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Yield performance of some short duration high yielding rice varieties during boro season in northern region of Bangladesh

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ABSTRACT

A field experiment was conducted at four locations of Rangpur Division during boro season from December 2021 to May 2022. Research field of BRRI regional station, Rangpur (Rashidpur, Mithapukur, Gopinathpur, Metro) and Dinajpur (Rampur, Parbatipur) were the trial sites. Five short duration Boro rice varieties, namely BRRI dhan28, BRRI dhan74, BRRI dhan81, BRRI dhan88 and Bangabandhu dhan100 were selected as treatment. The experiment was carried out in Randomized Complete Block Design (RCBD) with 4 replicates, using each site as a replicate. Highest yield performance was showed by BRRI dhan74 (8.2125 t ha^{-1}) including best performance in overall production and effective tiller number per plant, panicle length, 1000 grain weight, biological yield and percent spikelet sterility. The second best yield performance was observed in BRRI dhan88 (6.89 t ha^{-1}) followed by Bangabandhu dhan100 (6.33 t ha^{-1}) and BRRI dhan81 (6.2875 t ha^{-1}). The lowest yield performance was observed in BRRI dhan28 (5.305t ha^{-1}). To replace BRRI dhan28, farmers may choose BRRI dhan74, BRRI dhan88, Bangabandhu dhan100 and BRRI dhan81. Farmers who prefer medium coarse rice can cultivate BRRI dhan74, while those who like medium slender to long slender grain can grow BRRI dhan88, Bangabandhu dhan100 and BRRI dhan81 respectively.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cultivated cereal crops in the world and also staple food in many countries. It was reported that rice was grown more than 162 million hectares worldwide by 2010 (GRiSP, 2013). Rice is the primary staple food for more than half of the world's population with Asia, Sub-Saharan Africa and South America being the regions with the greatest consumption. Prasad et al. (2017) reported that rice is the main food source for more than 50% of the world's population and is grown in 122 countries. Therefore, for food security, the sustainable development of the world economy and society, rice production is a very important issue. In Bangladesh, rice was ranked first both production and consumption wise. Now, Bangladesh placed the third position worldwide in rice production, behind China and India with a production volume of 36.00 million tons (Rahman et al, 2021). There are three rice growing seasons in Bangladesh namely Aus, Aman and Boro. Total production of rice in Bangladesh mostly depends on boro season. Total production of rice in 2021-22 (Aus, Aman & Boro) was 38.15 million tons by cultivation of total 11.69 million hectares of land. (BBS, 2022). Boro cultivation area was 4.82 million hectare and production was 20.19 million tons in 2021-2022 season (BBS, 2022). The production of Boro season was 58.37% of total rice production in 2021-22. So, total production of rice is influenced by boro season. Moreover, the demand of food is increasing day by day due to

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increasing population. But land is decreasing due to industrialization and urbanization as increasing demand of rising population. So, its crying need to increase the production by increasing crop productivity and cropping intensity. To increase crop productivity, selection of high yielding variety is very important. To increase cropping intensity, short duration rice variety can play a vital role. BRRI dhan28 is most popular one of mega short duration Boro rice variety in Bangladesh released by Bangladesh Rice Research Institute (BRRI) in 1994. Now, BRRI released some short duration high yielding Boro rice varieties (BRRI dhan74, BRRI dhan81, BRRI dhan88 and Bangabandhu dhan100 which were released in 2014, 2017, 2018 and 2019 respectively) and which are cultivated throughout the country. Due to low productivity and higher disease incidence of BRRI dhan28 during boro season, farmers in northern region of Bangladesh are interested in growing others boro rice varieties with short duration and high yield. Farmers need short duration boro rice varieties to include early potato, mustard, winter vegetable, tobacco etc after harvesting short duration Aman rice. The present investigation was carried out to find the adaptation of newly released short duration Boro rice variety(s) in terms of yield performance in northern region of Bangladesh among these five boro rice varieties.

MATERIALS AND METHOD

A field experiment was conducted during Rabi (Boro) season of 2021-22 (from December 2021 to May 2022) at four locations of Rangpur Division (BRRI regional station, Rangpur (25.695628, 89.268080); Rashidpur, Mithapukur, Rangpur (25.583849, 89.270592); Gopinathpur, Metro, Rangpur (25.74486, 89.169862) and Rampur, Parbatipur, Dinajpur (25.686464, 88.90713). The climate is characterized by the alternate hot rainy season. Climatic data was collected from weather station of BRRI regional station, Rangpur and data is presented in Table 1. The experiment was laid down in Randomized Complete Block Design (RCBD) using five rice varieties (i.e., BRRI dhan28, BRRI dhan74, BRRI dhan81, BRRI dhan88 and Bangabandhu dhan100) with four replications. Four locations were used as replicates. Pre-germinated seed were sown in wet seedbed at BRRI regional station Rangpur research field on 2 December 2021. 35 days old seedlings were transplanted with single seedling per hill in four locations in the same day. Size of the single plot was $40m^2$ with maintaining 20cm x 20cm spacing. The experimental plot was uniformly fertilized with Urea, Triple Super phosphate (TSP), Muriate of potash (MoP), Gypsum and Zinc sulphate @ 130, 50, 80, 44.5 and 2.0 kg ha^{-1} respectively. The total TSP, Gypsum, Zinc sulphate and 2/3 MoP was applied at final land preparation and one third of urea were applied as basal dose at 10 days after transplanting (DAT). The rest of the urea was top dressed at two equal split doses at 25 days after DAT and at 45 DAT. Rest 1/3 of MoP was applied during 3rd top dressing of urea at 45 DAT. Rifit 500 EC @988 mL ha^{-1} was applied as pre-emergence weedicide to control weeds. For controlling of weeds hand weeding was done with the help of "Khurpi" at 25 days after transplanting. Irrigation was applied as per requirement. Cartap+Fipronil group i.e Suntap Plus 50WP @ 750g ha^{-1} was applied at heading stage to prevent insect infestation. During the experimentation fungal diseases were controlled by applying Azoxystrobin+Difenoconazole group i.e Amistar Top 325SC @ 500 mL ha^{-1}.

After physiological maturity, 20 m^2 of experimented area was harvested from every plot for the determination of yield contributing parameters. Five hills were selected randomly from each experimental plot to record necessary data. An area of 1.00 m^2 was selected in the middle portion of each plot to record plant height, number of tiller and number of effective tiller. Other yield parameters such as panicle length (cm), number of grains per panicle and number of sterile spikelets per panicle were collected just before the harvesting of rice plant. The 1000 grain weight (g), grain yield (initially grain yield was measured kg per plot which was then converted into t ha^{-1}) and straw yield (rice plant of one meter square was collected by cutting base of plant and after fully sundried weight was taken) after harvesting. All data were subjected to statistical analysis separately by using analysis of variance technique by R software (versions 4.2.1). The difference among treatment means was compared by using Least Significant Difference (LSD) test at 5% probability levels.

Biological yield was calculated by using the following formula:
Biological yield (t ha^{-1}) = Grain yield (t ha^{-1}) + Straw yield (t ha^{-1})

Harvest index was calculated using the following formula:
Harvest Index %=Grain yield/Biological yield x100

Table1: Recorded weather and climatic condition

Month	Monthly average air Temperature (^{0}C)			Monthly total Rainfall(mm)	Monthly average Relative humidity (%)	Monthly total Sunshine (hours)	Average solar Radiation (gm-Cal/cm^2)
	Max	Min	Average				
December, 2021	24.6	13.4	19.0	4.00	84	152.1	242.31
January, 2022	22.3	11.4	16.9	8.00	91	120.5	208.88
February, 2022	23.4	11.6	17.5	71.00	87	152.2	287.81
March, 2022	30.9	18.4	24.7	0.00	78	175.4	341.08
April, 2022	29.2	22.1	25.6	191.0	89	93.1	276.18
May, 2022	30.8	23.1	27.0	274.00	86	143.3	327.20

RESULTS AND DISCUSSION

Plant Height (cm)

Plant height exhibited an impressive variation among the tested rice varieties (Table 2). The highest plant height was observed in Bangabandhu dhan100 (107.375 cm) followed by BRRI dhan81 (101.775 cm) and lowest plant height was observed in BRRI dhan74 (96.825 cm) which was statistically similar to BRRI dhan88 (98.625 cm) and BRRI dhan28 (98.775 cm). Rice variety which has long plant height, can produce more straw yield and which can be used for fodder purpose. A longer plant height was reported in the conventional rice cultivars than the HYV because of having longer internodes (Islam et al. 2020), which also can contribute to enhance the straw yield reported by Howlader et al. (2017).

Number of tiller/hill

Yield potential of rice varieties depends on tillering capacity, specifically total effective tiller production. In this experiment, the number of tillers per hill showed statistically significant difference. Figure 1 showed that BRRI dhan28 produced highest number of tiller (15.50) and BRRI dhan81 (12.50) was found lowest tillering capability among the tested varieties. But in case of effective tiller production, Bangabandhu dhan100 (14.50) was found as the highest effective tiller production capability followed by BRRI dhan88 (14.00) and which was statistically significant and BRRI dhan81 (11.75) was found as the lowest effective tiller production. Tiller and effective tiller production vary from variety to variety. Jisan et al. (2014) concluded that, variation in number of tillers per hill might be due to varietal characters. Generally, rice plants having more tillers can exhibit a higher inconsistency in mobilizing assimilates and nutrients among tillers (Dubey et al. 2018), resulting in variations in grain development and yield (Wang et al. 2016). Highest number of non-effective tiller was found at BRRI dhan28. It has also been demonstrated that either excessive or insufficient tillering is unfavorable for high yield (Dubey et al. 2018).

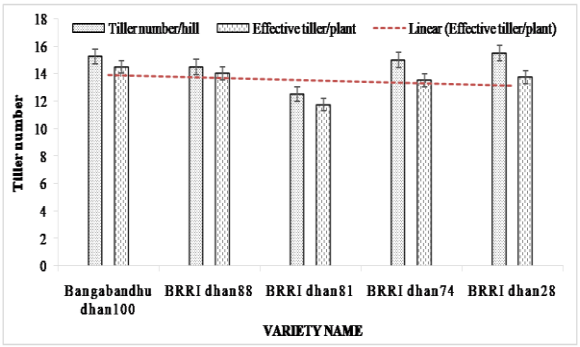

Figure 1: Comparison between total tiller number/hill and effective tiller number/hill among tested rice varieties

Flowering and Maturity time

There was statistically significance difference in case of days to flowering and days to maturity among tested varieties (Table 2). BRRI dhan28 was the shortest variety and Bangabandhu dhan100 need almost 5 days more time than BRRI dhan28. Flowering and maturity days vary due to varietal character, cultural practices and also environment.

Table 2: Plant height and comparison of days to flowering and days to maturity among tested varieties

Variety name	Plant height (cm)	Days to flowering	Days to maturity
Bangabandhu dhan100	107.375 a	124.00 a	148.00 a
BRRI dhan74	96.825 c	123.00 ab	147.00 ab
BRRI dhan 88	98.625 c	121.00 bc	144.00 bc
BRRI dhan81	101.775 b	120.00 c	144.00 c
BRRI dhan28(ck)	98.775 bc	118.00 c	143.00 c
Levels of significance	***	**	**
LSD	3.021409	2.826864	2.819859
CV	1.95	1.513901	1.260104

*. **, *** indicate significant at 5%, 1% and 0.1% level of probability, respectively. Values followed by the different letter(s) are significantly different from each other.

Panicle Length (cm)

Maximum length of panicle was observed in BRRI dhan74 (25.30 cm) and BRRI dhan28 (25.30 cm) which was statistically similar to other varieties but numerically different except BRRI dhan88 (22.25 cm).The length of panicle is a varietal character. Yield potential depends on panicle length. Roy et al. (2021) reported that panicle length and panicle numbers are two important yield components that contribute to final grain yield.

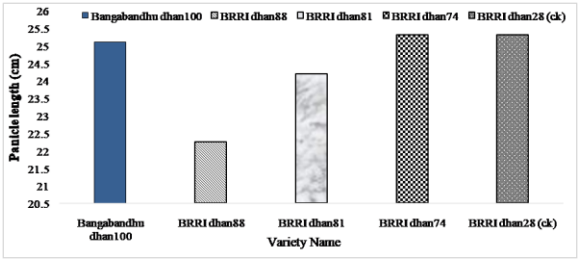

Figure 2: Length of panicle (cm) among tested varieties

Number of spikelet per panicle

Maximum number of filled grains was observed in BRRI dhan81 (133.00) followed by Bangabandhu dhan100 (126.00) and that was significantly different from other varieties (Figure 3). Lowest filled spikelet was found at BRRI dhan74 (94.00) followed by BRRI dhan28 (95.00).Variations in grain filling may have occurred due to genetic, environmental or cultural management practices adopted. Among these varieties, BRRI dhan74 grain is medium coarse but others are medium slender grain. On the other hand, the highest amount of unfilled spikelet was recorded in BRRI dhan81 (33.00) which was statistically similar with BRRI dhan88 (27.50) and lowest unfilled spikelet per panicle was recorded in BRRI dhan74 (17.00). The highest percent of sterile spikelet was found in BRRI dhan28 (28.81%) followed by BRRI dhan81 (26.74%), BRRI dhan88 (25.58%) and BRRI dhan74 (19.03%), lowest was observed at Bangabandhu dhan100 (14.78%) figure 3. Dutta et al. (2002) observed that yield was affected by the filled grains per panicle. Kiani and Nematzadeh (2012) observed that filled grains per panicle correlated significantly with grain yield. Sarkar (2014) reported that number of filled grains per panicles influenced significantly due to variety. Rice produces 15-20% sterile grains (BRKB). Sohel et al. (2009) reported that difference in spikelet sterility varied significantly by variety and plant spacing.

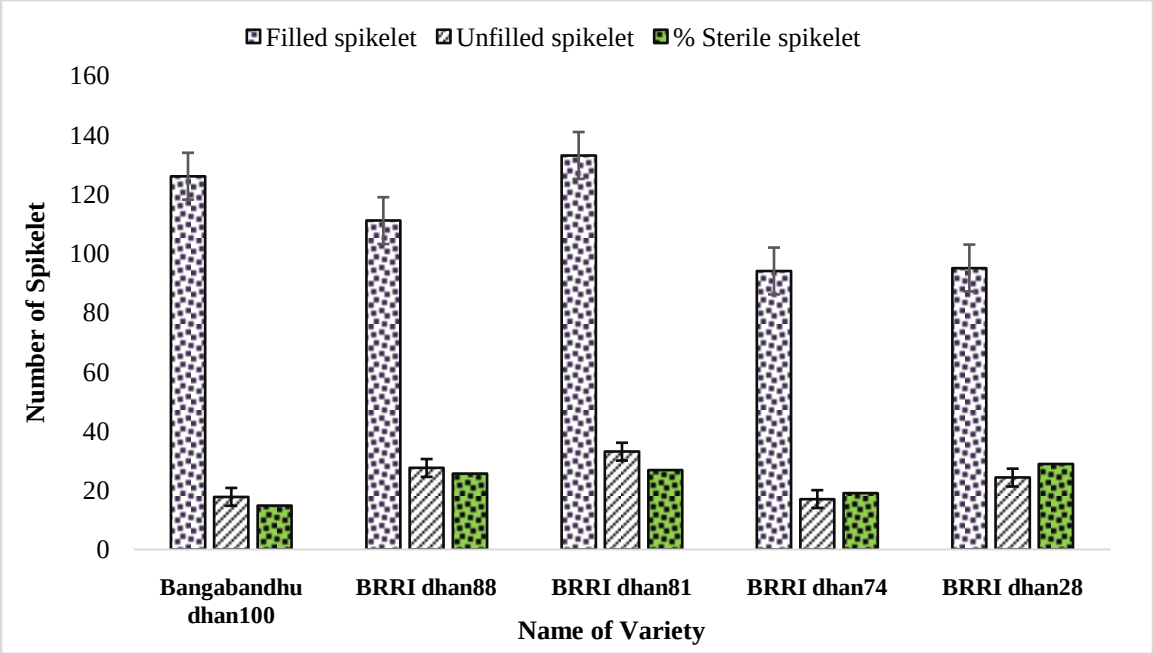

Figure 3: Spikelet numbers per panicle among tested varieties

1000-grain weight (g)

The 1000-grain weight was statistically significant among tested varieties. Table 3 showed that BRRI dhan74 (28.80g) had the highest 1000-grain weight and which was significantly different from others tested varieties. It was due to its larger grain size and weight compared to others varieties. It was also shown that the 1000-grain weight of BRRI dhan28 (22.90 g) was statistically similar with BRRI dhan88 (22.225 g) and 1000-grain weight of BRRI dhan81 (21.975 g) compared to BRRI dhan88 was also statistically significant. Lowest 1000 grain weight was observed in Bangabandhu dhan100 (17.85 g) which was significantly different from others tested varieties due to its slender grain size and shape. So, it can be concluded that 1000 grain weight is depend on variety and environmental factor. Larger and bold grain size increased the weight of rice grain, short and slender grain size decreased the weight of grain. Similar results were also reported by Murshida et al. (2017) and Hossain et al. (2017) in which they stated that larger grain size increased the weight of rice grain.

Table 3: Morpho-physiological characteristic of boro rice varieties

Variety name	Panicle length(cm)	1000 grain weight (g)	Yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index %
Bangabandhu dhan100	25.10 a	17.850 d	6.3300 bc	7.005 ab	13.3350 b	47.3414 b
BRRI dhan74	25.30 a	28.800 a	8.2125 a	6.7375 bc	14.95 a	54.84511 a
BRRI dhan 88	22.25 b	22.225 bc	6.8900 b	7.085 a	13.975 ab	48.90234 b
BRRI dhan81	24.20 a	21.975 c	6.2875 bc	6.5850 c	12.8725 b	48.46541 b
BRRI dhan28(ck)	25.30 a	22.900 b	5.3050 c	6.0350 d	11.34 c	46.48234 b
Levels of Sig.	***	***	**	***	**	**
LSD	1.133541	0.9030691	1.207256	0.3222078	1.426542	4.222771
CV	3.011681	2.576527	11.86374	3.126349	6.964781	5.570098

*. **, *** indicate significant at 5%,1% and 0.1% level of probability, respectively. Values followed by the different letter(s) are significantly different from each other.

Yield (t ha^{-1})

Grain yield differ from variety to variety due to genetic traits such as the number of effective tiller per hill, panicle length, filled grains per panicle and 1000 grain weight etc. Result showed (Table 3) that highest grain yield was recorded in BRRI dhan74 (8.2125 t ha^{-1}) which was statistically differ from other tested varieties. It was due to its coarse grain size, higher 1000 grain weight, larger panicle length and higher effective tiller number. It was observed from result that BRRI dhan28 (5.3050 t ha^{-1}) showed lowest yield which was statistically similar to BRRI dhan81 (6.2875 t ha^{-1}) and Bangabandhu dhan100 (6.33 t ha^{-1}) but numerically different. The present results on grain yield were also supported by the findings of Murshida et al. (2017) and Hossain et al. (2017) in which they stated that the genotype which ceased tiller emergence at an early stage, increased the partition of newly gained assimilates to the existing tillers, contributing towards higher yields. Kiani and Nematzadeh (2012) observed that filled grains per panicle correlated significantly with grain yield.

Straw yield (t ha^{-1})

Straw yield showed significant variation in different varieties. From the five rice varieties, highest straw yield was observed in BRRI dhan88 (7.085 t ha^{-1}) which was statistically similar with Bangabandhu dhan100 (7.005 t ha^{-1}) but numerically different (Table 3). Lowest straw yield was observed in BRRI dhan28 (6.035 t ha^{-1}). The straw yield was significantly affected by the plant height, total and effective tiller number of respective rice variety.

Biological yield (t ha^{-1})

Different varieties of boro rice showed statistically significant variation of biological yield. The result showed that highest number of biological yield was observed in BRRI dhan74 (14.95 t ha^{-1}) which was statistically similar with BRRI dhan88 (13.975 t ha^{-1}). Other-hand Bangabandhu dhan100 (13.3350 t ha^{-1}), BRRI dhan81 (12.8725 t ha^{-1}) and also BRRI dhan88 (13.975 t ha^{-1}) showed statistically similar result but numerically different. Lowest biological yield was observed in BRRI dhan28 (11.34 t ha^{-1}).

Harvest Index (HI) percent

Harvest index (%) considerably differ from variety to varieties. Result (Table 3) showed that BRRI dhan74 (54.84511) produced highest harvest index. BRRI dhan88 (48.90234) showed second highest harvest index and which was statistically similar with rest of tested varieties but numerically lowest harvest index (%) was found in BRRI dhan28 (46.48234).

CONCLUSION

According to the findings, BRRI dhan74 had a somewhat better yield potential. The yield potential of BRRI dhan88, Bangabandhu dhan100, and BRRI dhan81 was fairly moderate. BRRI dhan28 has a respectably low yield potential, yet it's still good. Farmers that prefer bold, coarse grains with good yields can grow BRRI dhan74. However, farmers that prefer slender and premium quality rice can grow BRRI dhan88, Bangabandhu dhan100, BRRI dhan81, and BRRI dhan28, respectively. Because to its short lifespan, high grain quality, and yield performance, BRRI dhan28 is the most popular variety, yet 27 years have elapsed since it was first published (BRRI dhan28 was released at 1994). Hence, BRRI dhan74, BRRI dhan88, Bangabandhu dhan100, and BRRI dhan81 can all be cultivated in-stead of BRRI dhan28.

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