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Evaluating the potentials of boro and aus rice varieties as a substitute to the short duration rice varieties in aman season

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ABSTRACT

Timely sowing/planting of Rabi crops in the T. Aman rice – Rabi crop – Boro rice pattern is very important. Short duration rice varieties are cultivated in Aman season to facilitate timely sowing of Rabi crops. Most of the short duration Aman rice varieties are sensitive to early transplanting and thus, early vacating of land for subsequent Rabi crops planting does not happen. This experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University to investigate the yield performance of some Boro rice varieties in response to date of transplanting in Aman season. Five rice varieties viz. BRRI dhan28, BRRI dhan48, BRRI dhan55, BRRI dhan58 and Binadhan-7 were transplanted on four dates *viz*. 21 June, 11 July, 1 August and 22 August 2016 in a split-plot design with three replications. The variety and date of transplanting had significant interaction effects on grain yield and most of the crop characters of rice. BRRI dhan58 produced the highest grain yield (5.45 t ha^{-1}), straw yield (6.17 t ha^{-1}), and biological yield (11.62 t ha^{-1}) within the lowest field duration (96 days) among the different varieties transplanted at different dates. Short duration Aman rice variety Binadhan-7 gave the highest grain yield of 5.10 t ha^{-1} when planted on 1 August and required field duration of 109 days while BRRI dhan48 gave the highest grain yield of 5.10 t ha^{-1} and required 107 days when transplanted on 22 August. The present study concludes that BRRI dhan58 could be used as a short duration rice variety for obtaining high yield in early Aman season and for vacating the land for facilitating early sowing of Rabi crops.

Keywords: Date of transplanting, crop phenology, field duration, early Aman rice, Rabi crops

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1 Introduction

Rice is grown in three distinct rice growing seasons namely Aus, Aman and Boro. Among these seasons, Aman rice covers an area of 5.68 million hectares with a production of 13.99 million tons (AIS, 2019). Transplant Aman rice – Fallow – Transplant Boro rice rice is the major cropping pattern in Bangladesh. Very recently, initiative has been taken to increase the cropping intensity and diversity by introducing a Rabi crop in between the two rice crops of the present cropping pattern. Many Rabi crops such as mustard, potato, lentil, cabbage, tomato etc. can be cultivated after the Aman rice and before the cultivation of Boro rice in the same field. The sowing time of these Rabi crops are very crucial and any delay of their sowing would result in severe yield penalty. Moreover, delayed planting of Rabi crops will also delay the sowing or transplanting of Boro rice. Thus, the success

of the newly introduced three crop based cropping pattern depends on the timely planting of the Rabi crop and this can be ensured by cultivation of a short duration rice variety in Aman season for vacating the land for Rabi crops. The introduction of this new Transplant Aman rice – Rabi crop – Transplant Boro rice pattern would help in increasing the farm productivity to meet up the increasing food demand of the rising population. As a result, many high yielding short duration rice varieties have recently been developed for Aman season.

High land covers about 40% of the total land area of Bangladesh and it covers about 18% of the total cropped area. In partially irrigated high land ecosystem, Transplant Aman rice – Rabi crop – Transplant Boro rice pattern would be a dominant cropping pattern (Elahi et al., 2001; Khan et al., 2004). Thus, cultivation of a short duration T. Aman rice would help in timely sowing of the subsequent Rabi crop (Khan et al., 2006). It would create an opportunity to facilitate legume cultivation to increase the productivity and improving sustainability of T. Aman rice – Pulse –Boro rice cropping pattern (Quayum et al., 2012). A number of short duration rice varieties have been developed and released for cultivation in Aman season. Mahmud et al. (2017) reported that Binadhan-7 gave the highest yield in Mymensingh condition among the different short duration varieties used such as BRRI dhan33, BRRI dhan39, BRRI dhan49, BRRI dhan56, BRRI dhan57, BRRI hybrid dhan4 and Binadhan-7. They also found that all the varieties required around 100 days from transplanting to maturity while that for BRRI dhan49 required more than 120 days. These rice varieties are very sensitive to early planting and there is a risk of yield penalty if very early planting is done. On the other hand, many Boro rice varieties such as BRRI dhan28, BRRI dhan58 etc. and Aus rice varieties such as BRRI dhan48 are available which are high yielding, photo insensitive and drought tolerant. These photo-insensitive varieties can be cultivated early in the season as an alternative to these high yielding short duration Aman rice varieties for early clearing the land for the subsequent Rabi crop planting.

Planting date is a very crucial factor in yield formation. Transplanting dates provide differential growth conditions for the crop and therefore, contribute a lot on the yield response of a variety. Different authors reported the benefits of choosing optimum planting dates in rice and in most of the cases, neither too early nor too late transplanting proved to give better yield by offering prolonged or shorter growth period (Safdar et al., 2008). Yield of a cultivar is directly related to environment in which it is grown. The highest yield can be obtained for planting at optimum time while both early and late planting would cause yield penalty (Akhtar et al., 2011). The main objective of the present study is to find alternative rice varieties having high yield and can be harvested early to get the land free for early sowing of Rabi crops. Therefore, the performance of some Boro and Aus rice varieties could be tested with an aim to find out some rice varieties which can be used as an alternative to the existing short duration Aman rice varieties for growing in Aman season as substitute to short duration rice varieties. Cultivation of these Aus and Boro rice varieties in Aman season would create an opportunity for producing Rabi crops for increasing the system productivity of Transplant Aman rice – Rabi crop – Transplant Boro rice pattern. Therefore, the present study has been undertaken with a view (i) to examining the yield performance of some high yield Aus and Boro rice varieties in Aman season (ii) to assessing their suitability as an alternative to short duration Aman rice varieites and (iii) to determining their optimum date of transplanting in Aman season.

2 Materials and Methods

2.1 Experimental site and soil

An experiment was conducted during Aman season (June - December) of 2016 at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. Geographically the experimental site is located at 24°43′8.3″N, 90°25′41.2″E at an elevation of 18 m from the sea level.. The experimental area was a fairly leveled well drained medium high land belonging to the Sonatola series of non–calcareous dark grey floodplain soil under the Old Brahmaputra Floodplain agro-ecological zone (UNDP and FAO, 1988). The experimental soil was silt loam having bulk density of 1.35 g cc^{-1} and pH 5.70. The soil contained 0.09% total nitrogen, 1.02% organic matter, 5.68 ppm available phosphorus, and 49.12 ppm exchangeable potassium and 8.28 ppm available sulphur.

2.2 Experimental treatments and design

The experiment comprised four dates of transplanting *viz*. 21 June, 11 July, 01 August and 22 August 2016 and five rice varieties *viz*. Binadhan-7, BRRI dhan28, BRRI dhan48, BRRI dhan55, and BRRI dhan58 in a split-plot design with three replications. The date of transplanting was assigned to the main plot and the variety in the sub plot randomly. The size of unit plot was 4.0 × 2.5 m (10 m^2) where block to block and plot to plot distances were 1m and 0.5 m, respectively.

2.3 Crop husbandry

Twenty-two days old seedlings were transplanted on at 25 cm × 15 cm spacing with three seedlings $hill^{-1}$ on the dates as per treatment specification. The experimental plots were fertilized with Triple supper

phosphate, Muriate of potash, Gypsum and Zinc sulphate at final land preparation @ 100, 70, 60, and 10 kg ha^{-1}, respectively. Urea was applied at 200 kg ha^{-1} as top dressing in three equal splits at 15, 30 and 45 days after transplanting (DAT). Crops were infested with different weeds. Weeding was done manually twice at 30 and 45 DAT. Flood irrigation was given in the experimental field to maintain a constant level of standing water up to 6 cm in early stage to enhance tillering and 10–12 cm in later stage to discourage late tillering. The field was finally drained out before 15 days of harvest. The plants were infested with yellow stem borer (*Scirpophaga incertulas*). It was successfully controlled by applying Diazinon 60EC @ 1 L ha^{-1}. Successive two sprays at seven day intervals were required. At maturity (when 90% of the seeds became golden yellow in color) three square meter area from each plot was randomly selected from the central portion and cut manually from the ground level to take grain and straw yields.

2.4 Data recording

The crop was harvested at maturity. The harvested crops of each plot were separately bundled, properly tagged, then brought to the threshing floor and were threshed manually. The grains were cleaned and dried to a moisture content of 14%. Straws were sun dried properly. Final grain and straw yields $plot^{-1}$ were recorded and converted to t ha^{-1}. Grain yield and straw yield were altogether regarded as biological yield. Prior to harvesting, five hills were randomly selected from each plot for recording necessary data on crop yield related attributes such as plant height, number tiller $hill^{-1}$ and number of grain $panicle^{-1}$. Data on crop phenology such as days to panicle initiation (PI), flowering and harvesting were recorded. The harvesting schedule of all the rice varieties transplanted at different dates is presented below:

Variety	Date of transplanting			
	21-Jun	11-Jul	01-Aug	22-Aug
	Date of harvesting			
Binadhan-7	16-Sep	09-Oct	28-Oct	21-Nov
BRRI dhan28	08-Sep	29-Sep	26-Oct	18-Nov
BRRI dhan48	15-Sep	05-Oct	27-Oct	16-Nov
BRRI dhan55	20-Sep	16-Oct	06-Nov	25-Nov
BRRI dhan58	08-Sep	27-Sep	19-Oct	10-Nov

2.5 Statistical analysis

Data recorded for growth, yield and yield contributing characters were compiled and tabulated in proper form for statistical analyses. Analysis of variance was done with the help of MSTAT–C computer package programme. The mean differences among the treatments were evaluated with DMRT test.

3 Results and Discussion

3.1 Phenology

Days to panicle initiation (PI), days to flowering and days to maturity from date of transplanting were significantly affected by variety, date of transplanting and their interaction. On an average, the variety BRRI dhan55 required the longest duration for each of the phonological stages. Table 1 showed that the durations from sowing to PI, sowing to flowering and sowing to maturity were 73, 90 and 114 days, respectively. On the other hand, these durations are the lowest for variety BRRI dhan58 which are 60, 72 and 99 days, respectively. The crop transplanted on 22 August required the longest duration from sowing to maturity (108 days) while that transplanted on 21 June required the shortest crop duration (102 days). The interaction effect of variety and transplanting date for crop duration (sowing to maturity) showed that BRRI dhan55 transplanted on 22 August required the longest duration of 116 days while the variety BRRI dhan58 transplanted on 21 June required the shortest duration of 96 days (Table 2). It was also noted that the crop duration of variety BRRI dhan58 were 96 days to 98 days while that for BRRI dhan55 was 110 days for 21 June transplanting to 116 days when transplanted on 22 August. In the present study, Binadhan-7 was used as the short duration rice variety for Aman season. The crop duration of this variety was 107 and 110 days for transplanting during 21 June and 22 August 2016. Thus, the result clearly showed that BRRI dhan58 matures 10-12 days earlier than Binadhan-7 for transplanting at any dates during July and August in Aman season. Mahmud et al. (2017) reported that short duration rice varieties BRRI dhan57 and Binadhan-7 required 87-88 and 101-102 days field duration (transplanting to maturity) respectively for different transplanting during 26 July to 15 August 2013. The field duration for Binadhan-7 and BRRI dhan58 were 90 and 83 days, respectively (Table 2). The present study clearly showed that BRRI dhan58 required shorter field duration than Binadhan-7 and thus, transplanting of BRRI dhan58 June - August in Aman season would allow harvesting of Aman rice at the desired time for sowing of Rabi crop at optimum time.

3.2 Yield related traits

Date of transplanting and variety had significant effect on plant height, tillers m^{-1} and effective tillers m^{-2}. Number of grains panicle and 1000-grain weight differed significantly for variety but not for date of transplanting. The interaction effect of date of transplanting and variety were significant for plant height, number of total and effective tillers, number of grains $panicle^{-1}$, number of sterile spikelet

Table 1. Effect of date of transplanting and variety on phonological events of rice in aman season 2016

	Days to pI	Days to F	Days to M
Transplanting date			
21-Jun	61.20b	75.00d	102.00d
11-Jul	62.67a	77.0c	104.60c
01-Aug	64.60a	80.80b	106.20b
22-Aug	67.60a	83.60a	108.40a
LS	**	**	**
LSD	0.95	0.02	1.09
CV (%)	2.8	1.3	1.41
Variety			
Binadhan-7	66.50b	82.50b	110.25b
BRRI dhan28	61.25b	74.00d	100.75d
BRRI dhan48	62.75c	74.50c	105.50c
BRRI dhan55	73.25a	90.50a	114.25a
BRRI dhan58	60.00d	72.25c	99.25e
LS	**	**	**
LSD (0.05)	1.067	0.07	1
CV (%)	2.81	1.3	1.41

PI = panicle initiation, F = flowering, M = maturity; In a column, figures having the same letters do not differ significantly while dissimilar letters indicate the significant difference, ** = 1% level of significance, LS = level of significance, CV = coefficient of variation

Table 2. Interaction effect of date of transplanting and variety on phonological events of rice in aman season 2016

Transplanting date	Variety	Days to PI	Days to F	Days to M
21-Jun	Binadhan-7	63.0efg	79.0gh	107.0de
	BRRI dhan28	58.0gh	71.0i	97.0ij
	BRRI dhan48	59.0fgh	74.0jk	103.0f
	BRRI dhan55	70.0b	87.0c	110.0c
	BRRI dhan58	57.0h	69.0m	96.0k
11-Jul	Binadhan-7	64.0bc	80.0ef	108.0c
	BRRI dhan28	59.0fgh	72.0kl	98.0hi
	BRRI dhan48	60.0efg	75.0ij	105.0e
	BRRI dhan55	71.0a	88.0a	115.0a
	BRRI dhan58	58.0gh	70.0m	97.0k
01-Aug	Binadhan-7	65.0bc	87.0ocd	109.0b
	BRRI dhan28	60.0efgh	73.0jk	106.0g
	BRRI dhan48	61.0def	76.0hi	107.0de
	BRRI dhan55	72.0a	89.0a	116.0a
	BRRI dhan58	59.0gh	71.0dc	98.0jk
22-Aug	Binadhan-7	66.0bcd	82.0cd	110.0b
	BRRI dhan28	61.0efgh	73.0gh	108.0de
	BRRI dhan48	62.0def	77.0g	107.0de
	BRRI dhan55	73.0a	90.0a	116.0a
	BRRI dhan58	60.0cde	72.0ab	99.0gh
LS		**	**	**
LSD (0.05)		2.13	0.1	2.5
CV (%)		2.8	1.3	1.41

PI = panicle initiation, F = flowering, M = maturity; In a column, figures having the same letters do not differ significantly while dissimilar letters indicate the significant difference, ** = 1% level of significance, LS = level of significance, CV = coefficient of variation

Table 3. Effect of date of transplanting dates and variety on yield related traits of rice in aman season 2016

	PH (cm)	Tillers m^{-2} (no.)	Eff. tillers m^{-2} (no.)	Grains $panicle^{-1}$	Ster. spik. $panicle^{-1}$	WTS (g)
Transplanting date						
21-Jun	101.09a	351.87a	336.48a	110.18	24.44	21.73
11-Jul	94.04ab	321.85b	300.42b	110.08	39.2	21.66
01-Aug	94.75ab	308.88b	292.25b	109.97	25.33	21.66
22-Aug	91.18b	301.95b	269.13c	103.11	25.71	21.65
LS	**	**	**	NS	NS	NS
LSD	3.29	25.8	16.16	1.28	0.65	0.07
CV (%)	4.67	10.79	7.5	14.58	13	3.42
Variety						
Binadhan-7	95.05ab	314.60bc	294.88bc	115.29ab	24.31	21.03c
BRRI dhan28	93.14b	299.87c	276.03c	106.80ab	25.6	20.03d
BRRI dhan48	94.53ab	292.07c	276.47c	107.08ab	29.19	20.07d
BRRI dhan55	92.28b	332.80b	298.13b	95.6b	41.08	24.04a
BRRI dhan58	101.14a	366.34a	351.09a	116.86a	23.18	23.21b
LS	**	**	**	*	NS	**
LSD (0.05)	3.2	28.85	18.57	1.44	0.73	0.05
CV (%)	4.67	10.79	7.51	14.58	13	3.42

PH = plant height, WTS = 1000-grain weight; In a column, figures having the same letters do not differ significantly, ** and * = 1% and 5% level of significance, respectively, NS = not significant, LS = level of significance, CV = coefficient of variation

Table 4. Effect of date of transplanting dates and variety on yield related traits of rice in aman season 2016

Trans. date	Variety	PH (cm)	Tillers m^{-2} (no.)	Eff. tillers m^{-2} (no.)	Grains $panicle^{-1}$	Ster. spik. $panicle^{-1}$	WTS (g)
21-Jun	Binadhan-7	86.0gh	277.3efg	251.3fgh	115.3cde	24.4ij	21.013d
	BRRI dhan28	96.7a-f	299.9c-g	338.0abc	112.6a-e	25.2i	20.006e
	BRRI dhan48	103.3ab	227.6a-f	322.4bcd	116.1cd	33.4f	20.060e
	BRRI dhan55	99.4abcd	370.9ab	372.6ab	93.9ij	30.4g	24.033a
	BRRI dhan58	101.5abc	372.6ab	352.9ab	120.7a	22.9jk	23.433b
11-Jul	Binadhan-7	95.5bf	315.6b-g	293.9de	117.4bc	24.2ij	21.036d
	BRRI dhan28	96.5a-f	299.6c-g	268.6efg	110.2fg	27.6h	20.036e
	BRRI dhan48	95.3b-f	284.6defg	280.8def	114.6cde	37.5bc	20.090e
	BRRI dhan55	91.4defg	344.9a-e	306.0cde	94.7i	31.6g	24.030a
	BRRI dhan58	101.0abc	364.6abc	351.0ab	117.3bc	22.2k	23.146c
01-Aug	Binadhan-7	104.7a	387.3a	296.4de	119.7ab	23.4ijk	21.036d
	BRRI dhan28	97.3a-e	346.6a-d	251.3fgh	109.0g	28.2h	20.010e
	BRRI dhan48	91.0defg	279.6efg	277.3ef	112.3ef	38.7ab	20.073e
	BRRI dhan55	89.9efgh	272.1fg	283.3def	92.5ij	34.4fg	24.053a
	BRRI dhan58	100.1abc	369.2b	294.8de	115.2cde	23.9ijk	23.143c
22-Aug	Binadhan-7	94.2-g	277.333efg	293.6de	112.8ef	25.3i	21.020d
	BRRI dhan28	82.7h	253.066g	246.1fgh	104.9h	35.2de	20.020e
	BRRI dhan48	88.5fgh	277.333efg	225.3h	110.3fg	39.8a	20.063e
	BRRI dhan55	88.5fgh	343.200a-e	230.5gh	91.4j	36.6cd	24.040a
	BRRI dhan58	102.0abc	358.800abc	349.7ab	113.3def	24.6ij	23.120c
LS		**	**	**	**	**	**
LSD (0.05)		7.4	57.7	37.1	2.9	1.4	0.1045
CV (%)		4.7	10.79	7.5	14.58	13	3.42%

PH = plant height, WTS = 1000-grain weight; In a column, figures having the same letters do not differ significantly while dissimilar letters indicate the significant difference, **= 1% level of significance, LS = level of significance, CV = coefficient of variation

Table 5. Effect of date of transplanting dates and variety on grain and straw yield of rice in aman season 2016

	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Transplanting date				
21-Jun	4.99a	5.73	10.72a	46.62a
11-Jul	4.67ab	5.8	10.47b	44.59b
01-Aug	4.52b	5.51	10.03c	45.09b
22-Aug	4.33b	5.47	9.80c	44.21b
LS	**	NS	**	**
LSD	0.19	0.02	0.19	1.027
CV (%)	7.47	11.41	8.35	5.53
Variety				
Binadhan-7	4.91a	5.85	10.76a	45.64a
BRRI dhan28	4.47b	5.42	9.89b	45.20a
BRRI dhan48	4.44b	5.39	9.83b	45.21
BRRI dhan55	4.38b	5.62	10b	43.83b
BRRI dhan58	4.95a	5.89	10831c	45.67a
LS	**	NS	**	**
LSD (0.05)	0.2	0.03	21	1.15
CV (%)	7.47	11.41	8.35	5.53

In a column, figures having the same letters do not differ significantly while dissimilar letters indicate the significant difference, **= 1% level of significance, LS = level of significance, CV = coefficient of variation

panicle^{-1} and 1000-grain weight. The crop transplanted on 21 June produced the tallest plant (101.09 cm), highest number of total tiller m^{-2} (351.87) and effective tillers m^{-2} (336.48) while the crop transplanted on 22 August produced the shortest plants (91.18 cm), lowest number of total (301.95) and effective (269.13) tillers m^{-2} (Table 3). Among the varieties, BRRI dhan58 produced the tallest plants (101.14 cm) while BRRI dhan55 produced the shortest plants (92.28 cm). The highest number of total tiller m^{-2} (366.34) and effective tillers m^{-2} (351.09) were found in BRRI dhan58 and the lowest values were found with BRRI dhan28 and BRRI dhan48. The highest number of grains panicle^{-1} was produced with BRRI dhan58 (116.86) while the lowest was found in BRRI dhan55 (95.6). The 1000-grain weight was the highest in BRRI dhan55 (24.04 g) and the lowest was with BRRI dhan28 (20.03 g). The variety Binadhan-7 transplanted on 01 August 2016 produced that tallest plants (104.7 cm) BRRI dhan28 transplanted on 22 August produced that shortest plants (82.7 cm). The highest number of total tiller m^{-2} was found with Binadhan-7 transplanted on 01 August 2016 (387.3) which was statistically similar with that for BRRI dhan58 transplanted at all the four dates. The highest number of effective tiller for Binadhan-7 was produced when it was transplanted on 01 August which was similar for transplanting on 11 July and 22 August but reduced for transplanting on 21 June. BRRI dhan58, BRRI dhan55 and BRRI dhan28 produced similar and highest number of effective tillers when transplanted on 21 June 2016 (Table 4). It was noted that BRRI dhan58 produced the highest number of effective tillers consistently across all the transplanting dates. The highest number of grains panicle was found with BRRI dhan58 transplanted on 21 June (120.7) which was statistically similar with that for Binadhan-7 transplanted on 01 August (119.7). The result showed that the highest number of sterile spikelet was produced in BRRI dhan48 for transplanting on 22 August (39.8) The highest 1000-grain weight was found in BRRI dhan55 for transplanting in all the dates while the lowest values were found with BRRI dhan28 and BRRI dhan48. The growth and yield related traits of rice such as plant height, number of tillers and effective tiller differed among the varieties (Singh and Gangwer, 1989; Shamsuddin et al., 1988) because of differences in their genetic make-up (Panwar et al., 2012; Ghoneim et al., 2018).

3.3 Grain and straw yield

Date of transplanting and variety had significant effect on grain yield but not on straw yield. The highest grain yield was found with 21 June transplanting which was followed by 11 July transplanting. The later transplanting dates gave the lowest yield (Table 5). Among the varieties, BRRI dhan58 gave the highest yield (4.95 t ha^{-1}) which was statistically similar with that for Binadhan-7 (4.91 t ha^{-1}). The highest biological yield (10.72 t ha^{-1}) and harvest index (46.62%) was found for transplanting on 21 June and

Table 6. Interaction effect of transplanting dates and variety on grain and straw yield of rice in aman season 2016

Trans. date	Variety	Grain yield (t ha^{-1})	↑ Yield over control (%)	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
21-Jun	Binadhan-7	4.317e	–	5.150i	9.467i	44.69abcd
	BRRI dhan28	4.947b	14.59	6.060b	11.007b	44.94abcd
	BRRI dhan48	4.843bc	12.18	5.610fg	10.453de	46.33abc
	BRRI dhan55	4.763bcd	10.33	5.920c	10683de	44.58bcd
	BRRI dhan58	5.450a	26.24	6.170a	11.62a	46.90a
11-Jul	Binadhan-7	4.517cde	–	5.590fgh	10.107efgh	45.60abcd
	BRRI dhan28	4.467cde	−1.11	5.280k	9.747hi	45.83abcd
	BRRI dhan48	4.187e	−7.31	5.340j	9.527i	43.95d
	BRRI dhan55	4.913b	8.77	5.360f	10.543cd	46.60ab
	BRRI dhan58	4.383de	−2.97	5.440i	9.823ghi	44.62bcd
01-Aug	Binadhan-7	5.093ab	–	5.810d	10.903bc	46.71ab
	BRRI dhan28	4.163e	−18.26	5.320jk	9.483ghi	43.90abcd
	BRRI dhan48	4.823bc	−5.3	5.540h	10.363def	46.54ab
	BRRI dhan55	4.400de	−13.61	5.700e	10.1efgh	43.56de
	BRRI dhan58	4.170e	−18.12	5.900c	10.07efgh	41.41e
22-Aug	Binadhan-7	4.137e	–	5.330jk	9.467i	43.70d
	BRRI dhan28	4.517cde	9.18	5.590fgh	10.107efgh	4469abc
	BRRI dhan48	5.097ab	23.21	6.210a	11.307ab	45.08abcd
	BRRI dhan55	4.817bc	16.43	5.590fgh	10.407def	46.29abc
	BRRI dhan58	4.420de	6.84	5.570gh	9.99fgh	44.24cd
LS		**	–	**	**	**
LSD (0.05)		0.418	–	0.052	0.4118	2.296
CV (%)		7.47	–	11.41	8.35	5.53

In a column, figures having the same letters do not differ significantly while dissimilar letters indicate the significant difference, **= 1% level of significance, LS = level of significance, CV = coefficient of variation

the lowest values were 9.80 t ha^{-1} and 44.21%, respectively for 22 August transplanting. Binadhan-7 produced the highest biological yield (10.76 t ha^{-1}) and the lowest was found with BRRI dhan48 (9.83 t ha^{-1}). The highest harvest index was found with BRRI dhan58 (45.67%) and the lowest with BRRI dhan28 (45.20%).

The interaction of transplanting date and variety was significant for grain yield, straw yield, biological yield and harvest index. BRRI dhan58 transplanted on 21 June produced the highest grain yield (5.45 t ha^{-1}) which was statistically at par with Binadhan-7 transplanted on 01 August (5.09 t ha^{-1}) and BRRI dhan48 transplanted on 22 August 2016 (5.09 t ha^{-1}). The highest straw yield was found in BRRI dhan48 transplanted on 22 August (6.21 t ha^{-1}) which was statistically at par with BRRI dhan58 for 21 June transplanting (6.17 t ha^{-1}). The highest biological yield (11.62 t ha^{-1}) was obtained from BRRI dhan58 which was statistically similar with that for BRRI dhan48 transplanted on 22 August (11.31 t ha^{-1}). The highest harvest index was attained by BRRI dhan58 transplanted on 21 June (46.90%) and the lowest was found with BRRI dhan58 transplanted on 01 August (41.41%). Mahmud et al. (2017) found the highest grain yield in Binadhan-7 among the seven short duration Aman rice varieties for transplanting on 26 July. They reported that the yield improvement was attributed to production of higher number of effective tiller in Binadhan-7 than others. In the present study Binadhan-7 gave the highest yield for transplanting on 01 August while BRRI dhan58, BRRI dhan28, BRRI dhan55 and BRRI dhan48 gave higher yield than Binadhan-7 when transplanted on 21 June (Table 6). When transplanted on 22 August, BRRI dhan48 gave the highest yield among the varieties. Thus, BRRI dhan58 and BRRI dhan28 could be considered for transplanting in June for producing high rice yield to catch the early rabi crops.

4 Conclusions

Binadhan-7 gave the highest yield for 11 July and 01 August transplanting and both the delay and early transplanting reduced the yield of this variety. All the Boro and Aus rice varieties transplanted on 21 June gave higher yield than Binadhan-7 and the

highest yield was found with BRRI dhan58 (5.45 t ha^{-1}) and the second highest yield was obtained by BRRI dhan28, BRRI dhan48 and BRRI dhan55. BRRI dhan48 produced the highest yield for transplanting on 22 August. The present study concludes that the Boro and Aus rice varieties can be used as the substitute of Binadhan-7 for earlier clearing of land for sowing of Rabi crops at the earliest desired time for obtaining higher productivity and profitability.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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