REGENERATION CAPACITY OF INBRED AND HYBRID RICE INFLUENCED BY PLANT GROWTH REGULATORS AND CUTTING MANAGEMENT

MD. FARHAN ISHRAK

DEPARTMENT OF AGRONOMY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

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BY

MD. FARHAN ISHRAK

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Approved by:

Dr. Md. Hasanuzzaman
Professor
Department of Agronomy
Sher-e-Bangla Agricultural University
Supervisor

Dr. Md. Fazlul Karim
Professor
Department of Agronomy
Sher-e-Bangla Agricultural University
Co-supervisor

Prof. Dr. Md. Abdullahil Baque
Chairman
Department of Agronomy
Examination Committee

Department of Agronomy
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207
PABX: 99110351 & 9144270-79

CERTIFICATE

This is to certify that thesis entitled, **"Regeneration capacity of inbred and hybrid rice influenced by plant growth regulators and cutting management"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agronomy,** embodies the result of a piece of bonafide research work carried out by **Md. Farhan Ishrak,** Registration **No. 15-06716** under my supervision and guidance. No part of the 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: June, 2022
Place: Dhaka, Bangladesh

Prof. Dr. Md. Hasanuzzaman
Supervisor
Department of Agronomy
Sher-e-Bangla Agricultural University
Dhaka-1207

DEDICATED TO
MY
BELOVED PARENTS

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SAU, Dhaka **The Author**

Regeneration capacity of inbred and hybrid rice influenced by plant growth regulators and cutting management

ABSTRACT

An experiment was carried out at the Agronomy Field, Sher-e-Bangla Agricultural University, Dhaka during the period from November 2021 to July 2022 with a view to study the effects of variety of main crop and N dose (applied after the harvesting of main crops) on the performance of ratoon crop of boro rice. The experiment was carried out in a Split Plot Design, where three factors were selected as variety, plant growth regulators and cutting managements. The plot size was 3 square meters (1 m ×0.5 m). The plots were replicated three times and thus the total number of plots was 36 per split with 2 splits containing different boro rice variety. V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin were selected treatments. For main crop the highest grain yield (7.53 t/ha.) was observed from the variety BRRI hybrid dhan 5. The lowest grain yield (6.53 t/ha.) was found from the variety BRRI Dhan 47. In ratoon crop the highest grain yield (0.79 t/ha.) was observed from the variety BRRI hybrid dhan 5 which is 10.53% of the main crop. The lowest grain yield (0.41 t/ha.) was found from the variety BRRI Dhan 47 which is 6.31% of the main crop. The interaction of variety and cutting height of main crop and application of PGRs had significant effect on any of the crop characters of ratoon crop. The interaction of variety and cutting height of main crop had highly significant effect on final grain yield of ratoon crop along with other yield contributing factors and found the highest grain yield (0.75 t/ha.) observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin and the lowest grain yield (0.35 t/ha.) was found from the treatment combination of $V_1C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control. Yield of ratoon crop for BRRI hybrid dhan 5 was found 10.53% of the main crop and 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin combination can be considered for commercial ratoon crop cultivation.

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LIST OF ABBREVIATION AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
FAO	=	Food and Agriculture Organization
et al.	=	And others
DAS	=	Days after Sowing
Mg	=	Milligram
kg	=	Kilogram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources Development Institute
g	=	Gram
cm	=	Centimeter
wt	=	Weight
LSD	=	Least Significant Difference
^{0}C	=	Degree Celsius
NS	=	Not significant
Max	=	Maximum
Min	=	Minimum
%	=	Percent
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of Coefficient of Variance

CHAPTER I

INTRODUCTION

Rice cultivation is favoured by the hot, humid climate and the large number of deltas across Asia's vast tropical and subtropical areas. As a main source of nourishment for more than two billion people in Asia and many millions in Africa and Rice (*Oryza sativa* L.) is a semi aquatic cereal among the oldest and most important Latin America, it is by far one of the most important commercial food crops. Rice is a nutritious food, providing about 90% of calories from carbohydrates and as much as 13% of calories from protein (AIS, 2021). Rice is the staple food of about 140.6 million people of Bangladesh and contributes 14.6% to the national GDP and supplies 71% of the total calories and 51% of the protein in a typical Bangladeshi diet. Bangladesh with its flat topography, abundant water and humid tropical climate constitutes an excellent habitat for the rice plant. In Bangladesh, 5.55 million hectare of arable land of which 75% is devoted to rice cultivation (BBS, 2021). Rice is grown in the country under diverse ecosystem like irrigated, rainfed and deep-water conditions in three distinct overlapping seasons namely aus, aman and boro. Among these three seasons, the monsoon rice, transplanted aman covers the largest area (50.58% of total rice area) and average yield of aman rice is 2.55 t ha^{-1} (BBS, 2021). The population of Bangladesh is still growing by two million every year and may increase by another 30 millions over the next 20 years.

Three successive rice crops can be grown within one year by adapting suitable short duration rice varieties under irrigated conditions. But in the rainfed areas the cropping intensity is minimum (Krishnamurthty, 1979). About two-thirds of the total rice area of Asia is rainfed which remains fallow after the monsoon season. Intensifying rice cropping in drought areas, soil moisture is the most limiting factor. Increasing rice grain yields per unit of area is one approach to improving total rice production (Santos *et al.*, 2003). However, the development of ratooning rice is one of the methods to increase the yield all over the world because additional rice yields can be achieved with minimal agricultural inputs (Harrell *et al.*, 2009). Ratoon cropping of rice is the practice of obtaining a second crop from the stubble of a previously harvested (main) crop (Coale and Jones, 1994). Therefore, the benefit in ratooning lies in the facts of avoiding of elaborate land preparation, saving of seed and planting costs (Zandstra and Samson, 1979), economic use of machineries, high water use efficiency (Prashar, 1970) and considerable saving in cropping time as it has the advantage of reduced growth duration (Haque and Coffman, 1980). It reduced production cost by 73 percent (Calendacion *et al.,* 1992). Rice ratooning has several stated advantages: low production costs, high water use efficiency, and reduced growth duration (Jones, 1993). For example, the average yield of the main crop was 12633 kg ha^{-1} and the ratoon was 7115 kg ha^{-1} in Fujian province of southeast China (Chen *et al.,* 2007). The field duration of a ratoon crop is less than 50% of the main crop, even when early varieties are employed. Ratooning of rice has been reported to be a practical means of increasing rice production and the cost of production is very low (Mohan *et al.,* 2000). The ratoon crop of rice can extract moisture and nutrients from 2 deeper soil layers by the already established root system and it may be harvested before the onset of drought. Ratooning of rice eliminates two labor-saving operations: raising seedlings in the seedbed and transplanting in the main field (Bahar & Datta, 1977).

The ratoon cropping systems have been used in India, Thailand, Taiwan, Swaziland, China, the United States and Philippines (Nakano and Morita, 2007). In the USA 50% of the rice crop is ratooned (Flinchum and Evatt, 1972). The non-acceptance of rice ratooning for large scale commercial farming in tropical Asia seems to be due to its low yield potential and vulnerability to pests and diseases (Mahadevappa, 1979). If grain yield of the ratoon crop alone is considered, it may be seen discouraging. However, if consideration is given to the time factor to express yield, ratoon cultures are found to be very encouraging (Quddus and Pendleton, 1990). On an average, ratoon rice can give a yield roughly equivalent upto 40% of that of the main crop with 40% reduction in crop duration (Samson, 1980). Faria (1984) mentioned that production of irrigated ratoon rice in Brazil covered 30% of that of the first crop and in other countries the corresponding figure was 50%. Ratoon yield is generally less than the main crop but higher yields have also been reported by Santhi *et al.,* (1993).

Under Bangladesh context, there are potentials for rice ratooning from the stubble of boro rice with residual soil moisture and monsoon rain. In this country, crop intensification through rice ratooning constitutes one of the important options for the farmers in achieving food security. Here rice crops may be grown thrice in a year in aus, aman and boro seasons. But, it is not always possible to accommodate three crops in a year through conventional rice culture. In this context, ratooning can play a very significant role with its very short growth duration, usually taking only 35 to 60% of the time required for the main crop (Jones, 1985). Ratooning thus helps in adding extra yield. On the other hand, in rice based cropping pattern when transplanted aman (T. aman) is grown after boro rice, crops like mustard, pea etc., whose optimum sowing time is the first week of November, cannot be accommodated. In such a situation ratoon cropping of boro rice can ensure three crops in a year as well as crops like mustard, lentil, pea etc. can also be accommodated in the pattern.

It is thought that rice ratooning might play a significant role in increasing total crop production trend in Bangladesh too. In an effort to better understand the factors influencing rice ratoon crop growth, the International Rice Research Institute (IRRI) published a comprehensive report (Chauhan *et al.*, 1988) identifying key factors influencing a rice cultivar's ratoon potential: plant maturity at main crop harvest, main crop harvest height, main crop cultural practices, temperature, sunlight, leaf senescence, and carbohydrate and N content of main crop stubble. Ratooning is a natural phenomenon in grass family (*Gramineae*) which is basically a varietal character and differs among cultivars (Zhang *et al.*, 2009) The photosynthetic products and nutrient left in the rice stubbles had a great effect on the growth and development of the ratoon crop (Liu *et al.*, 1993).

Although ratoonability is a varietal characteristic, manipulation of cultural practices can enhance a good ratoon crop of rice (Quddus, 1981). however. information is still not enough with regard to ratooning. The farmers are also not familiar with the production technology of rice ratoon cropping. though the l3angladesh Rice Research Institute has been developing high yielding varieties of rice, it has extended little short towards the development of varieties having high ratoonahilitv.

However. though in general, the yield in ratoon crop was comparatively less than that in main crop, experimental evidences revealed that ratoon crop would he advantageous in areas where a single crop of rice was cultivated and where the soil had sufficient moisture to sustain the ratoon crop. Ratoon crop was also advantageous in that two good crops could he obtained in two seasons from the same land with a considerable saving in time. cost of production, Better cultivation and management technique may increase the yield of ratoon crops. Such as the application of plant growth regulators (PGR) on rice plants. Cytokinin and Gibberellin are two major PGR that promotes plant growth. Therefore, it is a necessity to study the effect of PGR on ratooning of rice. In the following study a series of inbreed and hybrid rice varieties were incorporated with different PGR and cutting managements to examine the growth, regeneration capacity and ratoon season yield. Based on above proposition, this research work was designed to evaluate the effect of PGR and cutting management on yield and yield components performance of some selected hybrid and inbred rice varieties the following objectives:

1. To examine the differences in the growth, regeneration rate and ratoon season yield of inbreed and hybrid rice varieties to explore the possible mechanisms.
2. To determine the cutting height on the growth, yield and yield components of ratoon rice, and
3. To determine the effect of PGR on the growth, yield and yield components of ratoon rice.

CHAPTER II

REVIEW OF LITERATURE

The growth and development of rice may be varying due to the use of ratoon. Ratoon plants using inbred and hybrid rice cultivars are important especially when tillers are used as planting material. New technologies are available now and received much attention to the researchers throughout Bangladesh to develop its suitable production technologies for rice areas. Although this idea is not a recent one but research findings in this regard is scanty. Some of the pertinent works on these technologies have been reviewed in this chapter.

2.1. Effect of variety

Ratooning is thought to be a varietal character. There is a great scope to enhance ratoonability through varietal selection. Rahman *et al.,* (2004) conducted a field experiment at the Bangladesh Rice Research Institute (BRRI), Charbadna farm, Barisal, from boro 2001 to aman 2002. Seven photoperiod-sensitive rice varieties including three fine grain aromatic varieties were transplanted in 15 December and 30 December 2001. The ratoon-yields of both aromatic and non-aromatic varieties were encouraging and produced about 2 t ha^{-1} grain yield, which was more than the average yield of local varieties normally cultivated in the transplanted aman season in that region. The highest yield was obtained from BR23 (2.87 t ha^{-1}) followed by BRRI dhan37 (2.63 t ha^{-1}). From this experiment, it was revealed that the photoperiod-sensitive rice varieties could be planted in the early boro season and the ratoons from this crop also produced a good harvest.

Tang *et al.,* (2002) found that among 37 cultivars, yield and yield components of ratoon crops of hybrid rice were better than those of conventional cultivars. He also found that the number of panicles $plant^{-1}$, spikelets $panicle^{-1}$ and the number of grains $panicle^{-1}$ were the important factors that affected the yield of ratoon crop of rice. Plant height and panicle length had significant negative correlation with yields.

Xie *et al.,* (2005) used eight hybrid rice combinations to study the source-sink characteristics and yields of main and ratoon crops. The leaf area (LA) index (LAI) and the LA per culm of the ratoon crop were approximately 1/3 and 1/7-1/3 of those of the main crop, respectively. The total sink volume of the ratoon crop was higher by 1.5 - to 2.0-fold than that of the main crop. The ratio of the number of grains to the LA in the ratoon crop was higher than that of the main crop by 1.5- to 2.0-fold. Based on the yield of the ratoon crop and total yields under the climatic conditions of Changsha region, Hunan, China, during 2002, the optimum combination for ratooning was Peiai 64 S/E32, followed by Kangliangyou 2054 and T98A/259.

Lin *et al.,* (2001) studied the morphological and functional differences of root systems among the three ratooning rice varieties; Shanyouming 86, Teyou 70 and Shanyou 63, and their correlation. The results showed that Shanyourning 86 had the most flourishing root systems and yields of this variety was the highest both in the main and ratoon crop season. Teyou 70 had a flourishing root system in the first season, dropped sharply after the maturing period and as a result, its yield was high in the main crop and low in the ratoon crop.

According to Cheng *et al.,* (2001) during the harvest of the main crop, the soluble carbohydrate content of the tillering stem and stem sheath was not correlated with their ratoonability in hybrid rice, but the soluble carbohydrate content of the main stem was interrelated. Xu and Xiong (2000) conducted an experiment with thirty-three hybrid rice combinations to study the relationship between ratio of grain to leaf area and ratoonability during 1995 to 1998. The result showed significant negative correlations between the ratio of grain to leaf area and the ratoonability of the main crop. The ratooning ability of varieties could be changed under the ratio of grain to leaf area. The reason was that there were significant positive correlations between dry weight of maternal stems and the ratoonability, and significant negative correlations between the ratio of grain to leaf area and dry weight of the maternal stems.

Significant positive correlations between the number of grains per panicle among varieties and the ratio of grain to leaf area of main crop were observed. There were significant negative correlations between the number of grains panicle^{-1} of main crop and the yield of the ratoon rice. A field experiment was laid-down to evaluate the ratoon grain yield potentials of thirty rice cultivars and advanced lines under lowland conditions during wet season at Philippine Rice Research Institute (PhilRice), Philippines by Oad *et al.,* (2002).

Grain yield showed positive correlation with plant height, ratoon rating, 1000 grain weight, number of panicles, panicle length, seed length, and tillers at harvest. Path analysis indicated that ratoon crop parameters had low positive direct effects. It was revealed from the contribution of individual characters to the variance of yield that the contribution of the characters to the determination of yield was largest for total tillers at harvest, panicles per plant, panicle length and finally ratoon rating. The study suggests that selecting 7 varieties may base higher ratoon rice grain yields or advanced lines, which has higher tillers, more panicles per plant, lengthy panicles, and high ratoon rating. Chen *et al.,* (2000) conducted an experiment with two-line rice hybrid Peiliangyou 500 and Shanyou 63 that were ratooned after growing as a middle-season crop. Total yield of the main and ratoon crop of Peiliangyou 500 was 12.08 t ha^{-1}, which was 37.5% higher than yield of the control cultivar Shanyou.

Shi and Shi (1997) conducted an experiment to determine the benefits of ratoon cultivation in rice. In trials during 1992-96, authors found that the main crop yielded 7.60-9.46 t ha^{-1} and the ratoon crop yielded 3.10-6.24 t ha^{-1}. Reddy (1995) conducted two separate experiments, using 135 varieties in the first and 6 high yielding varieties in the second and observed that yield of ratoon crops ranged from 0 to 2.05 t/ha^{-1} in Papua New Guinea. The author also mentioned that variety Acc 1981 gave the highest ratoon yield. Sajjad (1994) evaluated main crop and ratoon crop yields and yield components of rice varieties Wantok, Tambu, Niupela and Senis grown in Papua New Guinea. It was found that grain yield in the main crop was highest (8.5 t ha^{-1} vs. 6.9-7.3 t ha^{-1} in other cultivars) in variety Senis, while in the ratoon crop yield was highest in Tambu (3.9 t ha^{-1}) followed by Wantok (3.3 t ha^{-1}) and it was lowest in Senis (1.7 t ha^{-1}).

Bollich and Turner (1988) gave a trial with five varieties and found that among the varieties the average number of days to heading for Texmont was 82, compared with

81, 87, 90 and 92 days for Maybelle, Skybonnet, Gulfmont and Lemont, respectively. Overall yields of Texmont, were 7.34 t ha^{-1}, compared with 7.37, 7.32, 7.02, 6.46, 6.09 and 5.91 t ha^{-1} for Gulfmont, Maybelle, Lemont, Skybonnet, Labelle and Tebonnet respectively. Texmont performed superior ratoonability with ratoon yields ranging from 2.45 to 2.72 t/ha^{-1}.

Srinivasan and Purushothaman (1993) reported that the ratoon crop of variety Bhavani performed better than Ponni with regard to growth, yield attributes and grain yield. Ratoon grain yield produced by Bhavani was 2.75 t ha^{-1} which was 50.2% of the main crop yield. The ratoon grain yield produced by Ponni was 1.75 t/ha^{-1} which was 38% of the main crop yield. Sutaryo and Suprihatno (1993) conducted an experiment with six F1 hybrids and a control (Dodokan) and reported that ratoon yields ranged from 14 to 22% of the main crop and hybrids of V20A with IR25912, IR64 and 1R28178 gave the highest ratoon yields of 1.3, 1.1 and 1.3 t ha^{-1}, respectively. In an experiment Zhang (1991) observed that hybrid rice ratoon crops yield was 17% more than conventional rice ratoon crops.

Tan and Li (1990) conducted an experiment with 24 hybrids and breeding lines in order to observe the differences in ratoonability among them and found that most of the hybrids had good ratoonability of which Dyou 10, Shanyou 66 and Minghui 63 produced higher ratoon tillers $hill^{-1}$. Palchamy *et al.*, (1990) reported that among 3 varieties Bhavani had a significantly higher ratoon grain yield, stem thickness and stubble carbohydrate content than Ponni and IR20 in both boro and aman season. Mahadevappa (1988) found that varieties differed widely in ratoonability, type of tillers produced, growth period duration, grain quality and yield.

Prakash and Prakash (1988) planted 23 mid-season and late genotypes and found that the main crop yielded from 2.02 to 4.73 t/ha^{-1}. The ratoon crop yield ranged from 0.1 in Pushpa to 1.81 t/ha^{-1} in IET7431. In terms of the ratoon crop yield as a percentage of the main crop yield, BPT2685 was the best with 1.61 t/ha^{-1} (71.24%). Chauhan *et al.*, (1988) observed that of 24 advanced photoperiod insensitive summer rice genotypes ratooned by cutting the stems 15 cm above the ground, only 10 showed regeneration and RP 1664-4661-693-1333 had the greatest ratoonability with 94.9% hill regeneration.

Rosamma *et al.,* (1988) compared the grain weight and germination of main and ratoon crops of 5 rice varieties and observed varietal differences for both traits. The authors also observed that the highest 1000-grain weight was found in Jaya {28g (main crop), 24g (ratoon crop)}.

Palchamy ans Purushothaman (1988) assessed grain yield in main and ratoon crops in 10 early and mid season varieties and noticed that ratoon crop yields ranged from 0.43 t/ha^{-1} (variety Ponni) to 2.20 t/ha^{-1} (variety Bhavani). Qiu and Jin (1988) conducted an experiment to evaluate the ratoonability of 28 varieties in a greenhouse by cutting mature plants to a height of 15 cm and found that 1829, IR30, 1843 and 1864 had relatively high ratoonability, and 13 varieties had intermediate ratoonability. Singh *et al.,* (1987) showed that 10 out of 24 breeding lines had ratoonability and it varied from 59.4 to 94.9%. The author also showed that ratoon grain yield ranged from 0.8 to 1.7 t/ha^{-1} and the line 1664-4461-693-1333 gave the highest ratoon grain yield.

Evatt and Beachell (1960) from their investigation reported that the practical means of increasing rice yield could be extended by using early maturing varieties (109-132 days from sowing to maturity). The authors obtained yields of 1.68 to 2.24 t/ha from ratoon crops. Szokolay (1956) reported that the various rice varieties showed different ratoonability. The author experimented with three varieties of rice, namely, Century patna No.2, Swazi No.1 and Swazi No.2, and obtained 3.06, 1.50, and 3.30 t/ha^{-1} ratoon yield, respectively.

Maurya *et al.,* (1987) carried out an experiment by harvesting the main rice crop taking only the panicles. In the ratoon crop the number of effective tillers, number of grains, 1000-grain weight and grain yield ranged from 14-16 $plant^{-1}$, 81-90 $panicle^{-1}$ 15.8-17.7 g and 2.0 -2.7 t/ha^{-1}, respectively; depending on varieties.

Chang *et al.,* (1985) carried out an experiment with 163 varieties to assess the variation in ratoonability and showed that ratoonability varied from 0% to 122.9%.

The authors also noticed that the indica varieties had an overall higher ratoonability (29%) than the japonica varieties (19.5%).

2.2 Effect of environment

The effects of climate change on the growth and yield of ratoon rice were studied in Zhuxi, Jiangxi, China by Ming *et al.*, (2007). Sunlight and temperature were the main factors limiting the yield of ratoon rice. The average temperature and minimum temperature were the most closely related to the yield. Sunshine was another important factor associated with the yield of ratoon rice. Although light and heat resources were abundant in the research area, a large gap between actual yield and potential yield was observed.

Kaichu, (1958) however, obtained a ratoon crop of up-to 80% of the main crop. This variation of the yield performance of the ratoon crop, however, might be due to the variation in environmental condition, variety, clipping height, cultural practices and other unforeseen factors such as damages of grains by birds and rats. Ichii (1982) found that ratoon rice grown at 30℃ produced a higher dry weight than that in plants grow at 20℃. In addition, grain yield at 20oC was significantly lower than yields at high and normal temperature due to high spikelet sterility. Temperature also affects duration of ratoon rice growing. Crop maturity lengthens from 56 days at high temperature to 96 at low temperature. It was supported by Ziska (1997) and Chawhan *et al.*, (2008).

2.3 Effect of harvesting time of main crop

Thuamkham (2003) reported that the cutting time had a significant effect on number of effective tillers hill^{-1}, panicle m^{-2}, percent of filled spikelet, grain yield and harvest index at 0.01 probability level. The highest number of effective tillers hill^{-1} (8.66), panicle m^{-2} (138.60), percent of filling spikelet (82.59), grain yield (1294.10 kg/ha^{-1}) and harvest index (30.50) were obtained in harvesting physiological maturity. This was perhaps due to decreased to delay cutting time and decreased in temperature cause reduce in yield and component yield. Cutting time had no significant effect on number of tillers $hill^{-1}$, number spikelets $panicle^{-1}$, 1000 grain weight and biological yields.

Xiong *et al.,* (1991) conducted an experiment to see the effect of different time of harvest of the main crop by harvesting it at 22, 25, 28, 31 and 34 days after main crop heading on the performance of ratoon crop and reported that cutting the main crop 34 days after heading when axillary buds began sprouting, resulted in the highest yield in the ratoon crop. Siddique *et al.,* (1995) showed that the optimum harvesting time of the main crop was at its physiological maturity for better performance of ratoon crop.

Wang *et al.,* (1995) harvested main crop of hybrid rice in different dates and showed that if cut before booting stage then re-growth was done by leaf production, but when cut after panicle emergence stage then re-growth was occurred by tiller production and if cut between these two dates then re-growth was done by both leaf and tiller production. The author also reported that the highest grain and protein yields were given by cutting between panicle emergence and grain filling stage.

According to Haque (1975) and Yang *et al.,* (1958) found that, the stage of maturity of the main crop at harvest affected ratooning. Votong (1975) reported that delaying main-crop harvest to 44-56 days after flowering reduced ratoon crop growth duration. Reddy *et al.,* (1979) found no significant affect ratoon yields Harvesting at 30, 35, 40 and 45 days after main crop flowering.

2.4 Effect of cutting height

Andrade *et al.,* (1988) conducted an experiment to see the effect of cutting height of 10, 20 or 30 cm above ground level on the yield and grain quality of ratoon crop of 10 rice varieties and found that 10 cm cutting height reduced the ratooning ability of all varieties and the best ratoon crop in terms of yield and quality was occurred with a cutting height of 30 cm. A recent study conducted by Samson (1980) at IRRI showed that the grain yield of a ratoon crop was higher from a 15 cm than from a 3 cm cutting height of the first crop.

Amorim *et al.,* (1986) conducted an experiment with 10 varieties and lines of irrigated rice by cutting the main crop to a height of 10, 20 and 30 cm and observed that grain yield ranged from 218 to 857, 157 to 750 and 315 to 1714 kg ha^{-1}, respectively. Other experimental reports showed that clipping height of the primary crop had effects on the maturity period and yield of the ratoon crop. It was supported by Jones (1993).

Chauhan *et al.,* (1985) found that tiller regenerated from higher nodes formed more quickly, grew faster, and matured earlier. In contrast the panicles from ratoons coming from lower nodes produced more grains $panicle^{-1}$ than those from upper nodes, but it caused lower fertility percentage. IRRI (1975) showed the effects of different cutting heights on the yield of IR28. Four cutting heights used were at ground level, 5, 15 and 20 cm. The optimum cutting height in relation to grain yield production was found to be 15 or 20 cm above ground level.

IRRI (1975) also reported from another experiment in the same year that cutting the main crop at 15 and 20 cm above ground level produced a significantly higher grain yield in the ratoon crop than the crop was cut at 5 cm. Ratoons were not produced on the majority of the hills when the main crop was cut at ground level and 5 to 7 cm water was maintained. More tillers were produced in the ratoon crop when the cutting height was 15 or 20 cm. Sun *et al.,* (1988) found that panicles from upper nodes contributed more to ratoon grain yields than those from lower nodes.

2.5 Effect of other management practices

Santos *et al.,* (2003) found that the fungicide applications increased grain yield and reduced incidence of grain discoloration and consequent improvement in the quality of the product. Esmaili *et al.,* (2007) conducted a study in Iran to investigate the effects of plant residue management methods with and without Azolla and ducks, on weed density as well as on yield and harvest index of rice. The lock-lodging and common regional harvest methods had the highest and lowest weed populations, respectively. The number, height and dry weight of weeds were also decreased with Azolla and ducks. The highest yield and harvest index were obtained from lock-lodging due to increased total number of productive tillers, number of panicles m^{-2}

and total number of spikelets spike^{-1}. The ducks also increased the grain yield of rice due to increases in these parameters and high 1000- grain weight.

Review of literature cited and discussed above revealed that there are so many factors that influenced the different crop characters of ratoon rice e.g. environment; temperature, humidity etc. management practice; irrigation, harvesting of main crop, cutting height, pesticide application, manuring and fertilization etc. In this context some experiment show that variety and N fertilizer application after harvesting main crop have a great and direct impact on yield and quality of ratoon rice production.

Because Naydo (2004) stated that, ratooning ability is an important and potential characteristic of rice varieties. On the other hand, nitrogen fertilizer is another important factor that greatly influences growth and yield of ratoons. Nitrogen has been observed to improve tillering and increase grain yield of the ratoon crop (Vergara *et al.*, 1988; De Datta and Bernasor, 1988; Bahar and De Datta, 1977).

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field, Sher-e- Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during November 2021 to July 2022. A brief description on experimental site, layout of the experimental site, climate, soil, land preparation, layout of the experimental design, intercultural operations, data collection and analysis procedure are stated below.

3.1. Experimental Site

The experimental site belongs to the agro-ecological zone of "Madhupur Tract", AEZ-28. This was a region of complex relief and soils developed over the Madhupur clay, where floodplain sediments buried the dissected edges of the Madhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain (FAO-UNDP, 1988). For better understanding, the experimental site is shown in the AEZ Map of Bangladesh in Appendix I.

3.2. Soil

The soil of the experimental area was silty clay in texture, red brown terrace soil type, olive–grey with common fine to medium distinct dark yellowish-brown mottles. Soil pH was 5.9 and had organic carbon 0.43%. The land was well drained with good irrigation facilities. The experimental site was a medium high land. It was above flood level and sufficient sunshine was available during the experimental period. The morphological characters of soil of the experimental plots are as following - Soil series: Tejgaon, General soil: non-calcareous dark grey. The physicochemical properties of the soil are presented in Appendix II.

3.3. Climate

The climate of the experimental area was subtropical that was characterized by high temperature, high humidity and heavy rainfall from April to September, with low temperature and minimum rainfall from October to February. Average temperature and average rainfall were increasing after February to onward. (Appendix III).

3.4. Planting materials

Boro rice variety released by BRRI was selected as planting materials. Selected varieties were BRRI hybrid dhan 5 (hybrid) and BRRI Dhan 47 (Inbred).

3.5. Treatments of the experiment

The experiment was consisted of the following treatments:

Factor A: Variety

1. V_1= BRRI hybrid dhan 5 (hybrid)
2. V_2 = BRRI Dhan 47 (Inbred).

Factor B: Cutting height

1. C_0: Cutting at ground level
2. C_1: 10 cm above ground (second node)
3. C_2: 15 cm above ground (third node)

Factor C: Application of PGR

1. G_0: Control
2. G_1: 100 ppm auxin
3. G_2: 100 ppm gibberellin
4. G_3: 100 ppm auxin+100 ppm gibberellin

3.6 Experimental design and layout

The experiment was carried out in a Split plot design, where three factors were selected as variety, plant growth regulators and cutting managements. The plot size was 3 square meters (1 m ×0.5 m). The plots were replicated three times and thus the total number of plots was 36 per split with 2 splits containing different boro rice variety. Thus, there were 36-unit plots per splits, each of 2.75 m × 1.5 m size (4.13m^2). The 12 treatments and 2 varieties of the experiment were assigned with 3 replications.

3.7 Description of the variety

BRRI hybrid dhan 5: The stem of BRRI hybrid dhan 5 is strong and leaves are deep green like HYV. Grain is medium fatty & rice is fine. Its life cycle is 145 days & average yield is 8.00 t ha^{-1}. The sowing and transplanting time 15 November-15 December and 15 December-15 January respectively and seed rate is 15-20 kg ha^{-1}. Seedling of 30-35 days should be transplanted in the main field with the recommended spacing of 20 ×15 cm (1-2 seedlings $hill^{-1}$). After 50% ripening of the grain harvesting may be done.

BRRI dhan 47: The breeding line number of BRRI dhan 47 is 633307-4B-4-3. It is developed by crossing between the line IR 515111-B-B-34-B and TCCP266-2-49-B-B-3 of International Rice Research Institute (IRRI). That breeding line was brought to Bangladesh through the PETRRA (Poverty Elimination Through Rice Research Assistance) project & was selected to be cultivated in the saline prone area of Sathkhira with the farmer's participation in Boro season by variety selection method. The seedling of this variety is resistance to 12-14 dS m^{-1} salinity. It can resist 6 dS m^{-1} level of salinity during rest of the life cycle. It is the main feature of this variety. The height of this variety is about 101 cm. Flag leaf is wide, long & erect. Grains are medium fatty & white spotted which are melted after boiling. Its life cycle is about 152 days. In saline soil it is capable to give a yield of 6.00 t ha^{-1}. Sowing time of this variety is 15-30 November and the seedling of 35-40 days should be transplanted with spacing of 25 cm ×15 cm.

3.8. Cultural operation

The brief description of all cultural operations, performed during the course of experimentation is given below.

3.8.1. Cultural operation for main crop

Following cultural operations were performed for growing main crop.

3.8.1.1. Collection of seed

Seed of high yielding rice variety viz. BRRI hybrid dhan 5 (hybrid) and BRRI Dhan 47 (Inbred) was collected from Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur.

3.8.1.2. Sprouting of seed

The seeds were dipped in water in a bucket for 24 hours. The seeds were then taken out of water and kept thickly in gunny bags. The seeds started sprouting after 24 hours and completed sprouting within 48 hours and became suitable for sowing in the seed bed by 72 hours.

3.8.1.3. Preparation of seed bed and seed sowing

A piece of high land was selected in the Agronomy Field of Sher-e-Bangla Agricultural University, Dhaka for raising seedlings. The land was puddle with country plough, cleaned and levelled thoroughly with ladder to get a well puddle and levelled seed bed. The sprouted seeds were sown in the prepared seed beds on 29 November 2021.

3.8.1.4. Land preparation

The land was opened in a water saturated condition with power tiller during last week of the December, 2021. The land was then repeatedly ploughed and cross ploughed with power tiller according to experimental specification immediately after final land preparation. Weeds and stubbles were cleared off from individual plots and finally plots were levelled properly by wooden plank so that no water pocket could remain in the field.

3.8.1.5. Field layout

Plots were laid out in the field following split plot design on 31 December 2021. Ails, drains and channels were made according to the layout.

3.8.1.6. Fertilizer application

Fertilizers were applied to the plots following the recommendation by BRRI for the specific variety. The whole amount of fertilizers except N was applied before final land preparation. Urea was top dressed in three equal splits at 15, 30 and 45 days after transplanting.

3.8.1.7. Uprooting of seedlings and transplanting

The seedlings were uprooted from the seed bed early in the morning on 8 January 2022 with due care so as to avoid injury and kept on soft mud in shade to avoid mechanical injury to the roots. The uprooted thirty-two days old seedlings were transplanted in the main field @ 1 seedling $hill^{-1}$ for hybrid and 2-3 seedlings $hill^{-1}$ for inbreed with proper spacing on 9 January 2022.

3.8.1.8. Gap filling

Seedlings in some hills died off and those were replaced by the healthy seedlings from the same source on 18 January 2022.

3.8.1.9. Water management

Irrigation was provided during the whole growth period of the crop in order to maintain a constant water level in the field. Before top dressing of urea, water was drained off the plots. The plots were again irrigated after the application of urea. Excess water was drained out during the heavy rainfall. Before 15 days of harvest the field was finally drained out to enhance maturity.

3.8.1.10. Weeding

Crops were infested with different weeds. Weeding was done two times by hand pulling on 2 February 2022 and 1 March 2022.

3.8.1.11. Plant protection measures

Proper crop protection measures were taken during the entire course of crop production. The crop was infested by the stem borer and rice bug at the vegetative phase and which were successfully controlled by application of Rigit 10 G @ 6.8 kg ha^{-1} on 18 February 2022 and Ripcord @ 500 ml ha^{-1} (25 ml/10L water) on 12 March 2022, respectively.

3.8.1.12. General observation

The field was observed frequently to notice any change in plant characters, and it was observed that the general condition of the crop was good from transplanting to harvesting.

3.8.1.13. Harvesting of the main crops

The main crop was harvested on different date from 26 April 2022 to 8 May 2022 from different plots depending on the maturity keeping a cutting height of 10 and 15 cm from the ground level.

3.8.2. Cultural operation for ratoon crop

3.8.2.1. Cultural management

The next day after harvesting of the main crop, the field was hand weeded and urea was top dressed at the rate mentioned as the treatments. It was then mixed thoroughly with soil by a weeder. Some irrigation was necessary as there was little or no rainfall during the growing period of the ratoon crop. Drainage was made as and when was required. Disease infection and insect attack was not significant to take plant protection measure. To protect the crop from birds, attack the field was observed frequently. However, some grains were lost by birds and rats attack.

3.8.2.2. Harvesting of the ratoon crop

Ratoon crop was harvested from 20 June 2022 to 8 July 2022 depending on the maturity of the grain of the different plots.

3.9. Sampling and processing of the data

Ten hills from each plot of main and ratoon crop were randomly selected, uprooted and properly tagged before harvesting for recording the necessary data on crop characters. The crop of each plot was harvested at full maturity when 80% of the grains turned in golden yellow colour.

3.10. Data collection

Data on the following yield and yield contributing characters of main crop and ratoon crop were collected:

i) Plant height at 30, 40, 90 DAT and at harvest
ii) Number of effective tiller hill^{-1}
iii) Number of non-effective tiller hill^{-1}
iv) Number of total tiller hill^{-1}
v) Panicle length (cm)
vi) Number of filled grains panicle^{-1}
vii) Number of unfilled grains panicle^{-1}
viii) Number of total grains panicle^{-1}
ix) 1000-grain weight
x) Grain yield
xi) Straw yield
xii) Biological yield
xiii) Harvest index

3.11. Procedure of data collection

Data was collected on sixteen yield and yield contributing parameters of both main and ratoon crop. A brief outline of data collection procedure is given below.

Plant height: Plant height was measured in cm from the ground level to the tip of the longest panicle.

Number of filled grains panicle^{-1}: Presence of any food material in the spikelet was considered as grain. Total number of grains of ten randomly selected panicle were counted. Average mean of filled grains of these ten panicles was taken as number of filled grains panicle^{-1}.

Number of unfilled grains panicle^{-1}: Grains lacking any food material inside the grain was considered as sterile spikelet and such grains present on each panicle were counted.

Number of total grains panicle^{-1}: Sum of the both filled and unfilled grains per panicle considered as number of total grains per panicle.

Grain yield hill^{-1}: The grain yield (g) of randomly selected 10 hills was taken and average yield of each hill was recorded.

1000-grain weight: One thousand clean dried grains were counted from the seed stock obtained from the ten sample plants of each plot and their weight (g) was taken in by using an electric balance.

Grain yield: Grains obtained from each unit plot were sun dried and weighed carefully. The dry weights of grains from the plants of the ten sample hills were added to the respective plot yield to record the final grain yield of each plot. The grain yield was eventually converted to t ha^{-1}.

Straw yield: Straw obtained from each unit plot including the straw of ten sample hills of respective unit plot was dried in the sun and weighed to record the straw yield of each plot and finally converted to t ha^{-1}.

Biological yield: Biological yield (g) was measured by adding grain and straw yield and recorded.

Harvest index: Harvest index is the ratio of economic yield (i.e. grain yield) to biological yield and was calculated with the following formula (Gardner *et al.*, 1985).

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

3.12. Statistical analysis

The recorded data for different parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done with the help of computer software package MSTAT-C program. The mean differences among the treatments were adjudged by Least Significant Difference (LSD) (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

This chapter includes the presentation and discussion of the results found from the experiment. The results have been presented, discussed and possible interpretations were given in tabular and graphical forms. The results obtained from the experiment have been presented under separate headings and sub-headings as follows:

4.1 Growth contributing characters

4.1.1 Plant height

Effect of different variety on main crop and ratoon crop

Plant height showed main crop and ratoon crop was statistically significant variations due to different selected varieties for all 30, 45 days after harvest for ratoon crop and 30, 40, 90 DAT and at harvest for main crop, (Table 1). Considering the main crop at 30, 45, 90 DAT and at harvest, the tallest plant (19.75, 52.25, 98.25 and 110.25 cm) respectively were observed from the variety BRRI hybrid dhan 5 on the other hand, the shortest plant (12.25, 41.25, 87.25 and 106.50 cm) respectively was found from the variety BRRI Dhan 47. After the harvesting of main crop ratoon crop was developed and plant height measured up to 30 and 45 days from the harvest of main crop. Plant height of ratoon crop at 30 and 45 day was found highest (17.56 and 51.33 cm) for BRRI hybrid dhan 5 and lowest was resulted from (11.38 and 38.75 cm) BRRI Dhan 47.

Effect of different cutting height on ratoon crop

Plant heights of ratoon crop were significantly influenced by different levels of cutting height at 30 and 45 days (Table 1). At 30 and 45 days, the tallest plant (19.50 and 52.75 cm) respectively was observed from C_2: 15 cm above ground (second node). The shortest plant (12.25 and 46.25 cm) respectively were found from C_0: Cutting at ground level (Table 1). This variation might be due to more nutrients stored in 15 cm cutting height than that in 10 cm or 0 cm for the nourishment of the subsequent plant.

Effect of different levels of PGRs on main crop and ratoon crop

Plant heights were observed statistically significant due to different PGRs levels in both main for all 30, 45, 90 DAT and at harvest; and for ratoon crop 30 and 45 days after harvest, (Table 1). For main crop at 30, 45, 90 DAT and at harvest, the tallest plant (19.25, 52.25, 101.5 and 110.25 cm) respectively was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The shortest plant (10.25, 34.75, 87.75 and 105.75 cm) respectively were found from G_0: Control. After harvest ratoon crop was developed and plant height measured, highest plant height at 30 and 45 days (15.67 and 46.09 cm) respectively was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The shortest plant at 30 and 45 days (8.21 and 30.33 cm) respectively were found from G_0: Control (Table 1).

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences for plant heights only at 30 days after harvest for ratoon crop, (Table 2). At 30 days after harvest, the tallest plant (19.25 cm) was observed from the treatment combination of $V_1C_2G_3$: BRRI hybrid dhan 5; 15 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin on the other hand, the shortest plant (11 cm) respectively were found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control. After 45 days after harvest, the tallest plant (51.25 cm) was observed from the treatment combination of $V_1C_2G_3$: BRRI hybrid dhan 5; 15 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin on the other hand, the shortest plant (34 cm) respectively were found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control (Table 2). In every case the plant height of the ratoon crop was lower than the main crop and it ranged from 70-73% of the main crop. It was due to less ability to use the resources in plant body and it was confirmed by Jones (1993).

Table 1. Effect of different levels of cutting height and PGRs on plant height of selected varieties at different days after transplanting (DAT) and harvest on main crop and ratoon crop

Treatments	Plant height (cm) at							
	30 DAT		45 DAT		90 DAT		At harvest	
	Main crop	Ratoon crop	Main crop	Ratoon crop	Main crop	Ratoon crop	Main crop	Ratoon crop
Variety								
V_1	19.75a	17.56a	52.25a	51.33a	98.25a	--	110.25a	--
V_2	12.25b	11.38b	41.25b	38.75b	87.25b	--	106.50b	--
LSD (0.05)	2.04	1.97	2.07	4.88	4.17	--	2.55	--
Level of sig.	*	*	**	*	*	--	*	--
Cutting height								
C_0	--	12.25d	--	46.25c	--	--	--	--
C_1	--	15.00b		50.25b	--	--	--	--
C_2	--	19.50a	--	52.75a	--	--	--	--
LSD (0.05)	--	2.11	--	2.19	--	--	--	--
Level of sig.	--	*	--	*	--	--	--	--
Plant growth regulators								
G_0	10.25d	8.21d	34.75d	30.33d	87.75c	--	105.75c	--
G_1	12.75c	10.50c	38.75b	35.67b	99.25ab	--	108.00b	--
G_2	14.00b	13.17b	36.25c	32.15c	98.75bc	--	107.75b	--
G_3	19.25a	15.67a	52.25a	46.09a	101.5a	--	110.25a	--
LSD (0.05)	2.48	2.01	2.23	4.18	3.39	--	2.03	--
Level of sig.	*	*	**	*	*	--	*	--
CV%	7.98		7.15		8.44	--	8.51	--

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

Table 2. Combined effect of different levels of cutting height and PGRs on plant height of selected varieties at different days after harvest on ratoon crop

Treatments			Plant height (cm) of Ratoon crop at	
			30 Days	45 Days
V_1	C_0	G_0	12.00d	34.00
		G_1	12.50d	37.00
		G_2	14.50c	35.00
		G_3	18.00b	50.33
	C_1	G_0	12.25d	35.75
		G_1	12.75d	38.75
		G_2	14.00c	36.25
		G_3	18.30b	50.25
	C_2	G_0	11.25de	34.33
		G_1	12.75d	37.50
		G_2	15.00bc	36.15
		G_3	19.25a	51.25
V_2	C_0	G_0	11.00e	34.00
		G_1	12.67d	34.00
		G_2	12.90d	34.75
		G_3	14.75c	47.00
	C_1	G_0	12.00d	34.33
		G_1	13.50c	36.00
		G_2	14.50c	36.50
		G_3	16.00bc	48.33
	C_2	G_0	12.00d	35.00
		G_1	12.50d	37.00
		G_2	14.50c	35.00
		G_3	18.75b	49.00
LSD (5%)			1.93	2.71
Level of sig.			*	NS
CV (%)			7.10	7.14

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

4.1.2 Effective tiller hill^{-1}

Effect of different variety on main crop and ratoon crop

Effective tiller hill^{-1} significantly influenced by different selected varieties for both main and ratoon crop (Table 3). For main crop the highest effective tiller hill^{-1} (18.67) was observed from the variety BRRI hybrid dhan 5. The lowest effective tiller hill^{-1} (15.00) was found from the variety BRRI Dhan 47. Similar variations were also observed for ratoon crop where the highest effective tiller hill^{-1} (12.33) was observed from the variety BRRI hybrid dhan 5. The lowest effective tiller hill^{-1} (10.75) was found from the variety BRRI Dhan 47. The variation in producing the number of effective tillers per hill in different variety was also observed by Siddique *et al.* (1995) due to varietal effect.

Effect of different cutting height on ratoon crop

After harvesting of main crop ratoon crop was developed and effective tiller hill^{-1} were found statistically significant due to different levels of cutting height, (Table 3). The highest effective tiller hill^{-1} (14) was observed from C_1: 10 cm above ground (second node). The lowest effective tiller hill^{-1} (10) was found from C_0: Cutting at ground level. Similar results were found by Mengel and Wilson (1981) and Yuan *et al.* (1996).

Effect of different levels of PGRs on main crop and ratoon crop

Effective tiller hill^{-1} were observed statistically significant due to different PGRs levels, (Table 3). Considering the main crop highest effective tiller hill^{-1} (19) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest effective tiller hill^{-1} (14) respectively were found from G_0: Control. For ratoon crop similar tend was observed and highest effective tiller hill^{-1} (16.15) was observed from G_3: 100 ppm auxin+100 ppm gibberellin, whereas, the lowest effective tiller hill^{-1} (11) respectively were found from G_0: Control (Table 3). Similar results were found by Kavoosi *et al.* (2004).

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels on ratoon crop showed non-significant differences for effective tiller hill^{-1} (Table 4). The highest effective tiller hill^{-1} (18.50) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest effective tiller hill^{-1} (11) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control.

4.1.3 Non-effective tiller hill^{-1}

Effect of different variety on main crop and ratoon crop

Significant variations of non-effective tiller hill^{-1} was found for main and ratoon crop due to different varieties (Table 3). Considering the main crop lowest non-effective tiller hill^{-1} (3) was observed from the variety BRRI hybrid dhan 5. The highest non-effective tiller hill^{-1} (4) was found from the variety BRRI Dhan 47. For the ratoon crop lowest non-effective tiller hill^{-1} (3) was observed from the variety BRRI hybrid dhan 5. The highest non-effective tiller hill^{-1} (3.50) was found from the variety BRRI Dhan 47 (Table 3).

Effect of different cutting height on ratoon crop

Non-effective tiller hill^{-1} were measured for ratoon crop and found statistically significant due to different levels of cutting height (Table 3). The lowest non-effective tiller hill^{-1} (2) was observed from C_1: 10 cm above ground (second node). The highest non-effective tiller hill^{-1} (4.33) was found from C_0: Cutting at ground level.

Effect of different levels of PGRs on main crop and ratoon crop

Non-effective tiller hill^{-1} were observed statistically significant for main crop and ratoon crop due to different PGRs levels (Table 3). The lowest non-effective tiller hill^{-1} in main crop (2.67) was observed from G_3: 100 ppm auxin+100 ppm gibberellin, and the highest non-effective tiller hill^{-1} (4) respectively were found from G_0: Control. Considering the ratoon crop lowest non-effective tiller hill^{-1} (2.33) was observed from

G_3: 100 ppm auxin+100 ppm gibberellin, and the highest non-effective tiller hill^{-1} (3.50) respectively were found from G_0: Control (Table 3).

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels was measured for ratoon crop which resulted non-significant differences for non-effective tiller hill^{-1} (Table 4). The lowest non-effective tiller hill^{-1} (2) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin, and the highest non-effective tiller hill^{-1} (4.33) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control (Table 4)

4.1.4 Total tiller hill^{-1}

Effect of different variety on main crop and ratoon crop

For total tiller hill^{-1} statistically significant variations was observed in main and ratoon crop due to different selected varieties (Table 3). The highest tiller hill^{-1} (22) was observed from the variety BRRI hybrid dhan 5. The lowest tiller hill^{-1} (20.33) was found from the variety BRRI Dhan 47.

Effect of different cutting height on ratoon crop

Total tiller hill^{-1} were found statistically significant for ratoon crop due to different levels of cutting height, (Table 3). The highest tiller hill^{-1} (18) was observed from C_1: 10 cm above ground (second node). The lowest tiller hill^{-1} (15.67) was found from C_0: Cutting at ground level.

Effect of different levels of PGRs on main crop and ratoon crop

Total tiller hill^{-1} were counted for both main and ratoon crop and found statistically significant due to different PGRs levels (Table 3). For the main crop highest tiller hill^{-1} (22) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest tiller hill^{-1} (19) respectively were found from G_0: Control. And for the ratoon crop highest tiller hill^{-1} (20.15) was observed from G_3: 100 ppm auxin+100 ppm gibberellin whereas, the lowest tiller hill^{-1} (18) respectively were found from G_0: Control.

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences in ratoon crop for total tiller hill^{-1} (Table 4). The highest tiller hill^{-1} (20.75) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest tiller hill^{-1} (15) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control (Table 4)

4.1.5 Panicle length (cm)

Effect of different variety on main crop and ratoon crop

Panicle length showed statistically significant variations due to different selected varieties (Table 3). Considering the main crop highest panicle length (26.50 cm) was observed from the variety BRRI hybrid dhan 5. The lowest panicle length (23.14 cm) was found from the variety BRRI Dhan 47. For ratoon crop highest panicle length (19.98 cm) was observed from the variety BRRI hybrid dhan 5 and the lowest panicle length (17.33 cm) was found from the variety BRRI Dhan 47. This result is supported by Santos *et al.* (2003).

Effect of different cutting height on ratoon crop

Panicle length of ratoon crop were observed statistically significant due to different levels of cutting height, (Table 3). The highest panicle length (19.89 cm) was observed from C_1: 10 cm above ground (second node). The lowest panicle length (15.74 cm) was found from C_0: Cutting at ground level. It was observed that the ratoon crop required short duration to panicle emergence. There were some tillers at the lower nodes in the main crop which were late and shorten and probably were in panicle emergence stage that probably attributed to the shorten duration for panicle emergence as the crop was harvested leaving 10 cm hill above ground.

Table 3. Effect of different levels of cutting height and PGRs on tiller $hill^{-1}$ and panicle length of selected varieties of rice on main crop and ratoon crop

Treatments	Effective tiller $hill^{-1}$ (No.)		Non-effective tiller $hill^{-1}$ (No.)		Total tiller $hill^{-1}$ (No.)		Panicle length (cm)	
	Main crop	**Ratoon crop**	**Main crop**	**Ratoon crop**	**Main crop**	**Ratoon crop**	**Main crop**	**Ratoon crop**
Variety								
V_1	18.67a	12.33a	4.00	3.50	22.00a	16.26a	26.50a	19.98a
V_2	15.00b	10.75b	3.00	3.00	20.33b	13.78b	23.14b	17.33b
LSD (0.05)	1.05	1.67	0.66	0.71	2.15	2.10	3.12	1.13
Level of sig.	*	*	NS	NS	*	*	*	**
Cutting height								
C_0	--	10.00b	--	4.33	--	15.67b	--	15.74c
C_1	--	14.00a	--	2.00	--	18.00a	--	19.89a
C_2	--	13.00b	--	3.67	--	16.10ab	--	17.63b
LSD (0.05)	--	*	--	NS	--	*	--	*
Level of sig.	--	7.24	--	9.02	--	4.88	--	2.79
Plant growth regulators								
G_0	14.00c	11.00c	4.00	3.50	19.00b	18.00b	25.15c	16.33c
G_1	16.00b	13.47b	4.00	3.00	20.00b	19.00b	26.76b	17.25b
G_2	18.67ab	15.33ab	3.00	3.00	21.67ab	19.67ab	27.00b	18.00b
G_3	19.00a	16.15a	2.67	2.33	22.00a	20.15a	29.33a	20.50a
LSD (0.05)	1.08	1.77	0.95	0.73	2.32	2.14	3.15	1.19
Level of sig.	*	*	NS	NS	*	*	*	**
CV%	6.49	7.82	7.20	5.39	7.95	10.14	8.01	2.11

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

Effect of different levels of PGRs on main crop and ratoon crop

Panicle length were observed statistically significant for both main and ratoon crop due to different PGRs levels, (Table 3). Panicle length of main crop (29.33 cm) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest panicle length (25.15 cm) respectively were found from G_0: Control. For ratoon crop, panicle length (20.50 cm) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and lowest panicle length (16.33 cm) respectively were found from G_0: Control.

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences in ratoon crop for panicle length (Table 4). The highest panicle length (21.50 cm) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest panicle length (16 cm) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control.

Table 4. Combined effect of different levels of cutting height and PGRs on tiller hill^{-1} and panicle length of selected varieties of ratoon crop of boro rice

Treatments			Effective tiller hill^{-1} (No.)	Non-effective tiller hill^{-1} (No.)	Total tiller hill^{-1} (No.)	Panicle length (cm)
V_1	C_0	G_0	12.50	3.70	16.00c	16.75c
		G_1	14.00	3.00	17.75b	17.50c
		G_2	16.50	2.75	18.00b	18.00b
		G_3	17.00	2.00	19.50ab	19.50b
	C_1	G_0	13.00	3.00	17.00b	19.50c
		G_1	15.50	2.75	18.00b	18.75b
		G_2	17.75	2.50	17.50ab	19.00b
		G_3	18.50	2.00	20.75a	21.50a
	C_2	G_0	13.00	4.00	17.00b	17.50c
		G_1	15.00	4.00	18.00b	17.75c
		G_2	16.75	3.00	18.50b	19.00b
		G_3	17.50	2.50	20.50ab	20.75ab
V_2	C_0	G_0	11.00	4.33	15.00d	16.00d
		G_1	14.67	4.00	17.00b	17.00c
		G_2	15.00	3.00	17.00b	18.00b
		G_3	16.75	2.67	18.00b	18.50b
	C_1	G_0	12.50	3.70	16.00c	18.75c
		G_1	14.00	3.00	17.75b	17.50c
		G_2	16.50	2.75	18.00b	18.00b
		G_3	17.00	2.00	19.50ab	19.50b
	C_2	G_0	12.00	3.33	16.00c	16.50c
		G_1	14.00	3.00	17.50b	17.33c
		G_2	16.00	2.50	18.00b	18.00b
		G_3	17.00	2.00	18.50b	19.00b
LSD (5%)			1.93	2.04	2.71	4.05
Level of sig.			NS	NS	*	*
CV (%)			7.10	3.89	7.14	5.38

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 =

BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

4.2 Yield and yield contributing characters

4.2.1 Filled grain panicle^{-1}

Effect of different variety on main crop and ratoon crop

Considering main and ratoon crop filled grain panicle^{-1} showed statistically significant variations due to different selected varieties (Table 5). For the main crop highest filled grain panicle^{-1} (230) was observed from the variety. The lowest filled grain panicle^{-1} (228) was found from the variety BRRI Dhan 47. On the other hand, highest filled grain panicle^{-1} of ratoon crop (110.05) was observed from the variety and the lowest filled grain panicle^{-1} (87.33) was found from the variety BRRI Dhan 47.

Effect of different cutting height on ratoon crop

For ratoon crop filled grain panicle^{-1} were found statistically significant due to different levels of cutting height (Table 5). The highest filled grain panicle^{-1} (115.33) was observed from C_1: 10 cm above ground (second node). The lowest filled grain panicle^{-1} (107) was found from C_0: Cutting at ground level. The highest grain yield at 10 cm cutting height might be due to more accumulation of food materials into grains from comparatively vigorous plants.

Effect of different levels of PGRs on main crop and ratoon crop

Filled grain panicle^{-1} were observed for both main crop and ratoon crop and found statistically significant due to different PGRs levels (Table 5). In main crop the highest filled grain panicle^{-1} (233) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest filled grain panicle^{-1} (227) respectively were found from G_0: Control. Whereas in ratoon crop the highest filled grain panicle^{-1} (121.50) was observed from G_3: 100 ppm auxin + 100 ppm gibberellin and the lowest filled grain panicle^{-1} (76) respectively were found from G_0: Control (Table 5).

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels was measured for ratoon crop which showed significant differences for filled grain panicle^{-1} (Table 6). The highest filled grain panicle^{-1} (123) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest filled grain panicle^{-1} (90) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control.

4.2.2 Unfilled grain panicle^{-1}

Effect of different variety on main crop and ratoon crop

Unfilled grain panicle^{-1} showed statistically significant variations in both main and ratoon crop due to different selected varieties (Table 5). For main crop lowest unfilled grain panicle^{-1} (22.67) was observed from the variety BRRI hybrid dhan 5. The highest filled grain panicle^{-1} (24) was found from the variety BRRI Dhan 47. For ratoon crop lowest unfilled grain panicle^{-1} (30.50) was observed from the variety BRRI hybrid dhan 5 and the highest filled grain panicle^{-1} (34.33) was found from the variety BRRI Dhan 47 (Table 5). Therefore, we can assume that, this factor (ratooning) was dominated by varietal characteristics.

Effect of different cutting height on ratoon crop

Unfilled grain panicle^{-1} were observed statistically significant for ratoon crop due to different levels of cutting height (Table 5). The lowest unfilled grain panicle^{-1} (31.33) was observed from C_1: 10 cm above ground (second node). The highest unfilled grain panicle^{-1} (38) was found from C_0: Cutting at ground level.

Effect of different levels of PGRs on main crop and ratoon crop

Unfilled grain panicle^{-1} were observed statistically significant for both main and ratoon crop due to different PGRs levels (Table 5). Considering main crop the lowest unfilled grain panicle^{-1} (20.33) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The highest unfilled grain panicle^{-1} (24.67) respectively were found from

G_0: Control. For ratoon crop the lowest unfilled grain panicle^{-1} (29.90) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the highest unfilled grain panicle^{-1} (39.10) respectively were found from G_0: Control (Table 5).

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed non-significant differences for unfilled grain panicle^{-1} in ratoon crop (Table 6). The lowest unfilled grain panicle^{-1} (30.33) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The highest unfilled grain panicle^{-1} (35) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control (Table 6).

4.2.3 Total grain panicle^{-1}

Effect of different variety on main crop and ratoon crop

For main and ratoon crop total grain panicle^{-1} showed statistically significant variations due to different selected varieties (Table 5). The highest grain panicle^{-1} (255) was observed from the variety BRRI hybrid dhan 5 of main crop and the lowest grain panicle^{-1} (253.33) was found from the variety BRRI Dhan 47. The highest grain panicle^{-1} (124.78) was observed from the variety BRRI hybrid dhan 5 of ratoon crop and the lowest grain panicle^{-1} (130.14) was found from the variety BRRI Dhan 47.

Effect of different cutting height on ratoon crop

Total grain panicle^{-1} were statistically significant variations due to different levels of cutting height of ratoon crop (Table 5). The highest grain panicle^{-1} (148.67) was observed from C_1: 10 cm above ground (second node). The lowest grain panicle^{-1} (110) was found from C_0: Cutting at ground level**.** The highest grain yield at 10 cm culm height might be due to more accumulation of Ibod materials into grains from comparatively vigorous plants. Haque (1975) also reported that cutting the main crop 10 cm above the ground level produced the highest yield in ratoon crop.

Effect of different levels of PGRs on main crop and ratoon crop

Total grain panicle^{-1} were observed statistically significant due to different PGRs levels in both main and ratoon crop (Table 5). In main crop the highest grain panicle^{-1} (252) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest grain panicle^{-1} (249) respectively were found from G_0: Control. On the other hand, in ratoon crop the highest grain panicle^{-1} (151) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest grain panicle^{-1} (111.25) respectively were found from G_0: Control.

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences for total grain panicle^{-1} of ratoon crop (Table 6). The highest grain panicle^{-1} (154) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest grain panicle^{-1} (125) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control (Table 6).

4.2.4 Weight of 1000 seeds (g)

Effect of different variety on main crop and ratoon crop

Weight of 1000 seeds showed statistically significant variations due to different selected varieties of main and ratoon crop (Table 5). The highest weight of 1000 seeds (27.36 g) were observed from the variety BRRI hybrid dhan 5 of main crop and the lowest weight of 1000 seeds (24.25 g) were found from the variety BRRI Dhan 47. The highest weight of 1000 seeds (23.75 g) were observed from the variety BRRI hybrid dhan 5 of ratoon crop and the lowest weight of 1000 seeds (20.33 g) were found from the variety BRRI Dhan 47 (Table 5). Fageria *et al*. (1997) also found similar results.

Effect of different cutting height on ratoon crop

Weight of 1000 seeds were statistically significant variations due to different levels of cutting height for ratoon crop (Table 5). The highest weight of 1000 seeds (24.03 g) were observed from C_1: 10 cm above ground (second node). The lowest weight of 1000 seeds (20.25 g) were found from C_0: Cutting at ground level.

Effect of different levels of PGRs on main crop and ratoon crop

Effect of different levels of PGRs on main crop and ratoon crops weight of 1000 seeds were measured and observed statistically significant due to different PGRs levels (Table 5). From main crop the highest weight of 1000 seeds (27.01 g) was measured from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest weight of 1000 seeds (25.36 g) respectively were found from G_0: Control. On the other hand, from ratoon crop the highest weight of 1000 seeds (24.70 g) was measured from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest weight of 1000 seeds (19.33 g) respectively were found from G_0: Control. But numerically the lowest 1000-grain weight was found in BRRI dhan47 without 100 ppm auxin+100 ppm gibberellin application.

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences for weight of 1000 seeds on ratoon crop (Table 6). The highest weight of 1000 seeds (25.01 g) were observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin and the lowest weight of 1000 seeds (21 g) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control.

Table 5. Effect of different levels of cutting height and PGRs on grain panicle^{-1} and weight of 1000 seeds of selected varieties of rice on main crop and ratoon crop

Treatments	Filled grain panicle^{-1} (No.)		Unfilled grain panicle^{-1} (No.)		Total grain panicle^{-1} (No.)		Weight of 1000 seeds (g)	
	Main crop	Ratoon crop	Main crop	Ratoon crop	Main crop	Ratoon crop	Main crop	Ratoon crop
Variety								
V_1	230.00a	110.05a	22.67b	30.50b	255.00a	130.14a	27.36a	23.75a
V_2	228.00b	87.33b	24.00a	34.33a	253.33b	124.78b	24.25b	20.33b
LSD (0.05)	2.88	2.10	2.01	1.81	1.74	2.03	0.63	0.81
Level of sig.	**	*	*	*	*	*	**	**
Cutting height								
C_0	--	78.00c	--	38.00a	--	110.00c	--	20.25c
C_1	--	115.33a	--	31.33c	--	148.67a	--	24.03a
C_2	--	107.00b	--	33.00b	--	141.00b	--	21.09b
LSD (0.05)	--	3.04	--	2.12	--	2.44	--	1.17
Level of sig.	--	*	--	*	--	*	--	**
Plant growth regulators								
G_0	227.00b	76.00d	24.67a	39.10a	249.00c	111.25d	25.36b	19.33b
G_1	228.50b	105.33c	23.00ab	35.00b	251.33b	138.33c	26.81ab	20.67ab
G_2	231.67ab	113.80b	21.00bc	33.50c	252.00b	140.05b	27.01a	24.70a
G_3	233.00a	121.50a	20.33c	29.90d	254.00a	151.00a	26.98ab	23.06ab
LSD (0.05)	2.97	2.11	2.03	1.97	1.85	2.05	0.64	0.82
Level of sig.	**	*	*	*	*	*	**	**
CV%	10.15	6.83	9.17	8.94	9.88	8.02	6.03	6.72

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

Table 6. Combined effect of different levels of cutting height and PGRs on grain panicle^{-1} and weight of 1000 seeds of selected varieties ratoon crop of boro rice

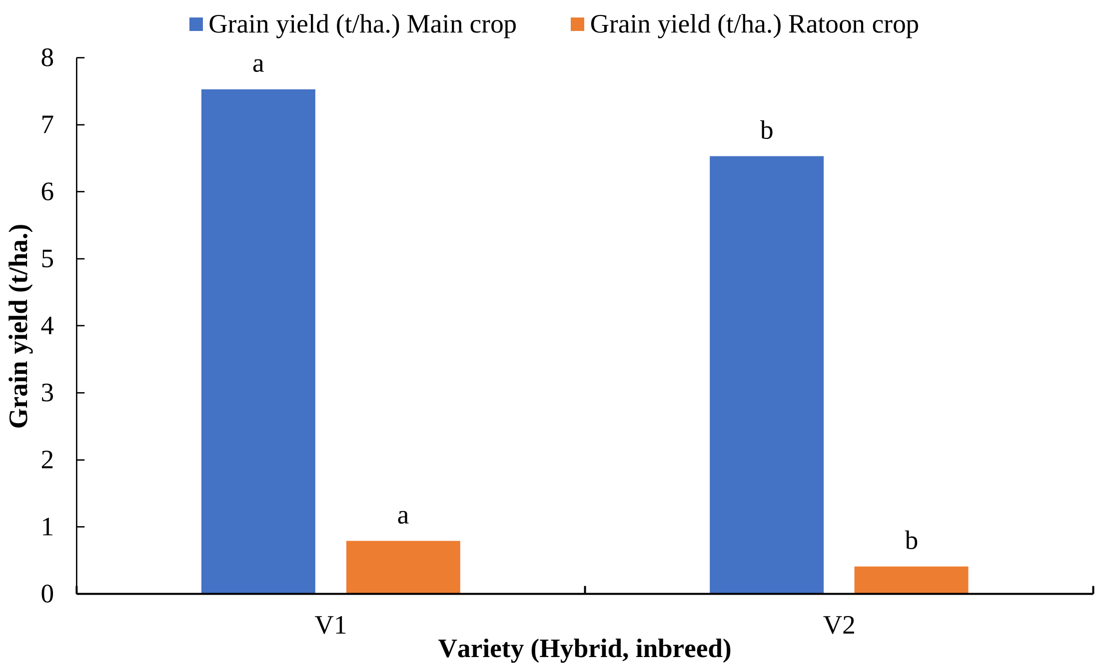
Treatments			Filled grain panicle^{-1} (No.)	Unfilled grain panicle^{-1} (No.)	Total grain panicle^{-1} (No.)	Weight of 1000 seeds (g)
V_1	C_0	G_0	114.00c	33.00	148.00d	23.30b
		G_1	116.50b	33.00	149.00d	23.80b
		G_2	119.50b	30.50	148.50d	24.00b
		G_3	120.00ab	29.00	150.00c	23.67b
	C_1	G_0	117.00b	34.67	151.00b	23.36b
		G_1	118.50b	33.00	151.33b	24.81ab
		G_2	121.67ab	31.00	152.00b	25.01a
		G_3	123.00a	30.33	154.00a	24.98ab
	C_2	G_0	115.00c	34.00	150.00c	23.33b
		G_1	117.50b	33.00	151.00b	25.50ab
		G_2	120.50ab	30.75	151.75b	26.00ab
		G_3	121.75ab	30.00	152.50b	24.00b
V_2	C_0	G_0	90.00d	35.00	125.14g	21.00c
		G_1	114.00c	34.33	145.50f	22.80bc
		G_2	117.00b	34.00	147.50e	23.10b
		G_3	118.00b	32.15	150.00c	23.30b
	C_1	G_0	114.00c	33.00	148.00d	22.00c
		G_1	116.00b	33.00	149.00d	23.00b
		G_2	119.00b	30.00	148.00d	24.00b
		G_3	120.00ab	30.33	150.00c	23.50b
	C_2	G_0	111.00d	35.00	145.00f	22.00c
		G_1	115.00c	34.00	146.00e	22.78bc
		G_2	119.00b	31.00	148.00d	24.10b
		G_3	120.00ab	31.33	150.00c	23.33b
LSD (5%)			1.90	2.03	1.50	2.05
Level of sig.			*	NS	*	**
CV (%)			6.30	8.90	7.51	7.38

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

4.2.5 Grain yield (t/ha.)

Effect of different variety on main crop and ratoon crop

Grain yield showed statistically significant variations due to different selected varieties on main crop and ratoon crop (Table 7). For main crop the highest grain yield (7.53 t/ha.) was observed from the variety BRRI hybrid dhan 5. The lowest grain yield (6.53 t/ha.) was found from the variety BRRI Dhan 47. In ratoon crop the highest grain yield (0.79 t/ha.) was observed from the variety BRRI hybrid dhan 5 which is 10.53% of the main crop. The lowest grain yield (0.41 t/ha.) was found from the variety BRRI Dhan 47 which is 6.31% of the main crop (Figure 1). This result was in agreement with Maharudrappa (1996).



[V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred)]

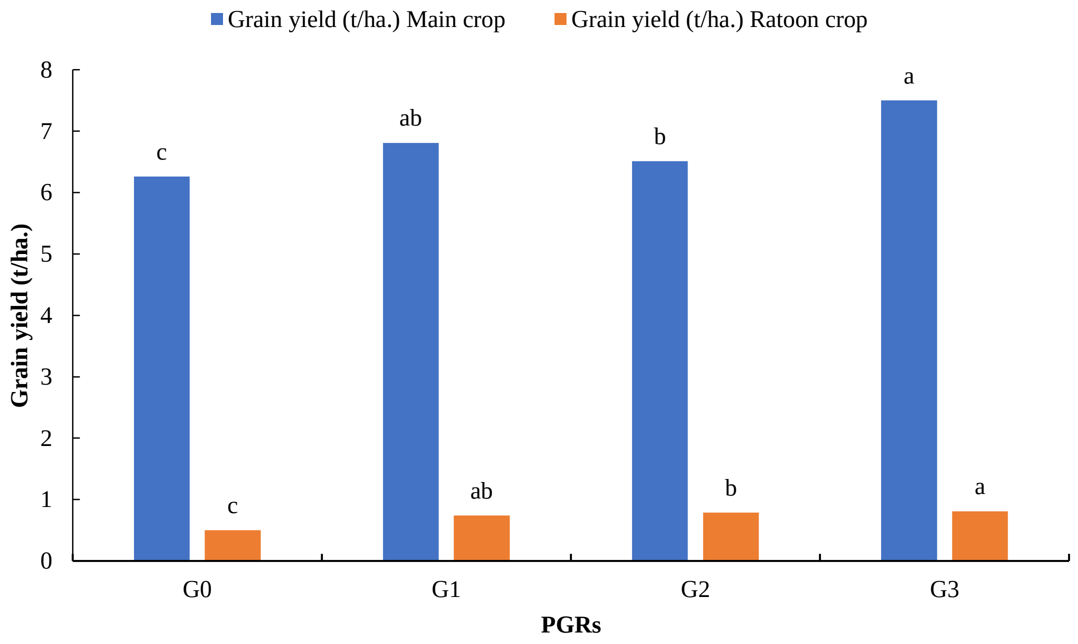
Figure 01. Effect of different variety on yield on main crop and ratoon crop

Effect of different cutting height on ratoon crop

Grain yield of ratoon crop were statistically significant variations due to different levels of cutting height (Table 7). The highest grain yield (0.88 t/ha.) was observed from C_1: 10 cm above ground (second node) and the lowest grain yield (0.38 t/ha.) was found from C_0: Cutting at ground level.

Effect of different levels of PGRs on main crop and ratoon crop

Effect of different levels of PGRs on main crop and ratoon crops' grain yield were observed statistically significant due to different PGRs levels (Table 7). The highest grain yield of main crop (7.50 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest grain yield (6.26 t/ha.) respectively were found from G_0: Control. The highest grain yield of ratoon crop (0.81 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest grain yield (0.50 t/ha.) respectively were found from G_0: Control (Table 7).



[G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

Figure 02. Effect of different levels of PGRs on yield on ratoon crop

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences for grain yield of ratoon crop (Table 8). The highest grain yield (0.75 t/ha.) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin and the lowest grain yield (0.35 t/ha.) was found from the treatment combination of $V_1C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control.

4.2.6 Straw yield (t/ha.)

Effect of different variety on main crop and ratoon crop

Considering main crop and ratoon crop straw yield showed statistically significant variation for different varieties (Table 7). For main crop the lowest straw yield (7.36 t/ha.) was observed from the variety BRRI hybrid dhan 5 and the highest grain yield (8.13 t/ha.) was found from the variety BRRI Dhan 47. Whereas on ratoon crop the lowest straw yield (1.23 t/ha.) was observed from the variety BRRI hybrid dhan 5 and the highest grain yield (1.09 t/ha.) was found from the variety BRRI Dhan 47 (Table 7).

Effect of different cutting height on ratoon crop

Effect of different cutting height of ratoon crop on straw yield were found statistically significant due to different levels of cutting height (Table 7). The highest straw yield (1.53 t/ha.) was observed from C_1: 10 cm above ground (second node). The lowest straw yield (1.16 t/ha.) was found from C_0: Cutting at ground level.

Effect of different levels of PGRs on main crop and ratoon crop

Straw yield of main and ratoon crop was observed statistically significant due to different PGRs levels (Table 7). On main crop, the highest straw yield (7.36 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest straw yield (6.36 t/ha.) respectively were found from G_0: Control. Whereas for ratoon crop, the highest straw yield (1.51 t/ha.) was observed from G_1: 100 ppm auxin and the lowest straw yield (1.40 t/ha.) respectively were found from G_3: 100 ppm auxin+100 ppm gibberellin.

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences for straw yield of ratoon crop (Table 8). The highest straw yield (1.54 t/ha.) was observed from the treatment combination of $V_2C_0G_3$: BRRI dhan 47; Cutting at ground level and 100 ppm auxin+100 ppm gibberellin. The lowest straw yield (1.15 t/ha.) was found from the treatment combination of $V_2C_1G_1$: BRRI dhan 47; Cutting at 10 cm above node and 100 ppm auxin.

4.2.7 Biological yield (t/ha.)

Effect of different variety on main crop and ratoon crop

Biological yield of main crop and ratoon crop showed statistically significant due to different selected varieties (Table 7). Considering main crop the highest biological yield (14.46 t/ha.) was observed from the variety BRRI hybrid dhan 5 and the lowest biological yield (13.78 t/ha.) was found from the variety BRRI Dhan 47. For ratoon crop the highest biological yield (1.89 t/ha.) was observed from the variety BRRI hybrid dhan 5 and the lowest biological yield (1.63 t/ha.) was found from the variety BRRI Dhan 47.

Effect of different cutting height on ratoon crop

Biological yield of ratoon crop were statistically significant variations due to different levels of cutting height (Table 7). For ratoon crop the highest biological yield (2.40 t/ha.) was observed from C_1: 10 cm above ground (second node). The lowest grain yield (1.55 t/ha.) was found from C_0: Cutting at ground level. C_1: 10 cm above ground (second node) treatment gave higher biological yield. It might be due to higher straw yield by this treatment.

Effect of different levels of PGRs on main crop and ratoon crop

Biological yield was observed statistically significant due to different PGRs levels for both main and ratoon crop (Table 7). For main crop the highest biological yield (14.88 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest biological yield (13.25 t/ha.) respectively were found from G_1: 100 ppm auxin. Whereas, on ratoon crop the highest biological yield (2.01 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest biological yield (1.71 t/ha.) respectively were found from G_0: Control.

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences for biological yield of ratoon crop (Table 8). The highest biological yield (2.20 t/ha.) was observed from the treatment combination of $V_1C_2G_3$: BRRI hybrid dhan 5; 15 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest biological yield (1.59 t/ha.) was found from the treatment combination of $V_2C_0G_1$: BRRI Dhan 47; Cutting at ground level and 100 ppm auxin.

4.2.8 Harvest index (%)

Effect of different variety on main crop and ratoon crop

The harvest index was found statistically significant due to different selected varieties on both main crop and ratoon crop (Table 7). For main crop the highest harvest index (52.10%) was observed from the variety BRRI hybrid dhan 5. The lowest harvest index (49.33%) was found from the variety BRRI Dhan 47. Considering ratoon crop the highest harvest index (41.80%) was observed from the variety BRRI hybrid dhan 5 and the lowest harvest index (25.16%) was found from the variety BRRI Dhan 47.

Effect of different cutting height on ratoon crop

The harvest index was statistically significant for different levels of cutting height on ratoon crop (Table 7). The highest harvest index (57.50%) was observed from C_1: 10 cm above ground (second node). The lowest harvest index (32.76%) was found from C_0: Cutting at ground level.

Effect of different levels of PGRs on main crop and ratoon crop

Effect of different levels of PGRs on main crop and ratoon crops' harvest index was measured and found statistically significant due to different PGRs levels (Table 7). For main crop the highest harvest index (55.10%) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest harvest index (47.20%) respectively was found from G_0: Control. On the other hand, for ratoon crop the highest harvest index (55.85%) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest harvest index (35.70%) respectively was found from G_0: Control (Table 7).

Combined effect of different varieties, cutting height and PGRs on ratoon crop

Combined effect of different varieties, cutting height and PGRs levels showed significant differences for harvest index of ratoon crop (Table 8). The highest harvest index (39.27%) was observed from the treatment combination of $V_1C_1G_3$: BRRI Dhan 47; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest harvest index (18.92%) was found from the treatment combination of $V_1C_0G_0$: BRRI hybrid dhan 5; Cutting at ground level and Control.

Table 7. Effect of different levels of cutting height and PGRs on yield of selected varieties of rice on main crop and ratoon crop

Treatments	**Grain yield (t/ha.)**		**Straw yield (t/ha.)**		**Biological yield (t/ha.)**		**Harvest index (%)**	
	Main crop	**Ratoon crop**	**Main crop**	**Ratoon crop**	**Main crop**	**Ratoon crop**	**Main crop**	**Ratoon crop**
Variety								
V_1	7.53a	0.79a	7.36b	1.09b	14.46a	1.89a	52.10a	41.80a
V_2	6.53b	0.41b	8.13a	1.23a	13.78b	1.63b	49.33b	25.16b
LSD (0.05)	0.40	0.08	0.31	0.15	0.27	0.19	2.08	2.63
Level of sig.	**	**	**	**	**	*	*	*
Cutting height								
C_0	--	0.38c	--	1.16c	--	1.55c	--	32.76c
C_1	--	0.88a	--	1.53a	--	2.40a	--	57.50a
C_2	--	0.70b	--	1.34b	--	2.04b	--	52.25b
LSD (0.05)	--	1.01	--	0.23	--	0.21	--	3.89
Level of sig.	--	**	--	**	--	*	--	*
Plant growth regulators								
G_0	6.26c	0.50c	7.41a	1.40d	13.87b	1.71c	47.25c	35.70c
G_1	6.81ab	0.74b	6.36b	1.51a	13.25bc	1.89ab	51.00b	51.65b
G_2	6.51b	0.79ab	7.36ab	1.47b	14.51ab	1.96ab	50.00bc	54.42ab
G_3	7.50a	0.81a	6.59b	1.45c	14.88a	2.01a	55.10a	55.85a
LSD (0.05)	0.41	0.09	0.36	0.16	0.28	0.21	2.17	2.88
Level of sig.	**	**	**	**	**	*	*	*
CV%	10.35	8.44	7.39	7.83	5.41	5.82	5.03	6.04

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 =

BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

Table 8. Combined effect of different levels of cutting height and PGRs on yield of selected varieties of boro rice ratoon crop

Treatments			Grain yield (t/ha.)	Straw yield (t/ha.)	Biological yield (t/ha.)	Harvest index (%)
V_1	C_0	G_0	0.45cd	1.24cd	1.69bc	26.63f
		G_1	0.50bc	1.20cd	1.70bc	29.41e
		G_2	0.60bc	1.30bc	1.90b	31.58d
		G_3	0.58bc	1.31bc	1.89b	30.69e
	C_1	G_0	0.66b	1.41ab	2.07ab	31.88d
		G_1	0.71ab	1.36bc	2.07ab	34.30c
		G_2	0.73ab	1.19cd	1.92ab	38.02ab
		G_3	0.75a	1.16d	1.91ab	39.27a
	C_2	G_0	0.62bc	1.40ab	2.02ab	30.69e
		G_1	0.66b	1.33bc	1.99ab	33.17c
		G_2	0.73ab	1.33bc	2.06ab	35.44b
		G_3	0.70ab	1.50ab	2.20a	31.82d
V_2	C_0	G_0	0.35c	1.50ab	1.85bc	18.92j
		G_1	0.40cd	1.19cd	1.59d	25.16f
		G_2	0.45cd	1.54a	1.99ab	22.61h
		G_3	0.43cd	1.50ab	1.93ab	22.28h
	C_1	G_0	0.40cd	1.20cd	1.60cd	25.00f
		G_1	0.47cd	1.15d	1.62cd	29.01e
		G_2	0.50bc	1.15d	1.65cd	30.30e
		G_3	0.48b	1.30bc	1.78b	26.97f
	C_2	G_0	0.34c	1.35b	1.69bc	20.12i
		G_1	0.40cd	1.25c	1.65cd	24.24g
		G_2	0.44cd	1.45ab	1.89b	23.28g
		G_3	0.41cd	1.40ab	1.81ab	22.65h
LSD (5%)			0.13	0.14	0.13	1.22
Level of sig.			**	*	**	*
CV (%)			10.06	12.55	7.1	3.89

[In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability; V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin]

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out at the Agronomy Field, Sher-e-Bangla Agricultural University, Dhaka during the period from November 2021 to July 2022 with a view to study the effects of variety of main crop and N dose (applied after the harvesting of main crops) on the performance of ratoon crop of boro rice. The experiment was carried out in a Split plot design, where three factors were selected as variety, plant growth regulators and cutting managements. The plot size was 3 square meters (2 m ×1.5 m). The plots were replicated three times and thus the total number of plots was 36. V_1= BRRI hybrid dhan 5 (hybrid), V_2 = BRRI Dhan 47 (Inbred); C_0: Cutting at ground level, C_1: 10 cm above ground (second node), C_2: 15 cm above ground (third node); G_0: Control, G_1: 100 ppm auxin, G_2: 100 ppm gibberellin, G_3: 100 ppm auxin+100 ppm gibberellin were selected treatments.

Plant height showed main crop and ratoon crop was statistically significant variations due to different selected varieties for all 30, 45 DAT and 30, 40, 90 DAT and at harvest. Considering the main crop at 30, 45, 90 DAT and at harvest, the tallest plant (19.75, 52.25, 98.25 and 110.25 cm) respectively were observed from the variety BRRI hybrid dhan 5 on the other hand, the shortest plant (12.25, 41.25, 87.25 and 106.50 cm) respectively was found from the variety BRRI Dhan 47. After the harvesting of main crop ratoon crop was developed and plant height measured up to 30 and 45 days from the harvest of main crop. Plant height of ratoon crop at 30 and 45 day was found highest (17.56 and 51.33 cm) for BRRI hybrid dhan 5 and lowest was resulted from (11.38 and 38.75 cm) BRRI Dhan 47. For main crop the highest effective tiller hill^{-1} (18.67) was observed from the variety BRRI hybrid dhan 5. The lowest effective tiller hill^{-1} (15.00) was found from the variety BRRI Dhan 47. Similar variations was also observed for ratoon crop where the highest effective tiller hill^{-1} (12.33) was observed from the variety BRRI hybrid dhan 5. The lowest effective tiller hill^{-1} (10.75) was found from the variety BRRI Dhan 47.

Considering the main crop lowest non-effective tiller hill^{-1} (3) was observed from the variety BRRI hybrid dhan 5. The highest non-effective tiller hill^{-1} (4) was found from the variety BRRI Dhan 47. For the ratoon crop lowest non-effective tiller hill^{-1} (3) was observed from the variety BRRI hybrid dhan 5. The highest non-effective tiller hill^{-1} (3.50) was found from the variety BRRI Dhan 47. The highest tiller hill^{-1} (22) was observed from the variety BRRI hybrid dhan 5. The lowest tiller hill^{-1} (20.33) was found from the variety BRRI Dhan 47. Main crop highest panicle length (26.50 cm) was observed from the variety BRRI hybrid dhan 5. The lowest panicle length (23.14 cm) was found from the variety BRRI Dhan 47. For ratoon crop highest panicle length (19.98 cm) was observed from the variety BRRI hybrid dhan 5 and the lowest panicle length (17.33 cm) was found from the variety BRRI Dhan 47.

For the main crop highest filled grain panicle^{-1} (230) was observed from the variety. The lowest filled grain panicle^{-1} (228) was found from the variety BRRI Dhan 47. On the other hand, highest filled grain panicle^{-1} of ratoon crop (110.05) was observed from the variety and the lowest filled grain panicle^{-1} (87.33) was found from the variety BRRI Dhan 47. Considering main crop lowest unfilled grain panicle^{-1} (22.67) was observed from the variety BRRI hybrid dhan 5. The highest filled grain panicle^{-1} (24) was found from the variety BRRI Dhan 47. For ratoon crop lowest unfilled grain panicle^{-1} (30.50) was observed from the variety BRRI hybrid dhan 5 and the highest filled grain panicle^{-1} (34.33) was found from the variety BRRI Dhan 47. The highest grain panicle^{-1} (255) was observed from the variety BRRI hybrid dhan 5 of main crop and the lowest grain panicle^{-1} (253.33) was found from the variety BRRI Dhan 47. The highest grain panicle^{-1} (124.78) was observed from the variety BRRI hybrid dhan 5 of ratoon crop and the lowest grain panicle^{-1} (130.14) was found from the variety BRRI Dhan 47.

The highest weight of 1000 seeds (27.36 g) were observed from the variety BRRI hybrid dhan 5 of main crop and the lowest weight of 1000 seeds (24.25 g) were found from the variety BRRI Dhan 47. The highest weight of 1000 seeds (23.75 g) were observed from the variety BRRI hybrid dhan 5 of ratoon crop and the lowest weight of 1000 seeds (20.33 g) were found from the variety BRRI Dhan 47. For main crop the highest grain yield (7.53 t/ha.) was observed from the variety BRRI hybrid dhan 5. The lowest grain yield (6.53 t/ha.) was found from the variety BRRI Dhan 47. In ratoon crop the highest grain yield (0.79 t/ha.) was observed from the variety BRRI hybrid dhan 5 which is 10.53% of the main crop. The lowest grain yield (0.41 t/ha.) was found from the variety BRRI Dhan 47 which is 6.31% of the main crop.

Plant heights of ratoon crop were statistically significant variations due to different levels of cutting height at 30 and 45 days (Table 1). At 30 and 45 days, the tallest plant (19.50 and 52.75 cm) respectively was observed from C_2: 15 cm above ground (second node). The shortest plant (12.25 and 46.25 cm) respectively were found from C_0: Cutting at ground level (Table 1). This variation might be due to more nutrients. The highest effective tiller hill^{-1} (14) was observed from C_1: 10 cm above ground (second node). The lowest effective tiller hill^{-1} (10) was found from C_0: Cutting at ground level.

The highest grain panicle^{-1} (148.67) was observed from C_1: 10 cm above ground (second node). The lowest grain panicle^{-1} (110) was found from C_0: Cutting at ground level**.** The highest weight of 1000 seeds (24.03 g) were observed from C_1: 10 cm above ground (second node).

The lowest weight of 1000 seeds (20.25 g) were found from C_0: Cutting at ground level. The highest grain yield (0.88 t/ha.) was observed from C_1: 10 cm above ground (second node) and the lowest grain yield (0.38 t/ha.) was found from C_0: Cutting at ground level. The highest straw yield (1.53 t/ha.) was observed from C_1: 10 cm above ground (second node). The lowest straw yield (1.16 t/ha.) was found from C_0: Cutting at ground level. For ratoon crop the highest biological yield (2.40 t/ha.) was observed from C_1: 10 cm above ground (second node). The lowest grain yield (1.55 t/ha.) was found from C_0: Cutting at ground level. The highest harvest index (57.50%) was observed from C_1: 10 cm above ground (second node). The lowest harvest index (32.76%) was found from C_0: Cutting at ground level.

Panicle length of main crop (29.33 cm) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest panicle length (25.15 cm) respectively were found from

G_0: Control. For ratoon crop, panicle length (20.50 cm) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and lowest panicle length (16.33 cm) respectively were found from G_0: Control. In main crop the highest filled grain panicle^{-1} (233) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest filled grain panicle^{-1} (227) respectively were found from G_0: Control. Whereas in ratoon crop the highest filled grain panicle^{-1} (121.50) was observed from G_3: 100 ppm auxin + 100 ppm gibberellin and the lowest filled grain panicle^{-1} (76) respectively were found from G_0: Control**.** Considering main crop the lowest unfilled grain panicle^{-1} (20.33) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The highest unfilled grain panicle^{-1} (24.67) respectively were found from G_0: Control. For ratoon crop the lowest unfilled grain panicle^{-1} (29.90) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the highest unfilled grain panicle^{-1} (39.10) respectively were found from G_0: Control. In main crop the highest grain panicle^{-1} (252) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest grain panicle^{-1} (249) respectively were found from G_0: Control. On the other hand, in ratoon crop the highest grain panicle^{-1} (151) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest grain panicle^{-1} (111.25) respectively were found from G_0: Control.

From main crop the highest weight of 1000 seeds (27.01 g) was measured from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest weight of 1000 seeds (25.36 g) respectively were found from G_0: Control. On the other hand, from ratoon crop the highest weight of 1000 seeds (24.70 g) was measured from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest weight of 1000 seeds (19.33 g) respectively were found from G_0: Control. The highest grain yield of main crop (7.50 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest grain yield (6.26 t/ha.) respectively were found from G_0: Control. The highest grain yield of ratoon crop (0.81 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest grain yield (0.50 t/ha.) respectively were found from G_0: Control. On main crop, the highest straw yield (7.36 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest straw yield (6.36 t/ha.) respectively were found from G_0: Control. Whereas for ratoon crop, the highest straw yield (1.51 t/ha.)

was observed from G_1: 100 ppm auxin and the lowest straw yield (1.40 t/ha.) respectively were found from G_3: 100 ppm auxin+100 ppm gibberellin.

For main crop the highest biological yield (14.88 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest biological yield (13.25 t/ha.) respectively were found from G_1: 100 ppm auxin. Whereas, on ratoon crop the highest biological yield (2.01 t/ha.) was observed from G_3: 100 ppm auxin+100 ppm gibberellin and the lowest biological yield (1.71 t/ha.) respectively were found from G_0: Control. For main crop the highest harvest index (55.10%) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest harvest index (47.20%) respectively was found from G_0: Control. On the other hand, for ratoon crop the highest harvest index (55.85%) was observed from G_3: 100 ppm auxin+100 ppm gibberellin. The lowest harvest index (35.70%) respectively was found from G_0: Control.

The highest filled grain panicle^{-1} (123) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest filled grain panicle^{-1} (90) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control. The lowest unfilled grain panicle^{-1} (30.33) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The highest unfilled grain panicle^{-1} (35) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control.

The highest grain panicle^{-1} (154) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest grain panicle^{-1} (125) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control. The highest weight of 1000 seeds (25.01 g) were observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin and the lowest weight of 1000 seeds (21 g) was found from the treatment combination of $V_2C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control. The highest grain yield (0.75 t/ha.) was observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin and the lowest grain yield (0.35 t/ha.) was found from the treatment combination of $V_1C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control. The highest straw yield (1.54 t/ha.) was observed from the treatment combination of $V_2C_0G_3$: BRRI dhan 47; Cutting at ground level and 100 ppm auxin+100 ppm gibberellin. The lowest straw yield (1.15 t/ha.) was found from the treatment combination of $V_2C_1G_1$: BRRI dhan 47; Cutting at 10 cm above node and 100 ppm auxin. The highest biological yield (2.20 t/ha.) was observed from the treatment combination of $V_1C_2G_3$: BRRI hybrid dhan 5; 15 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest biological yield (1.59 t/ha.) was found from the treatment combination of $V_2C_0G_1$: BRRI Dhan 47; Cutting at ground level and 100 ppm auxin. The highest harvest index (39.27%) was observed from the treatment combination of $V_1C_1G_3$: BRRI Dhan 47; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin. The lowest harvest index (18.92%) was found from the treatment combination of $V_1C_0G_0$: BRRI hybrid dhan 5; Cutting at ground level and Control.

Conclusion

The primary objective of this experiment was to test the varieties in terms of their grain yield considering main crop and ratoon crop. For main crop the highest grain yield (7.53 t/ha.) was observed from the variety BRRI hybrid dhan 5. The lowest grain yield (6.53 t/ha.) was found from the variety BRRI Dhan 47. In ratoon crop the highest grain yield (0.79 t/ha.) was observed from the variety BRRI hybrid dhan 5 which is 10.53% of the main crop. The lowest grain yield (0.41 t/ha.) was found from the variety BRRI Dhan 47 which is 6.31% of the main crop.

1. The interaction of variety and cutting height of main crop and application of PGRs had significant effect on any of the crop characters of ratoon crop.
2. The interaction of variety and cutting height of main crop had highly significant effect on final grain yield of ratoon crop along with other yield contributing factors and found the highest grain yield (0.75 t/ha.) observed from the treatment combination of $V_1C_1G_3$: BRRI hybrid dhan 5; 10 cm above ground (second node) and 100 ppm auxin+100 ppm gibberellin and
3. The lowest grain yield (0.35 t/ha.) was found from the treatment combination of $V_1C_0G_0$: BRRI Dhan 47; Cutting at ground level and Control.

Recommendation

The yield was not economically so much higher as found in the previous literature. So, some other variety may be tested for the commercial ratoon crop cultivation. Some core recommendations can be stated as-

• To select a high-performance ratoon rice variety under Bangladesh context more comprehensive study should be conducted.

• Decisions about the appropriate application rate of PGRs demands further field specific research based on findings on the benefit over cost of PGRs application.

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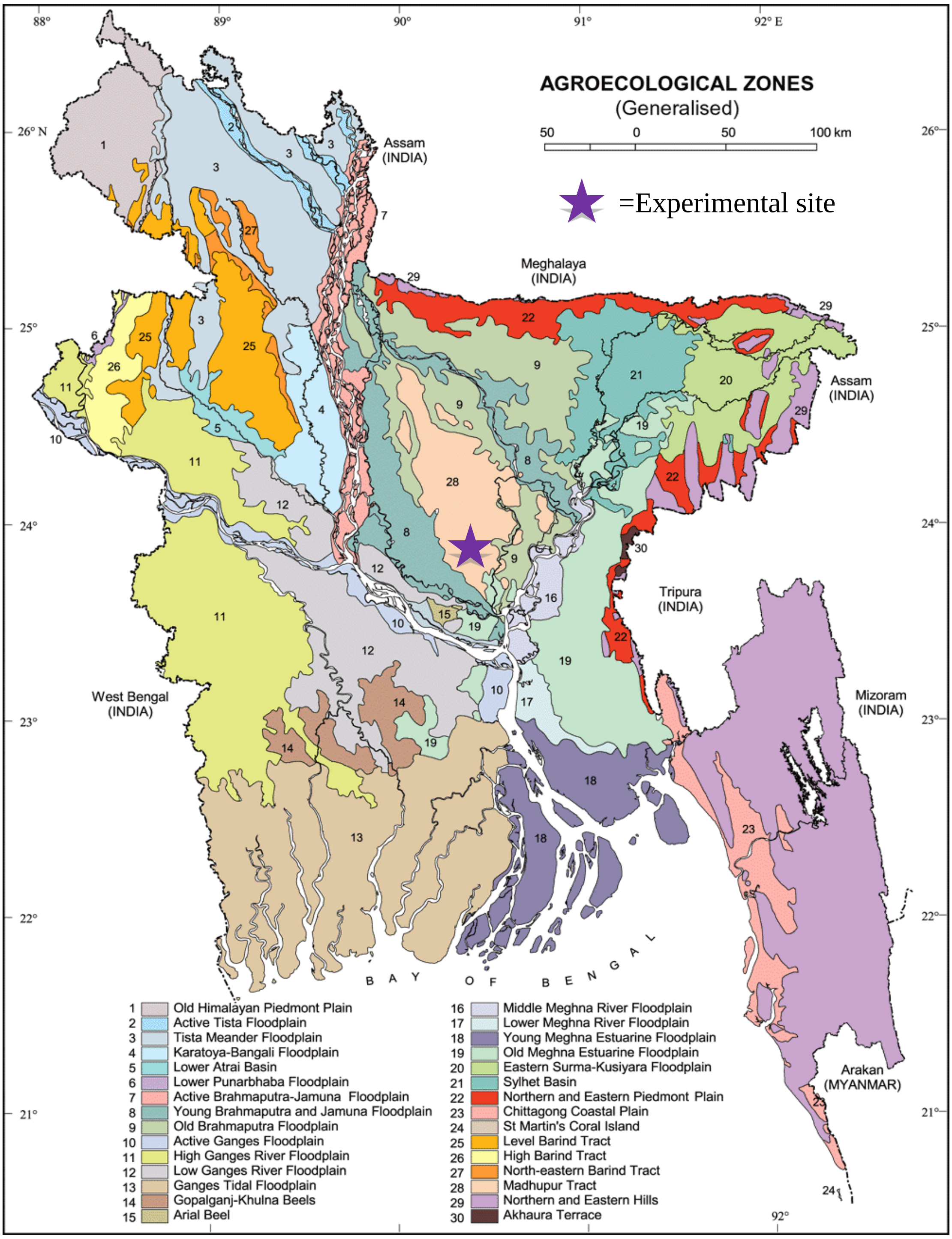
APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Characteristics of soil of experimental site.

A. Morphological characteristics of the experimental site

Morphological features	**Characteristics**
Location	Sher-e-Bangla Agricultural University Agronomy research field, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Shallow Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly levelled

B. The initial physical and chemical characteristics of soil of the experimental site (0 - 15 cm depth)

Physical characteristics	
Constituents	Percent
Sand	26
Silt	45
Clay	29
Textural class	Silty clay
Chemical characteristics	
Soil characters	Value
pH	5.9
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total nitrogen (%)	0.03
Available P (ppm)	20.54
Exchangeable K (me/100 g soil)	0.10

Appendix III. Monthly meteorological information during the period from November, 2021 to April, 2022

Year	Month	Air temperature (^0C)		Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2021	November	28.10	11.83	58.18	47.00
	December	25.00	9.46	69.53	00.00
2022	January	25.20	12.80	69.00	00.00
	February	27.30	16.90	66.00	39.00
	March	31.70	19.20	57.00	23.00
	April	33.50	25.90	64.50	119.00

Meterological Centre, Agargaon, Dhaka (Climate Division)