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Effect of variety and spacing of transplanting on the yield and yield components of *boro* rice

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ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from December 2008 to May 2009 to study the effect of variety and spacing of transplanting on the yield and yield components of *Boro* rice. The experiment consisted of two variety namely, BRRI dhan28 and BRRI dhan29 and four spacings viz. 25 cm × 10 cm, 25 cm × 15 cm, 25 cm × 20 cm and 25 cm × 25 cm. The experiment was laid out in a randomized complete block design with three replications. Higher grain yield (5.03 t ha^{-1}) was obtained from BRRI dhan29 than from BRRI dhan28 (4.30 t ha^{-1}). Spacing of transplanting at 25 cm × 15 cm gave the highest grain yield (5.39 t ha^{-1}) and the lowest grain yield (4.18 t ha^{-1}) was found in 25 cm × 10 cm spacing of transplanting. The highest grain yield (5.95 t ha^{-1}) was found in BRRI dhan29 coupled with 25 cm × 15 cm spacing of transplanting and the lowest grain yield (3.15 t ha^{-1}) was found in BRRI dhan28 coupled with 25 cm × 10 cm spacing of transplanting. Performance of BRRI dhan29 was better than that of BRRI dhan28 in the *Boro* season. Among the different spacings of transplanting, 25 cm × 15 cm gave better performance. Transplanting with 25 cm × 15 cm spacing appeared as the promising practice in *Boro* rice cultivation in terms of yield.

Introduction

Bangladesh is mainly agro-based country. Agriculture plays an important role here in the national economy contributing 20.60% of her Gross Domestic Product (GDP) (ER, 2009). The area and production of rice in Bangladesh were about 10.37 million hectares and 25.13 million tons, respectively with an average yield of only 2.43 t ha^{-1} (BBS, 2006). The growth, yield and yield components of rice are greatly influenced by plant spacing. Optimum plant spacing ensures the plants to grow properly both in their aerial and underground parts through efficient utilization of solar radiation and nutrients (Miah et al., 1990).

It is mainly due to lack of potential varieties and management practices. Among different management practices, optimum rate and judicious application method of fertilizer are considered to be the major determinants for maximizing the yield of transplant Aman rice. Variety is one of the most important factors to be considered for getting increased rice production. Use of high yielding varieties and hybrid varieties in Bangladesh has been increased remarkably in recent years. As a result, the country has almost reached a level of self-sufficiency in rice grain. Selection of potential variety and application of optimum amount of nutrient elements can play an important role in increasing yield and national income. Nitrogen is one of the essential plant nutrients which can augment the production of rice to a great extent. Application of urea-N plays a vital role in vegetative growth, development of yield components and yield of rice (BRRI, 1990). The importance of the role of nitrogenous fertilizer in increasing rice yields has been widely recognized, particularly after the development of modern varieties. But N-use efficiency is very low and the recovery of N in wetland rice seldom exceeds 40% (De Datta & Buresh, 1989). Farmers of Bangladesh generally apply nitrogenous fertilizers in several split applications and the efficiency of applied nitrogen uptake by the rice plant ranges between 25 and 35% (Singh & Yadav, 1985). The savings in applied N reached 70 and 35 kg ha volatilization, denitrification, and other process; consequently N fertilizer use efficiency decreases. Besides these deficiency of nitrogen also hampers the growth and yield of rice. Modifying urea material is an important aspect of nitrogen management in rice from the viewpoints of its efficient utilization. To maximize the losses of N, the slower release nitrogenous fertilizer has been advocated with deep placement. Deep placement of USG effectively increases N use efficiency (31.7%) compared to conventionally applied prilled urea (Jaiswal and Singh, 2001).

In view of above discussion, the present study was undertaken with the following objectives- to evaluate the performance of two *Boro* rice varieties, to find out the optimum spacing of transplanting in order to obtain higher yield, and also to find out the effect of interaction among these factors, if any, on yield and yield components of *Boro* rice.

Materials and methods

Experimental site

The experiment was conducted at the Agronomy Field laboratory, Bangladesh Agricultural University, Mymensingh, during the period from January to May 2009.

Experimental design

The experiment consisted of the following treatments- i) two varieties namely, BRRI dhan28 and BRRI dhan29, ii) four spacings of transplanting viz. 25cm × 10 cm, 25 cm × 15 cm, 25 cm × 20 cm, 25 cm × 25 cm. Randomized complete block design was followed in this experiment with three replications. Each of the replication represented a block in the experiment. Each block was divided into 24 unit plots where 24 treatment combinations were allocated at random. There were 72 unit plots in the experiment. The size of unit plot was 4.0 m × 2.5 m. The distances between blocks and plots were 1 m and 50 cm, respectively.

Variety and cultivation procedure

Two rice varieties (BRRI dhan28 and BRRI dhan29) were used as plant material in the experiment. In the experiment, chemical fertilizers i.e. triple superphosphate (76 kg ha^{-1}), muriate of potash (60 kg ha^{-1}), gypsum (50 kg ha^{-1}) and zinc sulphate (10 kg ha^{-1}) were applied at the time of final land preparation. Urea Super Granules (175 kg ha^{-1}) was applied in the middle of 4 hills of two adjacent rows at a time at 15 Days after Transplanting (DAT).

Data collection and analysis

Data on individual plant parameters were recorded from five randomly selected hills of each plot and those on seed moisture percentage, grain yield, straw yield, biological yield and harvest index were recorded from the whole plot at harvest. All the collected data were analyzed following the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez & Gomez, 1984) using a computer operated programme namely MSTAT.

Results and discussion

Effect of variety

Effect of variety on yield and yield contributing components of rice have been presented in Table 1. BR11 produced the tallest plant (139.20 cm) while the shortest plant (109.8 cm) was obtained from Pajam and the height of BRRI dhan40 was 131.00 cm. These results were consistent to those of Om et al. (1998), Khisha (2002) and Rahman (2003). The highest number of total tillers per hill was observed in BR11 (16.60) and the lowest one (10.30) was counted in Pajam. Results indicated that the highest number of effective tillers per hill was produced by BR11 (12.4) and the lowest one (7.4) was produced by Pajam. The probable reason of the differences in producing the effective tillers per hill is the genetic make-up of the variety which is primarily influenced by heredity. This finding corroborates with those reported by BINA (1998), Om et al. (1998) and Bhowmick and Nayak (2000). The result showed that BR11 produced the longest panicle length (25.61 cm). Pajam produced the shortest panicle length (23.38 cm). The highest number of grains $panicle^{-1}$ (135.1) was found from BR11. These result are consistent with Srivastava and Thipathi (1998), Bhowmick and Nayak (2000), Singh and Gangwer (1989). Values for 1000-grain weight ranged from 26.16 g to 20.27 g. It can be seen that BR11 produced the highest (26.16 g) 1000-grain weight. The lowest (20.27 g) value was obtained from Pajam. These results are in agreement with Samsuddin et al. (1988) and Chowdhury et al. (1993) who reported variation in 1000-grain weight among the varieties. BR11 gave the highest grain yield (5.13 tha^{-1}). Grain yield from BRRI dhan40 was recorded as 4.52 tha^{-1}. Pajam produced the lowest grain yield (3.54 tha^{-1}). Varietal differences regarding grain yield was also reported by Patel (2000) and Khisha (2002). This might be due to the genetical causes of the varieties. The highest straw yield (5.90 tha^{-1}) was produced by BR11 while the lowest straw yield (3.99 tha^{-1}) was recorded from Pajam. Khisha (2002) observed that the plant height was significantly influenced by variety.

Effect of variety on yield and yield contributing characters of *Boro* rice (cv. BRRIdhan28 and BRRI dhan29) have been presented in Table 1. The plants of BRRI dhan29 were taller than BRRI dhan28. It was observed that BRRI dhan29 produced the tallest plant (88.86 cm) at maturity than BRRIdhan28 (83.16 cm). Variety show significant variation on total number of tillers $hill^{-1}$. From the experimental results it was found that BRRI dhan29 produced higher number of tillers $hill^{-1}$(15.08) than BRRI dhan28 (14.22). The results indicated that BRRI dhan29 produced higher number of effective tillers $hill^{-1}$(11.49) than BRRI dhan28.Number of non-effective tillers $hill^{-1}$ was significantly influenced by variety. Variety BRRI dhan29 produced higher number of non-effective tillers $hill^{-1}$ (3.59) than variety BRRI dhan28**.**The results showed that BRRI dhan29 produced longer panicle (23.98 cm) than BRRI dhan28**.**Variety had significant effect on the number of grains $panicle^{-1}$. The results indicated that variety BRRI dhan29 produced higher number of grains $panicle^{-1}$ (140.63) than BRRI dhan28 (123.36)**.** Sterile spikelets $panicle^{-1}$ was significantly influenced by variety. The result indicated that higher number of sterile spikelets $panicle^{-1}$ (17.19) was obtained from BRRI dhan29 than that of BRRI dhan29. It was found that variety BRRI dhan29 produced higher 1000-grain weight (22.74 g) than the variety BRRI dhan28.

Variety had highly significant effect on grain yield. The results showed that variety BRRI dhan29 produced higher grain yield (5.03 tha^{-1}) than variety BRRI dhan28 (4.30 tha^{-1}). The variety BRRI dhan29 produced higher straw yield (6.82 tha^{-1}) than variety BRRI dhan28 (5.82 tha^{-1}).Variety had statistically significant effect on biological yield. The results indicated that BRRI dhan29 produced higher biological yield (11.85 tha^{-1}) than variety BRRI dhan28 (10.12 tha^{-1}).BRRI dhan29 produced higher harvest index (42.54%) than that of BRRI dhan28.

Effect of spacing of transplanting

Various experiments on spacing of rice have been carried out in Bangladesh as well as in the other parts of the world to find out the suitable spacing for obtaining maximum yield (Mia, 1999). Improper spacing reduced yield up to 20-30% (IRRI, 1997). Plant spacing directly affects the normal physiological activities through intra-specific competition (Oad et al., 2001). Wider space allows the individual plants to produce more tillers but it provides the smaller number of hills per unit area which results in low grain yield (Baloch et al., 2002; Vijayakumar et al., 2004). Therefore, optimum plant spacing for a specific crop is needed to be explored. Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) have developed some rice cultivars viz., BINA dhan5, BINA dhan6, Irratom24 and BRRI dhan29 which are producing more yield than the existing cultivars.

Effect of spacing of transplanting on yield and yield contributing characters of *Boro* rice (cv. BRRI dhan28 and BRRI dhan29) have been presented in Table 2. The highest plant height (87.81 cm) was recorded from 25 cm × 10 cm spacing of transplanting and followed by 25 cm × 20 cm spacing and 25 cm × 15 cm spacing of transplanting. The highest total number of tillers $hill^{-1}$ (17.30) was obtained at 25 cm × 25 cm spacing of followed by 25 cm × 20 cm spacing of transplanting and the lowest total number of tillers $hill^{-1}$ (12.11) was obtained at 25 cm × 10 cm spacing of transplanting. The highest number of effective tillers $hill^{-1}$ (13.76) was obtained from 25 cm × 25 cm spacing and the lowest (8.56) was found from 25 cm ×10 cm spacing of transplanting. At 25 cm × 25 cm spacing effective tillers increased probably due to the efficient space, moisture and nutrients. Apparently, the results indicated that the highest number of non-effective tillers $hill^{-1}$ (3.56) was produced by 25 cm × 10 cm spacing of transplanting and lowest one (3.52) was produced by 25 cm × 10 cm spacing of transplanting. Panicle length was the highest at 25 cm × 20 cm spacing of transplanting and the lowest at 25 cm × 10 cm spacing of transplanting. The highest number of grains $panicle^{-1}$ (141.24) was found at 25 cm × 15 cm spacing followed by 25 cm × 20 cm, 25 cm × 25 cm spacing of transplanting and the lowest number of grains $panicle^{-1}$ (120.05) was found at 25 cm × 10 cm spacing of transplanting.

The result indicated that the highest number of sterile spikelets $panicle^{-1}$ (18.64) was found from the 25 cm × 20 cm spacing, which was statistically identical with 25 cm × 10 cm, 25 cm × 25 cm spacing of transplanting and the lowest number of sterile spikelets $panicle^{-1}$ (11.76) was found at 25 cm × 15 cm spacing of transplanting. Different spacing of transplanting had no significant effect on 1000-grain weight..The highest grain yield (5.39 tha^{-1}) was obtained from 25 cm × 15 cm spacing, followed by 25 cm × 20 cm, 25 cm × 25 cm spacing of transplanting and the lowest grain yield (4.18 t ha^{-1}) was obtained from 25 cm × 10 cm spacing of transplanting The highest straw yield (7.24 tha^{-1}) was obtained from the 25 cm × 15 cm spacing of transplanting and the lowest straw yield (5.83 tha^{-1}) was obtained from 25 cm × 25 cm spacing, which was statistically identical with 25 cm × 10 cm spacing of transplanting. A significant variation in biological yield was observed due to the spacing of transplanting. The highest biological yield (12.63 tha^{-1}) was obtained from 25 cm × 15 cm spacing of transplanting and the lowest biological yield (10.03 tha^{-1}) was produced at 25 cm × 10 cm spacing of transplanting. It was evident that the highest harvest index (43.08%) was found from 25 cm × 25 cm spacing of transplanting and the lowest harvest index (41.55 %) was recorded from 25 cm × 10 cm spacing of transplanting.

Table 1. Effect of variety on some crop characters, yield and yield components of *Boro* rice

Variety	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
V_1	83.16	14.22	10.82	3.40	21.39	123.36	13.46	22.46	4.30	5.82	10.12	42.39
V_2	88.86	15.08	11.49	3.59	23.98	140.63	17.19	22.74	5.03	6.82	11.85	42.54
S(x)	0.30	0.18	0.14	0.09	0.20	0.42	0.84	0.07	0.02	0.03	0.03	0.16
Level of sign.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

V_1 = BRRI dhan28, V_2 = BRRIdhan29;

Table 2. Effect of spacing transplanting on some crop characters, yield and yield components of *Boro* rice

Spacing of transplanting (cm)	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non effective tillers hill^{-1}	Panicle length (cm)	No of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
S_1=25cm x 10cm	87.81a	12.11d	8.56d	3.56	22.06	120.05c	15.52a	22.48	4.18d	5.85c	10.03d	41.55c
S_2=25cm x 15cm	84.76c	13.72c	10.40c	3.32	22.71	141.24a	11.76b	22.60	5.39a	7.24a	12.63a	42.84ab
S_3=25cm x 20cm	86.33b	15.48b	11.92b	3.56	23.11	132.78b	18.64a	22.56	4.67b	6.36b	11.03b	42.39b
S_4=25cm x 25cm	85.15bc	17.30a	13.76a	3.54	22.86	133.90b	15.37a	22.77	4.40c	5.83c	10.23c	43.08a
S(x)	0.42	0.25	0.20	0.13	0.28	0.59	1.18	0.10	0.02	0.04	0.05	0.22
Level of sign.	0.01	0.01	0.01	NS	NS	0.01	0.01	NS	0.01	0.01	0.01	0.01

In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

Table 3. Interaction effect variety and spacing of transplanting on some crop characters, yield and yield components of *Boro* rice

Interaction (Variety × Spacing of transplanting)	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non effective tillers hill^{-1}	Panicle length (cm)	No of grains panicle^{-1}	No.of sterile spikelets panicle^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
$V_1 \times S_1$	85.46	11.24d	7.98d	3.27ab	20.91	112.15g	13.25	22.31	3.68h	5.35	9.03f	40.70d
$V_1 \times S_2$	81.51	12.29c	9.29c	3.00b	21.57	134.68d	9.66	22.38	5.15b	6.74	11.89b	43.42a
$V_1 \times S_3$	83.76	15.73b	11.93b	3.80a	21.96	123.82f	18.19	22.49	4.36f	5.86	10.22d	42.55abc
$V_1 \times S_4$	81.92	17.62a	14.09a	3.53ab	21.12	122.77f	12.72	22.66	4.00g	5.33	9.33e	42.91abc
$V_2 \times S_1$	90.17	12.98c	9.13c	3.84a	23.21	127.95e	17.80	22.65	4.68e	6.35	11.03c	42.40bc
$V_2 \times S_2$	88.01	15.16b	11.51b	3.64a	23.85	147.81a	13.86	22.81	5.64a	7.74	13.37a	42.26c
$V_2 \times S_3$	88.90	15.22b	11.91b	3.31ab	24.26	141.75c	19.10	22.63	4.99c	6.86	11.85b	42.23c
$V_2 \times S_4$	88.38	16.98a	13.42a	3.56ab	24.60	145.03b	18.01	22.87	4.80d	6.33	11.13c	43.26ab
S(x)	0.59	0.35	0.28	0.18	0.40	0.84	1.67	0.14	0.03	0.06	0.07	0.31
Level of sign.	NS	0.01	0.01	0.01	NS	0.01	NS	NS	0.01	NS	0.01	0.01

In a column, figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).

Effect of interaction of variety and spacing of transplanting

Interaction effect variety and spacing of transplanting on some crop characters, yield and yield components of *Boro* rice have been presented in Table 3. Interaction between BRRI dhan29 with 25 cm × 10 cm spacing of transplanting produced the tallest plant (90.17 cm) and the shortest plant (81.51 cm) was recorded from the interaction of BRRI dhan28 with 25 cm × 15 cm spacing of transplanting. Interaction of BRRI dhan28 with 25 cm × 25 cm spacing of transplanting produced the highest total tillers hill^{-1} (17.62) and interaction of BRRI dhan28 with 25 cm × 10 cm spacing of transplanting produced the lowest total tillers hill^{-1} (11.24). The highest number of effective tillers hill^{-1}(14.09) was found in BRRI dhan28 with 25 cm × 25 cm spacing which was statistically identical with BRRI dhan29 and 25 cm × 25 cm of spacing of transplanting and the lowest one (7.98) was with BRRI dhan28 and 25 cm ×10 cm spacing of transplanting interaction. Interaction between BRRI dhan28 and 25 cm × 20 cm spacing of transplanting produced the highest number of non-effective tillers hill^{-1} (3.80) which was statistically identical with BRRI dhan29 with 25 cm × 10 cm and BRRI dhan29 with 25 cm × 15 cm spacing of transplanting and the lowest one (3.00) was found from the interaction of variety BRRI dhan28 and 25 cm × 15 cm spacing of transplanting. Apparently, the highest length of panicle (24.60 cm) was observed from the combination of BRRI dhan29 with 25 cm × 25 cm spacing and the lowest (20.91 cm) was observed in BRRI dhan28 with 25 cm × 10 cm spacing of transplanting. Interaction between BRRI dhan29 with 25 cm × 15 cm spacing show highest (147.81) grains panicle^{-1} and lowest was found combination BRRI dhan28 with 25 cm × 10 cm spacing of transplanting. The interaction of variety and spacing of transplanting did not show any significant variation on number of sterile spikelets panicle^{-1}. The interaction of variety and spacing of transplanting did not show any significant influence on 1000-grain weight. The highest grain yield (5.64 tha^{-1}) was produced by the combination of BRRI dhan29 with 25 cm × 15 cm spacing of transplanting and the lowest grain yield (3.68 tha^{-1}) was produced by the combination of BRRI dhan28 with 25 cm × 10 cm spacing of transplanting. The interaction of variety and spacing of transplanting did not show any significant variation on straw yield. The highest biological yield (13.37 tha^{-1}) was produced by the combination of BRRI dhan29 with 25 cm × 15 cm spacing of transplanting and the lowest biological yield (9.03 tha^{-1}) was produced by the combination of BRRI dhan28 with 25 cm × 10 cm spacing of transplanting. The highest harvest index (43.42%) was found from the interaction between BRRI dhan28 with 25 cm × 15 cm spacing and the lowest harvest index (40.70%) was found from BRRI dhan28 with 25 cm × 10 cm spacing of transplanting.

Conclusion

It can be concluded that the performance of BRRI dhan29 was better than that of BRRI dhan28 in the *Boro* season. Among the different spacings of transplanting, 25 cm × 15 cm gave better performance. Transplanting with 25 cm × 15 cm spacing appeared as the promising practice in *Boro* rice cultivation in terms of yield.

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