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Effect of Transplanting Date on Growth and Yield of Hybrid and Inbreed Rice

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ABSTRACT

An experiment was conducted in the Experimental Field of Sher-e-Bangla Agricultural University, Dhaka to find out the effect of transplanting date on the growth and yield of hybrid and inbred rice. The experiment was carried out from November 2021 to April 2022. It comprised two factors *viz*, factor A: Varieties (Heera dhan2, BRRI dhan84, and BRRI dhan89) and factor B: Dates of transplanting (01 January, 15 January, 30 January, and 15 February). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were collected on different aspects of growth, yield attributes, and yield. Regarding the interaction of variety and date of transplanting, the interaction of V_1T_1 (Heera dhan2 transplanted on 1st January) was the highest yielder (5.82 tha^{-1}) among the other interactions, which was attributed to higher 1000-grain weight. The above result suggested and concluded that Heera dhan2 transplanting on 1st January provided the higher yield.

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Introduction

Rice (*Oryza sativa* L.) is the 2nd most important cereal crop after wheat in the world. It meets 21% of the world's calorie needs and is a vital source of nutrition and energy for those living in the Asia-Pacific area (Zhao *et al*., 2020). USDA (2023) estimated that there were about 165 million hectares of rice-cultivated land globally in crop year 2022, with a total yield of 513.68 million tons. Rice which is the driving force of Bangladesh agriculture occupies about two-thirds of the cultivated land area and constitutes 90% of the food grain production in Bangladesh (BBS, 2020). Bangladesh is the third-largest rice producer in the world. Bangladesh produces 37.96 million tons of rice on an area of around 11.70 million hectares (FAO, 2022). It is vital to Bangladesh's economy, making a major contribution to both the GDP and food supply. It particularly demonstrates Bangladesh's independence (Mainuddin and Kirby, 2015; Timsina *et al*., 2018). This claim is further supported by the per capita consumption, which is 179.9 kg year compared to the global average of 53.5 kg annually (FAO, 2020). A cereal crop that is widely farmed in Bangladesh, rice helps to generate employment opportunities and increases farmer income (Sarker *et al*., 2012; Alam *et al*., 2016). Bangladesh is a densely populated country and at present its population growth rate is 1.1% (BBS, 2022) Rice crop area is decreasing day by day due to high population pressure. Therefore, attempts should be taken to increase the yield per unit area by cultivating hybrid and inbred varieties and proper management. In general, hybrids are more vigorous and larger in size than the parent stock. Hybrid rice has a great capacity for tillering. In the early and intermediate growth stages of vegetative growth, hybrid rice collects more dry matter, which produces more panicle^{-1} spikelet. They have more spikelet in panicle^{-1} and larger panicles. These elements produce what is known as inbred rice, which often produces 15% or more than regular rice. BRRI has developed 113 high yielding rice varieties including one hundred five inbred and eight hybrids. Moreover, these varieties are cultivated in about 80 percent of the total rice areas and contribute almost 91 percent of total rice production of the country. Date of transplanting involves planting different fields within a community or farm over a number of weeks instead of planting every field at once over the course of a week or less. Staggered planting of rice seedlings with varying ages is the practice of using seedlings from the same source that are planted at the best time and then at separate times. A higher rice yield is guaranteed when healthy seedlings at the ideal age are transplanted. For rice to establish a uniform stand, the age of the seedling at transplanting is a crucial element (Ginigaddara, and Ranamukhaarachchi, 2011). The yield components and rice yield are influenced by the age of the seedling (Amin and Haque, 2009 and Faghani *et al*., 2011). The planting time of rice crops is crucial due to the variety's differences in duration, photosensitivity, thermo sensitivity, and vegetative lag period. Longer-duration variety may not perform better in late planting conditions, although photo- and thermo-insensitive cultivars may perform better in normal to late planting conditions with minimal impact on crop production. The extent of reduction in yield under late transplanting may be differ with their duration (Ram *et al*., 2005). Grain yield is also influenced by the timing of transplantation; delayed transplanting has been shown to reduce rice output (Arora *et al*., 2006).When comparing early transplanting dates to late transplanted crops, there was a substantial difference in the growth metrics such as plant height, tillers/clump, leaf area index (LAI), dry matter output, and crop growth rate (Nila *et al*. 2018; and Roy *et al*. 2019). The number of days to 50% flowering rose as seedling age grew. The main reasons for the rice yield improvement of 12-15% using staggered transplanting over normal transplanting methods were improved panicle development and tillering. Staggered transplanting enhanced biomass accumulation and raised grain filling rates, both of which contributed to overall yield increases. The findings of Mobasser *et al*. (2007), significant tiller buds on the lower nodes of the main culm degenerate when seedlings remain longer time in the nursery beds, which reduces the number of tillers produced. When seedlings are transplanted at the appropriate time, tillering and growth occur naturally.

Adjustment of specific crop growth stage with specific climatic conditions helps to ensure higher yield. Shifting of planting date is the most important option for adjustment of specific crop growth stage with specific climatic conditions. Furthermore, changing the planting date has a significant impact on the phasic development and partitioning of dry matter since it directly affects the thermal and photo periods (Patel *et al*., 2019). By staggering the transplanting of rice seedlings, farmers can better adapt to unpredictable weather patterns, mitigate the risk of crop failure, and optimize resource utilization for sustainable rice production. Among the cultivation techniques, optimal seedling age is one of the key elements of cultivation techniques which might result in enhanced growth, development, and yield. There is a lot of research data on different hybrid and inbred rice varieties, however, there is limited information available on interaction of the staggered transplanting and different hybrid (Heera dhan-2) and inbred (BRRI Dhan-84, BRRI Dhan-89) varieties. Considering the above facts, the current study was undertaken to carry out with the following objectives: to compare the performance of hybrid and inbred rice under the varying seedling age at staggered transplanting and to ascertain the impact of seedling age at staggered transplanting on growth variables, yield and yield components of hybrid and inbred rice.

Materials and methods

The trial was carried out during the period of November, 2021 to April, 2022. The current experiment was carried out in Sher-e-Bangla Agricultural University's experimental field. The site was located at 23.077' N latitude, 90.035' E longitude, and 8.2 meters above sea level (Anon., 2004). The area of the experimental region is situated in the sub-tropical climatic zone and is characterized by low temperature and ample sunshine from November to February during Rabi season covering October to March. The soil of the experimental field belonged to “The Madhupur Tract”, AEZ-28.

Rice varieties were Heera dhan-2, BRRI dhan 89, BRRI dhan 84 were used as the test crop in this experiment. The experiment consisted of two factors. Factor A: Planting time; T_1 =1st January, T_2 = 15th January, T_3 = 30th January, T_4 = 15th February and factor B: Varieties; V_1 = Heera dhan-2, V_2 = BRRI dhan 84, V_3 = BRRI dhan 89. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Seeds of BRRI Dhan 89, Heera dhan-2, BRRI dhan 84 were collected from BRRI (Bangladesh Rice Research Institute).

The nursery bed was prepared by puddling with repeated plowing followed by laddering. On November 02, 2021 the sprouted seeds were uniformly spread on the beds. When necessary, gentle irrigation was applied to the bed. Fertilizer was not used in the nursery bed. The specified amount of cow-dung, poultry manure, and triple super phosphate, muriate of potash, gypsum, and zinc sulphate were applied at final land preparation. Urea was applied in three equal splits, at 15, 35, and 50 days after transplanting (DAT). Seedlings were transplanted on the well-puddled experimental plots following a staggering of transplanting on 1st January, 15th January, and 30th January, 15th February of 2022 with the spacing of 20 × 15 cm. To ensure proper growth and development, intercultural operations were provided. When necessary, plant protection measures were undertaken. When 80-90% of the grains had changed to a straw color, the crop was considered fully mature and ready for harvest. Different growth and yield data were collected such as plant height, number of tillers hill^{-1}, and number of effective tillers (panicles) hill^{-1}, panicle length, filled grains panicle^{-1}, unfilled grains panicle^{-1}, weight of 1000-grains, grain yield, and straw yield.

The data obtained for different characters were statistically analyzed to observe the significant difference among different treatments. With the aid of the computer program named Statistix 10 data analysis software, the collected data were statistically analysed using the analysis of variance (ANOVA) technique. The mean differences were then adjusted using the Least Significant Difference (LSD) test at the 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Plant height

Effect of variety and date of transplanting showed a significant variation on plant height of rice at 60 DAT and 90 DAT (Table 1). At 60 DAT and 90 DAT the highest plant height (98.84 cm and 123.15 cm,) was observed from the Heera dhan-2 transplanting on 1st january treatment and the lowest plant height (76.18 cm and 90.17 cm) was observed from V_2T_4 treatment. The variation is due to varietal characters and also late transplanting. Late transplanting means adverse temperature and it leads to a short vegetative growth period which might have affected the plant height.

Tillers hill-1

Effect of varieties and date of transplanting showed a significant variation on the number of tillers hill^{-1} of boro rice at 60 and 90 DAT (Table 1). At 60 DAT and 90 DAT, the highest number of tillers hill^{-1} (14.56 and 19.49) was observed from the Heera dhan-2 transplanting on 1st January treatment respectively and the lowest (10.50 and 11.36) was observed from V_2T_4 treatment.

Table 1. Combined effect of variety and date of transplanting on plant height and tiller number per hill at different days after transplanting (DAT)

Treatment	Plant height		Number of total tiller hill-1	
	60 DAT	90 DAT	60 DAT	90 DAT
V_1 T_1	98.84 a	123.15 a	14.56 a	19.49 a
V_1 T_2	92.26 bc	121.51 a	13.08 bc	16.67 bc
V_1 T_3	87.22 cd	116.67 bc	13.26 b	14.89 d-f
V_1 T_4	83.47 de	113.24 bd	12.61 b-d	13.16 e-g
V_2 T_1	80.19 fg	102.27 fg	11.85 c-e	15.13 c-f
V_2 T_2	85.86 d	98.78 hi	11.50 d-f	14.01 d-f
V_2 T_3	88.47 c	91.37 i	10.66 ef	12.63 fg
V_2 T_4	76.18 g	90.17 i	10.50 f	11.36 g
V_3 T_1	86.86 d	107.53 de	11.53 d-f	13.83 c-e
V_3 T_2	88.71 c	115.32 c	12.49 b-d	16.10 b-d
V_3 T_3	94.82 b	117.64 b	11.53 d-f	13.83 c-e
V_3 T_4	82.31 f	103.34 f	11.10 ef	13.15 d-f
LSD (0.05)	3.94	3.40	1.05	1.28
CV%	3.98	1.86	5.84	5.09

In a column means having a similar letter(s) are statistically identical and those having a dissimilar letter(s) differ significantly as per 0.05 level of probability.

Effective tillers hill-1

Interaction of varieties and date of transplanting showed significant variation in the number of effective tillers hill^{-1} of rice (Table 2). The highest number of effective tillers hill^{-1} (16.43) was observed from the Heera dhan-2 transplanting on 1st January) treatment which was statistically at par with V_1 T_2 (15.39) whereas, the lowest (11.32) was observed from BRRI dhan84 transplanting on 15 February.

Panicle length

Significant influence was observed on panicle length due to the different combination of varieties and the date of transplanting of boro rice (Table 2). The highest length of panicle (30.84 cm) was obtained from Heera dhan-2 when transplanting on 1st January. In contrast, the lowest number of panicle length (22.95 cm) was recorded from the treatment combination BRRI dhan84 when transplanting on 15 February.

Filled grains panicle^{-1}

Significant influence was observed on the number of filled grains panicle^{-1} due to the combination of variety and different dates of transplanting of hybred and inbred rice (table 2). The highest number of filled grains (132.18) panicle^{-1} was observed from V_1 T_1 which was statistically similar to V_3T_1 and V_1T_2 (120.75 and 122.46, respectively). Filled grains panicle^{-1} is one of the most important yield contributing parameters in the case of grains panicle^{-1}. In this study it was observed that Heera dhan-2 gave higher filled grains panicle^{-1} among the three varieties. These results were consistent with Kamal (2006) who also observed significant variation among the interaction effects of varieties and transplanting date.

Unfilled grains panicle^{-1}

The combination of variety and date of transplanting showed significant influence on the number of sterile or unfilled grains panicle^{-1} (Table 2). From the interaction of V_2 T_4 (BRRI dhan84 when transplanting on 15 February) the highest number of unfilled grain panicle^{-1} (31.07) was obtained whereas the lowest (10.73) was recorded from the interaction of V_1T_1 (Heera dhan-2 when transplanting on 1st january). Heera dhan-2 gave lower unfilled grains panicle^{-1} among the three varieties. On the other hand, 1st Janauary transplanting may enhance suitable condition to produce enough photosynthates to fill the grain and Heera dhan-2 produced the highest photosynthates for grain fillings. 15 February transplanting reduced the amount of assimilates of photosynthesis, transportation and storing of assimilates in the grain drastically reduced.

Table 2. Combined effect of variety and different date of transplanting on effective tillers hill-1, panicle length, filled grains panicle^{-1} and unfilled grains panicle^{-1} of rice

Treatment	Effective tillers hill-1 (no.)	Panicle length (cm)	Filled grains panicle-1 (no.)	Unfilled grains panicle-1 (no.)
V_1T_1	16.43 a	30.84 a	132.18 a	10.73 o
V_1T_2	15.39 a	28.32 b	122.46 a	13.90 mn
V_1T_3	14.09 c-e	27.64 bc	110.53 b	17.26 kl
V_1T_4	13.41 de	26.75 bc	99.45 bc	18.29 k
V_2T_1	13.45 bc	25.92 b-d	105.83 b	17.31 kl
V_2T_2	12.98 b-d	24.97 b-e	100.67 b	26.79 f
V_2T_3	12.05 c-e	23.86 de	90.55 c	27.89 b-e
V_2T_4	11.32 e	22.95 e	82.87 c	31.07 a
V_3T_1	15.10 a	27.27 b-d	120.75 a	13.93 mn
V_3T_2	14.03 b-d	26.57 b-d	112.53 b	16.10 l
V_3T_3	13.14 c-e	26.09 b-e	102.95 b	21.28 ij
V_3T_4	12.09 e	25.42 c-e	95.17 bc	24.60 gh
LSD (0.05)	1.36	2.26	17.54	1.03
CV%	6.05	5.08	6.56	2.94

In a column means having a similar letter(s) are statistically identical and those having a dissimilar letter(s) differ significantly as per 0.05 level of probability.

1000 grain weight

The thousand grain weight of hybrid and inbred rice is significantly influenced by the combined effect of variety and date of transplanting (table 3). The highest 1000-grain weight (24.88 g) was recorded from Heera dhan-2 when transplanting on 1st January. On the other hand, the lowest 1000-grain weight was obtained from BRRI dhan 84 when transplanting on 15 February treatment.

Grain yield

The grain yield was significantly influenced by the interaction of variety and the date of transplanting (table 3). The highest grain yield (5.82 t ha^{-1}) was obtained from Heera dhan-2 when transplanting on 1st January treatment. On the other hand, V_2T_4 showed the lowest result (3.53 t ha^{-1}) which was statistically similar to V_2T_3 (3.71 t ha^{-1}) and V_3T_4 (3.79 t ha^{-1}). Hossain and Sikdar (2009) found that all the cultivars gave the maximum grain yield when transplanted on 15 July. BRRI dhan 34 gave the highest yield (3.4 t ha^{-1}) when transplanted on 15 July. Kataribhog (2.73 t ha^{-1}), Radhunipagal (2.5 t ha^{-1}), Badshabhog (2.53 t ha^{-1}) and BRRI dhan 38 (2.77 t ha^{-1}) gave the highest yield on 15 July. A delay transplanting on 14 August reduced the yield compared with the transplanting on dates. Such a reduction was attributed mainly due to restricted tillering and crop growth.

Straw yield

The effect of the combination of variety and date of transplanting of straw yield of hybrid and inbred rice was significant (table 3).The highest straw yield (6.13 t ha^{-1}) was obtained from V_1T_1 (Heera dhan-2 when transplanting on 1st January) treatment which was statistically similar to V_3T_1 (5.72 tha^{-1}), V_1T_2 (5.68 tha^{-1}). On the other hand, V_2T_4 (BRRI dhan 84 when transplanting on 15 February) treatment showed the lowest result (4.28 t ha^{-1}). All the varieties have shown the lowest straw yield in 15 February planting.

Table 3. Combined effect of variety and different date of transplanting on 1000 grain weight, grain yield, and straw yield of rice

Treatment	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
V_1T_1	24.88 a	5.82 a	6.13 a
V_1T_2	24.14 a	5.27 b	5.68 a
V_1T_3	23.61 b	4.66 c-d	5.64 a
V_1T_4	22.91 bc	4.27 e	4.85 c
V_2T_1	23.74 ab	4.52 c-d	5.21 b
V_2T_2	23.00 ab	4.07 e	4.70 c
V_2T_3	22.46 bc	3.71 f	4.46 c
V_2T_4	21.01 c	3.53 f	4.28 d
V_3T_1	24.06 a	5.34 b	5.72 a
V_3T_2	23.32 ab	4.74 c-d	5.19 b
V_3T_3	22.79 bc	4.23 e	4.92 e
V_3T_4	21.89 bc	3.79 f	4.42 c
LSD (0.05)	1.93	0.46	0.63
CV%	5.79	5.85	7.02

In a column means having a similar letter(s) are statistically identical and those having a dissimilar letter(s) differ significantly as per 0.05 level of probability.

Conclusion

Considering the above result of this experiment the following conclusions can be drawn: Among the hybrid and inbred rice varieties, Heera dhan-2 gave a higher yield. The optimum transplanting date for higher grain yield of hybrid rice was 1st January.

Recommendations

The study might be conducted at the different Agro-ecological condition for the conformation of the result. Further study should be needed in different AEZ of Bangladesh for accuracy of the results obtained from the present experiment.

Conflict of Interest

There is no conflict of interest in this research article

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