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EFFECT OF TRANSPLANTING DATE ON GROWTH AND YIELD OF ADVANCED LINES OF TRANSPLANTED AMAN RICE

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ABSTRACT

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This research was conducted in order to investigate the effects of time of planting on the grain yield and yield components of three advanced lines of rice under the Agro Ecological Zone (AEZ), Modhupur Tract. The research was conducted as a split plot using Randomized Complete Block Design (RCBD) with three replications in the Aman season of 2016 under the research field of Bangladesh Rice Research Institute (BRRI), Gazipur. In this research, the dates 01 August, 16 August, 31 August and 16 September were considered as the main factor in the main plots, and the advanced lines/varieties BR(Bio)9786-BC2-119-1-1, BR(Bio)9786-BC2-132-1-3 and BRRI dhan49 (check variety) were regarded as the secondary factors in the sub plots. The results showed that planting time significantly affected the plant height, the number of panicle per meter square, the number of tillers per meter square, the number of grains per panicle, 1000-grain weight and grain yield. Among the cultivars, the advanced line BR(Bio)9786-BC2-119-1-1 and BR(Bio)9786-BC2-132-1-3 produced significantly higher plant height, the number of panicle, the number of tillers, the number of grains per panicle, 1000-grain weight and grain yield than check variety BRRI dhan49 in all transplanting dates. The advanced line BR(Bio)9786-BC2-119-1-1 and BR(Bio)9786-BC2-132-1-3 produced average 1.02 and 0.57 t ha⁻¹ higher yields respectively over the check variety BRRI dhan49 under the transplanting date 01 August to 31 August. The highest growth duration (130-146 days) was observed for the check variety BRRI dhan49 that followed by BR(Bio)9786-BC2-132-1-3 (132-141 days) and BR(Bio)9786-BC2-119-1-1 (130-140 days).

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INTRODUCTION

The monsoon-season rainfed rice is the Aman, which is the most widespread, including along the coastal areas. Aman is planted in two ways: direct seeding with Aus in March and April and transplanting between July and August. Bangladesh, traditionally, transplanted (T.) Aman occupies the largest rice harvested area. The broadcasting Aman is mostly planted in deeply flooded lowland areas. The transplanted Aman crops are grown mostly under rainfed conditions (FAO, 2002). The population growth rate of Bangladesh is 2 million per year, and if the population increases at this rate, the total population will reach 215.4 million by 2050, when 44.6 MT of clean rice will be required (Kabir et al., 2015). An increase in total rice production is required to feed this ever-increasing population. Rice yield therefore, needs to be increased from the present 3.17 to 4.82 t/ha in 2050 (Kabir et al., 2015). At the same time, the total cultivable land is decreasing at a rate of more than 1% per year owing to the construction of industries, factories, houses, roads, and highways (Shelley, 2016). During this time total rice area will also shrink to 10.28 million hectares. Total Aman rice covers 55, 90, 340 hectares land with a production of 1, 34, 83, 437 metric tons (BBS, 2015). Aman rice previously contributed a major portion of total rice, but Boro is now the major contributor to total rice production in the country, despite Aman coverage area being greater.

Flash floods affect 24% of rainfed lowland Aman rice areas, mainly at the seedling stage. The unpredictable rainfall often affects Aman transplanting. Heavy rainfall and flood cause Aman crop damage at the seedling stage and also delay planting. Transplanted Aman usually suffers from water stress at the reproductive stage or at early ripening phases, reducing crop yield phases (Shelley, 2016). A crop growth simulation model showed a yield potential of 7.218 t/ha with early transplanting on 1 June, under low water stress during flowering and maturity stage, while high water stress during flowering, maturity, and both flowering and maturity stages results in yield reduction of 46%, 37%, and 73%, respectively (Mahmood et al., 2004). Late Aman faces low-temperature stress at the reproductive stage that causes increased spikelet sterility, subsequently decreasing yield (Nahar et al., 2009).

Among various package of production technologies transplanting dates play a pivotal role in the development of rice crop. Transplanting of modern varieties in the early T. Aman season is risky; on the other hand there are a few suitable T. Aman varieties for late plantation (Kumar and Jha, 2000). T. Aman, BRRI dhan49, was used in this study, which one derived from the successful crossing of the two lines BR4962-12-4-1 and IR33380-7-2-1-3. This variety is suitable for rainfed high and medium high land ecosystem in Bangladesh (BRRI, 2018). It is photo insensitive and its PH 100 cm, GD 135 days and early than BR11 another previous variety of T. Aman. This variety is good at yield than other local traditional T. Aman lines/genotypes (BRRI, 2018). These two advanced lines, BR(Bio)9786-BC2-119-1-1 and BR(Bio)9786-BC2-132-1-3 were derived from wide hybridization between mega variety of Boro season BRRI dhan29 and wild rice *Oryza rufipogon* (IRGC 103404) and two times backcrossing. Before releasing a variety it is very important to determine optimum time of transplanting date to get higher yield. The promising lines have high yield potentials to be selected by planting rice seeding under varied planting dates in a particular season. Therefore, considering the above facts, the present study was conducted to determine the optimum planting time of T. Aman advance rice lines with higher grain yield to select best advance line to release as variety.

MATERIALS AND METHODS

The experiment was conducted at BRRI farm, Gazipur in T. Aman 2016, to find out optimum transplanting date of two advanced lines. Advanced lines, BR(Bio)9786-BC2-119-1-1 and BR(Bio)9786-BC2-132-1-3 including the check variety BRRI dhan49. The experiment consisted of four transplanting dates viz. 01 August, 16 August, 31 August and 16 September. Twenty-five days old seedling was transplanted with 20 cm x 20 cm spacing and one seedling per hill. The experiment was laid down in split-plot design, where planting date was in the main plot and the advanced lines were in the sub-plot. Fertilizers were applied @76-12-52-12 kg ha⁻¹N-P-K-S, respectively. All fertilizers were applied during final land preparation but urea was applied as top dress in three equal splits at 10, 30 and 45 DAT (day after transplanting). The soil at the study site is of fine silty clay loam type. The location previously had a 3-season rice. The field was cleared and manually ploughed to provide for cultivation. Each plot was demarcated with a 40 cm walk way and a plot size of 3.2 m x 2.2 m.

Weeds were manually controlled (2 times) 20 days after sowing and at maximum tillering stage. Also, Durs ban was applied at 50 ml/16 liters at panicle initiation stage to control stem borer infestation within the field. At harvest, the middle portion of each plot (5 m²) was harvested and the grain weight (grain yield was reported at 14% moisture) represent the plot after drying (Saito *et al.*, 2006). Twenty five selected rice hills were sampled from inside the harvested area for measurement of plant height, panicle number, and number of tillers and averaged.

Data were collected on days to 50% flowering, plant height (PH), number of tillers per meter square, number of panicle per meter square, 1000-grain weight. Except for days to flowering, all other data were collected at harvest. Harvesting was undertaken within 5 months after planting when 50% of the crop had reached physiological maturity; PH was measured in cm while GW (grain weight) was taken in g using an electronic scale. Plant height (PH) was measured from the plant base to the topmost part with a tape measure. Statistical analysis was performed using statistics 10.0 software.

RESULTS AND DISCUSSIONS

Plant height

Transplanting date had a significant effect on plant height (Table 1). The highest plant height belonged to the third transplanting date with an average of 114 cm (Table 1). Plant height decline on the second transplanting date can be attributed to higher environmental temperatures during the reproductive stage, and the maturation period. The genotypes were significantly different in terms of plant height (Table 1). The highest plant height was observed in BR(Bio)9786-BC2-119-1-1 with an average of 119 cm (Table 2). The lowest plant height belonged to BRR1 dhan49 with an average of 102 cm (Table 2). Disregarding temperature, the difference between the genotypes was due to genetic differences. The interaction effects of transplanting date and genotypes were significant on plant height (Table 3). Genotypes, BR(Bio)9786-BC2-119-1-1 gave the highest plant height at all the transplanting date. And variety BRR1 dhan49 gave the lowest plant height at all the transplanting date (Table 3). Majority of rice farmers prefer tall plants to lessen the burden of slouching to cut the panicles with a knife during harvesting. However, extremely tall rice cultivar have a propensity to lodge, particularly, under stormy conditions; hence high yielding, relatively medium height and improved rice cultivars or their interspecific hybrids are recommended by Soares *et al.*, (2014).

Number of tillers

Transplanting date had a significant effect on number of tiller (Table 1). The highest number of tiller per meter belonged to the second transplanting date with an average of 230 (Table 1). Number of tiller decline on the forth transplanting date can be attributed to higher environmental temperatures during the reproductive stage and the maturation period. The genotypes were significantly different in terms of number of tiller (Table 2). The highest number of tiller was observed in BR(Bio)9786-BC2-119-1-1 with an average of 223 (Table 2). The lowest number of tiller belonged to BRR1 dhan49 with an average of 217 (Table 2). Disregarding temperature, the difference between the genotypes was due to genetic differences. The interaction effects of transplanting date and genotypes were significant on number of tiller (Table 3). Genotypes, BR(Bio)9786-BC2-119-1-1 gave the highest number of tiller at all the transplanting date. And variety, BRR1 dhan49 gave the lowest number of tiller at all the transplanting date (Table 3).

Grain yield

Transplanting date was significantly affected on grain yield (Table 1). The highest grain yield belonged to the third transplanting date with an range of 6.00-5.08 t ha⁻¹. The reason can be attributed to the suitable growth season duration, coincidence of the phenological stages- especially the heading and grain filling stages- with day length and temperature more favorable and positive influence of temperature on dynamic formation of the yield components, and ultimately, the generation of active sinks in addition to the higher dry matter accumulation capacity. Grain yield in forth transplanting date declined due to panicle shedding, low dry matter production and the presence of reduction of grain per panicle (Table 1). The results were in accordance with the findings of Noorbakhshian, (2003), Pirdashti *et al.*, (2003) and Gines *et al.*, (1987). There was a significant difference among the genotype and variety in terms of grain yield (Table 2). The highest grain yield

was obtained for BR (Bio) 9786-BC2-119-1-1 and BR (Bio) 9786-BC2-132-1-3 genotypes with 6.63 t ha⁻¹ and 6.02 t ha⁻¹; the lowest amount was observed for BRR1 dhan49 with 5.45 t ha⁻¹. This disparity was caused by the difference between genotypes in terms of the growth period duration, panicle emergence time, and fertility rate, the number of grains per panicle, the 1000 grains weight, and heat-sensitivity level (Table 2). These results were in agreement with the findings of Kawakata and Yajima (1995) and Yoshida (1978) who suggested a determining role for temperature and day duration on panicle emergence and their impacts on physiological, growth and maturity processes and finally, on the highest grain yield. The interaction effect of transplanting date and genotypes was significant on grain yield (Table 3). The highest and lowest rice grain yield were observed in the first transplanting date for BR(Bio)9786-BC2-119-1-1 with 6.63 t ha⁻¹ and BRR1 dhan49 with 5.45 t ha⁻¹ respectively (Table 3). All genotypes exhibited their highest yield at first transplanting date and their lowest yield at forth transplanting date. Excessive heat during the pollination period and grain filling stage caused disorder in grain formation and grain weight which reduced the grain yield.

Table 1. Mean comparison results of yield and yield components

Treatments	Plant Height (cm)	Tiller/m ²	Panicle/m ²	Grain/panicle	1000 grain weight	Grain yield(t/ha)
Transplanting date						
TD1	111	228	219	120	23.37	6.03
TD2	110	230	217	118	23.41	5.94
TD3	114	226	214	114	23.04	5.61
TD4	112	200	176	86	23.39	3.73
CV%	6.51	8.90	6.82	6.33	2.82	2.86
Lsd (0.05)	3.5	7.6	12.9	9.1	0.15	0.12

Table 2. Mean comparison results of yield and yield components

Treatments	Plant Height (cm)	Tiller/m ²	Panicle/m ²	Grain/ panicle	1000 grain weight	Grain yield(t/ha)
Genotypes/ variety						
V1	119	224	207	111	24.97	5.70
V2	115	222	204	107	24.12	5.35
V3	102	217	209	110	20.79	4.93
CV%	6.51	8.90	6.82	6.33	2.82	2.86
Lsd (0.05)	2.4	6.8	6.1	5.5	0.20	0.14

Number of grains

Transplanting date was significantly influenced the number of grains per panicle (Table 1). The highest and lowest number of grains per panicle respectively belonged to the first and forth transplanting dates (Table 1). Note that grains number in panicle is affected by factors such as panicle growth conditions and the formation of its components including primary and secondary branches and florets before emergence and also panicle fertility rate and photosynthetic products supply during the maturity period. Thus, it seems that due to thermal conditions, lower weight and more panicles infertility and further competition for absorbing photosynthetic products were among the causes of reduction in the number of filled grains per panicle on the

first transplanting date. The results are similar the findings of Butler *et al.*, (2002) and Shah and Bhurer (2005). There was a significant difference among the genotypes and check variety in terms of the number of grains (Table 2). The highest number was achieved for BR(Bio)9786-BC2-119-1-1 (Table 2). This arises from the genetic difference and different genotypes responses to environmental conditions. The obtained results were in accordance with reports by Yoshida and Parao (1976) about the determining impact of rice cultivar potential and environmental conditions on the number of filled grains per panicle. The interaction effects of transplanting date and genotypes/variety were significant on the number of grains per panicle (Table 3). The highest number of filled grains was obtained for BR(Bio)9786-BC2-119-1-1 genotype than check variety BRRI dhan49 on the first planting date (Table 3). The decrease in the number of grains on the forth planting date resulted from factors such as higher temperature during the maturity and grain filling stages besides the lower number of fertile florets and disorder in provision of the required photosynthetic matters. The results were in line with reports by Yoshida (1981) concerning the contribution of climatic conditions to the number of filled grains during meiosis division time, the heading stage and maturity period.

Table 3. Mean comparison results of yield and yield components

Treatments	Plant Height	Tiller/m ²	Panicle/m ²	Grain/panicle	1000 grain weight	Grain yield(t/ha)
TD1V1	120	233	222	122	25.00	6.63
TD1V2	117	228	217	117	24.16	6.02
TD1V3	98	224	220	121	20.95	5.45
TD2V1	119	232	216	120	25.01	6.40
TD2V2	116	234	216	116	24.36	6.00
TD2V3	96	225	219	120	20.86	5.44
TD3V1	119	229	217	114	24.80	6.00
TD3V2	115	224	215	111	23.89	5.75
TD3V3	110	225	212	118	20.38	5.08
TD4V1	118	201	175	90	25.10	3.77
TD4V2	114	202	170	86	24.09	3.66
TD4V3	105	196	185	83	21.00	3.75
CV%	6.51	8.90	6.82	6.33	2.82	2.86
Lsd (0.05)	7.1	19.32	17.9	16.2	0.56	0.26

Table 4. Effect of transplanting date on growth duration of advanced lines/varieties in T. Aman rice

Advanced lines/varieties	Growth Duration			
	1 Aug.	16 Aug.	31 Aug	16 Sep.
BR(Bio)9786-BC2-119-1-1	134	131	130	140
BR(Bio)9786-BC2-132-1-3	133	134	132	141
BRRI dhan49(ck)	136	135	130	146

Number of panicles

Transplanting date was affected the number of panicles significantly (Table 1). The highest number of panicles per square meter belonged to the first, second and third dates with averages of 219, 217 and 214 respectively. On the first second and third transplanting dates, temperature contribution to stimulate panicles increased the number of panicles and they eventually became fertile panicles. The number of panicles decreased due to temperature reduction on the forth planting date. The results conformed to those obtained

by Rakesh and Sharma (2004). The genotypes had significant different numbers of panicles per square meter (Table 2). The highest and lowest numbers of panicles were respectively achieved for BR(Bio)9786-BC2-119-1-1 and BRR1 dhan49 variety (Table 2). Different numbers of panicles might result from genetic differences. The interaction effect of transplanting date and genotypes was significantly effective on the number of panicles per square meter (Table 3). The maximum was obtained for BR(Bio)9786-BC2-119-1-1 on the first planting date with an average of 222 panicles per square meter (Table 3). The interaction effect of genotypes and transplanting date showed that the lowest number of panicles was found on the fourth transplanting date for all genotypes and check variety. The panicles capacity of rice genotypes and variety reduced the number of panicles due to shortened the panicle period duration owing to lowering of temperature particularly the irrigation water temperature on the fourth transplanting date. The results were aligned with the findings by Yoshida (1981) and Xu *et al.*, (1997) concerning the influences of environmental temperature, water temperature in particular, and some other environmental factors.

1000-grains weight

The transplanting date effect was significant on the 1000-grain weight (Table 1). The highest value of the 1000-grain weight belonged to the second, fourth and first transplanting dates with averages of 23.41, 23.29 and 23.37 g (Table 1). Reduction in the 1000-grain weight on the third transplanting date was due to excessive environment heat since the time of panicle emergence and grain components formation and during grain filling duration. The results of this research were in accordance with the findings by Hashemi *et al.*, (1995). The genotypes were significantly different in terms of the 1000-grain weight (Table 2). The highest value was obtained for BR(Bio)9786-BC2-119-1-1 with an average of 24.97 g than the check variety BRR1 dhan49. Ostensibly, this condition is caused due to the difference among the genotypes and variety in terms of the panicle emergence time, grain size, grain filling duration and the sensitivity level to high environmental temperatures (Table 2). These results were in good agreement with the findings of Zelifeh (1979) who reported that different impressibility of grain weight from temperature and also temperature effect on maturity period duration and final weight besides the relationship between grain size and the filling period. The interaction effects of transplanting date and genotypes/variety were significant on the 1000-grain weight (Table 3). The highest and lowest 1000-grain weight were reported for BR(Bio)9786-BC2-119-1-1 on the first transplanting date and BRR1 dhan49 on the second transplanting date (Table 3).

Growth duration

The highest growth duration (130-146 days) was observed for the check variety BRR1 dhan49 that followed by BR (Bio) 9786-BC2-132-1-3 (132-141 days) and BR(Bio)9786-BC2-119-1-1 (130-140 days).

CONCLUSION

The advanced lines, BR (Bio) 9786-BC2-119-1-1 and BR(Bio)9786-BC2-132-1-3 produced significantly highest grain yield than check variety BRR1 dhan49. The advanced line BR(Bio)9786-BC2-119-1-1 and BR(Bio)9786-BC2-132-1-3 produced about 1.0 and 0.57 t ha⁻¹ higher yield respectively over the check variety BRR1 dhan49 under the transplanting date 01 August to 31 August. The line BR(Bio)9786-BC2-119-1-1 had higher the number of panicles, the number of tillers, the number of grains per panicle, 1000-grain weight and grain yield than the check variety BRR1 dhan49. The highest growth duration (130-146 days) was observed for the check variety BRR1 dhan49 that followed by BR(Bio)9786-BC2-132-1-3 (132-141 days) and BR(Bio)9786-BC2-119-1-1 (130-140 days). Among the genotypes, the line BR(Bio)8214-23-1-3-1 may be considered as a good advanced line in T. Aman season for release as high yielding Aman variety.

CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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