RESPONSE OF HYBRID RICE VARIETIES TO THE SYSTEM OF RICE INTENSIFICATION (SRI) IN BORO SEASON

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CERTIFICATE

This is to certify that the thesis entitled ***"RESPONSE OF HYBRID RICE VARIETIES TO THE SYSTEM OF RICE INTENSIFICATION (SRI) IN BORO SEASON"*** *submitted to the Department of AGRICULTURAL BOTANY, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (M.S.)*** *in* ***AGRICULTURAL BOTANY,*** *embodies the results of a piece of bona fide research work carried out by* ***FATEMA YEASMIN,*** *Registration. No.* ***11-04648*** *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. Kamal Uddin Ahamed)
Supervisor

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RESPONSE OF HYBRID RICE VARIETIES TO THE SYSTEM OF RICE INTENSIFICATION (SRI) IN BORO SEASON

ABSTRACT

An experiment was conducted during the period of December 2015 to May 2016 at central agricultural research farm of Sher-e-Bangla Agricultural University Dhaka-1207, Bangladesh to study the response of hybrid rice varieties to the System of Rice Intensification (SRI) in *Boro* season. Treatment consisted of two factors; factor A consists of three levels of system of rice cultivation i.e.1. Low land transplant condition (T_1), 2. Raised upland condition (T_2), 3.Raised transplant condition (T_3); and factor B consists of five varieties i.e. BRRI hybrid dhan3 (V_1), Bolaka (V_2), Moyna (V_3), Gold (V_4), BRRI dhan45 (V_5). Results indicated that the highest values of vegetative growth i.e. plant height, leaves hill^{-1}, leaf area index, Chlorophyll content, tillers hill^{-1}, dry matter hill^{-1}; yield contributing character i.e. number of grains panicle^{-1}, 1000 grains weight, yield and harvest index were the highest in low land transplant condition (T_1) and in BRRI hybrid dhan3 (V_1). The combined effect of T_1V_1 gave the best result for all vegetative parameters and reproductive development. Therefore, low transplant condition (T_1) with BRRI hybrid dhan3 (V_1) could be the best the combination to get higher yield.

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LIST OF ACRONYMS

AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
Chl	Chlorophyll
CV%	Percentage of coefficient of variance
cv.	Cultivar
DAT	Days after transplanting
^0C	Degree Celsius
et al	And others
FAO	Food and Agriculture Organization
g	gram(s)
ha^{-1}	Per hectare
HI	Harvest Index
kg	Kilogram
mg	Milligram
MP	Muriate of Potash
N	Nitrogen
NS	Not significant
%	Percent
SAU	Sher-e-Bangla Agricultural University
SE	Standard Error
SRDI	Soil Resources and Development Institute
TSP	Triple Super Phosphate
LSD	Least Significant Difference

CHAPTER I

INTRODUCTION

In Bangladesh agriculture, rice (*Oryza sativa* L.) is the most dominant crop which covers about 77% of total cropped area. It has 7.85 million hectares of arable land, of which more than 70% is devoted to rice production and more than 90% of the population depends on rice as their major food crop (BBS, 2015). Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. The population of Bangladesh is increasing at an alarming rate and the cultivable land is reducing due to urbanization and industrialization resulting in more shortage of food. The nation is losing 0.7% of cropping land and adding about 2.3 million people every year (Momin and Husain, 2009). The country produces 1.2 million tons food deficits every year (Julfiquar, 2014). Under the above scenario, there is no opportunity to increase rice area consequently; much of the additional rice required will have to come from higher average yield on existing land. Clearly, it will require adoption of new technology and to produce 50 million ton of rice by 2030, the yield should be increased to 5.5 t ha^{-1} compared to 3.25 t ha^{-1} at present (Hossain, 2015).

Rice is the major food grain for more than one third of the world's population (Prasertsak and Fukai, 1997). About 75% of the world's rice supply comes from 79 million hectares of irrigated rice production in Asia (Cabangon *et al*., 2002). However, rising labor costs and the need to intensify rice production through double and triple cropping provide economic incentives for a switch to alternative establishment methods (De Datta, 1986), such as direct sowing, mechanism transplanting, seedling broadcasting or a combination of methods. Simultaneously, the availability of high-yielding, short-duration varieties and chemical weed control methods have made such a switch technically viable (Pandey and Velasco, 2002). Changes in crop establishment have important implications for farm operations, including primary tillage, seedbed preparation, planting, weeding, and water management (Ergiuza *et al*., 1990), that have a considerable impact on rice growth, especially seedling development and rice canopy structure establishment (Saha and Bharti, 2010). In the transplanting system, including manual transplanting and mechanical transplanting, rice seedling development is generally delayed due to injuries to the root caused by uprooting and replanting (Salam *et al*., 2001). Furthermore, the balance between water and transpiration in seedlings also changes, causing the leaves to wilt or partly die (Sasakawa and Yamamoto, 1978). Therefore, the growth and development of the seedlings become stagnant temporarily; this is the so-called "transplanting shock" (Sasakawa and Yamamoto, 1978; Salam *et al*., 2001). In the seeding broadcasting system, seedlings are grown in a nursery or plate, and at 15-20 days old, they are broadcast manually to the puddled field. The seedlings take root and begin to grow upright 2-3 days later. Their root growth into the soil is shallow and as a result the young plants are distributed randomly throughout the feld (Zhang *et al*., 1998; Dai *et al*., 2001). Accordingly, most of the seedling roots are concentrated in the upper layer of soil and are supposed to be sensitive to chemical fertilizer (Dai *et al*., 2001; Zhang *et al*., 2008). However, due to the lower level of injuries during replanting, the revival time of rice seedlings that have been broadcast is shorter than that of transplanted seedlings, and tillers appear rapidly with vigorous roots (Zhang *et al*., 2008). These traits were also partly found in direct seeded (DS) rice, which has been reported to have a shorter time from seeding to mid tillering/heading stage (Pandey and Velasco, 2002), shallow but vigorous root activity and greater biomass production at its early stage (Naklang *et al*., 1996). Changes in rice establishment generally result in marked differences in seedling/tillering characteristics at the vegetative stage which will ultimately affect the grain yield as well as the efficiency of utilization of resources, such as fertilizer, water and/or solar energy (Zhang *et al*., 2008; Chandrapala *et al*., 2010; Saha and Bharti, 2010). Rice establishment is also sensitive to agronomic practices such as planting density, water and fertilizer management, weed control alone or in combination. The system of rice intensification (SRI), a widely used but controversial rice cultivation method developed in Madagascar during the early 1980s (Dobermann, 2004; Sheehy *et al*., 2004; Stoop *et al*., 2009; Uphoff *et al*., 2009; Kassam *et al*., 2011), has generated considerable global debate. According to Stoop *et al*. (2002), SRI is not a fixed technological package, but rather a set of principles for raising the productivity of all of the factors involved in rice production, including land, labor, capital, seed and water. These principles include (1) careful transplanting of young seedlings at wide spacing on a precise grid with only one seedling per hill; (2) water management that keeps the soil moist but not continuously flooded; (3) frequent (i.e., three to four times during the growth period) manual or mechanical weeding before canopy closure; and (4) reliance on high rates of organic compost for fertilizer. The purpose of using young seedlings, wide spacing and a single seedling per hill was to provide enough resources for stronger individual plants in the rice group, which attracted the interest of Chinese agronomists. In traditional agronomic practice, a large crop population is achieved through heavy planting density of the land race variety. The use of organic fertilizer and intermittent irrigation also results in high grain yield and high resource utilization.

Recently, System of Rice Intensification (SRI) has attracted attention because of its apparent success in increasing rice yield. System of Rice Intensification (SRI) is a technique or a set of practices and principles rather than as a 'technology package' (Uphoff, 2004). SRI raises productivity not by relying on external inputs, e.g., new seeds and fertilizer, but by changing the way farmers manage their rice plants, soil, water and nutrients (Uphoff, 2005). With SRI management practices control or modify the microenvironment and the obvious advantage from SRI appears to be the yield increase in farmers field without any new seeds or chemical and mechanical inputs (Stoop, *et al.*, 2002). Hybrid rice has 15-30% higher yield potential over inbred rice varieties (BRRI 2014; Zhang, 2008; Abou-Khalifa *et. al*. 2007). To increase production, more hybrid rice is to be cultivated in *Boro* season. The economy of Bangladesh is remarkably influenced by rice and it was grown in about 12.95 million hectares of land with total production of about 26.19 million tons of yield. SRI is claiming to be a superior technology (Barrett *et al.,* 2004) which can increase the yield to a fantastic level (Sheehy *et al.,* 2004). This research program has been prepared to evaluate the performance of hybrid rice varieties under SRI in *Boro* season. Implementation of this research work will provide new information on hybrid rice cultivation. And this information would encourage cultivating more hybrid rice under SRI techniques. Considering the above mentioned factors, the proposed research work has been planned with the following objectives.

Objectives

1.To evaluate the growth and yield performance of hybrid rice varieties following System of Rice Intensification (SRI) cultivation method.

2.To identify the suitable hybrid variety(s) for cultivation following System of Rice Intensification (SRI) method.

CHAPTER II

REVIEW OF LITERATURE

The present experiment was conducted to study the response of hybrid rice varieties to the System of Rice Intensification (SRI) in *Boro* season. Some related literatures are discussed in this chapter.

Pandian *et al*. (2014) reported that, system of Rice Intensification (SRI) is a holistic agro-ecological crop management technique seeking alternatives to the high-input oriented agriculture and one among the scientific management tool of allocating irrigation water based on soil and climatic condition to achieve maximum crop production per unit of water applied over a unit area in unit time. System of Rice Intensification was the main focus technology demonstrated by Water Technology Centre (WTC), Tamil Nadu Agricultural University (TNAU) under Irrigated Agriculture Modernization and Water Bodies Restoration and Management (TN-IAMWARM) Project. The widespread adoption of SRI showed increasing trend in yield (from 28.3% in 2007-08 to 32.4% in 2010-11). The results of beneficiary wise analysis indicated that more beneficiaries reaped 40-50% yield increase followed by 20-30% yield increase over conventional. The data obtained from large scale demonstrations clearly indicated that the water requirement was less under SRI (885 mm) as compared to conventional (1180 mm). The demonstration of SRI technologies registered higher grain yield and Water Use Efficiency (WUE) of 6,406 kg ha^{-1} and 7.31 kg ha^{-1} mm^{-1}, respectively as compared to conventional (5,284 kg ha^{-1} and 4.51 kg ha^{-1} mm^{-1}). The water productivity in SRI was found to be 1,398 as against 2,274 lit. kg-1 in conventional irrigation.

Omwenga *et al*. (2014) stated that, the irrigated rice cultivation has long been associated with large amounts of water. The System of Rice Intensification (SRI), as opposed to conventional rice production, involves alternate wetting and drying (AWD) of rice fields. The objective of this study was to determine the optimum drying days period of paddy fields that has a positive effect on rice yields and the corresponding water saving. The experimental design used was randomized complete block design (RCBD). Four treatments and the conventional rice irrigation method were used. The treatments were the dry days allowed after draining the paddy under

SRI before flooding again. These were set as 0, 4, 8, 12 and 16 day-intervals. Yield parameters were monitored during the growth period of the crop where a number of tillers, panicles, panicle length and panicle filling were monitored. Amount of water utilized for crop growth for each treatment was measured. Average yield and corresponding water saving were determined for each treatment. The results obtained show that the 8 days drying period gave the highest yield of 7.13 tons/ha compared with the conventional method of growing rice which gave a yield of 4.87 tons/ha. This was an increase of 46.4% above the conventional method of growing rice. Water saving associated with this drying regime was 32.4%. This was taken as evidence that SRI improved yields with reduction in water use.

Chen *et al*. (2013) reported that, the impacts of the system of rice intensifcation (SRI) and conventional management (CM) on grain yield, yield components and tillering capacity were examined under 4 rice establishment methods transplanting (TP), seedling casting (SC), mechanical transplanting (MT) and direct seeding (DS). SRI produced significantly higher grain yield than CM under TP and MT but not under DS or SC. SRI produced a higher tillering rate than CM but did not affect ear-bearing tiller rate significantly. The obtained results also indicated that SRI increased biomass accumulation before heading and improved utilization of photosynthates in the grain-filling stage.

Reddy and Shenoy (2013) found that, the System of Rice Intensification (SRI), developed in Madagascar is gaining increasing credence and momentum as the farmers are now using its methods to raise their rice production while also reducing their use of external inputs and production costs. This paper focuses on this agronomic opportunity that can be particularly beneficial for resource-limited households. In the sample area positive impact of SRI technology was observed on sample farmers followed the suggested wider spacing of 25×25cm or 30×30cm, and by using 8-12 days seedlings, weed management, and sample farmers completely adopted the suggested water management practice, weed management practice and by applying the suggested quantity of organic manure. Saving on seed cost as the seed requirement is less, saving on water as irrigated, higher yields due to profuse tillering, increased panicle length and grain weight. However, the farmers expressed difficulty in adopting SRI on two counts, viz., labor scarcity and weed menace. These constraints have to be addressed to enable wider adoption of SRI technology by more number of rice cultivators.

Singh *et al.* (2011) indicated that ten days old seedling being at par with 20 days old seedling recorded maximum grain yield and straw yield.

Metwally *et al.* (2011) revealed that Giza 178-3 gave the highest values of no. of filled grain/panicle and no. of panicles/hill under low input of nitrogen.

Manjunatha *et al.* (2010) younger seedlings of 9 days and 12 days produced significantly higher grain yield than other aged seedlings viz., 15 days, 18 days and 21 days.

Ahmadikhah and Mirarab (2010) found that the effect of variety was significant for all of traits, except for thousand seed weight and biomass weight, totally indicating that varieties respond differentially to cultural practices. Breeding variety produced more yield than local one, although local variety also produced its maximum yield. Local variety had an invariable response to different levels of nitrogen, while breeding variety had a variable response. Breeding variety had maximum biomass in 15 cm spacing and local variety did not differentially respond to spacing level.

Kumar *et al*. (2009) stated that, System of Rice Intensification (SRI) developed in Madagascar 25 years ago is gaining wider acceptance in many countries including India. SRI method claims to greatly enhance water productivity and grain yield but there is lack of understanding of scientific principles underlying. Hence, in SRI method was evaluated across the country at 25 locations for four years. Results clearly indicated 7-20 per cent higher grain yield over the traditional irrigated transplanted rice. The varieties having better tillering ability and hybrids were found promising and recorded higher grain yield over HYVs with moderate tillering and scented cultivars. Root volume, dry mass, and dehydrogenase activity in soil (measure of microbial activity) was found to be higher in SRI method as compared to conventional method. SRI method reduced the seed rate by 80%, water requirement by 29% and growth duration by 8-12 days; thereby enhancing the water productivity and per day productivity of rice cultivars.

Hanumanthappa *et al.* (2009) indicated that twelve-day-old seedlings resulted in the highest number of tillers at 60 days after transplanting or (DAT) and grain yield.

Krishna and Biradarpatil (2009) found that twelve-day-old seedlings produced higher number of tillers, number of Panicles and productive tillers per plant during harvesting compared to 8-, 16- and 25-day-old seedlings.

Manjunatha *et al.* (2009) noticed that Crops grown with 9- and 12-day- old seedlings recorded the significant highest grain yields over the rest of the treatments.

Krishna and Biradarpatil (2009) found that the 12 days seedlings produced more number of tillers per plant and productive tillers per plant. Wider spacing of 40x40 cm found to have significant influence on growth parameters. Significantly higher seed yield per ha was produced by 12 days seedlings. The treatment combination of 12 days old seedling with wider spacing recorded maximum seed yield per ha. The seeds produced by transplanting of 12 days old seedlings with wider spacing recorded significantly higher germination and vigour index values.

Kumar *et al.* (2008) reported that the Pusa RH.6 recorded higher grain and straw yields, than Pusa RH.10. With regard to seedling age, 20-day-old seedlings resulted in the highest grain and straw yields. Among the planting densities, 25 plants/m resulted in the highest grain yield, whereas 50 plants/m resulted in the highest straw yield. The interaction between treatments revealed that the highest grain yields were obtained with Pusa RH.6 planted at 25 plants/m, and with 20-day-old seedlings planted at the same density.

Kumar *et al.* (2008) showed that the Pusa RH-6 cultivar proved significantly superior, recording higher values of growth and yield attributes, and resulted higher grain and straw yields. Transplanting of 20 days old seedlings exhibited higher growth and yield parameters and registered higher grain yield over 30 days old seedlings. Plant density of 25 plants/m appeared more appropriate and yielded higher grain yield over 33 and 50 plants/m. Interaction effect further indicated that transplanting of 20 days old seedlings at 25 plants/m was the most appropriate combination to realize high yield from hybrid rice.

Chandrakar *et al.* (2008) indicated that the youngest seedlings resulted in the lowest number of days to greatest number of productive tillers per plant, plant height, panicle length and number of seeds per plant.

Kumar *et al.* (2008) found that the seedling age had significant effect on yield, and a higher mean grain yield was obtained with 30-day-old seedlings (28% increase over 40-day-old seedlings).

Pasuquin *et al.* (2008) showed that grain yield was consistently higher for younger seedlings, with, in some cases, a difference as large as 1 t ha between 7- and 21-day transplanting. In contrast, no significant difference was observed for the influence of nursery type on the timing of tiller emergence and on grain yield. Some differences in seedling vigor (plant dry weight, specific leaf area, N content), higher in the case of dapog and wet bed, and in maximum tillering, higher in the case of the seedling tray, however, were observed. But these differences did not have a significant impact on the late increase in crop dry matter and on panicle number at maturity.

Raj *et al.* (2008) found that 14-day-old seedlings recorded significantly higher plant height, number of productive tillers, number of Panicles, number of grains per panicle and 1000-grain weight than older aged seedlings.

Reddy *et al.* (2008) found that 12 days old of seedlings showed maximum no. of tillers/hill, dry weight no. of productive tillers/m, length of panicle, grain yield and straw yield.

El-Maksoud (2008) noticed that the rice cultivars differed in their growth, grain yield, yield components and quality characters.

Abou-Khalifa *et al.* (2007) indicated that H1 hybrid rice variety surpassed other varieties for straw yield and grain yield (Ton/ha).

Rao *et al.* (2007) indicated that transplanting of 45 days old seedlings recorded significantly higher gross returns as well as net returns as compared to 30 and 60 days old seedlings in rice and rice-green gram system.

Upadhyay *et al.* (2007) the youngest seedlings resulted in higher number of effective tillers per hill, panicle length, number of grains per panicle and grain yield than the other seedlings.

Amin *et al.* (2007) noticed that the yield and yield contributing characters were influenced by seedling age, variety and their interaction. BRRI-38 cultivar gave the highest number of effective tillers/hill, panicle length, total spikelets panicle, grains panicle, 1000-grains weight and grain yield. Likewise, yield and yield contributing characters were the highest in youngest seedling. On the other hand, the variety (BRRI-38) with the same age as of seedlings 35 days old seedlings was found superior to other interactions, but, in the production of grains panicle and 1000-grains weight there was no significant effect in this interaction. From the findings it may be inferred that BRRI-38 with 35 days old seedlings produced the highest grain yield.

El-Rewainy *et al.* (2007) have shown that the youngest seedling, at panicle initiation stage, recorded the highest significant values of grain yield and most of its components of both cultivars (Sakha 101 and Sakha 102), while, the oldest seedling gave the tallest plants.

Mobasser *et al.* (2007) noticed that the effect of seedling age on the total number of tillers and number of panicles/m was significant probability level. The seedling age had a significant effect on the number of fertile tillers probability level. The spacing had a significant effect on the total number of tillers, number of fertile tillers, number of panicles/m, total number of spikelets per panicle, and grain yield. For this cultivar, transplanting of 25-day-old seedlings at a spacing of 15x15 cm is optimum with regard to yield attributes.

Reddy *et al.* (2007) reported that, data were recorded for panicles per m, grains per panicle, grain weight per panicle, sterility, panicle length, grain yield, days to physiological maturity, water requirement, cost of cultivation, net returns and returns per rupee invested. Although traditional cultivation produced the highest grain yield in Tellahamsa and BPT 5204, SRI also yielded on par to that of traditional cultivation.

Shen *et al.* (2006) noticed that the effect of seedling age on seedling quality and yield was predominant. The trend of grain yield reduction was obvious when seedling age was extended from 16 to 21 days after sowing.

Jamil *et al.* (2006) found that the highest mean grain yields were obtained with 35- and 42-day-old seedlings. Among the cultivars, SRI-13 registered the lowest mortality rate. PB-95 was superior with regard to the average plant height, number of grains per panicle and grain yield. The average number of fertile tillers was highest for PB-95 and SRI-8. Shaheen Basmati, PB-95 and SRI-8 recorded the highest 1000-grain weights.

Vijayakumar *et al.* (2006) reported that the treatment combination of 14 days old seedlings planted at 25x25 spacing+water-saving irrigation and SRI weeding significantly recorded the tallest plants, highest total dry matter production and greatest leaf area index. However, the tiller density per m was significantly highest in the treatment combination of 14 days old seedlinggs+15x10 cm spacing+water-saving irrigation+conventional weeding. During wet season, the number of days to first flowering was 85 days in the treatment combination of 14 days old seedlings planted at 20x20 cm spacing+conventional irrigation, the combination of 14 days old seedlings from dapog nursery planted at a spacing of 15x10 cm under limited irrigation of 2 cm on hair-line crack development+conventional weeding recorded 80 days to first flowering. Between panicle initiations (PI) to flowering (FL) and between FL to maturity stage the crop growth rate, relative growth rate and net assimilation rate were significantly increased by the treatment combination of 14 days old seedlings, wider spacing of 25x25 cm, limited irrigation of 2 cm with incorporation of weeds and disturbing the soil through SRI weeding.

Doni *et al*. (2005) reported that, System of Rice Intensification(SRI) is an agroecologically sound rice cultivation method that has been proven to improve yield and support Sustainable rice farming towards achieving green economy. A study was conducted to evaluate the impact of SRI practices from an agroecological perspective in Kampung Kesang Tasek, Ledang, Johore. The results showed that SRI significantly increases the number of rice tillers, plant height, filled grains and 1000 grain weight, and increase rice productivity up to 7.58 ton/ ha, increase the number of soil beneficial microbes, as well as insect biodiversity. The results proven that SRI should be considered as a potential cultivation method for sustainable rice production. The volunteer of the farmers to try this cultivation method support the success of this effort.

Uphoff (2005) concluded that the wider spacing between hills gives a higher population than in a standard square pattern with one plant per hill. When asked about the expected yield from these plots. The duration of the variety being used is 158 days, but he expects the SRI crop to mature in <152 days.

Ingale *et al.* (2005) noticed that transplanting two seedlings per hill at 20x15 cm spacing produced significantly a higher yield than transplanting of one seedling per hill. The above treatment combinations resulted in the highest net returns and benefit: cost ratio. Transplanting two 25-day-old seedlings per hill at 20x15-cm spacing with 150 kg N/ha is recommended for the commercial cultivation of Sahyadri rice hybrid.

El-Kady and Abdallah (2004) indicated that the milling recovery of Sakha 102 was higher than that of Giza 178 for all planting methods except transplanting.

Singh *et al.* (2004) revealed that the highest yield was obtained in plots with 21-day-old seedlings, followed by 31-day-old seedlings. Seed yield and quality reduction was observed in seedlings aged 31 days and higher. Seedlings aged 41 days produced poor quality seeds that showed below standard germination capacity.

Abdel-Rahman *et al.* (2004) indicated that. Giza 178 showed the highest panicle length, panicle dry weight, number of filled grains/panicle and grain yield (t/ha). GZ 1368 gave the highest values of plant height, number of panicles/m and straw yield while.

Uphoff (2004) noticed that young seedlings (15 days) produce larger, more productive mature plants. This can be explained in terms of the physiology of phyllochrons, transplanting during the 2nd or 3rd phyllochron so as to disturb the plant minimally and preserve maximally its potential for tillering and root growth.

Chopra and Chopra (2004) noticed that wider spacing of 20 × 15 and 30 × 15 cm recorded significantly higher number of panicales than the closer spacing 15 × 15 cm. However, the seed yield was not affected due to different spacing.

Uphoff (2004) found that the yield increased significantly, optimum performance with SRI methods has not yet been obtained. Optimum yield depends on spacing and the most appropriate management practices with the best selected variety for the particular conditions.

Rahaman *et al.* (2004) found that 20-day-old seedlings of photo- insensitive early cultivars Narendra 97 and IR 36, and 30-day-old seedlings of photo-sensitive late cultivars Swarna (MTU 7029) and Gayatri (CR 1018) recorded the highest yields, 1000-seed weight, and seed germination and seedling vigour index. During the boor season, 45-day-old seedlings of Narendra 97 and IR 36, and 45- and 55-day-old seedlings of Swarna and Gayatri recorded the highest seed yields, seed germination and vigour index.

Upadhyay *et al.* (2003) noticed that growing of 20 and 30-day-old seedlings produced significantly higher grain yield over growing of 40 - and 50- day-old seedlings.

Nayak *et al.* (2003) revealed that wider spacing of 20 × 15 cm recorded maximum plant height, total and effective tillers per hill and dry matter accumulation per clump than that closer spacing of 20 × 10 and 15 × 15 cm.

Rajesh and Thanunathan (2003) reported that crop planted with wider spacing of 20 × 15 cm recorded significantly higher grain yield as compared to crop planted with closer spicing of 20 × 10 and 15 × 15 cm.

Rajesh and Thanunathan (2003) noticed that the seedling age (30, 40 and 50 days) and spacing (20x15, 20x10 and 15x15 cm) were tested. Planting of 40-day-old seedlings with a spacing of 20x15 cm recorded the maximum grain yield.

Uphoff (2003) reported that water productivity was definitely highest with SRI, and also yield (though the latter not by a large margin, for reasons not clear to me given experience elsewhere; possibly this is another case where on- station soil conditions inhibit soil microbiological dynamics compared to what is possible on farmers' fields).

Chopra *et al.* (2002) reported that the thirty-five-day-old seedlings had greater number of panicles per hill, panicle length, 1000-seed weight, test weight, and seed yield than 55- to 65-day-old seedlings.

Makarim *et al.* (2002) found that 15-day old seedlings gave significantly higher grain yields than 21-d-old seedlings when a single seedling was planted $hill^{-1}$.

Verma *et al.* (2002) found that crop planted with 20 × 20 and 20 × 15 cm produced significantly more number of productive tillers per m^2 than the crop planted with 20 × 10 cm.

Fernandes and Uphoff (2002) reported that SRI cultivation has a yield advantage of over local practices. The yield beneficial effect of SRI is reflected in terms of increased yields, increased returns from labour, water saving, improvement of soil quality, reduced requirements of seeds, lowered cost of production, better food quality and environmentally safety are the feature of SRI cultivation.

Kewat *et al.* (2002) reported that the transplanting seedlings at the closest spacing of 20x10 cm produced significantly highest grain and straw yields and benefit than the wider spacing of 20x20 cm and 20x15 cm but was comparable to the 15x15 spacing. Similarly, transplanting of 21- and 28-day-old seedlings recorded significantly higher grain and straw yields, net monetary returns and benefit: cost ratio than transplanting of thin and lanky 14-day-old seedlings.

Rafaralahy (2002) reported grain yields above under SRI (with wider spaces and hybrid rice) method as compared to traditional method. The increase in the yield with SRI was attributed to the increase in number of ear bearing tillers per hill, total number of spikelets per panicle and panicle length.

Pattar *et al.* (2001) discriminated that planting of 35- or 45-day-old seedlings produced significantly higher yields, grain weight and number of filled grains per panicle compared to 25-day-old seedlings. When transplanting was delayed to the second fortnight of August, the performance of both 35- and 45- day-old seedlings was greater than that of 25-day-old seedlings.

Patra and Nayak (2001) found significantly higher panicle per m^2, grain yield and straw yield with closer spacing of 15 × 10 cm as compared to with wider spacing of 20 × 10 cm. However, panicle length, weight per panicle and 1000-grain weight did not influenced significantly by the spacing.

Pandey *et al.* (2001) reported that closer spacing of 15 × 10 cm resulted more grain yield than the wider spacing of 20 × 10 cm.

Molla *et al.* (2001) Stated that twenty-eight-day-old seedlings produced more tiller, panicles/m, and grain yield than 21-day-old seedlings.

Geethadevi *et al*. (2000) noticed that maximum grain yield was obtained with 20 × 10 cm spacing than that 15 × 10 cm spacing.

Geethadevi *et al.* (2000) found that rice crop planted with 20 × 10 cm spacing produced significantly more effective tillers per hill than the crop planted with 15 × 10 and 10 × 10 cm.

Shrivastava *et al*. (1999) revealed that more panicle length, filled grains per panicle, 1000-grain weight and grain yield was recorded with closer spacing of 15 × 10 cm as compared with wider spacing of 20 × 10 and 20 ×15 cm.

Siddiqui *et al.* (1999) recorded significantly higher grain and straw yield with closer spacing of 10 × 10 cm over the wider spacing of 20 × 10 cm.

Abdel-Rahman (1999a) noticed that Giza 178 produced the highest panicle length, number of filled grains/panicle, number of panicles/m, grain and straw yields.

Abdel-Rahman (1999b) revealed that Giza 178 produced the highest number of panicles/m^2, number of filled grains/panicle, grain and straw yields.

Padmaja and Reddy (1998) recorded significantly higher grain yield with 15 × 15 cm spacing than that with 20 × 15 cm spacing. They were also found significantly more filled spikelets per panicle with wider spacing of 20 × 15 cm as compared to that closer spacing of 15 × 15 cm.

Sanico *et al.* (1998) concluded that plant spacing (20 × 20, 20 × 30, 15 × 30 and 10 × 30 cm) gave no significant differences on yield components.

Liu *et al.* (1997) found that wider spacing 16.5 × 19.8 cm plant spacing was significant effect on all character under this study.

Samdhia (1996) recorded no significant effect of spacing (20 × 10, 15× 15 and 20 × 15 cm) on harvest index. However, maximum harvest index was obtained with wider spacing.

Krishnan *et al.* (1994) more panicle length was found with wider spacing of 20 × 10 cm than the closer spacing of 15 × 10cm.

Verma *et al.* (1988) found significantly higher harvest index with lower plant density 27 hills per m^2 (25 × 15 cm) than that with higher plant density of 44 hills per m^2 (15 × 15 cm).

Sukla *et al.* (1984) recorded more fertile grains per panicle and length of panicle with wider spacing (30 × 10 cm) as compared to that with closer spacing.

Ferraris *et al.* (1973) found that plant spacing (25 × 25, 25 × 12.5 and 25 × 6.25 cm) did not influenced grain yield significantly.

CHAPTER III

MATERIALS AND METHODS

The study was conducted at research field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh from December 2015 to May 2016 to study the response of hybrid rice varieties to the system of rice intensification (SRI) in *Boro* season. This chapter will deal with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recording and data analysis.

3.1. Experimental site

The study was conducted at research field of Sher-e-Bangla Agricultural University, Dhaka, under the Agro-ecological zone of Modhupur Tract, AEZ-28. The location of the site is $23^0 74^/$N latitude and $90^0 35^/$E longitude with an elevation of 8.2 meter from sea level.

3.2. Climate and weather

The geographical location of the experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October. Details of the meteorological data of air temperature, relative humidity and rainfall during the period of the experiment were collected from the SAU mini weather station, Sher-e-Bangla Agricultural University, Dhaka presented in Appendix I.

3.3. Soil

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

3.4. Plant materials

In this research work, fours hybrid rice varieties and one inbreed variety were used as plant materials. The rice varieties used in the experiment were BRRI hybrid dhan3, Bolaka, Moyna, Gold and BRRI dhan45 (check). The seeds were collected from the Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh.

3.5. Experimental details

3.5.1. Treatments

Two factor experiment was conducted to evaluate the performance of some hybrid rice varieties in *Boro* season.

Factor A: System of cultivation (main plot)

i. T_1= Low land transplant condition

ii. T_2= Raised upland condition

iii. T_3= Raised transplant condition

Low land transplant condition (T_1) with 33 days old seedling transplanting of traditional cultivation method in anaerobic condition plot was quite low than raised upland condition (T_2). In SRI method, raised upland condition (T_2) with 18 days old seeding transplanting in aerobic condition and raised transplant condition (T_3) 33 days old seeding transplanting in aerobic condition. Treated plot to be considered as low land condition as the plot was submerged during irrigation. T_2 and T_3 plots were prepared as wet with free flow of water during irrigation. Unit plots were divided from each other with free flow irrigation and drainage channel. Most of the time the channel was filled with water in such a level that the low land plot was kept ponded up to the hard dough stage of the crop. In contrast, the Raised upland and Raised transplant plots were kept the soil moist but non-continuously flooded throughout growing season. These plots were saturated with free horizontal flow of water from channel. However, the whole field was encircled with an outlet to drain excess water if there was rain.

Factor B: Rice varieties (sub plot)

i) V_1= BRRI hybrid dhan3

ii) V_2= Bolaka

iii) V_3= Moyna

iv) V_4= Gold

v) V_5= BRRI dhan45(check)

3.5.2 Experimental design

The experiment was laid out in Split Plot Design (SPD) with three replications. The layout of the experiment was prepared for distributing the varieties. There were 45 plots for this experiment having plot size 2.5 m × 4 m in each of 3 replications.

The treatments of the experiment were assigned at random into each block following the experimental design. Seedlings were sown in the seed bed. When age of seedling was 33 days for T_1, 18 days for T_2 and 33 days for T_3 then up rooted and transplanted maintaining line to line distance 20 cm and hill to hill distance 20 cm. Two seedlings hill^{-1} were used during transplanting.

3.6. Growing of crops

3.6.1. Raising of seedlings

3.6.1.1. 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.

3.6.1.2. Preparation of nursery bed and seed sowing

As per BRRI recommendation seedbed was prepared by puddling and repeated ploughing along with laddering. It was got ready with 1 m wide adding nutrients as per the requirements of soil. Seed were sown in the seed bed @ 70 g m^{-2} on 14 December, 2015. Weeds were removed and irrigation was gently supplied to the seedbed as when necessary.

In SRI method, seeds were sown in five portable trays containing soil and cow-dung for each variety on 14 December, 2015. Thin plastic sheets were placed at the base of the trays to protect water loss and applying water every day, which ensured proper growth of all the seedlings with proper moisture. These trays were kept inside a room at night and kept in sunlight at daytime for proper growth of seedlings. A mosquito net was used to cover the five trays to protect the seed from birds.

3.6.2. Preparation of the main field

The plot selected for the experiment was opened in December 2015 with a power tiller, and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed, and finally obtained a desirable tilth of soil for transplanting of seedlings.

3.6.3. Fertilizers and manure application

The following doses of manure and fertilizers (BRRI, 2013) were used.

Manure and Fertilizer	Doses
Cowdung	5 t ha^{-1}
Urea	220 kg ha^{-1}
TSP	165 kg ha^{-1}
MoP	180 kg ha^{-1}
Gypsum	70 kg ha^{-1}
Zinc	10 kg ha^{-1}

Whole amount of cow-dung, TSP, MP, Gypsum and Zinc and one third of urea were applied at the time of final land preparation following broadcasting method. Half of the rest two third of urea was applied at 20 DAT and the rest amount of urea was applied at 45 DAT.

3.6.4. Uprooting of seedlings

The nursery bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted without causing much mechanical injury to the roots.

3.6.5. Transplantation of seedlings in the field

The seedlings were transplanted in the main field and the rice seedlings were transplanted in lines each having a line to line distance of 20 cm and plant to plant distance was 20 cm for all varieties in the well-prepared plot.

3.6.6. Cultural operations

The details of different cultural operations performed during the course of experimentation are given below:

3.6.6.1. Irrigation and drainage

Three water regimes namely, low land transplant (kept flood during irrigation), raised upland, raised transplant were kept the soil moist with free of horizontal flow of coater from channel.

3.6.6.2. Gap filling

Gap filling was done for all of the plots at 7-10 days after transplanting (DAT) by planting same aged seedlings.

3.6.6.3. Weeding

First weeding was done from each plot at 15 DAT and second weeding was done from each plot at 40 DAT. Mainly hand weeding was done from each plot.

3.6.6.4. Plant protection

Furadan 57 EC was applied at the time of final land preparation and Dimecron 50 EC was applied at 30 DAT.

3.7. Harvesting, threshing and cleaning

The rice plant was harvested depending upon the maturity of grains and harvesting was done manually from each plot. Maturity of crop was determined when 80-90% of the grains become golden yellow in color. Ten pre-selected hills per plot from which different data were collected and 3 m^2 areas from middle portion of each plot was separately harvested and bundled, properly tagged and then brought to the threshing floor. Enough care was taken for harvesting, threshing and also cleaning of rice seed.
Fresh weight of grain and straw were recorded plot wise. Finally, the weight was adjusted to a moisture content of 12%. The straw was sun dried and the yields of grain and straw $plot^{-1}$ were recorded and converted to t ha^{-1}.

3.8. Data recording: Different data were recorded from the following parameters

A. Plant height (cm)
B. Number of leaves $hill^{-1}$
C. Leaf area index
D. Chlorophyll content
E. Number of tillers $hill^{-1}$
F. Number of effective tillers $hill^{-1}$
G. Number of non-effective tillers $hill^{-1}$
H. Dry matter $hill^{-1}$
I. Grains $panicle^{-1}$
J. Weight of 1000 grains
K. Grain yield (t ha^{-1})
L. Harvest index (HI)

3.8.1. Plant height

The height of plant was recorded in centimeter (cm) at the time of 75 DAT (days after transplanting) and at harvest. Data were recorded as the average of same 5 hills selected at random from the outer side rows (started after 2 rows from outside) of each plot. The height was measured from the ground level to the tip of the plant.

3.8.2. Leaves hill^{-1}

The number of leaves hill^{-1} was recorded at 75 DAT (days after transplanting) and at harvest by counting total leaves as the average of same 5 hills pre-selected at random from the inner rows of each plot.

3.8.3. Leaf area index

Leaf area index was estimated manually at the maximum growth stage and that was at 75 DAT. Data were collected as the average of 5 plants, selected from middle of each row. Final data were calculated multiplying by a correction factor 0.75.

3.8.4. Chlorophyll content

Flag leaves were sampled at 6 days after flowering and a segment of 20 mg from middle portion of leaf was used for chlorophyll analysis. Chlorophyll content was measured on fresh weight basis extracting with 80 % acetone and used beam spectrophotometer (Model: U-2001, Hitachi, Japan) according to Witham *et al.* (1986). Amount of chlorophyll was calculated using following formulae.

$$\text{Chlorophyll a (mg g}^{-1}) = [12.7\ (OD_{663}) - 2.69\ (OD_{645})] \times \frac{V}{1000\,W}$$

$$\text{Chlorophyll b (mg g}^{-1}) = [12.9\ (OD_{663}) - 4.68\ (OD_{645})] \times \frac{V}{1000\,W}$$

Where,

OD = Optical density of the chlorophyll extract at the specific wave length.

V = Final volume of the 80% acetone chlorophyll extract (ml)

W = Fresh weight in gram of the tissues extracted.

The total chlorophyll was calculated with the following formula:

$$\text{Total Chlorophyll (mg g-1)} = [20.2\ (OD_{645}) - 8.02\ (OD_{663})] \times \frac{V}{1000\,W}$$

Chlorophyll a: b: Chlorophyll a:b was estimated by dividing chlorophyll a by chlorophyll b.

3.8.5. Tillers hill^{-1}

The number of tillers hill^{-1} was recorded at 75 DAT (days after transplanting) and at harvest by counting total tillers as the average of same 5 hills pre-selected at random from the inner rows of each plot. Number of effective tillers hill^{-1} and number of non-effective tillers hill^{-1} also counted from each of plot.

3.8.6. Dry matter hill^{-1}

Total dry matter hill^{-1} was recorded at the time of 75 DAT (days after transplanting) and at harvest by drying plant sample. Data were recorded as the average of 3 sample hill plot^{-1} selected at random from the outer rows of each plot leaving the border line and expressed in gram.

3.8.7. Grains panicle^{-1}

The total number of grains was collected from the randomly selected 10 panicles in each plot and then average number of grains panicle^{-1} was calculated.

3.8.8. Weight of 1000 grains

One thousand grains were counted randomly from the total cleaned harvested grains of each individual plot and then weighed with an electric balance in grams and recorded.

3.8.9. Grain yield

The central 6 lines from each plot were harvested, threshed, dried, weighed and finally converted to t ha^{-1} basis.

3.8.10. Harvest index (%)

Harvest index was calculated dividing the grain yield by the total biological yield (grain and straw) of the same area and multiplying by 100.

3.9. Statistical Analysis

All the data collected on different parameters were statistically analyzed following the analysis of variance (ANOVA) technique using MSTAT-C computer package program and the mean differences were adjudged by least significant difference (LSD) test at 5 % level of significance (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to study the response of hybrid rice varieties to the system of rice intensification (SRI) in *Boro* season. Data on different growth and other parameters, yield attributes and yield were recorded. The analyses of variance (ANOVA) of the data on different parameters have been presented in Appendix section. The results have been presented with the help of graphs and tables and possible interpretations have been given under the following headings:

4.1. Plant height

4.1.1. Effect of system of cultivation

Significant result showed to system of cultivation on plant height of rice (Figure 1 and Appendix III). The ranges of plant height from 61.94 cm to 74.12 cm and 101.02 cm to 112.67 cm at 75 DAT and harvest time, respectively. For system of cultivation the tallest plant was recorded in T_1 treatment while the shortest plant was recorded in T_3 treatment. Pandian *et al.* (2014), Omwenga *et al.* (2014), Chen *et al.* (2013), Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Kumar *et al.* (2009) and Hanumanthappa *et al.* (2009) also reported the similar findings.

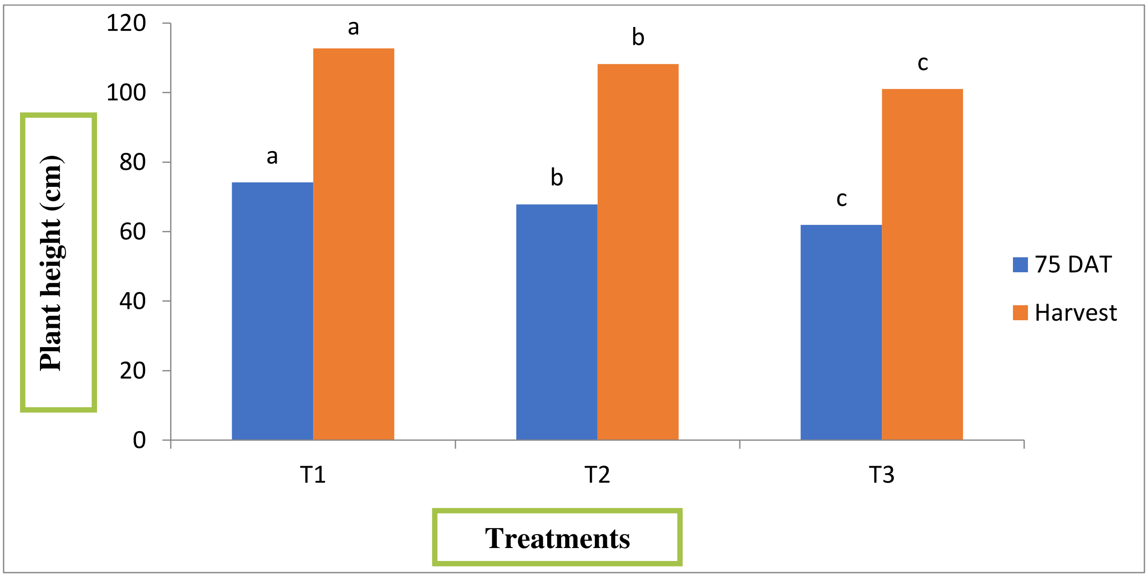

Figure 1. Effect of system of rice intensification (SRI) on plant height (cm)
DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.1.2. Effect of variety

The height of rice plant showed significant impact due to different varieties of rice cultivation (Figure 2 and Appendix III). The tallest rice plant was recorded in in case of V_1 while the shortest plant was in V_5. The plant height ranges from 65.86cm to 70.03 cm and 103.57 cm to 111.33 cm at 75 DAT and harvest time, respectively. This might be genetic variation among the varieties while V_1 was superior than the others. The present finding closely shows with the finding of Ahmadikhah and Mirarab (2010), Metwally *et al.* (2010) similar results.

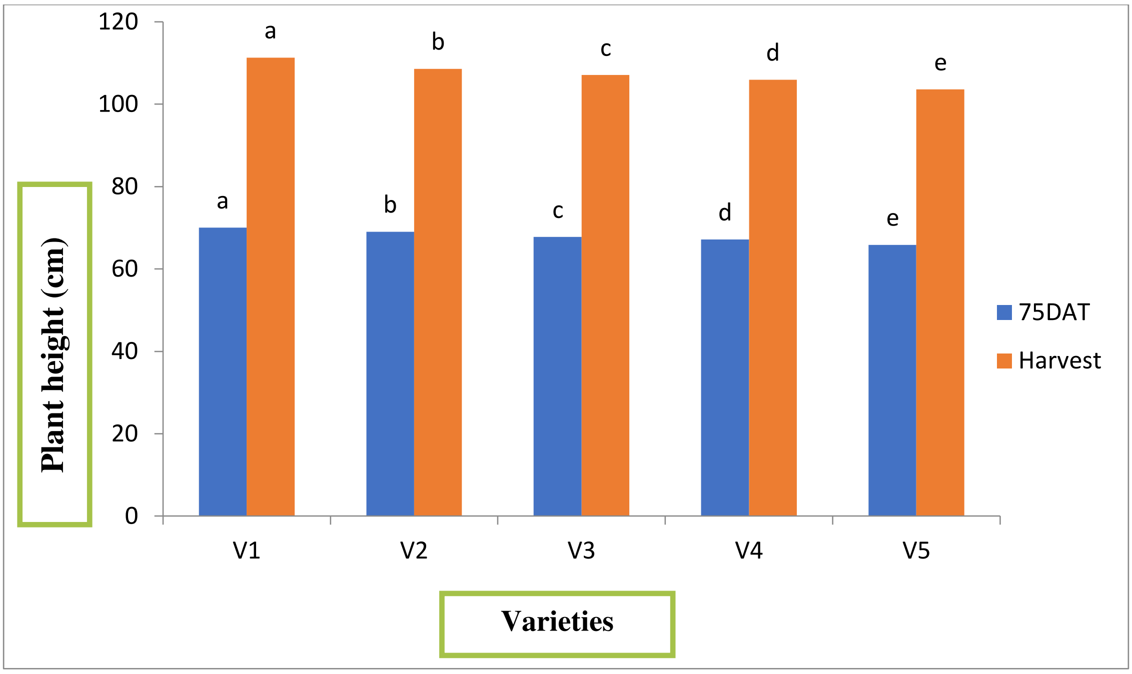

Figure 2. Effect of variety on plant height (cm)

DAT= Days after transplanting, V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.1.3. Combined effect of system of cultivation and variety

The interaction effect of system of cultivation and variety produced non-significant plant height (Table 1 and Appendix III). In spite of having non-significant impact, for the interaction effect the height of rice plant ranges from 59.63cm to 76.06cm and 96.32cm to 115.37cm at 75DAT and harvest time, respectively. The tallest plant was found in T_1V_1 and the shortest plant was found in T_3V_5 combination compared to the others combination.

Table 1. Combined effect of system of rice intensification (SRI) and variety on plant height (cm)

Treatments	Plant height (cm) at	
	75 DAT	Harvest
T_1V_1	76.06	115.37
T_1V_2	75.03	114.04
T_1V_3	73.75	112.38
T_1V_4	73.30	111.77
T_1V_5	72.39	109.77
T_2V_1	70.05	112.73
T_2V_2	68.70	109.33
T_2V_3	67.69	107.62
T_2V_4	67.26	106.79
T_2V_5	65.56	104.60
T_3V_1	63.98	105.89
T_3V_2	63.39	102.44
T_3V_3	61.80	101.26
T_3V_4	60.87	99.19
T_3V_5	59.63	96.32
LSD $_{(0.05)}$	NS	NS
CV (%)	5.942	6.468

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check); NS= Non-significant

4.2. Number of leaves hill^{-1}

4.2.1. Effect of system of cultivation

The number of leaves hill^{-1} showed significant difference for different system of rice cultivation (Figure 3 and Appendix IV). Due to system of rice cultivation, the ranges of number of leaves hill^{-1} was found 70.12 to 78.31 and 81.10 to 92.84 at 75 DAT and harvest times, respectively. The maximum number of leaves hill^{-1} was recorded in T_1 while the minimum number of leaves hill^{-1} was recorded in T_3. Pandian *et al*. (2014), Omwenga *et al.* (2014) and Manjunatha *et al.* (2009) also reported the similar findings.

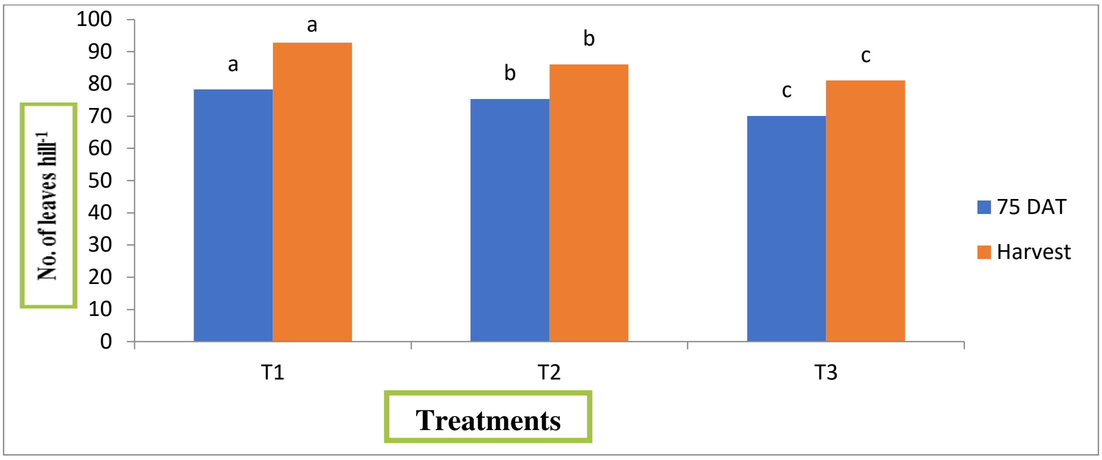

Figure 3. Effect of system of rice intensification (SRI) on number of leaves hill^{-1}

DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.2.2 Effect of variety

The different varieties of rice showed significant effect for number of leaves hill^{-1} (Figure 4 and Appendix IV). The maximum number of leaves hill^{-1} was found in case of V_1 variety while the minimum number of leaves hill^{-1} was recorded in V_5 variety. The leaves number ranges from 72.45 to 77.05 and 83.34 to 89.98 at 75 DAT and harvest time, respectively. The present findings closely confirm with the finding of Ahmadikhah and Mirarab (2010).

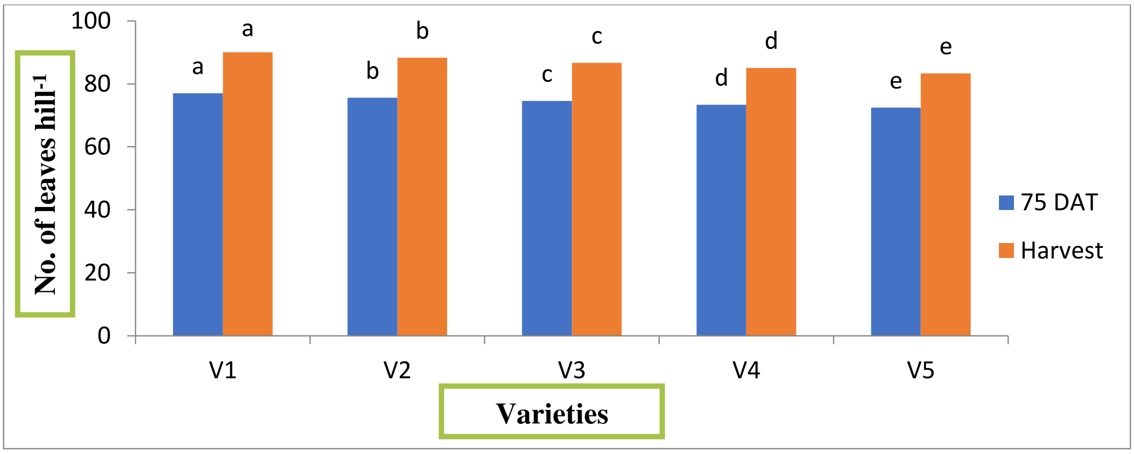

Figure 4. Effect of variety on number of leaves hill^{-1}

DAT= Days after transplanting; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.2.3. Combined effect of system of cultivation and variety

The interaction effect of system of cultivation and variety showed significant impact on number of leaves hill^{-1} only at harvest time (Table 2 and Appendix IV). The number of leaves hill^{-1} ranges from 67.86 to 80.75 and 77.48 to 96.41 at 75 DAT and harvest time, respectively while T_1V_1 produced the maximum number of leaves and T_3V_5 produced minimum number of leaves.

Table 2. Combined effect of system of rice intensification (SRI) and variety on number of leaves hill^{-1}

Treatments	Number of leaves hill^{-1} at	
	75 DAT	Harvest
T_1V_1	80.75	96.41 a
T_1V_2	79.09	94.12 b
T_1V_3	78.28	92.38 c
T_1V_4	77.23	90.98 cd
T_1V_5	76.20	90.33 de
T_2V_1	77.71	89.20 e
T_2V_2	76.33	87.67 f
T_2V_3	75.22	86.26 fg
T_2V_4	74.37	85.16 gh
T_2V_5	73.28	82.22 hi
T_3V_1	72.68	84.34 ij
T_3V_2	71.25	83.05 jk
T_3V_3	70.29	81.53 k
T_3V_4	68.50	79.11 l
T_3V_5	67.86	77.48 m
LSD $_{(0.05)}$	NS	1.8140
CV (%)	5.316	6.490

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.3. Number of tillers hill^{-1}

4.3.1. Effect of system of cultivation

The number of tillers hill^{-1} showed significant difference for different system of rice cultivation (Figure 5 and Appendix IV). Due to system of rice cultivation, the ranges of number of tillers hill^{-1} was found 19.57 to 12.18 and 34.70 to 22.52 at 75 DAT and harvest time, respectively. The maximum number of tillers hill^{-1} was recorded in T_1 while the minimum number of tillers hill^{-1} was recorded in T_3. The present study also shows the same result. Mobasser *et al.* (2007) noticed that the effect of seedling age on the total number of tillers was significant probability level.

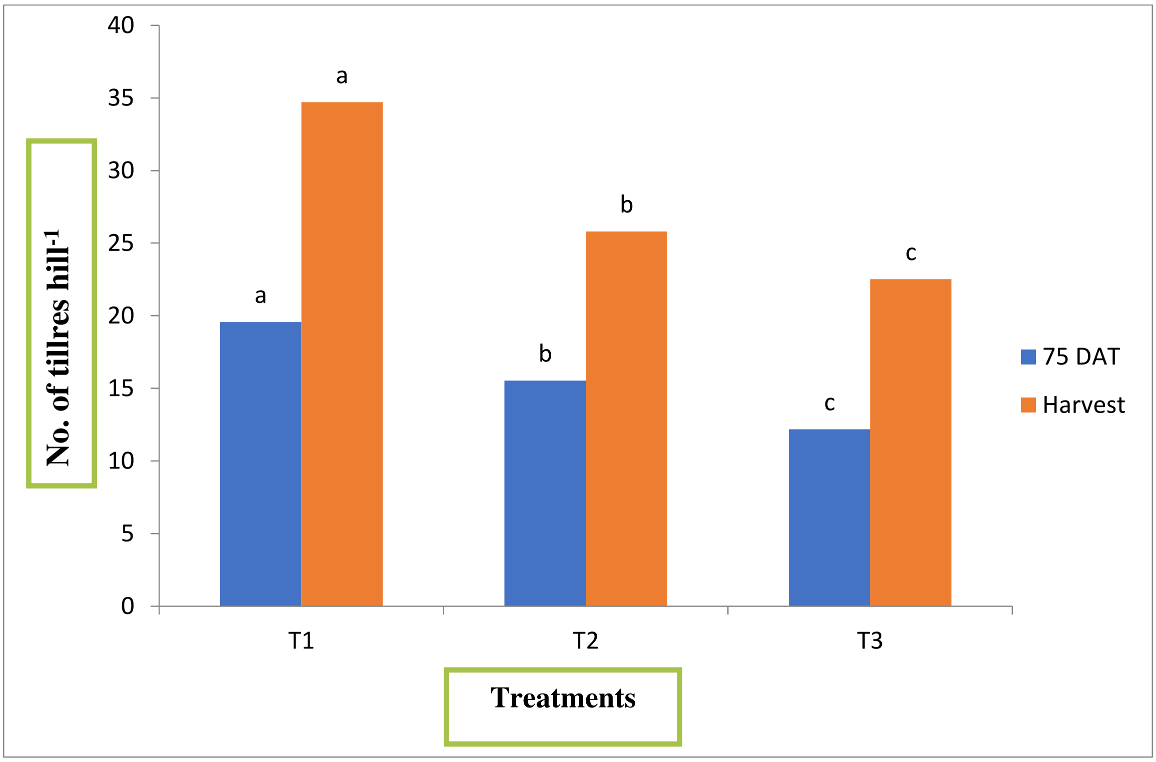

Figure 5. Effect of system of rice intensification (SRI) on number of tillers hill^{-1}

DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.3.2 Effect of variety

The different varieties of rice showed significant effect for number of tillers hill^{-1} (Figure 6 and Appendix IV). The maximum number of tillers hill^{-1} was found in case of V_1 variety while the minimum number of tillers hill^{-1} was recorded in V_5 variety. The tillers number range from 18.28 to 13.44 and 33.03 to 22.94 at 75 DAT and harvest time, respectively. The present finding closely confirm with the finding of Metwally *et al.* (2010), Abou khalifa (2009), Zaki *et al.* (2009), Kumar *et al.* (2008), Kumar *et al.* (2008), Abou-Khadra *et al.* (2008), Abou-Khalif *et al.* (2007), Zayed *et al.* (2007) similar results.

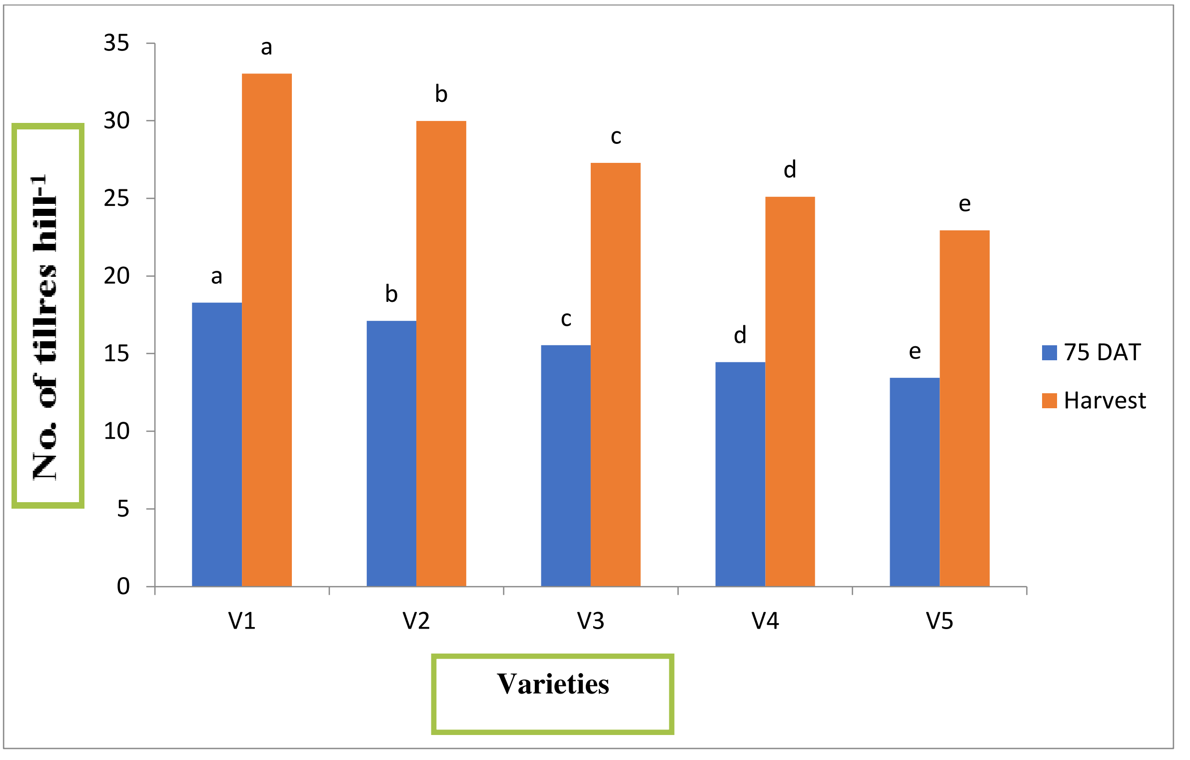

Figure 6. Effect of variety on number of tillers hill^{-1}
DAT=Days after transplanting, V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.3.3 Combined effect of system of cultivation and variety

In case of combined effect of system of cultivation and variety produced significant number of tillers hill^{-1} (Table 3 and Appendix VI). For combined effect number of tillers hill^{-1} ranges from 22.97 to 9.93 and 38.36 to 15.52 at 75 DAT and harvest respectively. The maximum number of tillers hill^{-1} was found in T_1V_1 and minimum number of tillers hill^{-1} was found in T_3V_5 combination compared to the others.

Table 3. Combined effect of system of rice intensification (SRI) and variety on number of tillers hill^{-1}

Treatments	No. of tillers hill^{-1}	
	75 DAT	**Harvest**
T_1V_1	22.97 a	38.36 a
T_1V_2	21.68 a	36.05 ab
T_1V_3	18.75 b	35.21 bc
T_1V_4	17.70 bc	33.31 cd
T_1V_5	16.75 bc	30.58 de
T_2V_1	17.67 cd	29.71 e
T_2V_2	16.40 cd	27.78 ef
T_2V_3	15.34 de	25.06 fg
T_2V_4	14.62 ef	23.70 gh
T_2V_5	13.65 ef	22.72 hi
T_3V_1	14.20 fg	31.02 hij
T_3V_2	13.22 fg	26.12 ij
T_3V_3	12.57 gh	21.61 j
T_3V_4	11.02 hi	18.32 k
T_3V_5	9.93 i	15.52 l
LSD $_{(0.05)}$	2.0146	2.8392
CV (%)	6.464	5.874

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.4. Leaf area index

4.4.1 Effect of system of cultivation

Due to the system of cultivation Leaf area index showed significant result (Figure 7 and Appendix V). The leaf area index ranges from 3.73 to 4.97. The heightest leaf area index was recorded in T_1 treatment and lowest leaf area index was recorded in T_3 treatment. Chen *et al*. (2013), Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Uphoff (2004), Chopra and Chopra (2004) also reported the similar findings.

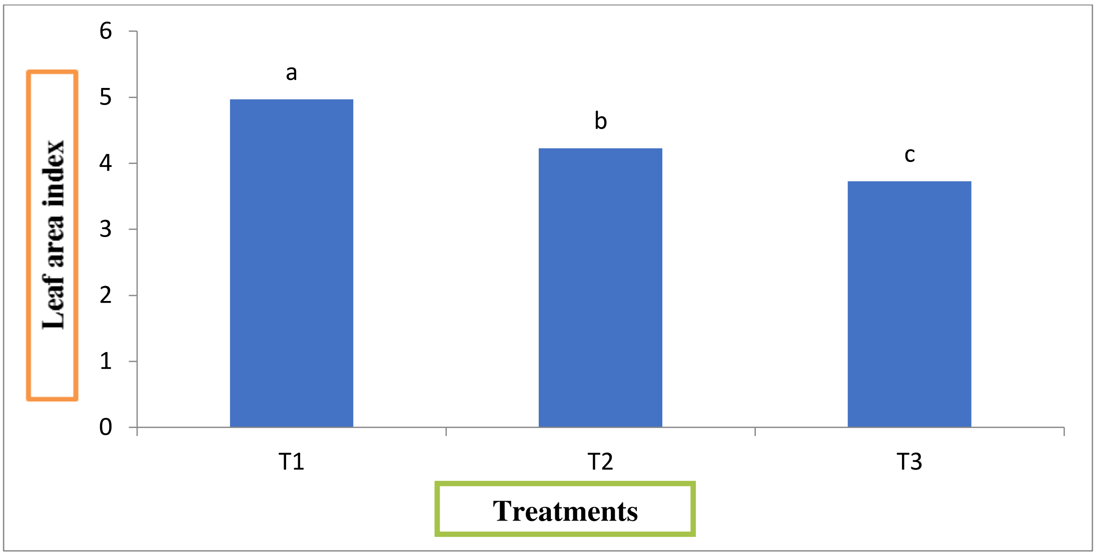

Figure 7. Effect of system of rice intensification (SRI) on leaf area index at 75 DAT

DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.4.2 Effect of variety

The leaf area index showed significant impact due to different varieties (Figure 8 and Appendix V). The highest leaf area index was recorded in case of V_1 while the lowest leaf area index was in V_4. The leaf area index ranges from 4.16 to 4.48. The present finding closely confirm with the findings of Ahmadikhah and Mirarab (2010), Metwally *et al.* (2010) and Kumar *et al.* (2008).

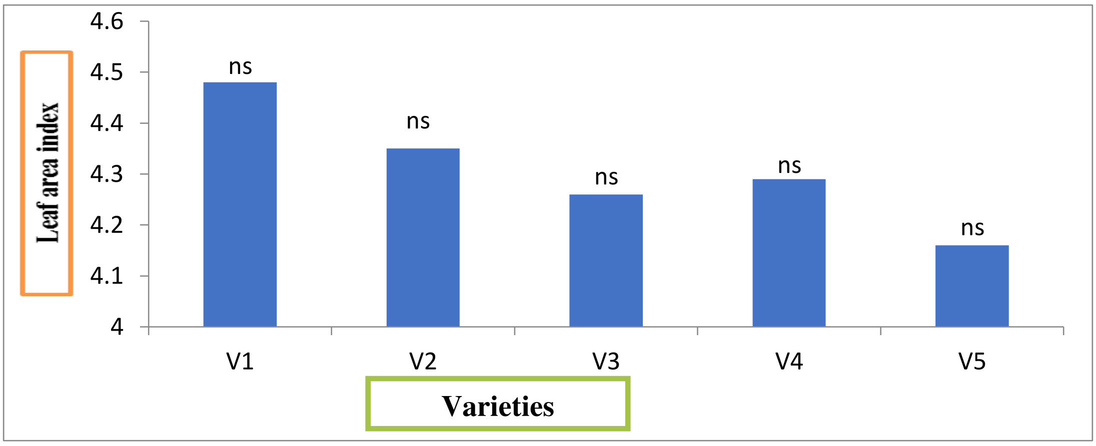

Figure 8. Effect of variety on leaf area index at 75 DAT

V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.4.3 Combined effect of system of cultivation and variety

The interaction effect of system of cultivation and variety produced non-significant leaf area index (Table 4 and Appendix V). For combined effect the leaf area index ranges from 3.51 to 5.08. The highest leaf area index was found in T_1V_1 and lowest leaf area index was found in T_3V_5 combination compared to the others combination.

Table 4. Combined effect of system of rice intensification (SRI) and variety on leaf area index

Treatments	Leaf area index
T_1V_1	5.08
T_1V_2	4.92
T_1V_3	4.82
T_1V_4	4.72
T_1V_5	5.29
T_2V_1	4.42
T_2V_2	4.33
T_2V_3	4.23
T_2V_4	4.14
T_2V_5	4.03
T_3V_1	3.95
T_3V_2	3.83
T_3V_3	3.74
T_3V_4	3.62
T_3V_5	3.51
LSD $_{(0.05)}$	NS
CV (%)	6.024

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check); NS= Non-significant

4.5. Chlorophyll content

4.5.1 Effect of system of cultivation

Chlorophyll content of rice showed significant difference at different system of cultivation application (Figure 9 and Appendix V). The highest Chl a (1.46 mg g^{-1}), Chl b (0.45 mg g^{-1}), Total Chl (1.92 mg g^{-1}) and ratio of a:b (3.28) was recorded in case of T_1 while the lowest value of Chl a (1.10 mg g^{-1}), Chl b (0.33 mg g^{-1}), Total Chl (1.44 mg g^{-1}) and ration of a:b (3.19) was recorded in T_3. Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Kumar *et al.* (2009) and Hanumanthappa *et al.* (2009) also reported the similar findings.

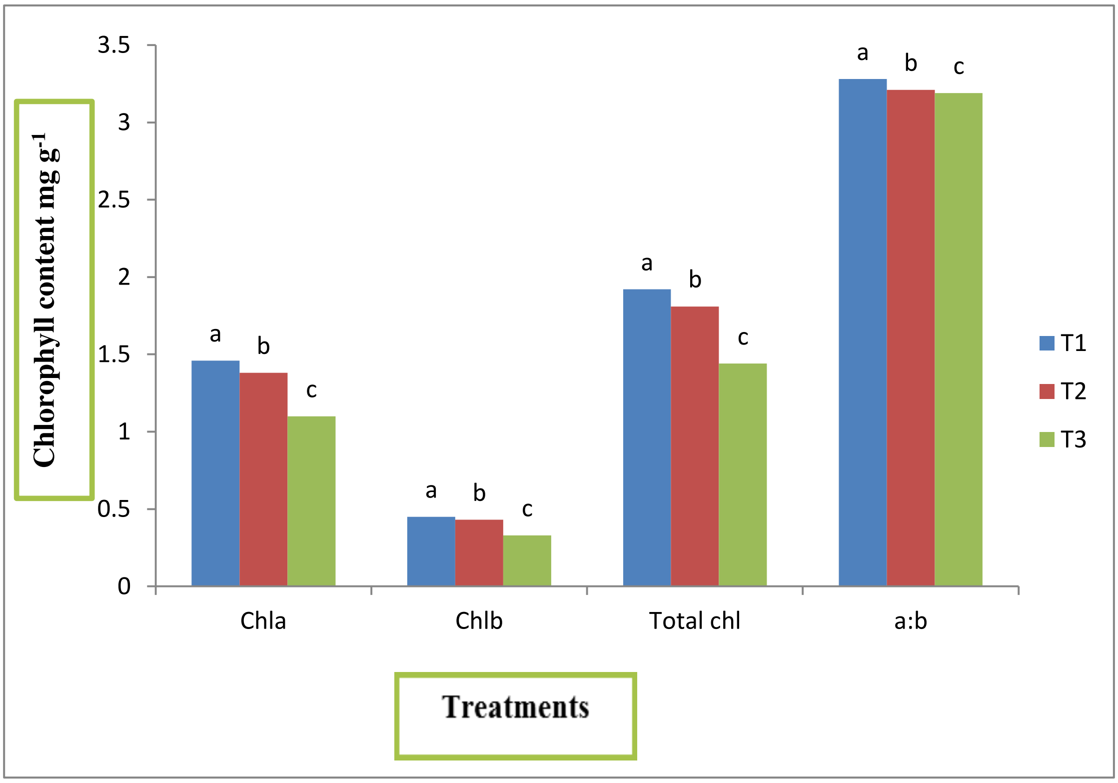

Figure 9: Effect of system of rice intensification (SRI) on Chlorophyll content (mg g^{-1})

T_1= Low land transplant condition, T_2= Raised upland condition, T_3=Raised transplant condition; Chl a=Chlorophyll a, Chl b= Chlorophyll b, Total chl=Total Chlorophyll

4.5.2 Effect of variety

Impact of variety on rice showed significant effect for chlorophyll content (Figure 10 and Appendix V). The highest value of Chl a (1.42 mg g^{-1}), Chl b (0.44 mg g^{-1}), Total Chl (1.86 mg g^{-1}) and ration of a:b (3.24) was found in V_1 treatment while the lowest value of Chl a (1.22 mg g^{-1}), Chl b (0.37 mg g^{-1}), Total Chl (1.60 mg g^{-1}) and ration of a:b (3.21) was recorded in case of V_5 variety. The present finding closely confirm with the findings of Metwally *et al.* (2010) and Kumar *et al.* (2008).

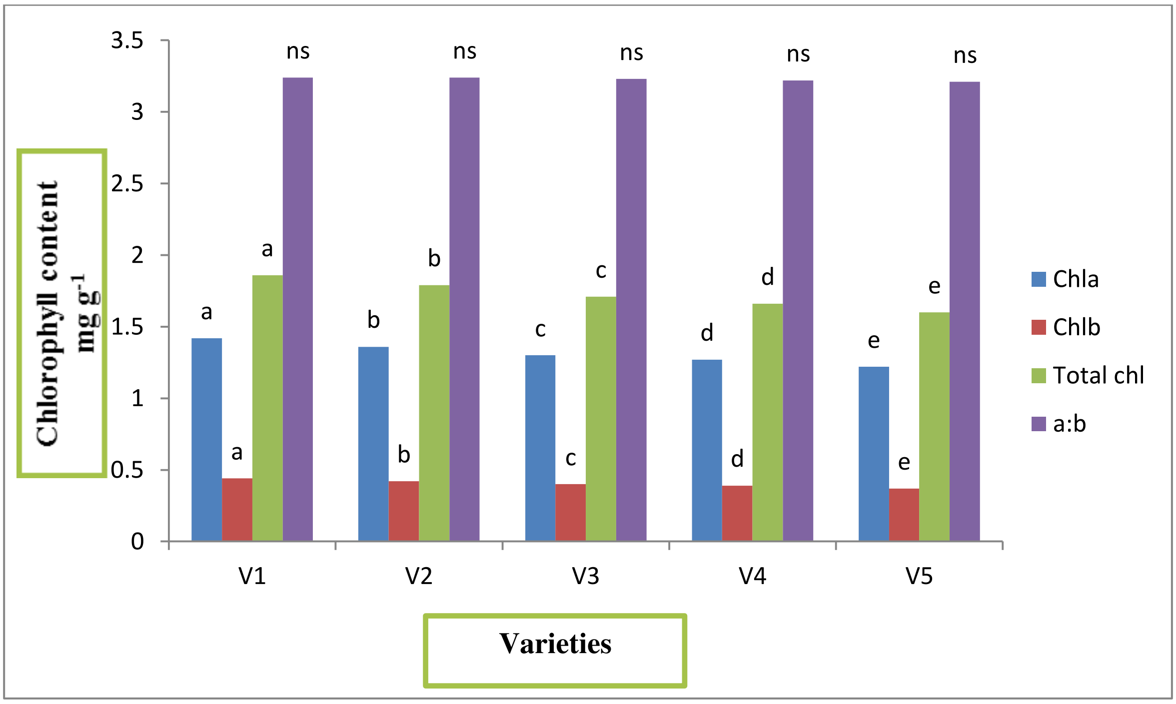

Figure 10: Effect of variety on Chlorophyll content (mg g^{-1})
V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check); Chl a=Chlorophyll a, Chl b= Chlorophyll b, Total chl=Total Chlorophyll

4.5.3 Combined effect of system of cultivation and variety

Combined effect of system of cultivation and variety showed positively significant impact on chlorophyll content of rice (Table 5 and Appendix V). The T_1V_1 produced the height value of Chl a (1.58 mg g^{-1}), Chl b (0.49 mg g^{-1}), Total Chl (2.18 mg g^{-1}) and T_3V_5 produced the lowest value of Chl a (1.02 mg g^{-1}), Chl b (0.31 mg g^{-1}), Total Chl (1.43 mg g^{-1}). The highest ratio of a:b was in T_3V_5 (3.31) and lowest ratio was in T_1V_1 (3.18).

Table 5. Combined effect of system of rice intensification (SRI) and variety On chlorophyll content

Treatments	Chlorophyll content			
	Chl a mg g^{-1}	Chl b mg g^{-1}	Total Chl mg g^{-1}	Ratio of a:b
T_1V_1	1.58 a	0.49 a	2.18 a	3.18
T_1V_2	1.51 b	0.47 b	2.08 b	3.18
T_1V_3	1.44 c	0.45 c	1.99 d	3.21
T_1V_4	1.41 d	0.44 cd	1.95 e	3.21
T_1V_5	1.37 e	0.43 d	1.90 f	3.19
T_2V_1	1.48 b	0.46 b	2.05 c	3.20
T_2V_2	1.45 c	0.45 c	1.99 d	3.22
T_2V_3	1.37 e	0.43 d	1.90 f	3.19
T_2V_4	1.34 f	0.41 e	1.85 g	3.22
T_2V_5	1.27 g	0.39 f	1.77 h	3.22
T_3V_1	1.20 h	0.37 g	1.67 i	3.24
T_3V_2	1.14 i	0.35 h	1.59 j	3.25
T_3V_3	1.10 j	0.33 i	1.53 k	3.30
T_3V_4	1.07 k	0.32 i	1.49 l	3.30
T_3V_5	1.02 l	0.31 j	1.43 m	3.31
LSD $_{(0.05)}$	0.07	0.02	0.08	NS
CV (%)	3.89	4.67	1.40	3.00

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check); NS= Non-significant

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

4.6.1 Effect of system of cultivation

Due to system of rice cultivation number of effective tillers hill^{-1} showed significant result (Figure 11 and Appendix VI). The number of effective tillers hill^{-1} range from 22.52 to 34.70 at harvest. The maximum number of effective tillers hill^{-1} was recorded in T_1 treatment and minimum number of effective tillers hill^{-1} was recorded in T_3

treatment. Manjunatha *et al.* (2010), Hanumanthappa *et al.* (2009), Krishna and Biradarpatil (2009), Manjunatha *et al.* (2009), Goel *et al.* (2009), Chandrakar *et al.* (2008), Kumar *et al.* (2008), Pasuquin *et al.* (2008) and Raj *et al.* (2008) also reported the similar findings.

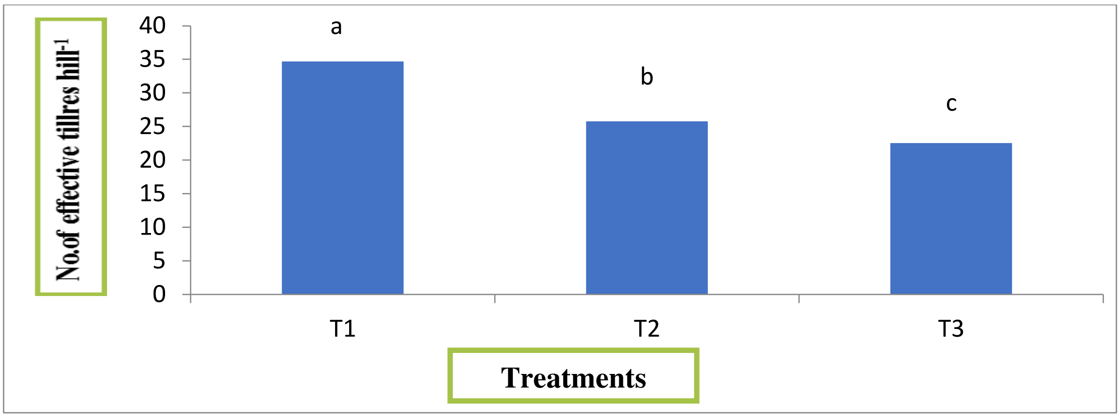

Figure 11. Effect of system of rice intensification (SRI) on number of effective tillers hill^{-1}

T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.6.2 Effect of variety

The number of effective tillers hill^{-1} showed significant impact due to different variety of rice (Figure 12 and Appendix VI). The maximum number of effective tillers hill^{-1} was recorded in case of V_1 while lowest number of effective tillers hill^{-1} was in V_5. The number of effective tillers hill^{-1} ranges from 22.94 to 33.03. The present finding closely confirm with the finding of Ahmadikhah and Mirarab (2010) and Metwally *et al.* (2010).

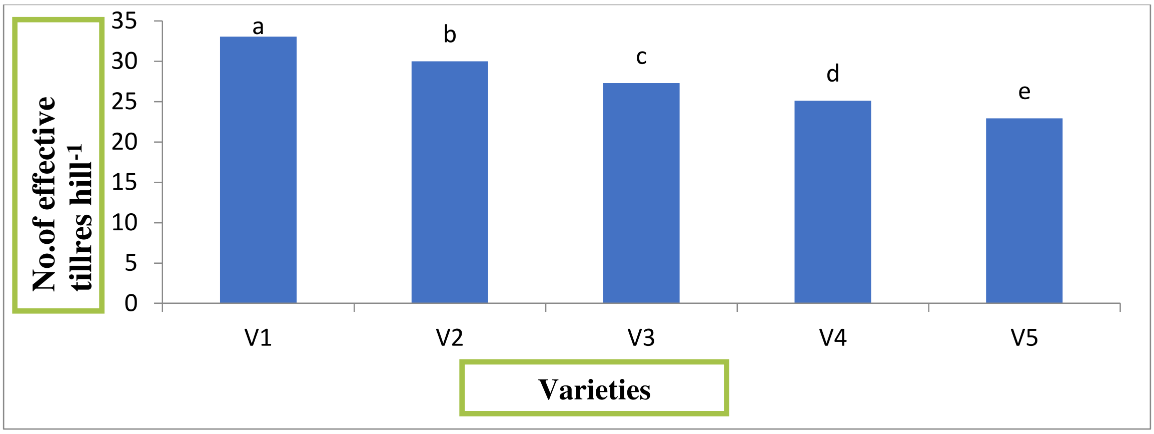

Figure 12. Effect of variety on number of effective tillers hill^{-1}

V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.6.3 Combined effect of system of cultivation and variety

Combined effect of system of cultivation and variety showed significant number of effective tillers hill^{-1} (Table 6 and Appendix VI). For combined effect number of effective tillers hill^{-1} ranges from 37.36 to 16.52 at harvest. The maximum number of effective tillers hill^{-1} was found in T_1V_1 and minimum number of effective tillers hill^{-1} was found in T_1V_5 combination compared to the others combination.

Table 6. Combined effect of system of rice intensification (SRI) and variety on number of effective tillers hill^{-1}

Treatments	No. of effective tillers hill^{-1}
T_1V_1	37.36 a
T_1V_2	36.05 ab
T_1V_3	34.21 bc
T_1V_4	33.31 cd
T_1V_5	30.58 de
T_2V_1	28.71 e
T_2V_2	26.78 ef
T_2V_3	24.06 fg
T_2V_4	23.70 gh
T_2V_5	22.72 hi
T_3V_1	31.02 hij
T_3V_2	26.12 ij
T_3V_3	21.61 j
T_3V_4	19.32 k
T_3V_5	16.52 l
LSD $_{(0.05)}$	2.7392
CV (%)	5.748

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

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

4.7.1 Effect of system of cultivation

The number of non-effective tillers hill^{-1} showed significant difference at different system of rice cultivation (Figure 13 and Appendix VI). Due to system of cultivation, the range of number of non-effective tillers hill^{-1} was found 3.06 to 5.18 at harvest. The maximum number of non-effective tillers hill^{-1} was recorded in T_3 while the minimum number of non-effective tillers hill^{-1} was recorded in T_1. Pandian *et al.* (2014), Omwenga *et al.* (2014), Chen *et al.* (2013), Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Chopra and Chopra (2004) and Uphoff (2004) also reported the similar findings.

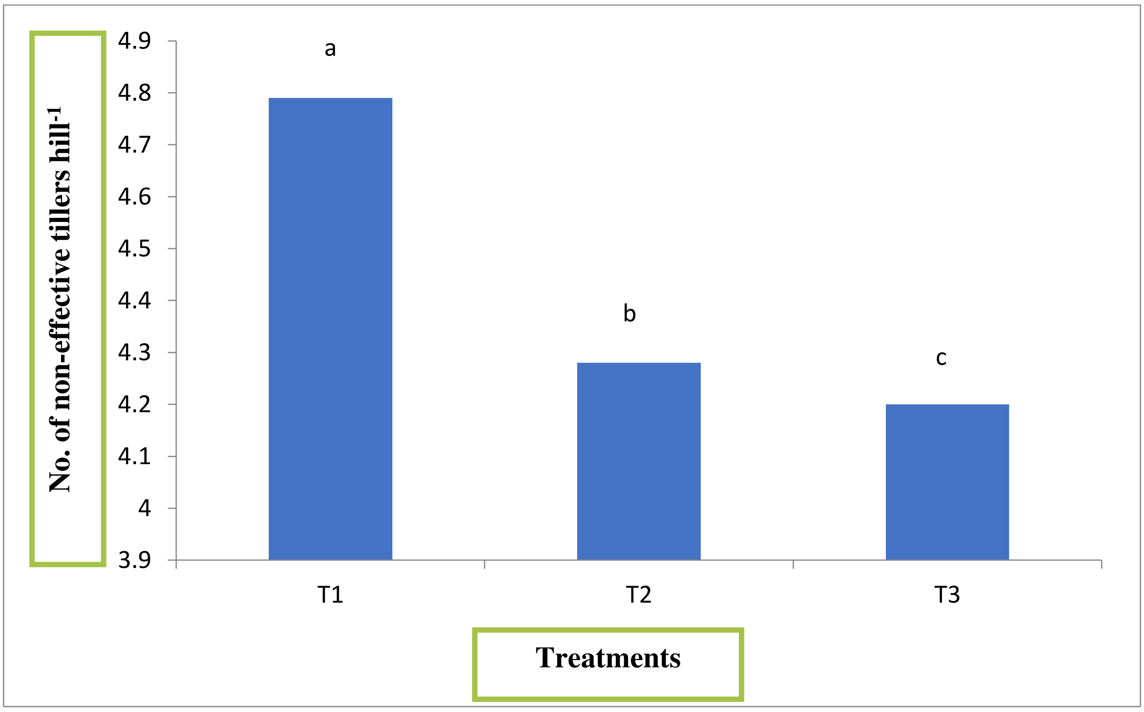

Figure 13. Effect of system of rice intensification (SRI) on number of non-effective tillers hill^{-1}

T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.7.2 Effect of variety

Impact of variety on rice showed significant effect for number of non-effective tillers hill^{-1} (Figure 14 and Appendix VI). The maximum number of non-effective tillers hill^{-1} was found in in case of V_5 variety while minimum number of non-effective tillers hill^{-1} was recorded in case of V_1 variety treatment. The number of non-effective tillers hill^{-1} ranges from 3.44 to 5.17 at harvest. The present finding closely confirm with the findings of Metwally *et al.* (2010), Ahmadikhah and Mirarab (2010) and Kumar *et al.* (2008).

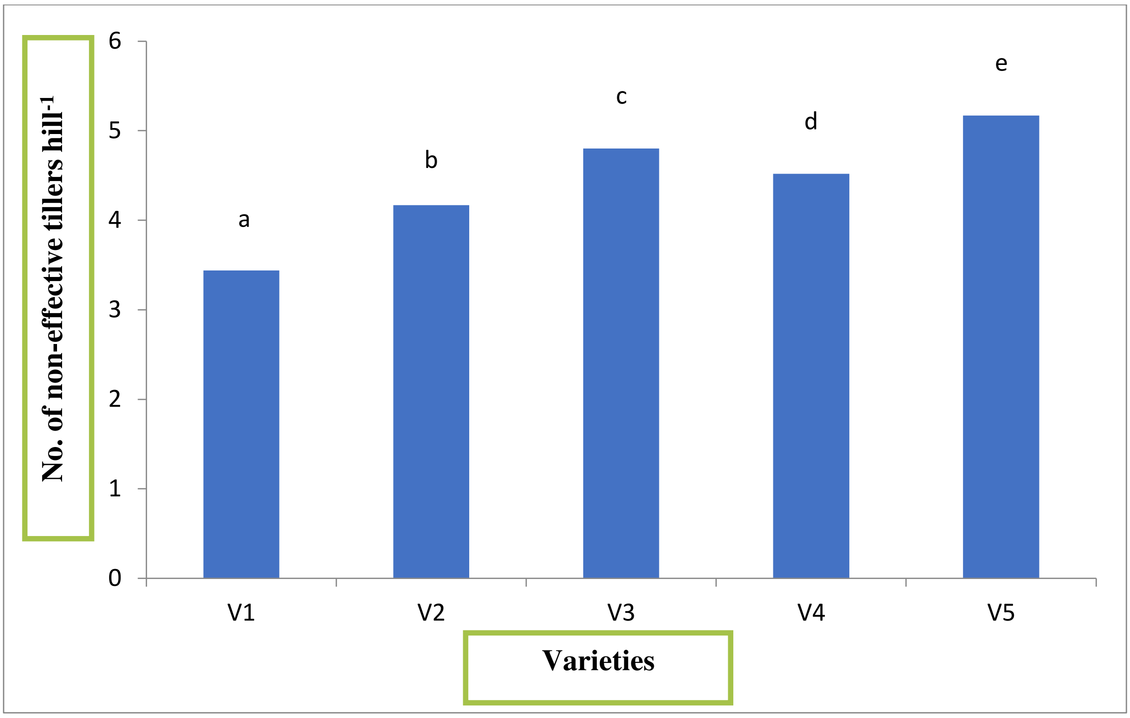

Figure 14. Effect of variety on number of non-effective tillers hill^{-1}
V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.7.3 Combined effect of system of cultivation and variety

Combined effect of system of cultivation and variety showed significant impact on number of non-effective tillers hill^{-1} (Table 7 and Appendix VI). The number of non-effective tillers hill^{-1} ranges from 3.06 to 5.18 at harvest while T_3V_5 produced the maximum number of non-effective tillers hill^{-1} and T_1V_1 produced minimum number of non-effective tillers hill^{-1}.

Table 7. Combined effect of system of rice intensification (SRI) and variety on number of non-effective tillers hill^{-1}

Treatments	No. of non-effective tillers hill^{-1}
T_1V_1	3.06 c
T_1V_2	4.10 b
T_1V_3	5.05 a
T_1V_4	4.07 b
T_1V_5	5.09 a
T_2V_1	4.12 b
T_2V_2	4.21 b
T_2V_3	5.16 a
T_2V_4	5.20 a
T_2V_5	5.24 a
T_3V_1	3.13 c
T_3V_2	4.19 b
T_3V_3	4.21 b
T_3V_4	4.29 b
T_3V_5	5.18 a
LSD $_{(0.05)}$	0.3987
CV (%)	6.807

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
DAT= Days after transplanting, T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.8. Plant dry weight

4.8.1 Effect of system of cultivation

Due to application of system of cultivation plant dry weight showed significant result (Figure 15 and Appendix VII). The plant dry weight ranges from 18.48 gm to 28.22 gm, 32.15 gm to 58.79 gm and 45.28 gm to 77.66 gm at vegetative stage, flowering stage and harvest time, respectively. The highest plant dry weight was recorded in T_1 treatment and the lowest plant dry weight was recorded in T_3 treatment. Pandian *et al.*

(2014), Omwenga *et al*. (2014), Chen *et al*. (2013), Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Kumar *et al*. (2009), Hanumanthappa *et al.* (2009), Krishna and Biradarpatil (2009), Manjunatha *et al.* (2009), Goel *et al.* (2009) and Chandrakar *et al.* (2008) also reported the similar findings.

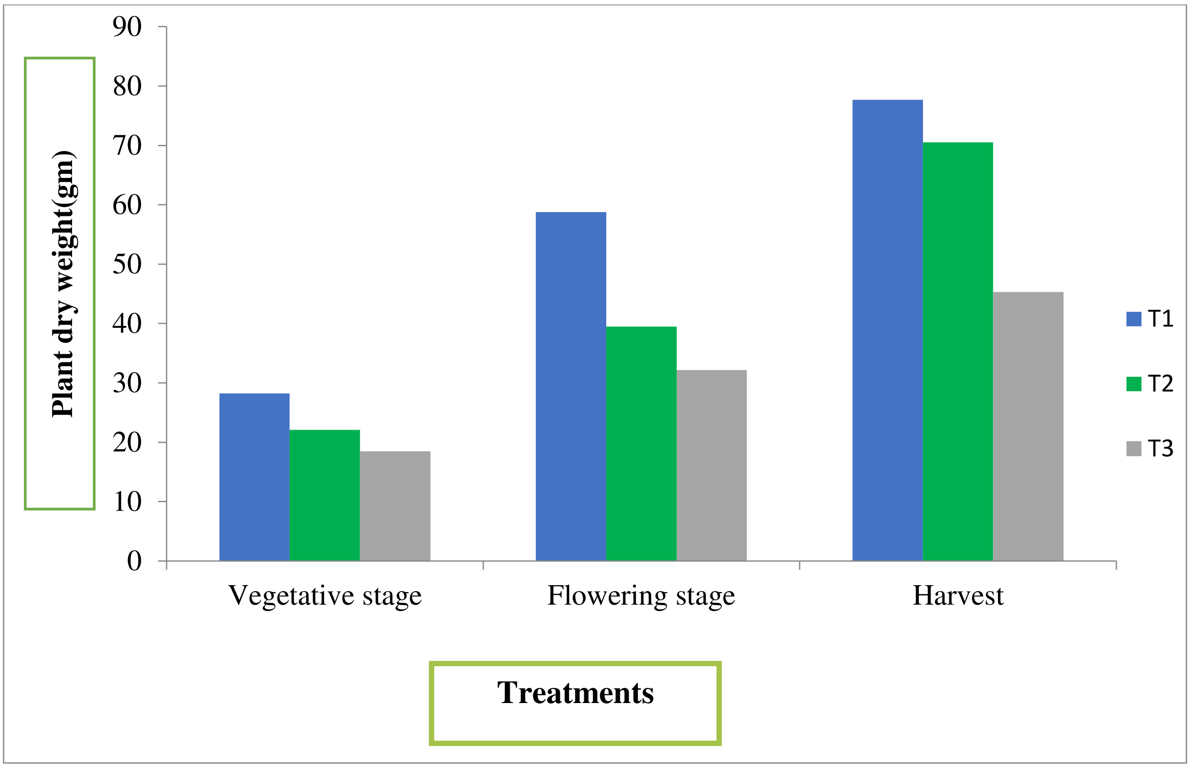

Figure 15. Effect of system of rice intensification (SRI) on plant dry weight (gm)

T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.8.2 Effect of variety

The plant dry weight showed significant impact due to different variety of rice cultivation (Figure 16 and Appendix VII). The significant influence of variety facilitated highest plant dry weight in V_1 while the lowest plant dry weight was in V_5. The plant dry weight ranges from 19.15 to 27.39, 36.41 to 49.09 and 59.87 to 68.84 at vegetative stage, flowering stage and harvest time, respectively. The present finding closely confirm with the finding of Ahmadikhah and Mirarab (2010), Metwally *et al.* (2010), Abou khalifa (2009), Zaki *et al.* (2009), Kumar *et al.* (2008), Kumar *et al.* (2008), Abou-Khadra *et al.* (2008), Abou-Khalif *et al.* (2007), Zayed *et al.* (2007), Sharief *et al.* (2005), El-Kady and Abdallah (2004), Abdel-Rahman *et al.* (2004a), Abdel-Rahman *et al.* (2004b).

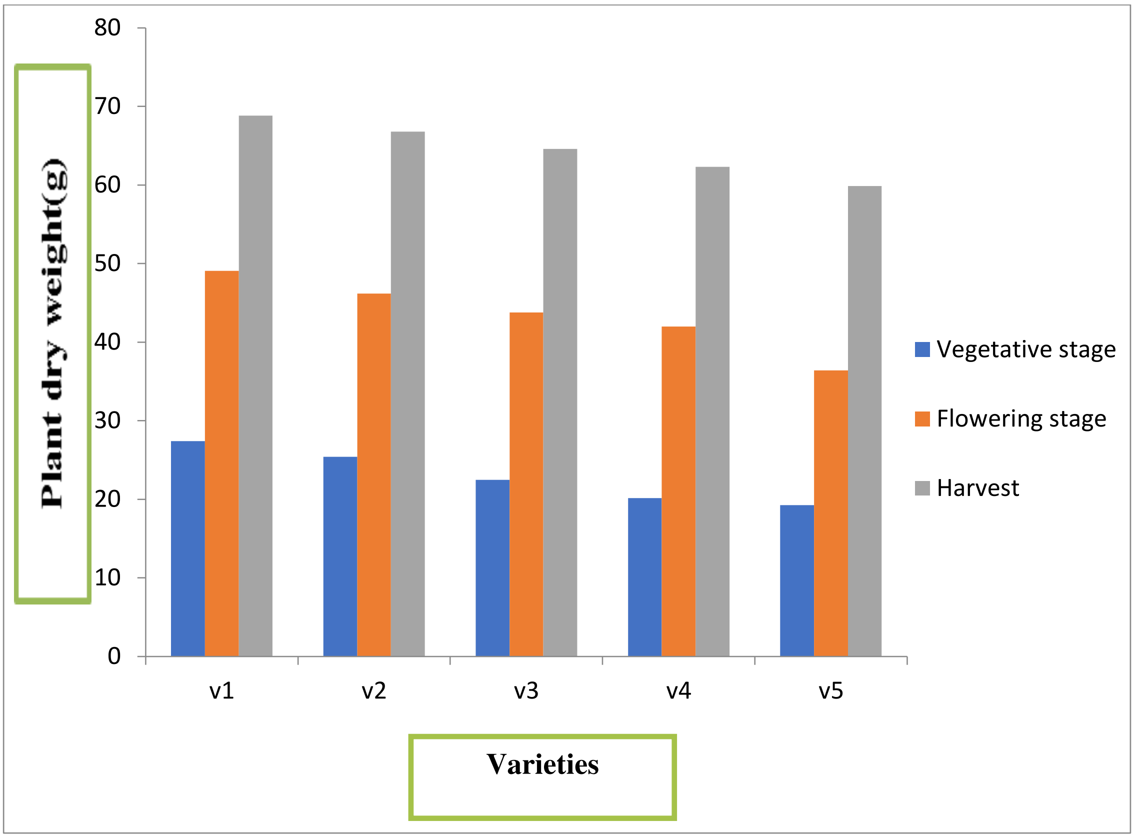

Figure 16. Effect of variety on plant dry weight (gm)
V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.8.3 Combined effect of system of cultivation and variety

Combined effect of system of cultivation and variety produced significant plant dry weight of rice (Table 8 and Appendix VII). For the interaction effect, plant dry weight ranges from 14.46 to 34.31, 28.05 to 65.34 and 39.52 to 81.74 at vegetative stage, flowering stage and harvest time, respectively. The highest plant dry weight was found in T_1V_1 and the lowest plant dry weight was found in T_3V_5 combination compared to the others combination.

Table 8. Combined effect of system of rice intensification (SRI) and variety on plant dry weight (gm)

Treatments	Plant dry weight (g) at		
	Vegetative stage	Flowering stage	Harvest
T_1V_1	34.31 a	65.34 a	81.74 a
T_1V_2	31.34 b	62.66 b	79.79 b
T_1V_3	27.38 c	60.65 bc	78.02 c
T_1V_4	24.65 cd	58.96 c	75.73 d
T_1V_5	23.41 de	46.32 d	73.02 de
T_2V_1	26.01 de	45.32 d	74.21 e
T_2V_2	24.27 ef	42.32 e	72.55 e
T_2V_3	21.25 fg	38.37 f	70.05 f
T_2V_4	19.05 g	36.69 fg	68.72 fg
T_2V_5	19.92 gh	34.87 fg	67.06 g
T_3V_1	21.86 gh	36.62 gh	50.57 h
T_3V_2	20.55 h	33.58 hi	48.06 i
T_3V_3	18.76 h	32.25 ij	45.71 j
$T_3 V_4$	16.77i	30.26jk	42.55k
$T_3 V_5$	14.46j	28.05k	39.521
LSD $_{(0.05)}$	2.4044	2.4978	1.9100
CV (%)	6.367	5.710	5.939

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.9. Number of filled grains panicle^{-1}

4.9.1 Effect of system of cultivation

Number of filled grains panicle^{-1} showed significant difference for different system of rice cultivation (Figure 17 and Appendix VIII). Due to system of cultivation, the range of number of filled grains panicle^{-1} was found 145.92 to 166.11. The minimum number of filled grains panicle^{-1} was recorded in T_3 while the maximum number of filled grains panicle^{-1} was recorded in T_1. Omwenga *et al*. (2014), Reddy and Shenoy (2013), Hanumanthappa *et al.* (2009), Manjunatha *et al.* (2009), Goel *et al.* (2009), Reddy *et al.* (2008), Vijayakumar *et al.* (2006), Doni *et al*. (2005), Khakwani *et al.* (2005), Uphoff (2005), Ingale *et al.* (2005) and Uphoff (2004) also reported the similar findings.

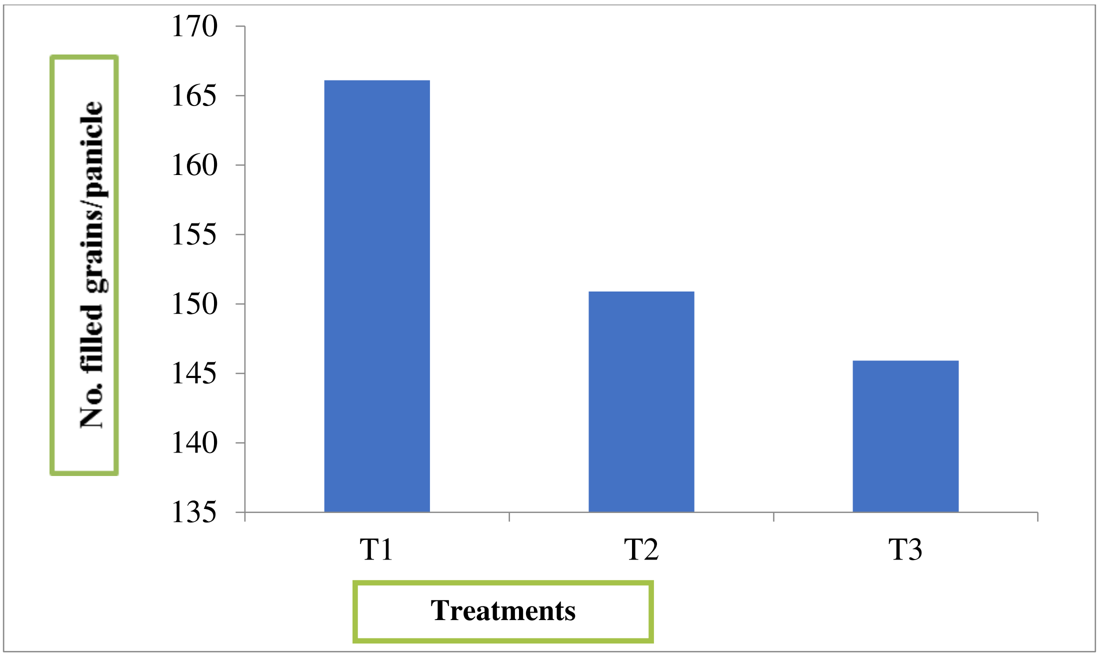

Figure 17. Effect of system of rice intensification (SRI) on number of filled grains panicle^{-1}

T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.9.2 Effect of variety

Impact of variety on rice showed significant effect for number of filled grains panicle^{-1} (Figure 18 and Appendix VIII). The minimum number of filled grains panicle^{-1} was found in case of V_5 variety while maximum number of filled grains panicle^{-1} was recorded in case of V_1 variety. The number of filled grains panicle^{-1} ranges from 146.24 to 162.61. The present finding closely confirm with the findings of Ahmadikhah and Mirarab (2010), Metwally *et al.* (2010) and Abdel-Rahman *et al.* (2004b).

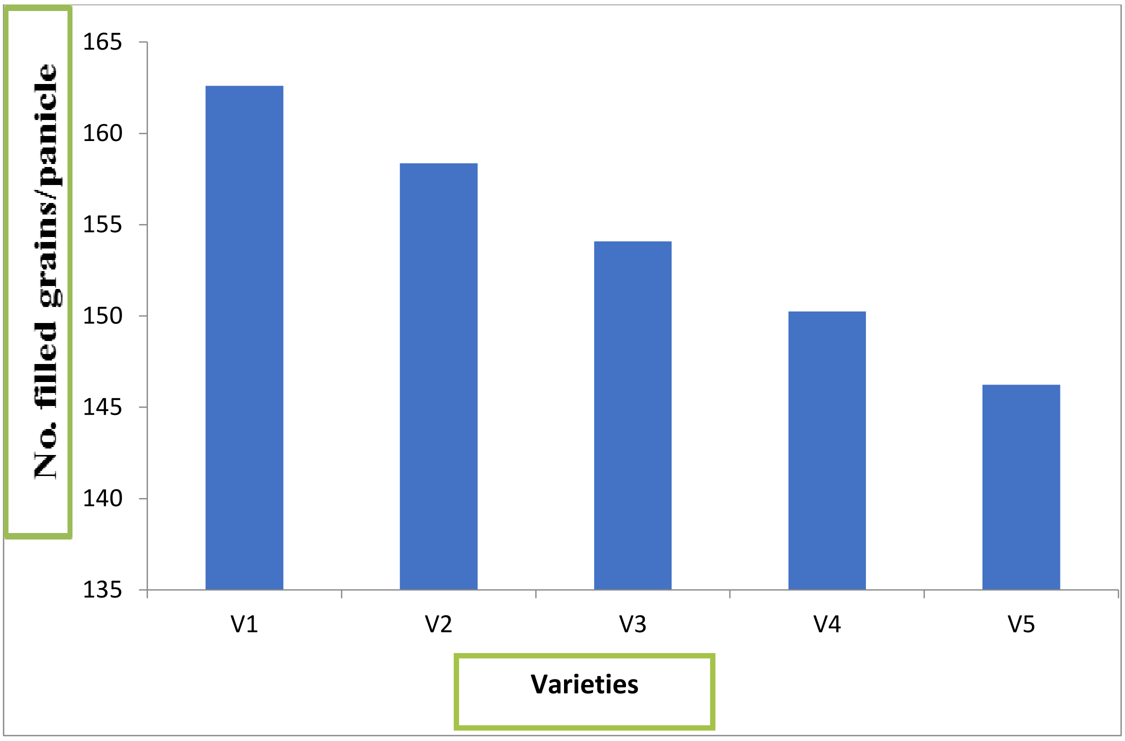

Figure 18. Effect of variety on number of filled grains panicle^{-1}
V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.10. Number of unfilled grains panicle^{-1}

4.10.1 Effect of system of cultivation

Number of unfilled grains panicle^{-1} showed significant difference for different system of rice cultivation (Figure 19 and Appendix VIII). Due to system of cultivation, the range of number of unfilled grains panicle^{-1} was found 15.78 to 45.24. The maximum number of filled grains panicle^{-1} was recorded in T_3 while the minimum number of unfilled grains panicle^{-1} was recorded in T_1. Chen *et al*. (2013), Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Kumar *et al*. (2009), Ingale *et al.* (2005), Chopra and Chopra (2004) and Uphoff (2004) also reported the similar findings.

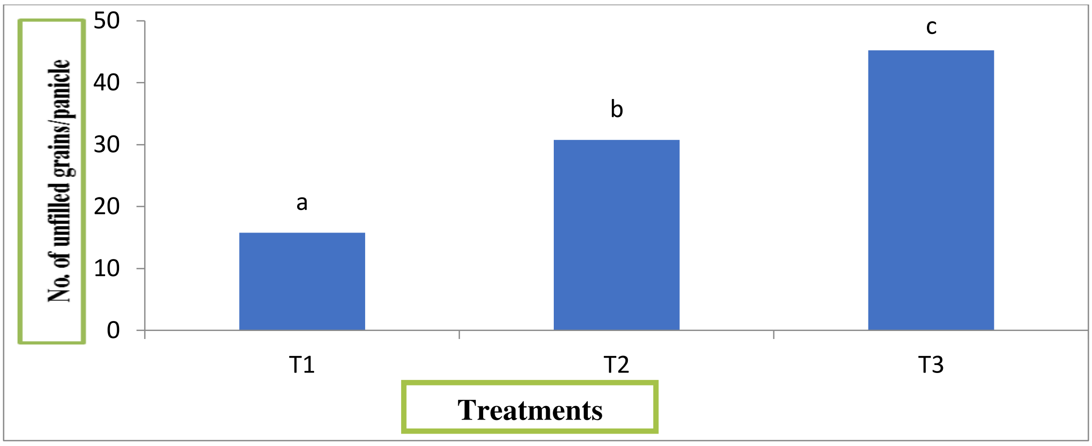

Figure 19. Effect of system of rice intensification (SRI) on number of unfilled grains panicle^{-1}

T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.10.2 Effect of variety

Impact of variety on rice showed significant effect for number of unfilled grains panicle^{-1} (Figure 20 and Appendix VIII). The maximum number of unfilled grains panicle^{-1} was found in case of V_5 variety while minimum number of unfilled grains was recorded in case of V_1 variety. The number of filled grains panicle^{-1} ranges from 26.15 to 35.55. The present finding closely confirm with the findings of Kumar *et al.* (2008), Abou-Khadra *et al.* (2008), Abou-Khalif *et al.* (2007), Zayed *et al.* (2007), Sharief *et al.* (2005), El-Kady and Abdallah (2004), Abdel-Rahman *et al.* (2004a), Abdel-Rahman *et al.* (2004b).

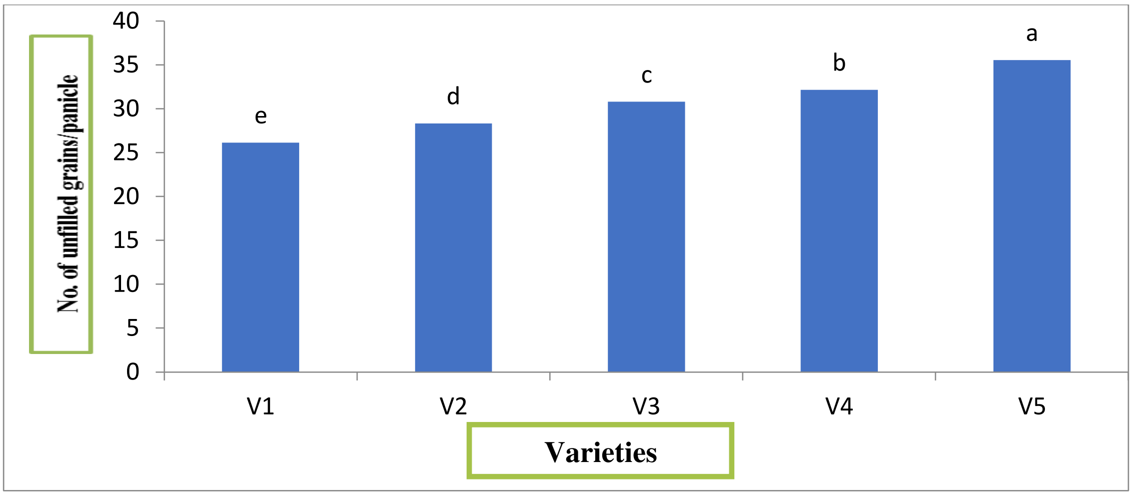

Figure 20. Effect of variety on number of unfilled grains panicle^{-1}

V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.10.3 Combined effect of system of cultivation and variety

Combined effect of system of cultivation and variety showed significant impact on number of unfilled grains panicle^{-1} (Table 11 and Appendix VIII). The number of unfilled grains panicle^{-1} were ranges from 12.62 to 50.03 while T_3V_5 produced the maximum number of unfilled grains panicle^{-1} and T_1V_1 produced minimum number of filled grains.

Table 9. Combined effect of system of rice intensification (SRI) variety on number of filled grains and number of unfilled grains panicle^{-1}

Treatments	No. filled grains panicle^{-1}	No. unfilled grains panicle^{-1}
T_1V_1	176.08 a	12.62 n
T_1V_2	171.31 b	14.71 m
T_1V_3	165.59 c	16.76 lm
T_1V_4	161.24 d	15.48 l
T_1V_5	156.35 d	19.35 k
T_2V_1	160.32 e	25.33 j
T_2V_2	155.41 e	27.67 i
T_2V_3	151.27 f	30.57 h
T_2V_4	146.28 f	32.93 g
T_2V_5	141.20 g	37.28 f
T_3V_1	151.44 h	40.50 e
T_3V_2	148.37 h	42.60 d
T_3V_3	145.39 i	45.05 c
T_3V_4	143.24 j	48.04 b
T_3V_5	141.16 j	50.03 a
LSD $_{(0.05)}$	1.6150	2.2409
CV (%)	6.203	5.954

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.11. Weight of 1000 grains

4.11.1 Effect of system of cultivation

Due to system of cultivation 1000 grains weight showed significant result of rice plant (Figure 21 and Appendix IX). The 1000 grains weight ranges from 28.07 gm to 29.71 gm. The highest 1000 grains weight was recorded in T_1 treatment and the lowest 1000 grains weight was recorded in T_3 treatment. Pandian *et al*. (2014), Omwenga *et al*. (2014), Chen *et al*. (2013), Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Kumar *et al*. (2009) and Hanumanthappa *et al.* (2009) also reported the similar findings.

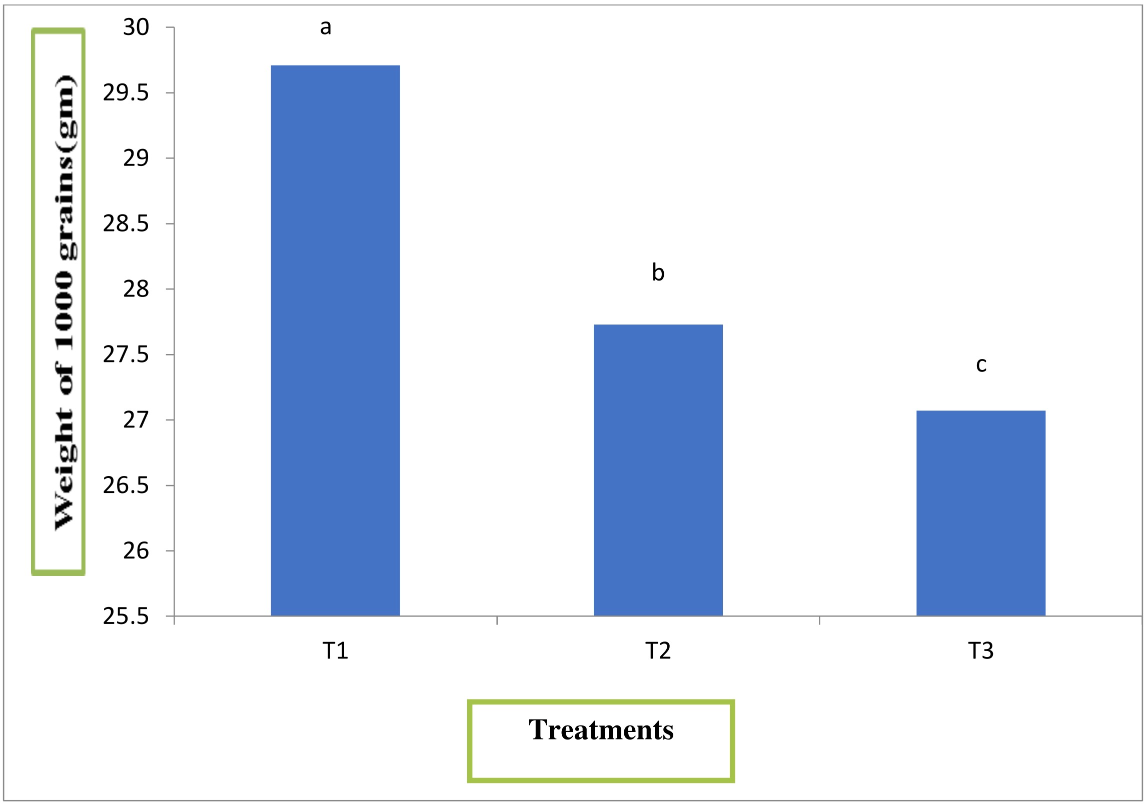

Figure 21. Effect of system of rice intensification (SRI) on 1000 grains weight (gm)

T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.11.2 Effect of variety

The 1000 grains weight showed significant impact due to different variety of rice cultivation (Figure 22 and Appendix IX). The highest 1000 grains weight was recorded in V_1 while lowest 1000 grains weight was in V_5. The 1000 grains weight ranges from 27.38 g to 28.82 g. The present finding closely confirm with the findings of Ahmadikhah and Mirarab (2010), Metwally *et al.* (2010), Abou khalifa (2009), Zaki *et al.* (2009) and Kumar *et al.* (2008).

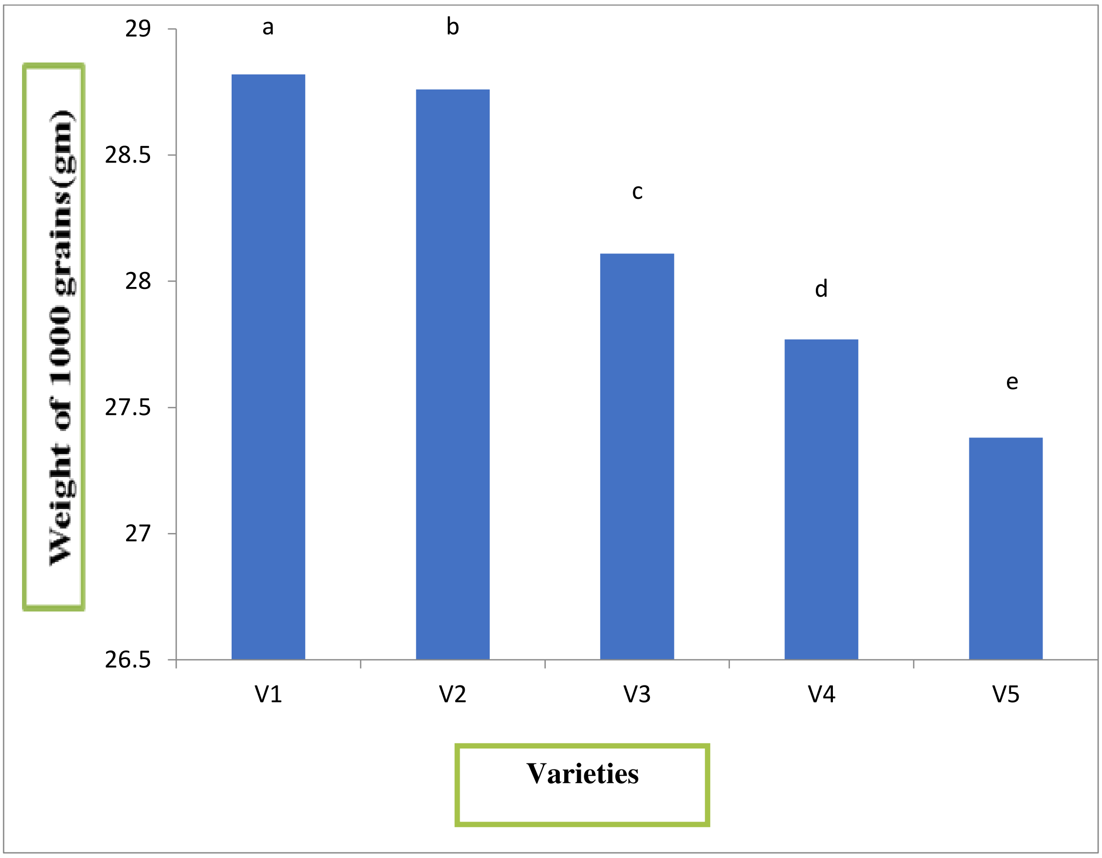

Figure 22. Effect of variety on 1000 grains weight (gm)
V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan4 (check)

4.11.3. Combined effect of system of cultivation and variety

Combined effect of system of cultivation and variety produced significant 1000 grains weight (Table 12 and Appendix IX). For combined effect, the 1000 grains weight ranges from 25.88 g to 30.12 g. The highest 1000 grains weight found in T_3V_5 and lowest weight of 1000 grains was found in T_1V_1 combination compared to the others combination.

Table 10. Combined effect of system of rice intensification (SRI) and variety on weight of 1000 grains (gm)

Treatments	1000 grains weight (gm)
T_1V_1	30.12 a
T_1V_2	30.09 a
T_1V_3	29.16 a
T_1V_4	30.05 b
T_1V_5	29.12 b
T_2V_1	28.14 c
T_2V_2	28.08 c
T_2V_3	28.14 c
T_2V_4	27.13 c
T_2V_5	27.14 c
T_3V_1	28.20 d
T_3V_2	28.11 d
T_3V_3	27.02 d
T_3V_4	26.13 e
T_3V_5	25.88 e
LSD $_{(0.05)}$	0.5383
CV (%)	5.793

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.12. Yield

4.12.1 Effect of system of cultivation

The yield of rice showed significant difference at different doses of system of cultivation application (Figure 23 and Appendix IX). Due system of cultivation, the range of yield of rice was found 4.45 t ha^{-1} to 6.35 t ha^{-1}. The highest grains yield was recorded in T_1 while lowest yield was recorded in T_3. Pandian *et al*. (2014), Omwenga *et al*. (2014), Chen *et al*. (2013), Reddy and Shenoy (2013), Singh *et al.* (2011), Manjunatha *et al.* (2010), Kumar *et al*. (2009), Hanumanthappa *et al.* (2009), Krishna and Biradarpatil (2009), Chandrakar *et al.* (2008), Kumar *et al.* (2008) and Uphoff (2004) also reported the similar findings.

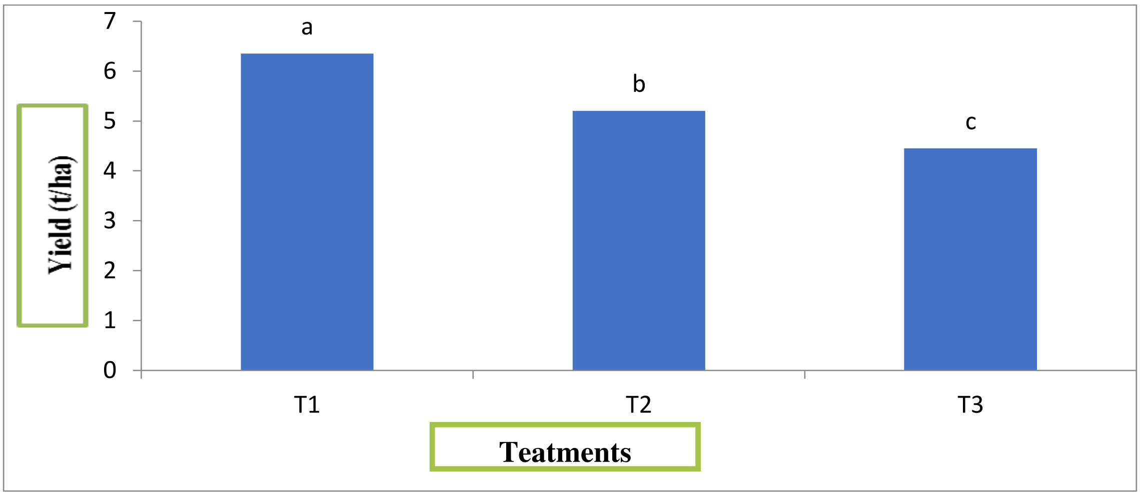

Figure 23. Effect of system of rice intensification (SRI) on yield (ton ha^{-1})
T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.12.2 Effect of variety

Impact of variety on rice showed significant effect for grain yield of rice (Figure 24 and Appendix IX). Due to the effect of variety on yield of rice, the highest yield was found in V_1 while the lowest yield was recorded in V_5 variety. The grains yield ranges from 4.16 t ha^{-1} to 6.57 t ha^{-1}. The present finding closely confirm with the finding of Ahmadikhah and Mirarab (2010), Metwally *et al.* (2010) and Kumar *et al.* (2008).

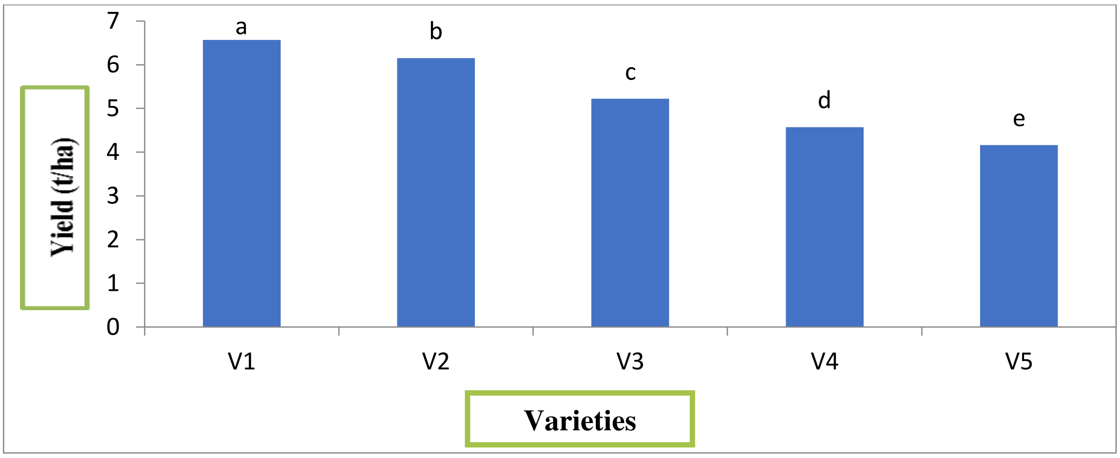

Figure 24. Effect of variety on grain yield (ton ha^{-1})
V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.12.3. Combined effect of system of cultivation and variety

Combined effect of system of cultivation and variety showed significant impact on grain yield of rice (Table 11 and Appendix IX). The grain yield of rice ranges from 3.29 t ha^{-1} to 8.08 t ha^{-1} while T_1V_1 produced the highest grain yield and T_3V_5 produced lowest grain yield.

Table 11. Combined effect of system of rice intensification (SRI) and Variety on grain yield (ton ha^{-1})

Treatments	Yield ha^{-1} (ton ha^{-1})
T_1V_1	8.08 a
T_1V_2	7.18 b
T_1V_3	6.19 c
T_1V_4	5.23 c
T_1V_5	5.07 c
T_2V_1	6.24 d
T_2V_2	6.13 d
T_2V_3	5.16 d
T_2V_4	4.34 d
T_2V_5	4.12 d
T_3V_1	5.37 e
T_3V_2	5.13 e
T_3V_3	4.30 e
T_3V_4	4.13 e
T_3V_5	3.29 f
$LSD_{(0.05)}$	0.3642
CV (%)	5.043

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.13. Harvest index

4.13.1. Effect of system of cultivation

Due to system of cultivation harvest index of rice plant showed significant result (Figure 25 and Appendix IX). The harvest index ranges from 39.20% to 44.16%. The highest harvest index was recorded in T_1 treatment and lowest harvest index was recorded in T_3 treatment. Singh *et al.* (2011), Manjunatha *et al.* (2010), Kumar *et al.* (2009), Hanumanthappa *et al.* (2009), Krishna and Biradarpatil (2009), Manjunatha *et al.* (2009), Goel *et al.* (2009), Krishna and Biradarpatil (2009), Pasuquin *et al.* (2008) and Raj *et al.* (2008) also reported the similar findings.

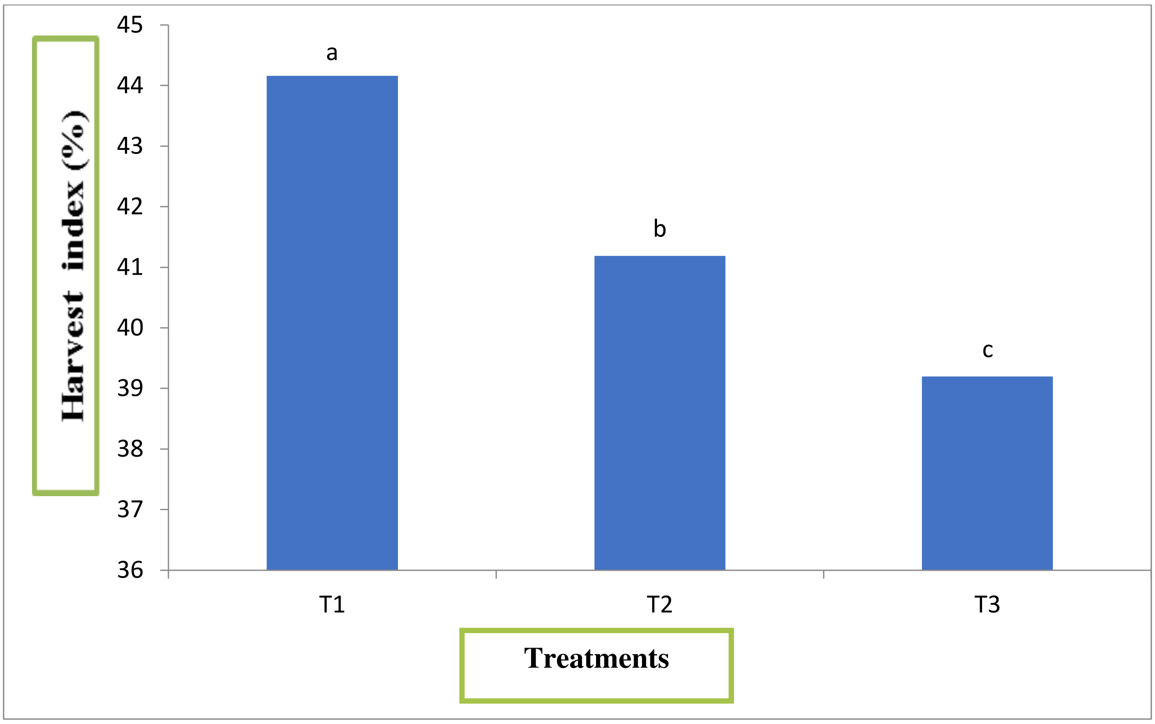

Figure 25. Effect of system of rice intensification (SRI) on harvest index (%)

T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition

4.13.2 Effect of variety

The harvest index showed significant impact due to different variety of rice cultivation (Figure 26 and Appendix IX). The highest harvest index was recorded in case of V_1 while the lowest harvest index was in V_5 variety. The harvest index ranges from 39.50% to 43.52%. The present finding closely confirm with the findings of

Ahmadikhah and Mirarab (2010), Metwally *et al.* (2010), Abou khalifa (2009), Zaki *et al.* (2009), Kumar *et al.* (2008), Kumar *et al.* (2008), Abou-Khadra *et al.* (2008), Abou-Khalif *et al.* (2007), Zayed *et al.* (2007), Sharief *et al.* (2005), El-Kady and Abdallah (2004), Abdel-Rahman *et al.* (2004a), Abdel-Rahman *et al.* (2004b).

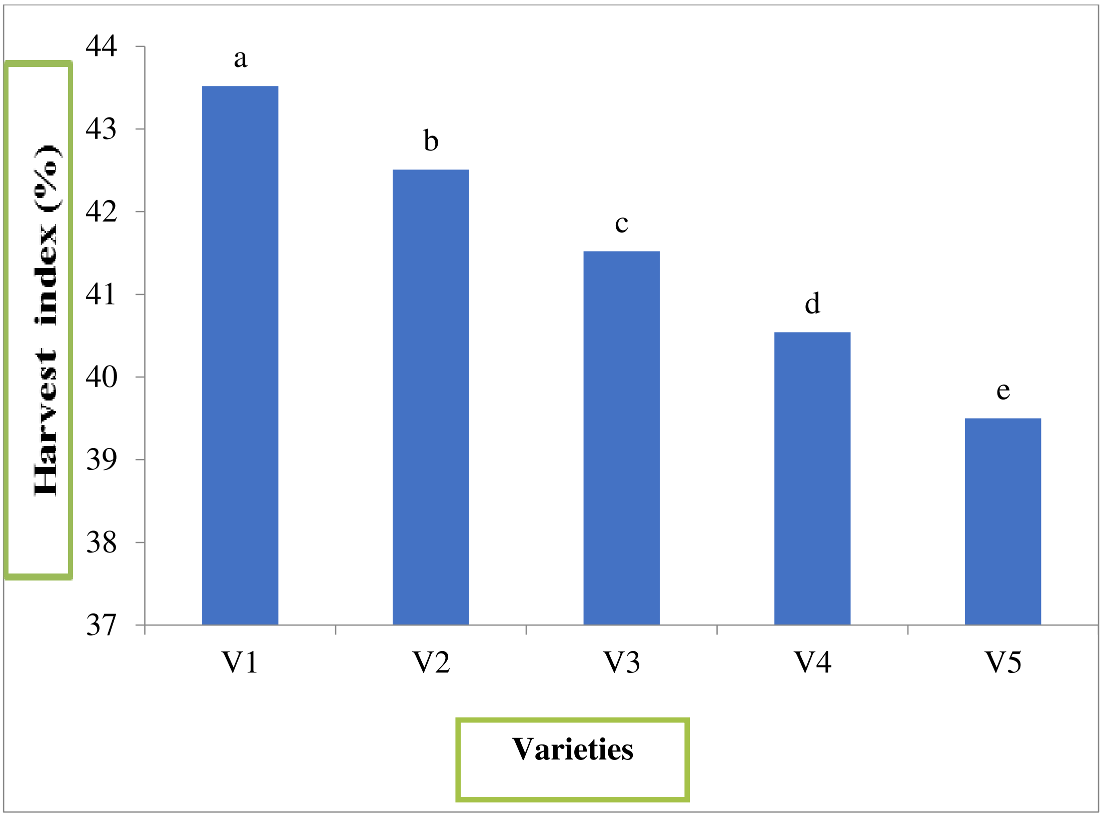

Figure 26. Effect of variety on harvest index (%)
V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check)

4.13.3. Combined effect of system of cultivation and variety

The combined effect of system of cultivation and variety produced non-significant harvest index (Table 14 and Appendix IX). For the interaction effect, the harvest index ranges from 37.16% to 46.19%. The highest harvest index was found in T_1V_1 and the lowest harvest index was found in T_3V_5 combination compared to the others combination.

Table 12. Combined effect of system of rice intensification (SRI) and Variety on harvest index (%)

Treatments	Harvest index (%)
T_1V_1	46.19
T_1V_2	45.20
T_1V_3	44.16
T_1V_4	43.16
T_1V_5	42.12
T_2V_1	43.17
T_2V_2	42.16
T_2V_3	41.16
T_2V_4	40.24
T_2V_5	39.23
T_3V_1	41.19
T_3V_2	40.17
T_3V_3	39.25
T_3V_4	38.22
T_3V_5	37.16
$LSD_{(0.05)}$	NS
CV (%)	5.775

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check), NS= Non-significant

4.14. Economics analysis

Supposing the rate of grain selling price 40tk. kg^{-1} and total selling price in conventional method was 254000tk. ha^{-1} and in SRI method selling price was 208000tk. ha^{-1}, 178000tk. ha^{-1} in raised upland (T_2) and raised transplant condition (T_3), respectively.

In case of conventional method (T_1) rate of seed needed 15 kg ha^{-1}, SRI method rate of seed needed 5 kg ha^{-1}, 6 kg ha^{-1} in in raised upland (T_2) and raised transplant condition (T_3), respectively. So, seed required about 3 times higher for conventional method than SRI and the average cost of seed was 300tk. kg^{-1}.

The labor wage 500tk. day^{-1} and working hours $8day^{-1}$. In conventional method (T_1), total cost needed for transplanting was 26000tk. ha^{-1} that is higher than SRI. Counting the total cost of irrigation in conventional method needed 22500tk. ha^{-1} otherwise SRI needed 15634tk. ha^{-1} in both raised upland (T_2) and raised transplant condition (T_3) that saving 6866 tk. ha^{-1} and saved about 30% water. In case of weeding needed more labor and cost in conventional method than SRI.

Table 13. Economic analysis of conventional method with SRI

Cost items	Conventional method(T_1) Tk. ha^{-1}	SRI method		Difference	
		Raised upland condition (T_2) Tk. ha^{-1}	Raised transplant condition (T_3) Tk. ha^{-1}	Raised upland condition (T_2) Tk. ha^{-1}	Raised transplant condition (T_3) Tk. ha^{-1}
Seed	4500	1500	1800	3000	2700
Transplanting	26000	15525	16000	10475	10000
Irrigation	22500	15634	15634	6866	6866
Weeding (2 times)	26040	23800	24500	2240	1540
Income	254000	208000	178000	46000	76000
Net Profit (income-total cost)	174960	151541	120066	———	———

Labor wage=500 Tk. day^{-1}, No. labor for transplanting in conventional method (T_1)= 52 ha^{-1}, No. of labor for transplanting in SRI; T_2 = 31.05 ha^{-1}, T_2=32 ha^{-1}, No. of labors for two times weeding in conventional (T_1) method= 52.08 ha^{-1}, No of labors for two times weeding in SRI, T_2= 47.60 ha^{-1}, T_3=$49ha^{-1}$, Grain selling rate= 40 tk.kg^{-1}, Grain yield = 6.35 t ha^{-1} in conventional method (T_1) and Raised upland condition (T_2) = 5.20 t ha^{-1}; Raised up transplant condition (T_3) = 4.45 t ha^{-1} in SRI)

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from December 2015 to May 2016 to study the response of hybrid rice varieties to the system of rice intensification (SRI) in *Boro* season. The experiment comprised of two factors, Factor A: three levels of system of rice cultivation i.e. T_1= Low land transplant condition, T_2= Raised upland condition, T_3= Raised transplant condition; and Factor B: five verities i.e. V_1= BRRI hybrid dhan3, V_2= Bolaka, V_3= Moyna, V_4= Gold, V_5= BRRI dhan45 (check). The experiment was laid out in Split Plot Design (SPD) with three replications. Data on different growth parameters, yield attributes and yield were recorded and analyzed.

The ranges of plant height from 61.94 cm to 74.12 cm and 101.02 cm to 112.67 cm at 75 DAT and harvest time, respectively. For system of cultivation the tallest plant was recorded in T_1 treatment while the shortest plant was recorded in T_3 treatment. The tallest rice plant was recorded in V_1 while the shortest plant was in V_5. The plant height ranges from 65.86 cm to 70.03 cm and 103.57 cm to 111.33 cm at 75 DAT and harvest time, respectively. This might be genetic variation among the varieties while V_1 superior than others. In spite of having non-significant impact, for the interaction effect the height of rice plant ranges from 59.63 cm to 76.06 cm and 96.32 cm to 115.37 cm at 75 DAT and harvest time, respectively. The tallest plant was found in T_1V_1 and the shortest plant was found in T_3V_5 combination compared to the others combination.

Due to system of rice cultivation, the ranges of number of leaves hill^{-1} was found 70.12 to 78.31 and 81.10 to 92.84 at 75 DAT and harvest times, respectively. The maximum number of leaves hill^{-1} was recorded in T_1 while the minimum number of leaves hill^{-1} was recorded in T_3. The maximum number of leaves hill^{-1} was found in V_1 variety while the minimum number of leaves hill^{-1} was recorded in V_5 variety. The leaves number ranges from 72.45 to 77.05 and 83.34 to 89.98 at 75 DAT and harvest time, respectively. The number of leaves hill^{-1} ranges from 67.86 to 80.75 and 77.48

to 96.41 at 75 DAT and harvest time, respectively while T_1V_1 produced the maximum number of leaves hill^{-1} and T_3V_5 produced minimum number of leaves hill^{-1}.

The number of tillers hill^{-1} range from 12.18 to 19.57 and 22.52 to 34.70 at 75 DAT and harvest time, respectively. The maximum number of tillers hill^{-1} was recorded in T_1 treatment and minimum number of tillers hill^{-1} was recorded in T_3 treatment. The maximum number of tillers hill^{-1} was recorded in V_1 while lowest number of tillers hill^{-1} was in V_5. The number of tillers hill-1 ranges from 13.44 to 14.45 and 22.94 to 33.03at 75 DAT and harvest time, respectively. For combine effect number of tillers hill-1 ranges from 9.93 to 22.97 and 15.52 to 38.66 at 75 DAT and harvest time, respectively. The maximum number of tillers hill^{-1} was found inT_1V_1 and minimum number of tillers hill^{-1} was found in T_1V_5 combination compared to the others combination.

The leaf area index ranges from 3.73 to 4.97. The highest leaf area index was recorded in T_1 treatment and lowest leaf area index was recorded in T_3 treatment. The highest leaf area index was recorded in V_1 while the lowest leaf area index was in V_4. The leaf area index ranges from 4.16 to 4.48. For combine effect the leaf area index ranges from 3.51 to 5.08. The highest leaf area index was found in T_1V_1 and lowest leaf area index was found in T_3V_5 combination compared to the others combination.

The highest Chl a (1.46 mg g^{-1}), Chl b (0.45 mg g^{-1}), Total Chl (1.92 mg g^{-1}) and ratio of a:b (3.28) was recorded in case of T_1 while the lowest value of Chl a (1.10 mg g^{-1}), Chl b (0.33 mg g^{-1}), Total Chl (1.44 mg g^{-1}) and ration of a:b (3.19) was recorded in T_3. The highest value of Chl a (1.42 mg g^{-1}), Chl b (0.44 mg g^{-1}), Total Chl (1.86 mg g^{-1}) and ration of a:b (3.24) was found in V_1 treatment while the lowest value of Chl a (1.22 mg g^{-1}), Chl b (0.37 mg g^{-1}), Total Chl (1.60 mg g^{-1}) and ration of a:b (3.21) was recorded in case of V_5 variety. The T_1V_1 produced the heightest value of Chl a (1.58 mg g^{-1}), Chl b (0.49 mg g^{-1}), Total Chl (2.18 mg g^{-1}) and T_3V_5 produced the lowest value of Chl a (1.02 mg g^{-1}), Chl b (0.31 mg g^{-1}), Total Chl (1.43 mg g^{-1}). The highest ratio of a:b was in T_3V_5 (3.31) and lowest ratio was in T_1V_1 (3.18).

The number of effective tillers hill^{-1} range from 22.52 to 34.70. The maximum number of effective tillers hill^{-1} was recorded in T_1 treatment and minimum number of effective tillers hill^{-1} was recorded in T_3 treatment. The maximum number of effective tillers hill^{-1} was recorded in V_1 while lowest number of effective tillers hill^{-1} was in

V_5. The number of effective tillers hill^{-1} ranges from 22.94 to 33.03 at harvest. For combine effect number of effective tillers hill^{-1} ranges from 16.52 to 37.36.The maximum number of effective tillers hill^{-1} was found in T_1V_1 and minimum number of effective tillers hill^{-1} was found in T_1V_5 combination compared to the others combination.

Due to system of cultivation, the range of number of non-effective tillers hill^{-1} was found 3.06 to 5.18 at harvest. The maximum number of non-effective tillers hill^{-1} was recorded in T_2 while the minimum number of non-effective tillers hill^{-1} was recorded in T_1. The maximum number of non-effective tillers hill^{-1} was found in V_5 while minimum number of non-effective tillers hill^{-1} was recorded in V_1 treatment. The number of non-effective tillers hill^{-1} ranges from 3.44 to 5.17 at harvest. The number of non-effective tillers hill^{-1} ranges from 3.06 to 5.18 at harvest while T_3V_5 produced the maximum number of non-effective tillers hill^{-1} and T_1V_1 produced minimum number of non-effective tillers hill^{-1}.

The plant dry weight ranges from 18.48 gm to 28.22 gm, 32.15 gm to 58.79 gm and 45.28 gm to 77.66 gm at vegetative stage, flowering stage and harvest time, respectively. The highest plant dry weight was recorded in T_1 treatment and the lowest plant dry weight was recorded in T_3 treatment. The significant influence of variety facilitated highest plant dry weight in V_1 while the lowest plant dry weight was in V_5. The plant dry weight ranges from 19.15 gm to 27.39 gm, 36.41 gm to 49.09 gm and 59.87 gm to 68.84 gm at vegetative stage, flowering stage and harvest time, respectively. For the interaction effect, plant dry weight ranges from 14.46 gm to 34.31 gm, 28.05 gm to 65.34 gm and 39.52 gm to 81.74 gm at vegetative stage, flowering stage and harvest time, respectively. The highest plant dry weight was found in T_1V_1 and the lowest plant dry weight was found in T_3V_5 combination compared to the others combination.

Due to system of cultivation, the range of number of filled panicle^{-1} grains was found 145.92 to 166.11. The minimum number of filled grains panicle^{-1} was recorded in T_3 while the maximum number of filled grains panicle^{-1} was recorded in T_1. The minimum number of filled grains panicle^{-1} was found in V_5 while maximum number of filled grains was recorded in V_1 variety. The number of filled grains panicle^{-1} ranges from 146.24 to 162.61. The number of filled grains panicle^{-1} were ranges from

141.16 to 176.08 while T_3V_5 produced the minimum number of filled grains panicle^{-1} and T_1V_1 produced maximum number of filled grains panicle^{-1}.

Due to system of cultivation, the range of number of unfilled grains panicle^{-1} was found 15.78 to 45.24. The maximum number of unfilled grains panicle^{-1} was recorded in T_3 while the minimum number of unfilled grains panicle^{-1} was recorded in T_1. The maximum number of unfilled grains panicle^{-1} was found in V_5 while minimum number of unfilled grains panicle^{-1} was recorded in V_1 variety. The number of filled grains ranges from 26.15 to 35.55. The number of unfilled grains panicle^{-1} were ranges from 12.62 to 50.03 while T_3V_5 produced the maximum number of unfilled grains panicle^{-1} and T_1V_1 produced minimum number of filled grains panicle^{-1}.

The 1000 grains weight ranges from 28.07 gm to 29.71 gm. The highest 1000 grains weight was recorded in T_1 treatment and the lowest 1000 grains weight was recorded in T_3 treatment. The highest 1000 grains weight was recorded in V_1 variety while lowest plant was in V_5 variety. The 1000 grains weight ranges from 27.38 gm to 28.82 gm. For combine effect, the 1000 grains weight ranges from 25.88 gm to 30.12 gm. The highest 1000 grains weight found in T_3V_5 and lowest plant was found in T_1V_1 combination compared to the others combination.

Due system of cultivation, the range of yield of rice was found 4.45 t ha^{-1} to 6.35 t ha^{-1}. The highest grain yield was recorded in T_1 while lowest yield was recorded in T_3. Due to the effect of variety on yield of rice, the highest yield was found in V_1 while the lowest yield was recorded in V_5 treatment. The grain yield ranges from 4.16 t ha^{-1} to 6.57 t ha^{-1}. The grain yield of rice ranges from 3.29 t ha^{-1} to 8.08 t ha^{-1} while T_1V_1 produced the highest grain yield and T_3V_5 produced lowest grain yield.

The harvest index ranges from 39.20% to 44.16%. The highest harvest index was recorded in T_1 treatment and lowest harvest index was recorded in T_3 treatment. The highest harvest index was recorded in V_1 variety while the lowest harvest index was in V_5 variety. The harvest index ranges from 39.50% to 43.52%. For the interaction effect, the harvest index ranges from 37.16% to 46.19%. The highest harvest index was found in T_1V_1 and the lowest harvest index was found in T_3V_5 combination compared to the other combinations.

Considering the result of the present study, following conclusion may be drawn:

- BRRI hybrid dhan3 provided higher yield and maximum profit in conventional method compared to SRI method.
- In SRI method, raised upland showed higher yield than raised transplant condition.
- BRRI hybrid dhan3 demonstrated comparatively better performance among five rice varieties in both method in *Boro* season.

Recommendation

- ✓ BRRI hybrid dhan3 may be used to cultivate for higher yield and profit in *Boro* season.
- ✓ Such experiment is needed to conduct in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.

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APPENDICES

Appendix I. Monthly recorded the average air temperature, rainfall, relative humidity and sunshine of the experimental site during the period from November 2016 to March 2017

Month	Air temperature (^0C)		Relative humidity (%)	Total rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
October, 2015	33.5	20.6	79	30.3	5.9
November, 2015	29.6	19.2	73	34.4	5.7
December, 2015	26.4	14.1	69	12.8	5.5
January, 2016	25.4	12.7	68	7.7	5.6
February, 2016	28.1	15.5	68	28.9	5.5
March, 2016	32.5	20.4	64	65.8	5.2
April, 2016	38.9	23.6	70	76.4	5.7
May, 2016	40.5	24.5	75	80.6	5.8

Source: Sher-e-Bangla Agricultural University Weather Station

Appendix II. Physical and chemical soil properties of experimental plot

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

Source: Soil Resources Development Institute (SRDI)

Appendix III. Anova of plant height

Source	DF	Plant height (cm) at	
		75 DAT	Harvest
Replication	2	11.763	4.924
SRI	2	555.673	518.457
Variety	4	23.810	76.157
SRI*Variety	8	0.233	1.947
Error	28	0.146	0.679

Appendix IV. Anova of number of leaves hill^{-1}

Source	DF	Number of leaves hill^{-1} at	
		75 DAT	Harvest
Replication	2	0.874	0.723
SRI	2	258.651	520.705
Variety	4	29.379	61.135
SRI*Variety	8	0.142	0.927
Error	28	0.275	0.222

Appendix V. Anova for leaf area and Chlorophyll content

Source	DF	Leaf area index	Chlorophyll content			
			Chl a	Chl b	Total chl	Ratio of a:b
Replication	2	0.14565	0.00057	0.00004	0.00086	0.00185
SRI	2	5.81085	0.52896	0.06027	0.94633	0.03281
Variety	4	0.12861	0.05353	0.00583	0.09467	0.00182
SRI*Variety	8	0.09088	0.00056	0.00004	0.00086	0.00118
Error	28	0.09101	0.00007	0.00001	0.00012	0.00080

Appendix VI. Anova for number of tillers hill^{-1}

Source	DF	Number of effective tiller hill^{-1}	Number of non-effective tiller hill^{-1}
Replication	2	7.326	0.27422
SRI	2	596.299	1.52388
Variety	4	142.076	3.94616
SRI*Variety	8	11.725	0.36301
Error	28	0.709	0.00938

Appendix VII. Anova for plant dry weight

Source	DF	Plant dry weight (g) at		
		Vegetative stage	Flowering stage	Reproductive stage
Replication	2	6.691	1.38	2.67
SRI	2	363.496	2837.49	4340.44
Variety	4	106.479	205.12	113.21
SRI*Variety	8	4.168	21.88	2.01
Error	28	0.410	0.59	0.31

Appendix VIII. Anova for number of grains panicle^{-1}

Source	DF	Filled grain panicle^{-1}	Unfilled grain panicle^{-1}
Replication	2	18.52	3.14
SRI	2	1660.16	3255.33
Variety	4	375.85	116.87
SRI*Variety	8	13.42	5.85
Error	28	0.20	0.43

Appendix IX. Anova for 1000 grain weight, yield and harvest index

Source	DF	1000 grain weight (g)	Yield (t ha^{-1})	Harvest index
Replication	2	0.1155	0.4841	0.4140
SRI	2	28.3272	13.8149	93.6253
Variety	4	3.5146	9.3718	22.4919
SRI*Variety	8	0.8349	0.2915	0.0056
Error	28	0.0264	0.0120	0.0031