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Effect of Variety and Date of Transplanting on Yield and Yield Attributes of Short-duration T. Aman Rice in the Rangpur Region

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ABSTRACT

An experiment was carried out at the Agronomy Field, Agriculture Training Institute, Department of Agricultural Extension, Tajhat, Rangpur during July to November, 2020 to investigate the response of some short duration aman rice varieties to date of transplanting. The experiment consisted of three transplanting dates viz. 25 July, 4 August and 14 August and four (04) short duration T. aman rice varieties viz. BRRI dhan62, BRRI dhan71, BRRI dhan75, and Binadhan-17. The experiment was laid out in split plot design with three replications. Transplanting dates were allocated into the main plot and varieties into the sub plot. Results indicate that BRRI dhan71 produced the highest grain yield (4.84 t ha^{-1}), 1000-grain weight (24.60 g) and harvest index (42.70%). The lowest grain yield (3.66 t ha^{-1}), straw yield (5.49 t ha^{-1}) and harvest index (39.97%) were produced by BRRI dhan62. BRRI dhan62 showed the minimum days to maturity (98.67 days) and maximum days to maturity (117.89 days) was recorded on the variety BRRI dhan71. The number of effective tillers $hill^{-1}$(8.86), number of filled grains $panicle^{-1}$ (113.22), grain yield (4.77 t ha^{-1}), straw yield (6.43 t ha^{-1}) and harvest index (42.56%) were highest on 25 July transplanting; decreased on 4 August transplanting and drastically declined on 14 August transplanting. It could be concluded that the highest grain yield (5.26 t ha^{-1}) for short duration T. aman rice cultivation can be possible by BRRI dhan71 transplanting on 25 July in the Rangpur region.

Introduction

Bangladesh has an agrarian economy in which rice (*Oryza sativa* L.) is the dominant crop. Rice is the staple food, reflected in the high per capita rice consumption in this country. Among the cultivated crops, rice occupies about 75% of the total cropped area (Anonymous, 2016). Bangladesh is in the third place of the list after India in rice production in the world. The production is likely to increase by 1.8 per cent, which may be 1 per cent in Indonesia and Thailand during the same time period. (FAO, 2017). T. aman rice is generally cultivated under rain fed condition during June –December. It

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covers the largest area (5.59 million hectares) with a production of 14.20 million tons (BBS, 2021) and average yield of T. aman was 2.50 t ha^{-1} which is very low. In Rangpur region, the area under T. aman rice was 0.62 million hectare and average yield was 3.03 t ha^{-1} during the fiscal year 2021-2022 (DAE, 2022). The range of cropping intensity values was recorded 190-255% and the average cropping intensity at Rangpur region was 219% (BRRI, 2017). Farmers of the Rangpur region tries to cultivate 3 crops in a year with T. aman rice-based cropping pattern. They are facing problems to adjust suitable T. aman rice variety and time of transplanting for higher yield. Short duration T. aman rice can also create opportunity to facilitate robi crops like potato, winter vegetable, maize, wheat, tobacco, mustard, onion, garlic and pulses before summer maize.

The areas of Rangpur region are frequently affected by drought in kharif season. Therefore, rice production in the area is substantially fluctuated due to seasonal variation in the amount and pattern of the rainfall. T. aman Rice production in Bangladesh is vulnerable to climate-related risk such as drought, which contributes to food insecurity. Adoption of drought-tolerant rice varieties can play an important role in increasing productivity, food grain supply, and income. As a result, rice farmers in those areas began to adopt drought-tolerant rice varieties. Some short duration T. aman rice varieties (viz. BRRI dhan56, BRRI dhan57 and BRRI dhan71, and BINA dhan-17) are not only photo insensitive but also drought tolerant (BRRI, 2022; BINA, 2016).

A number of technologies have been identified as potential for increasing rice yield including high–yielding rice varieties, efficient agronomic management techniques, enhancing nutrient and water management and controlling weeds (Hazel, 2010). Among these technologies improved or high yielding varieties is a particularly successful intervention used to increase yields (Evenson and Gollin, 2003). Choosing optimum date of transplanting for high yielding cultivars occupies an important part of high production package (Akhter et al., 2007).

The objectives of this research work were to assess the yield performance of short duration T. aman rice varieties; to find out the optimum date of transplanting for maximizing yield and to evaluate the interaction effect between variety and date of transplanting on yield and yield attributes of short duration T. aman rice varieties in Rangpur region.

Materials and methods

The experiment was carried out at the Agronomy Field of Agriculture Training Institute (ATI), Tajhat, Rangpur, Bangladesh during July to November 2020. The experimental site belongs to the Tista Meander Floodplain (AEZ-3) having loamy soils (UNDP and FAO, 1988). Two factors were included in the study. of experimental treatments were included in the study. Factor-A: Date of transplanting (03); i) 25 July (D_1), ii) 4 August(D_2), iii) 14 August (D_3). Factor-B: Variety (04); i) BRRI dhan62 (V_1), ii) BRRI dhan71 (V_2), iii) BRRI dhan75 (V_3), iv) Binadhan17 (V_4).

The experiment was laid out in a split-plot design with three replications by assigning date of transplanting in the main plot and variety in sub plot at random. The size of each unit plot was 3 m × 4 m (12 m^2). The number of plots in each replication was 12 and total number of unit plot was 36. Seeds were collected from the Bangladesh Rice Research Institute, Regional center, Rangpur and Bangladesh Institute of Nuclear Agriculture, Regional center, Rangpur. Seedlings were raised at the Agronomy Field, Agriculture Training Institute, Rangpur. Main land was prepared according to layout in 24 July 2020. A fertilizer dose of urea @174 kg ha^{-1}, TSP @ 32 Kg ha^{-1}, MOP @ 62 Kg ha^{-1}, Gypsum @ 80 Kg ha^{-1}, Zinc sulphate 4.0 Kg ha^{-1}, were applied. Decomposed cow dung was applied @ 4 t ha^{-1}. All fertilizers except urea were applied during final land preparation. 50% of urea was applied at 10 DAT and rest 50 % of urea was top dressed at 30 DAT. 20 days aged Seedlings were transplanted in the unit plots at the rate of three seedlings $hill^{-1}$ maintaining spacing of 20 cm×15 cm. Fertilizer application, thinning and gap filling, weeding, irrigation and drainage and other intercultural operations were done as and when necessary, according to the BRRI guidelines. The crops were harvested at maturity and data on plant height (cm), number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, panicle length (cm), number of filled grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, 1000 grain weight (g), grain

yield (t ha^{-1}), straw yield (t ha^{-1}), harvest index (%) and days to maturity (days) were collected from the randomly selected ten hills from each plot. Data were checked for all ANOVA assumptions. Analysis of variance (ANOVA) was done using Statistics 10.0 Software. Mean separations were done using All-Pairwise Comparison Test at 5% probability level.

Results

1. Number of effective tillers hill^{-1}

Effect of date of transplanting on the number of effective tillers hill^{-1} was significant. (Table 1). Results revealed that treatment D_1 produced the highest number of effective tillers (8.68) and the treatment D_3 was produced the lowest number of effective tillers hill^{-1} (7.31). Pandey et al. (2001) and Lu and Cai (2000) also reported that the number of effective tillers per m^2 decreases with late transplanting. Number of effective tillers hill^{-1} differed significantly due to number of seedling hill^{-1}. Interaction effect of date of transplanting and variety on effective tillers was significant. The treatments D_1V_2 produced the highest number of effective tillers (9.25), the 2nd highest number of effective tillers (8.81) was found in the treatment combination D_1V_3. The lowest number (7.12) of effective tillers was obtained from the treatment combination D_3V_4which was statistically identical with D_3V_1 and D_2V_4 (Table 5).

Table 1. Effect of date of transplanting on yield attributes of short duration T. aman rice

Date of transplanting	Effective tillers hill^{-1}(no.)	Non-effective tillers hill^{-1} (no.)	Plant height (cm)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)
D_1	8.68 a	0.23 c	110.08 a	27.01 a	113.22 a	23.56 b
D_2	7.71 b	0.30 b	107.10 b	25.49 b	111.12 a	25.76 b
D_3	7.31 c	0.51 a	104.99 c	24.62 c	104.89 b	31.09 a
LSD at 0.05	0.24	0.04	0.62	1.06	3.02	2.56
Mean	7.89	0.35	107.39	25.71	109.74	26.80
CV %	4.37	13.37	1.97	4.13	3.50	9.64

In a column, figures with the same letters do not differ significantly whereas figures with dissimilar letters differ significantly as per LSD All-Pairwise Comparisons Test. LSD = Least Significant Difference, CV= Co-efficient of Variation, D_1= 25 July, D_2 = 4 August, D = 14 August.

Table 2. Effect of date of transplanting on yield attributes of short duration T. aman rice

Date of transplanting	1000 –grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t hac^{-1})	Days to maturity	Harvest Index (%)
D_1	23.15 a	4.77 a	6.43 a	109.67 b	42.56 a
D_2	23.15 a	4.15 b	6.02 b	112.00 a	40.75 b
D_3	22.98 a	3.88 c	5.92 b	107.50 c	39.59 c
LSD at 0.05	0.19	0.11	0.24	1.42	0.59
Mean	23.09	4.27	6.12	109.73	40.96
CV %	1.00	3.70	2.59	0.79	1.63

In a column, figures with the same letters do not differ significantly whereas figures with dissimilar letters differ significantly as per LSD All- pairwise comparisons test. LSD = Least Significant Difference, CV= Co-efficient of Variation, D_1= 25 July, D_2 = 4 August, D = 14 August.

2. ***Number of non-effective tillers hill^{-1}***

Number of non-effective tillers hill^{-1} was significantly affected by the effect of date of transplanting. The highest number of non-effective tillers (0.51) obtained from the treatment D_3 and the lowest number (0.23) was produced in the D_1 treatment (Table-1). Significant influence by number of seedling hill^{-1} was found in the production of non-effective tillers.

3. Plant height

Different date of transplanting had significant influence on plant height. The tallest plant height (110.08 cm) was observed at the treatment D_1 and the shortest plant (104.99 cm) in the treatment D_3 (Table 1). These results were in good agreement with the findings of Sultana *et al.* (2020).

Table 3. Effect of variety on yield and yield attributes of short duration T.aman rice

Variety	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Plant Height (cm)	Panicle Length(cm)	Filled grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)
V_1	7.78 ab	0.41 b	97.56 d	26.46 b	106.46 c	12.93 c
V_2	8.10 a	0.21 c	125.07 a	28.11 a	110.33 b	27.48 b
V_3	8.08 a	0.58 a	106.61 b	23.43 d	104.39 c	32.95 a
V_4	7.63 b	0.20 c	100.32 c	24.83 c	117.79 a	33.85 a
LSD at 0.05	**0.35**	**0.05**	**2.10**	**1.06**	**3.80**	**2.56**
Mean	7.89	0.35	107.39	25.71	109.74	26.80
CV %	4.37	13.37	1.97	4.13	3.50	9.64

In a column, figures with the same letters do not differ significantly as per LSD All-Pairwise Comparisons Test. LSD = Least significant Difference, CV= Co-efficient of Variation, V_1 = BRRI dhan62, V_2 = BRRI dhan71, V_3 = BRRI dhan75,V_4= Binadhan-17

Table 4. Effect of variety on yield and yield attributes of short duration T. aman rice

Variety	1000 –grain weight(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Days to Maturity	Harvest Index (%)
V_1	24.03 b	3.66 d	5.49 d	98.67 d	39.97 c
V_2	24.60 a	4.84 a	6.48 b	117.89 a	42.70 a
V_3	20.69 d	4.08 c	5.86 c	107.56 c	40.98 b
V_4	23.06 c	4.49 b	6.67 a	114.78 b	40.21 c
LSD at 0.05	**0.16**	**0.16**	**0.16**	**0.86**	**0.66**
Mean	23.09	4.27	6.12	109.73	40.96
CV %	1.00	3.70	2.59	0.79	1.63

In a column, figures with the same letters do not differ significantly as per LSD All-Pairwise Comparisons Test. LSD = Least significant difference, CV= Co-efficient of Variation, V_1 = BRRI dhan62, V_2 = BRRI dhan71, V_3 = BRRI dhan75,V_4= Binadhan-17.

4. Panicle length (cm)

The effect of date of transplanting on panicle length was significant. The longest panicle (27.01 cm) was found in the treatment D_1 and the shortest (24.62 cm) in the treatment D_3 (Table 1). The panicle length was differed significantly due to effect of rice variety. The longest panicle (28.11 cm) was found from BRRI dhan71 (V_2) and the 2nd most longest (26.46 cm) panicle found in BRRI dhan62 (V_1). BRRI dhan75 (V_3) produced the shortest panicle (23.43 cm) among the varieties (Table 3). The **i**nteraction between date of transplanting and variety exerted significant effect. The longest panicle (30.52 cm) was obtained from D_1V_2). The 2nd longest panicle (27.90 cm) observed in D_2V_2. The treatment combination D_3V_4 produced the shortest (22.11 cm) panicle (Table 5).

5. Number of filled grains panicle^{-1}

The result showed that date of transplanting had non-significant effect on number of filled grain panicle^{-1}. However, maximum number of filled grains panicle^{-1}(113.22) were found in D_1 which was statistically similar to D_2 (111.12) filled grains was obtained. The minimum number of filled grains panicle^{-1} (104.89) were found in D_3 treatment (Table 1). These results are similar to those of Akram *et al.* (2007) who reported that the number of grains per panicle was significantly affected by the delayed sowing date. Binadhan-17 (V_4) produced the highest number of filled grains panicle^{-1} (117.79). The 2nd highest number (110.33) was found in V_2 (Table 3). However, the highest number of filled grains panicle^{-1} (119.23)

Table 5. Interaction effect of date of transplanting and yield and yield attributes of short duration T. aman rice.

Interaction (Date x Variety)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Plant Height (cm)	Panicle Length (cm)	Filled grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)
$_1V_1$	8.13 cd	0.38 b	99.7 0 e	26.73 bc	113.45 abc	9.62 f
D_1V_2	9.25 a	0.16 cd	127.63 a	30.52 a	112.95 abc	26.2 d
D_1V_3	8.81 ab	0.22 cd	108.54 c	24.47 de	107.22 cde	25.28 d
D_1V_4	8.52 bc	0.15 d	104.46 d	26.33 bcd	119.23 a	33.13 bc
D_2V_1	8.01 cde	0.38 b	97.35 ef	26.57 bc	108.61 cde	11.27 f
D_2V_2	7.64 defg	0.22 cd	124.32 b	27.90 b	112.00 bcd	26.99 d
D_2V_3	7.91 def	0.38 b	106.57 cd	23.71 ef	105.37 ef	31.47 bc
D_2V_4	7.26 g	0.22 cd	100.17 e	23.77 ef	118.50 ab	33.32 bc
D_3V_1	7.19 g	0.45 b	95.63 f	26.09 cd	97.30 g	17.92 e
D_3V_2	7.42 fg	0.23 c	123.27 b	25.91 cd	106.02 def	29.24 cd
D_3V_3	7.53 efg	1.13 a	104.73 d	22.11 f	100.59 fg	42.09 a
D_3V_4	7.12 g	0.24 c	96.32 f	24.38 ef	115.65 ab	35.09 b
LSD at 0.05	**0.61**	**0.08**	**3.63**	**2.11**	**6.58**	**4.43**
Mean	7.89	0.35	107.39	25.71	109.74	26.80
% CV	4.37	13.37	1.97	4.13	3.50	9.64

In a column, figures with the same letters do not differ significantly as per LSD All-pairwise comparisons test. LSD= Least Significant Difference, CV= Co-efficient of Variation.

Table 6. Interaction effect of date of transplanting and variety on yield and yield attributes of short duration T.aman rice

Interaction (Date x Variety)	1000 –grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Days to maturity	Harvest Index (%)
D_1V_1	24.12 bc	4.06 ef	5.72 c	102.33 e	41.53 b
D_1V_2	24.83 a	5.26 a	6.57 ab	122.00 a	44.46 a
D_1V_3	21.08 e	4.81 b	6.63 a	102.33 e	42.02 b
D_1V_4	23.07 d	4.96 b	6.78 a	112.00 c	42.21 b
D_2V_1	24.05 bc	3.53 g	5.47 cd	97.33 f	39.24 c
D_2V_2	24.65 a	4.84 b	6.58 ab	118.67 b	42.38 b
D_2V_3	20.84 e	3.88 f	5.41 cd	112.67 c	41.75 b
D_2V_4	23.06 d	4.36 cd	6.64 a	119.33 b	39.63 c
D_3V_1	23.91 c	3.39 g	5.28 d	96.33 f	39.14 c
D_3V_2	24.31 b	4.42 c	6.30 b	113.00 c	41.24 b
D_3V_3	20.14 f	3.56 g	5.53 cd	107.67 d	39.16 c
D_3V_4	23.05 d	4.15 de	6.59 ab	113.00 c	38.80 c
LSD at 0.05	**0.27**	**0.27**	**0.27**	**1.49**	**1.14**
Mean	23.09	4.27	6.12	109.72	40.96
% CV	1.00	3.70	2.59	0.79	1.63

In a column, figures with the same letters do not differ significantly as per LSD All-pairwise comparisons test. LSD= Least Significant Difference, CV= Co-efficient of Variation

was recorded from D_1V_4. The next highest number (118.50) was recorded in D_2V_4 which was statistically similar to D_3V_4 (115.65). The lowest number of filled grains panicle^1 (97.30) was recorded in the treatment combination D_3V_1 (Table 5).

6. Number of sterile spikelet panicle^{-1}

Number of sterile spikelets was differed significantly due to variation by the effect of date of transplanting of T. aman rice. The date of transplanting D_3 produced the highest number (31.09) of sterile spikelets panicle^{-1}. The lowest number of sterile spikelets panicle^{-1}(23.56) was found in the early transplanting D_1 (Table 1). Results showed that the highest number of sterile spikelets panicle^{-1} (42.09) was obtained from the treatment combination D_3V_3 while the treatment combination D_1V_1 produced the lowest number of sterile spikelets (9.62), it was statistically similar to D_2V_1 (Table 5).

7. 1000 -grain weight (g)

There were no significant differences among the means of 1000 -grain weight. Results revealed that 1st date of transplanting D_1 showed maximum weight of 1000- grain (23.28 g). Another 2 treatments produced 23.15 g and 22.85 g of 1000-grain from D_2 and D_3 treatments respectively (Table 2). Similar findings have been reported by Biswas and Salokhe (2001) who found that appropriate time of transplanting resulted in higher 1000- grain weight of rice. Weight of 1000-grains was significantly affected by the interaction of date of transplanting and variety. Treatment combination D_1V_2 produced the highest weight (24.83 g) which was statistically identical to D_2V_2. The lowest 1000-grain weight (20.14 g) was found from the treatment combination D_3V_3 (Table 6).

8. Grain yield (t ha^{-1})

Significant influence on grain yield (Table 2, Fig. 2) was observed due to the effect of date of transplanting (table 2). The highest grain yield (4.77 t ha^{-1}) was found in 1st date of transplanting D_1 (25 July). The treatment D_2 produced the 2nd

highest grain yield (4.15 t ha^{-1}) and the lowest grain yield (3.88 t ha^{-1}) was recorded from the treatment D_3 (14 July). Significant variation was observed on grain yield due to variety. The highest grain yield was obtained from the variety BRRI dhan71 but the lowest yield from the variety BRRI dhan62(Table 4 and Fig. 1). According to Table 4 the highest grain yield was observed in D_1V_2 (5.26 t ha^{-1}). The 2nd highest grain yield (4.96 t ha^{-1}) was found in the treatment combination D_1V_4 which was statistically similar to D_2V_2 and D_1V_3. The lowest grain yield (3.39 t ha^{-1}) was obtained from the treatment combination D_3V_1 which was statistically identical to D_2V_1 and D_3V_3 (Table 6).

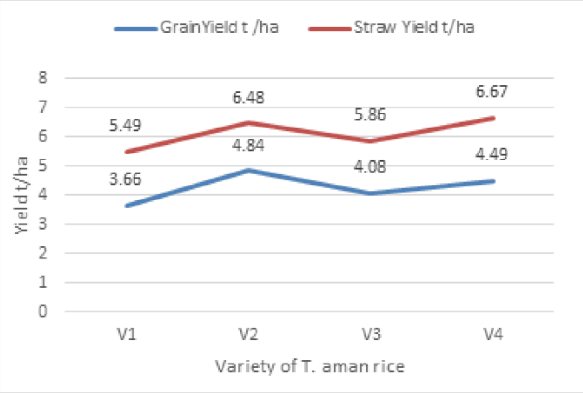

Fig. 1. Grain and Straw yield affected by variety of short-duration T. aman rice.

9. Straw yield (t ha^{-1})

Effect of date of transplanting on straw yield is statistically significant. The highest straw yield (6.43 t ha^{-1}) was produced from the treatment D_1 and the lowest straw (5.92 t ha^{-1}) was produced from the treatment D_3 which was statistically similar to D_2(Table 2, Fig. 2). The significant variation was observed in straw yield due to variety (Table 4, Fig. 1). It was observed that Variety V_4 (Binadhan-17) produced the highest amount of straw (6.67 t ha^{-1}). Variety V_2 (BRRI dhan71) produced the 2nd highest straw yield (6.48 t ha^{-1}). The variation of straw yield is probably due to the genetical make-up of the varieties. The results showed that the effect of the interaction between date of transplanting and variety of straw yield was non-significant. The treatment combination D_1V_4 produced the highest amount of straw (6.78 t ha^{-1}) and it was statically identical to D_2V_4 (6.64 t ha^{-1}) and D_1V_3 (6.63 t ha^{-1}). The lowest straw yield (5.28 t ha^{-1}) was found in the treatment combination D_3V_1 (Table 6).

10. Harvest Index (%)

Harvest Index was influenced significantly due to date of transplanting (Table 1). The highest harvest index (42.56 %) was found from the 1st date of transplanting D_1 and the lowest harvest index (39.58 %) from the last date of transplanting (D_3). The main effect of variety on harvest index (%) was differed significantly. It was found that (Table 4) the maximum harvest index (42.70 %) was found in the variety V_2 (BRRI dhan71). Variety V_3 (BRRI dhan75) showed 40.98 % harvest index. The interaction effect of date of transplanting and variety on harvest index was significant. The maximum harvest index (44.46 %) obtained from the treatment combination D_1V_2. The 2nd maximum harvest index (42.38 %) was shown in the treatment combination D_2V_2 which was statistically similar to D_1V_4, D_1V_3, D_2V_3, D_1V_1 and D_3V_2 (Table 6). The minimum harvest index (38.80%) was found in the treatment combination D_3V_4 which was statistically identical to D_2V_4, D_2V_1, D_3V_3, D_3V_1 (Table 6).

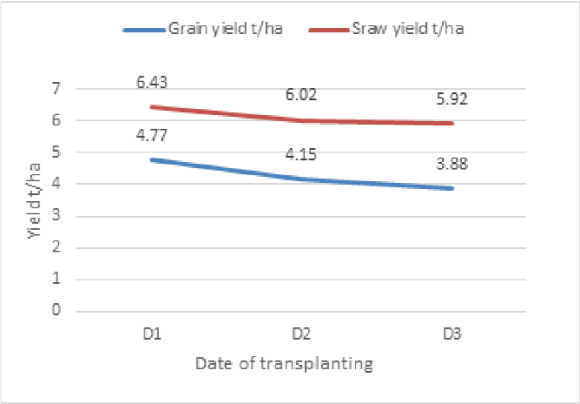

Fig. 2. Grain and straw yield affected by date of transplanting of short-duration T. aman rice

11. Days to maturity

There was a significant influence of date of transplanting on days to maturity of different varieties of T. aman rice. The minimum days to maturity (107.50) was observed in the treatment D_3 (14 August) and the maximum days to maturity (112.00) was found in the treatment D_1 (Table 2). The variety has significant effect on days to

maturity (Table 4). BRRI dhan62 (V_1) showed the minimum days to maturity (98.67), whereas BRRI dhan71 showed highest (117.89 days) days to maturity. Days to maturity was significantly affected by the interaction between date of transplanting and variety. The minimum days to maturity (96.33) was observed in D_3V_1 treatment combination which was statistically similar to D_2V_1 (97.33). The maximum days to maturity (122.00 days) recorded in D_1V_2 (Table 6).

Discussion

The highest number of effective tillers (8.10) was obtained from V_3 (BRRI dhan71) and which was statistically identical to V_3 (Table 3). The lowest number of effective tillers (7.63) was obtained from the treatment V_4. (Binadhan-17). This confirms the report of Sawant et al. (1986), who reported that variable effect of variety on the number of effective tillers hill^{-1}.

The highest number of non-effective tillers hill^{-1} (0.58) was obtained from the treatment V_3 (Table 3) and the minimum number of non-effective tiller (0.20) was found in the treatment V_4 which was statistically similar to treatment V_2. Interaction effect of date of transplanting and variety was significant. The maximum number of non-effective tillers (1.13) was found in the treatment combination D_3V_3 and the 2nd highest (0.45) was found in D_3V_1 which statistically identical with D_1V_1, D_2V_1 and D_2V_3. The minimum number of non-effective tillers hill^{-1} (0.15) in the treatment D_1V_4 (Table 5).

Significant effect on plant height was shown due to different varieties of rice. The tallest plant (125.07 cm) was found from the treatment V_2 (BRRI dhan71) and the shortest plant was observed (97.56 cm) from the treatment V_1 (Table 3). The difference in the plant may occur due to varietal genetic character, it is similar to Sarkar (2014) variable plant height due to varietal differences. The interaction effect was non-significant. The tallest plant (127.63 cm) was found from the treatment combination D_1V_2 (Table 5). The 2nd highest tall plant (124.32 cm) was found in the D_2V_2 which was statistically similar to D_3V_2 (123.27 cm). The treatment D_3V_1 produced the shortest plant (95.63 cm) which was statistically similar to D_3V_4 (96.32 cm).

The variation in the length of panicle was attributed to the genetic make-up or characteristic of the varieties. Babiker (1986) had also observed that panicle length differed due to varietal variation. The difference in the plant may occur due to varietal genetic character; it is similar to Sarkar (2014) variable plant height due to varietal differences.

The lowest number of grains (104.39) panicle^{-1} was produced from the BRRI dhan75 (V_3) which was statistically similar to BRRI dhan62 (106.46). Variation in grain filling may have occurred due to adopted genetic, environmental, or cultural management practices (Chowhan et al., 2017). Significant difference about interaction effect of date of transplanting and variety was observed among the results (Table 4).

The results revealed that the variety V_4 (Binadhan-17) produced the highest number (33.85) of sterile spikelets panicle^{-1} which was statistically similar to that of variety V_3 (32.95). The lowest sterile spikelets panicle^{-1} (12.94) was produced by the variety V_1 (Table 3). Number of sterile spikelets panicle^{-1} varied significantly due to the interaction effect of date of transplanting and variety (Table 5).

There was significant varietal difference with respect to 1000-grain weight (Table 4). It was found that the highest 1000-grain weight (24.60 g) from the variety BRRI dhan71 (V_2) and the lowest 1000-grain weight (20.69 g) was recorded from V_3 (BRRI dhan75).

The higher grain yield in optimum transplanting was owing to favorable yield attributing parameters. But the gradual decrease in the yield with delay in transplanting might be due to the relatively low temperature at the vegetative phase which could have adversely affected the plant growth and development. The results are in agreement with the findings of Shaon (2006), and Rahman (2004). Significant variation was observed among the grain yield due to the effect of different variety of short duration T. aman rice. BRRI dhan71 (V_2) produced the highest grain yield (4.84 t ha^{-1}). Binadhan-17 produced 4.49 t ha^{-1} grain yield which was the 2nd

highest. The lowest (3.66 t ha^{-1}) grain yield was obtained from the variety BRRI dhan62 (Table 4, Fig. 1). Similar research findings were also reported by IRRI (1978) and Alam (1988) who observed variation in grain yield of rice due to varieties. Tahsin et al. (2017) was also reported varietal differences in grain yield. There was a significant difference among the 4 varieties in yield performance.

The lowest straw yield of 5.49 t ha^{-1} was obtained from the variety V_1 (BRRI dhan62). These results were consistent with those of Mahmud (2014) and Khisha (2002) who also observed significant variation among the varieties.

The minimum harvest index (39.97%) was found from the variety BRRI dhan62 (V_1) which was statistically identical to Binadhan-17 (V_4). Tyeb, A. (2012) has founded the similar results and concluded that harvest index depends on inherent genetical attributes on same environmental condition.

This discussion proved that maturity might differ due to variety difference; it is supported by Ghosh et al. (2015), who has recorded variation of days to maturity due to different varieties, and Haque et al. (2016) reported wide genotypic variation in phenological events among 14 aus cultivars. The duration also depends on cultural management, soil, and climatic condition (edaphic factor), which agrees with Ahmed et al. (2015), demonstrated significant differences in attaining phenological stages due to varieties and variable management practices.

Conclusion

Adopting suitable varieties would increase rice production, and undoubtedly BRRI dhan71 is one of the promising high yielding rice variety, and it had a more significant edge over other varieties in terms of yield performance. Though BRRI dhan71 was needed highest days to maturity (113-122 days), it allowed farmers to cultivate next robi crops (potato, maize etc.) easily. Higher grain yield was obtained from early transplanting (25 July). In the light of this experiment, it can be suggested that BRRI dhan71 can be used as a short duration T. aman rice transplanting on 25 July without compromising yield and further trials and experiments can be conducted to include BRRI dhan71 in the Aman slot of several cropping patterns.

Authors' contribution

Conceptualization, NMAB, MAA and MBH; Methodology, NMAB, MAA and MBH; Investigation, NMAB, MAA and MBH; Data collection and analysis, NMAB, MB and MBH; Draft preparation, NMAB, MAA and MBH; Review and editing, MAA, MBH and MMH. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflict of interests.

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