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Effect of different transplanting dates on the yield and yield components of Binadhan-14 (*Oryza sativa* L.) under climatic conditions in Bangladesh

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ABSTRACT

Binadhan-14 (*Oryza sativa* L.) is a late transplanting rice variety with high yield potential, developed for *boro* season by BINA in 2013. Effects of different transplanting dates to yield of Binadhan-14 were assessed at three locations in Bangladesh during *boro* season in 2014-15. BRRI dhan 28 was used as a check variety. At each location, one month old seedlings were transplanted at five different dates with 15-day intervals between February 1 and April 1, 2015. A randomized complete block design with three replications was used to lay out plots in the experiment. Transplanting dates significantly influenced grain yield and yield contributing parameters, such as plant height, panicles per hill, panicle length and filled grains per panicle, except for 1000-grain weight. The highest grain yields were obtained when the rice was transplanted on February 1 and 15, 2015. The highest yield of Binadhan-14 was obtained at Rangpur (6.75 t/ha), followed by Mymensingh (6.25 t/ha) and Magura (5.90 t/ha). Results of this study suggest that February 1 to 15 would be the best time to transplant Binadhan-14 as a late transplanting *boro* variety under the climatic conditions in Bangladesh.

Key words : Date of transplanting, grain yield, late *boro* season, mutant, rice, variety

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important food crops in the world and a staple food for most Asian populations (Mizana *et al.*, 2015). It is the most important cereal crop in Bangladesh, with an estimated 34.8 million metric tonnes produced in this country in 2014 (FAO, 2014). It contains carbohydrates, fat, protein and reasonable amounts of vitamins (Nadeem *et al.*, 2010; Nam and Kim, 2015).

Bangladesh harvests three rice crops a year; *Boro* (planted in December/January and harvested in April/May), *Aus* (planted in March/April and harvested in June/July) and *Aman* (planted in July/August and harvested in November/December). Transplanting time is a vital factor that can significantly affect rice yield. Transplanting dates affect vegetative growth of rice and subsequently influence its yield (Denish *et al.*, 1997). Transplanting date influences other plant parameters such as plant height, effective tillers per hill, panicle length, grains per panicle, and grain and straw yields. Therefore, date of transplanting must be optimized to get higher crop yields (Khalid *et al.*, 2009).

Bangladesh Institute of Nuclear Agriculture (BINA) is a government research institute that has adopted nuclear techniques for the development of new crop varieties and is also responsible for technology dissemination. BINA has already released 82 improved varieties of different crops including 16 rice varieties (BINA, 2015). Binadhan-14, one of the rice varieties developed by using nuclear techniques; carbon ion irradiation applied on local land races Asfol from Japan, was released in 2013. It is late-transplanting

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mutant *boro* rice with high yield potential. It has short, erect leaves with early maturing and lodging-resistant characteristics. It requires 120-130 days (seed to seed) to mature. Its average grain yield was 6.85 t/ha when it was transplanted during the second week of February to the second week of March (BINA Annual Report, 2015b).

Influence of Climate on Binadhan-14

High temperature tolerance : It has been reported that rice yield begins to decline when air temperature exceeds 25°C and grain-filling stops when the temperature reaches above 36°C. However, it is known that Binadhan-14 can produce 6.5- 8.0 t/ha and more than 5.0 t/ha in transplanted aman season under such high temperature conditions (BINA Annual Report, 2015b).

Low temperature escape : In Bangladesh, temperatures start to rise in mid-January (south, east, west and mid regions) with the exception of the coolernorthern part, which sees an increase during the 1st week of February. This means seed-sowing of Binadhan-14 for raising seedlings for transplanting could be started from mid-January in the south, east, west and mid parts of the country, while sowing could be started later in northern parts. Since Binadhan-14 seedlings can be transplanted at 30-40 days old, preparing seed beds during the 1st to 2nd weeks of February would avoid low temperature-induced seedling injury.

Authors anticipate that, because of these traits, Binadhan-14 could play a vital role in food and nutritional security for the 160 million people of Bangladesh under changing climatic conditions. It could also be used internationally by rice breeders as a donor parent for future breeding programmes aimed at developing varieties with beneficial traits such as high temperature tolerance, short crop duration, high yield, high protein contents and photoperiod insensitiveness.

The objective of the study was to observe how yield performances of the variety Binadhan-14 were affected by different dates of transplanting and investigate the effect of transplanting time on yield and yield contributing characters within the context of climate change in Bangladesh.

MATERIALS AND METHODS

Binadhan-14 and the check variety BRRI dhan 28 were evaluated under five different dates of transplanting at 15-day intervals. The experiments were conducted at three locations in Bangladesh : BINA head quarter (HQ) in Mymensingh, BINA Sub-station Farm at Magura and BINA Sub-station Farm at Rangpur during *boro* season in 2014-15. Dates of transplanting were February 1 and 15, March 1 and 15 and April 1. The experiment was laid out as factorial randomized complete block design with three replications.

The unit plot size was 3 × 2 m. Two to three 30-day old seedlings were transplanted per hill with a planting spacing of 20 × 15 cm at three locations. The plots were fertilized with 105, 15, 60, 15 and 1.5 kg/ha of N, P, K, S and Zn as urea, triple super phosphate (TSP), murate of potash (MoP), gypsum and zinc oxide, respectively. All the fertilizers except urea were applied at final land preparation in full amount. Urea was applied in three splits : 30% at 7-10 days after transplanting (DAT), 30% at 20-30 DAT and the last 40% at panicle initiation stage.

Intercultural operations such as weeding, irrigation, insecticide application were done when necessary in each location. The crop was harvested at maturity which occurred at different dates.The data were analyzed using the analysis of variance technique. The mean differences were adjudged by Duncan's new multiple range test (DMRT).

RESULTS AND DISCUSSION

Effects of different transplanting times on yield of Binadhan-14 were evaluated at five different transplanting dates in three locations during *boro* season in 2015. The experiments were conducted at BINA HQ in Mymensingh, and BINA Sub-station Farms in Magura and Rangpur.

Bina Hq, Mymensingh

The highest number of effective tillers per hill (11.40), panicles per hill (9.57) and filled grains per panicle (115.83) were produced when the varieties were transplanted on February 1. The lowest number of effective tillers per hill (8.87) and panicles per hill (7.30) were obtained with the March 15 transplanting, whereas the

lowest number of filled grains per panicle (50.33) was obtained with the April 1 transplanting (Table 1). Thakur (1991) found similar results. As a point of reference using a check variety, Khalid *et al.* (2009) recorded the highest number of effective tillers per hill (12.79) and the lowest number of tillers per hill (8.82) for BRRI dhan 28 as *boro* rice. The results revealed that the February 1 transplanting gave the highest mean grain yield (6.15 t/ha), irrespective of varieties (Table 1). It was not, however, statistically different from the yield obtained with the February 15 transplanting. The mean grain yield with the April 1 transplanting was the lowest (3.40 t/ha), but it was not statistically different from yield with the March 15 transplanting. These results were confirmed by the findings of Chander and Pandey (1996) in a similar study.

The mean grain yield of Binadhan-14, irrespective of transplanting date, was 5.20 t/ha and was significantly different from that of the check variety BRRI dhan 28 (4.8 t/ha) (Table 1). In comparison, Khalid *et al.* (2009) recorded the highest BRRI dhan 28 grain yield at 4.33 t/ha. The interaction analysis results showed a Binadhan-14 grain yield of 6.25 t/ha when it was transplanted on February 1 or 15.

The highest Binadhan-14 grain yield was obtained at crop duration of 123-125 days in this study, while BINA (2015a) had reported a crop duration of 130 days and an average grain yield of 6.85 t/ha. Considering the yield and crop duration, the best transplanting time for Binadhan-14 in the Mymensingh region was February 1 to 15, which supported BINA (2015a) recommendation.

Sub-station Farm, Magura

The transplanting date had a significant effect on plant height, panicles per hill, panicle length, filled grains per panicle and grain yield at Magura. The highest numbers of effective tillers per hill (13.23), panicles per hill (11.55), filled grains per panicle (111.33) and grain yield (5.80 t/ha) were produced when the varieties were transplanted on March 1, February 15, February 1 and February 1, respectively (Table 2). Similar results were also reported by Yoshida (1981) and Ahmad *et al.* (1996). The

Table 1. Yield and yield contributing characters of rice varieties as affected by different dates of transplanting in late *boro* season, 2014-15 at Bina Hq, Mymensingh

Treatment	Plant height (cm)	No. of effective tillers/ hill	No. of panicles/ hill	Panicle length (cm)	No. of filled grains/ panicle	No. of unfilled grains/ panicle	1000-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Crop duration (days)
Dates										
Feb.01 (D_1)	93.17	11.40	9.57	21.93	115.83	20.20	22.90	6.15	7.67	126
Feb. 15 (D_2)	91.63	10.73	9.47	21.90	93.90	16.47	23.60	5.63	7.20	123
March 01 (D_3)	95.10	9.40	8.73	21.64	94.93	19.90	22.50	5.31	5.69	117
March 15 (D_4)	96.03	8.87	7.30	22.68	83.23	35.76	22.50	4.52	6.10	113
April 01 (D_5)	95.43	10.37	9.03	21.83	50.33	56.33	18.74	3.40	5.77	108
LSD (P=0.05)	1.58	0.73	0.41	0.46	2.23	1.75	0.87	0.12	0.14	-
Varieties										
Binadhan-14 (V_1)	89.88	10.32	8.78	21.39	88.92	33.80	22.27	5.20	5.78	116
BRRI dhan 28 (V_2)	98.67	9.98	8.85	22.60	86.37	25.67	21.74	4.80	7.19	119
T values	**	NS	NS	**	**	**	NS	**	**	-
Dates x Varieties										
D_1V_1	88.07	11.46	8.93	21.47	118.67	23.53	23.10	6.25	6.71	125
D_1V_2	98.27	11.33	10.20	22.40	113.00	16.87	22.71	6.05	8.63	127
D_2V_1	88.00	11.20	8.27	21.26	95.80	15.20	23.75	6.25	5.97	123
D_2V_2	95.27	10.26	10.67	22.53	92.00	17.73	23.46	5.01	8.45	123
D_3V_1	91.27	11.13	10.00	21.02	95.60	20.53	22.99	5.37	5.86	117
D_3V_2	98.93	7.67	7.47	22.26	94.27	19.27	22.01	5.25	5.52	117
D_4V_1	91.33	8.20	7.20	22.13	90.20	39.73	22.82	4.75	5.30	111
D_4V_2	100.73	9.53	7.40	23.23	76.27	31.80	21.78	4.30	6.90	111
D_5V_1	90.73	10.53	9.53	21.06	55.00	70.00	18.71	3.30	6.47	106
D_5V_2	100.13	10.20	8.53	22.60	45.67	42.67	18.77	3.30	6.47	106
LSD (P=0.05)	NS	1.03	**	NS	3.16	2.47	NS	0.16	0.19	-
C. V. (%)	1.31	5.56	3.63	1.63	1.98	4.56	3.07	1.80	1.67	-

**Significant at P=0.01 level. NS : Not Significant.

Table 2. Yield and yield contributing characters of rice varieties as affected by different dates of transplanting in late *boro* season, 2014-15 at BINA Sub-station Farm of Magura

Treatment	Plant height (cm)	No. of effective tillers/ hill	No. of panicles/ hill	Panicle length (cm)	No. of filled grains/ panicle	No. of unfilled grains/ panicle	1000-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Crop duration (days)
Dates										
Feb. 01 (D_1)	93.75	12.33	10.78	22.37	111.33	11.40	22.73	5.80	6.15	131
Feb. 15 (D_2)	92.33	12.83	11.55	22.64	106.63	10.63	23.25	5.54	6.08	119
March 01 (D_3)	101.47	13.23	11.51	20.76	93.48	30.20	21.69	4.40	7.13	125
March 15 (D_4)	96.60	12.80	9.63	21.80	83.75	14.98	21.93	4.37	5.93	123
April 01 (D_5)	79.03	12.70	11.13	22.30	59.07	56.10	18.60	2.20	8.48	124
LSD (P=0.05)	1.89	NS	0.49	0.72	2.81	0.47	0.09	0.17	4.56	-
Varieties										
Binadhan-14 (V_1)	86.27	12.05	10.09	20.72	88.20	21.36	21.70	4.39	6.48	122
BRRI dhan 28 (V_2)	98.98	13.50	11.75	23.27	93.50	27.97	21.57	4.53	7.03	126
T values	**	**	**	**	**	**	**	**	**	-
Dates x Varieties										
D_1V_1	89.50	11.87	10.40	20.87	112.33	13.80	22.34	5.90	6.15	129
D_1V_2	98.00	12.80	11.17	23.87	110.33	9.00	23.12	5.17	6.17	132
D_2V_1	86.87	12.03	10.43	21.75	112.33	10.73	23.05	5.85	5.93	115
D_2V_2	97.60	13.63	12.67	23.53	112.33	10.53	23.45	5.23	6.23	122
D_3V_1	88.80	12.47	10.70	19.33	97.50	22.40	22.28	4.40	6.543	123
D_3V_2	114.13	14.00	12.33	22.20	79.47	38.00	21.10	4.40	7.83	127
D_4V_1	91.00	12.10	8.33	21.13	96.53	12.67	21.92	4.60	5.70	121
D_4V_2	102.20	13.50	10.93	22.46	70.97	17.30	21.95	4.15	6.17	124
D_5V_1	75.07	11.80	10.60	20.53	66.40	47.20	18.94	2.56	8.20	122
D_5V_2	83.00	13.60	11.67	24.07	51.73	65.00	18.27	1.85	7.76	125
LSD (P=0.05)	2.68	NS	0.69	1.02	3.97	0.66	0.14	0.24	6.44	-
C. V. (%)	1.59	3.68	3.48	2.55	8.55	1.68	1.70	1.97	3.90	-

**Significant at P=0.01 level. NS : Not Significant.

results in this experiment revealed that the mean grain yield of Binadhan-14 was the highest with the February 1 transplanting (5.80 t/ha) and the February 15 transplanting (5.54 t/ha) with no statistically significant difference between them (Table 2). The mean grain yield of the check variety BRRI dhan 28, irrespective of transplanting dates, was 4.53 t/ha and was significantly different from that of the Binadhan-14 (4.39 t/ha). Ghosh *et al.*(1991) reported similar findings in their study.

The interaction analysis results showed that the maximum grain yield of the Binadhan-14 was obtained when transplanted on February 1 (5.90 t/ha) and when transplanted on February 15 (5.85 t/ha) with no statistical difference between them (Table 2). In comparison, the maximum yield of the check variety BRRI dhan 28 was produced when transplanted on February 15 (5.23 t/ha) and when transplanted on February 1 (5.17 t/ha) with no statistical difference between them. Crop duration of Binadhan-14 was 129 days (transplanted on February 1) and 115 days (transplanted on February 15)at Magura. Crop duration of Binadhan-14 with the February 1 transplanting was recorded as being longer than that associated with the February 15 transplanting. However, the difference in yields between the two dates (0.05 t/ha) was minimal with no statistically significant difference. Thus, the suitable transplanting date of Binadhan-14 was determined to be February 1 to 15, and the best date of transplanting was February 15 for a shorter crop duration in the Magura region.

Sub-station Farm, Rangpur

The transplanting date had a significant effect on plant height, panicles per hill, panicle length, filled grains per panicle and grain yield at Rangpur. The highest number of effective tillers per hill(13.07), panicles per hill (16.63), filled grains per panicle (89.65) and grain yield (6.65 t/ha) were recorded when the varieties were transplanted on March 1, March 15, March 1 and February 1, respectively (Table 3). Khalid *et al.* (2009) presented that the highest grain yield (5.08 t/ha) was obtained when *boro* rice was transplanted on January 20. The results in this study revealed that the

Table 3. Yield and yield contributing characters of rice varieties as affected by different dates of transplanting in late *boro* season, 2014-15 at BINA Sub-station Farm of Rangpur

Treatment	Plant height (cm)	No. of effective tillers/hill	No. of panicles hill	Panicle length (cm)	No. of filled grains/ panicle	No. of unfilled grains/ panicle	1000-seed weight (g)
Dates							
Feb. 01 (D_1)	97.97	12.77	11.75	21.10	88.80	23.57	22.85
Feb. 15 (D_2)	105.60	11.27	10.90	21.77	88.23	8.93	23.40
March 01 (D_3)	102.18	13.07	12.63	20.53	89.65	42.31	22.23
March 15 (D_4)	104.83	11.60	16.63	21.27	73.57	46.83	22.08
April 01 (D_5)	104.80	12.20	11.40	21.63	50.25	80.51	18.59
LSD (P=0.05)	2.45	0.95	0.93	NS	5.14	6.33	0.64
Varieties							
Binadhan-14 (V_1)	94.45	12.85	12.11	20.14	87.31	38.46	21.58
BRRI dhan 28 (V_2)	111.70	13.90	13.21	22.38	84.88	42.40	22.08
T values	**	**	**	**	**	**	**
Dates x Varieties							
D_1V_1	90.60	12.60	11.57	19.53	97.60	22.27	22.37
D_1V_2	105.33	12.93	11.93	22.67	87.00	24.87	23.33
D_2V_1	95.47	11.13	10.67	20.60	92.27	8.33	23.42
D_2V_2	115.73	11.40	11.13	22.93	84.20	9.53	23.38
D_3V_1	91.00	11.53	11.13	19.40	89.97	32.77	22.12
D_3V_2	113.37	11.60	14.13	21.67	89.33	51.87	22.35
D_4V_1	97.67	11.20	16.00	20.63	76.87	40.33	21.69
D_4V_2	112.00	10.00	17.27	21.90	70.27	53.33	22.48
D_5V_1	97.53	10.80	11.20	20.53	57.73	88.63	18.30
D_5V_2	112.07	10.60	11.60	22.73	42.77	72.40	18.89
LSD (P=0.05)	3.40	1.35	1.32	NS	7.26	8.95	NS
C. V. (%)	1.30	3.90	4.03	2.35	3.60	8.55	1.60

**Significant at P=0.01 level. NS : Not Significant.

highest grain yield was produced when transplanted on February 1 (6.65 t/ha) and February 15 (6.58 t/ha) with no statistical difference between them (Table 3). The mean grain yield of the Binadhan-14, irrespective of transplanting dates, was 5.89 t/ha and was significantly different from that of the check variety BRRI dhan 28 (5.53 t/ha) (Table 3). Nadeem *et al.* (2010) also reported similar results.

The interaction analysis results showed that the maximum grain yield of Binadhan-14 was produced when transplanted on February 1 (6.75 t/ha) and when transplanted on February 15 (6.63 t/ha) with no statistical difference between them. In comparison, the check variety BRRI dhan 28 produced 6.55 t/ha when transplanted on February 1 and 6.53 t/ha when transplanted on February 15. There was no statistical difference between the varieties with these transplanting dates. Interaction between the date of transplanting and the variety significantly influenced the yield contributing parameters except 1000-grain weight. Compared with the other two locations interaction results, Binadhan-14 showed a higher yield at Rangpur. Considering crop duration, it was determined that the most suitable transplanting date for Binadhan-14 would be February 1 to 15 for the Rangpur region.

CONCLUSION

The overall results of the experiments led to the conclusion that there was a significant effect of transplanting dates on the yield and yield contributing characters of the *boro* rice varieties studied. The highest grain yield was produced when Binadhan-14 was transplanted on February 1 at Mymensingh (6.15 t/ha), Magura (5.80 t/ha) and Rangpur (6.65 t/ha). The interaction between different transplanting dates and varieties was significant. The maximum grain yield of Binadhan-14 was obtained when the crop was transplanted on February 1 or 15 at all three sites in Mymensingh (6.25 t/ha), Magura (5.90 t/ha) and Rangpur (6.75 t/ha).

Therefore, it can be concluded, based on the results from this study, that Binadhan-14 should be transplanted on February 1 to 15

to obtain a higher grain yield. However, further studies considering different agro-ecological zones (AEZ) and fertilizer doses in conjunction with transplanting dates of Binadhan-14 are necessary.

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