP, and gypsum as soil application treatment)	01-01-2018
Transplanting	02-01-2018
Biometric observation at 30 DAT	02-02-2018
Insecticide application carbofuran 3G@1kg a.i ha^{-1}	06-02-2018
Biometric observation at 50 DAT	22-02-2018
Biometric observation at 80 DAT	24-03-2018
Biometric observation at harvest	07-05-2018
Net plot harvesting and threshing	09-05-2018
Harvesting of the bulk crop and threshing	22-05-2018
Drying of grain and straw plot wise	28-05-2018
Dry weight of straw and grain plot wise	04-06-2018

Appendix V. Analysis of variance of the data on plant height of Boro rice as influenced by combined effect of different variety and transplanting depth

Source of variation	df	Mean square of plant height (cm) at different days after transplanting (DAT)			
		30	50	80	At harvest
Replication	2	47.229	57.371	432.336	316.971
Variety (A)	2	12.866 NS	0.927 NS	468.211 NS	484.533 NS
Error	4	2.799	6.834	134.121	146.817
Transplanting depth (B)	3	2.463 NS	15.998*	11.421 NS	6.609 NS
Variety(A) X Transplanting depth (B)	6	8.947*	8.503*	9.246*	8.184*
Error	18	1.713	2.764	8.951	14.096

*Significant at 5% level of significance

NS Non significant

Appendix VI. Analysis of variance of the data on leaf area of Boro rice as influenced by combined effect of different variety and transplanting depth

Source of variation	df	Mean square of leaf area (cm^2) at different days after transplanting (DAT)			
		30	50	80	At harvest
Replication	2	1.214	7.304	23.802	4.789
Variety (A)	2	4.779 NS	48.756*	393.415*	769.522*
Error	4	1.952	8.268	40.571	51.958
Transplanting depth (B)	3	1.831*	44.985*	54.315 NS	17.289 NS
Variety(A) X Transplanting depth (B)	6	3.597*	12.286*	49.570*	35.979*
Error	18	0.510	7.550	31.628	24.251

*Significant at 5% level of significance

NS Non significant

Appendix VII. Analysis of variance of the data on dry weight of Boro rice as influenced by combined effect of different variety and transplanting depth

Source of variation	df	Mean square of dry weight hill^{-1} at different days after transplanting (DAT)			
		30	50	80	At harvest
Replication	2	0.708	126.327	385.290	199.951
Variety (A)	2	0.005 ^{NS}	0.026 ^{NS}	75.614 ^{NS}	467.534 ^{NS}
Error	4	0.041	8.162	38.116	135.573
Transplanting depth (B)	3	0.040 ^{NS}	6.412 ^{NS}	1108.857*	1841.026*
Variety(A) X Transplanting depth (B)	6	0.023*	9.887*	49.830*	225.737*
Error	18	0.048	6.867	55.406	195.770

*Significant at 5% level of significance

^{NS} Non significant

Appendix VIII. Analysis of variance of the data on Number of tillers hill^{-1} of Boro rice as influenced by combined effect of different variety and transplanting depth

Source of variation	df	Mean square of Number of tillers hill^{-1}at different days after transplanting (DAT)			
		30	50	80	At harvest
Replication	2	0.137	7.247	1.623	5.418
Variety (A)	2	0.413*	15.321*	19.517 ^{NS}	8.409 ^{NS}
Error	4	0.006	0.584	9.940	2.351
Transplanting depth (B)	3	0.407*	9.213*	5.920*	2.802 ^{NS}
Variety(A) X Transplanting depth (B)	6	0.339*	1.217*	5.181*	4.892*
Error	18	0.005	0.620	2.164	2.035

*Significant at 5% level of significance

^{NS} Non significant

Appendix IX. Analysis of variance of the data on number of effective tillers hill^{-1}, ineffective tillers hill^{-1}, total tillers hill^{-1} and panicle length (cm)of Boro rice as influenced by combined effect of different variety and transplanting depth

Source of variation	df	Mean square at different days after transplanting (DAT)			
		Effective tillers hill^{-1}	Ineffective tillers hill^{-1}	Total tillers hill^{-1}	Panicle Length (cm)
Replication	2	4.427	0.103	5.418	7.413
Variety (A)	2	7.918*	1.908*	8.409 ^{NS}	6.428 ^{NS}
Error	4	1.591	0.079	2.351	1.795
Transplanting depth (B)	3	3.071*	1.809*	2.802 ^{NS}	2.548 ^{NS}
Variety(A) X Transplanting depth (B)	6	2.026*	1.061*	4.892*	0.235*
Error	18	1.385	0.031	2.035	1.908

*Significant at 5% level of significance

^{NS} Non significant

Appendix X. Analysis of variance of the data on filled grains panicle-^{1}, unfilled grains panicle-^{1}, total grains panicle^{-1} and weight of 1000-grains (g) of Boro rice as influenced by combined effect of different variety and transplanting depth

Source of variation	df	Mean square at different days after transplanting (DAT)			
		Filled grains panicle-^{1} (No.)	Unfilled grains panicle-^{1} (No.)	Total grains panicle^{-1} (No.)	Weight of 1000 grains(g) (No.)
Replication	2	138.409	15.247	245.004	64.383
Variety (A)	2	1593.946*	68.605*	1082.381*	48.410*
Error	4	90.061	0.937	106.020	4.342
Transplanting depth (B)	3	256.600*	22.451*	153.340*	8.194*
Variety(A) X Transplanting depth (B)	6	33.592*	10.440*	76.222*	0.606*
Error	18	59.423	1.179	61.724	3.152

*Significant at 5% level of significance

^{NS} Non significant

Appendix XI. Analysis of variance of the data on grain yield, straw yield, biological yield and harvest index of Boro rice as influenced by combined effect of different variety and transplanting depth

Source of variation	df	Mean square at different days after transplanting (DAT)			
		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Replication	2	1.529	5.444	14.694	53.359
Variety (A)	2	10.379*	11.058*	39.523*	41.336 ^{NS}
Error	4	1.830	0.219	1.509	31.006
Transplanting depth (B)	3	0.709*	3.895*	7.835*	13.891 ^{NS}
Variety(A) X Transplanting depth (B)	6	0.405*	0.545*	1.002*	10.611*
Error	18	0.272	0.364	0.709	11.663

*Significant at 5% level of significance

^{NS} Non significant