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Research Article

Effect of different age of seedlings on the growth and yield performance of transplanted Aus rice variety

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ABSTRACT

An experiment was conducted in the Agriculture Field Laboratory, Noakhali Science and Technology University (NSTU) to evaluate the effects of age of seedlings on the yield and growth performance of transplanted Aus (T. Aus) rice variety from April 2019 to July 2019. The experiment was carried out assigning four age of seedlings (T1 = 22-day old, T2 = 24-day old, T3 = 27-day old, T4 = 30-day old) and two rice varieties (V1 = BRRI dhan83, V2 = BRRI dhan65). The experiment was laid out in a Randomized Complete Block Design with three replications. In case of variety, the highest plant height (102.108 cm), the highest grain yield (2.643 t/ha), and the highest harvest index (32.317%) were obtained in BRRI dhan83 where the lowest plant height (87.804 cm), the lowest grain yield (2.431 t/ha) and the lowest harvest index (32.068%) were obtained in BRRRI dhan65. The age of seedlings had significantly affected total tillers/hill, effective tillers/hill, panicle length in T. Aus rice variety. The highest plant height (98.16 cm), straw yield (6.122 t/ha), the maximum number of effective tillers/hill (15.347) were obtained in 24 days old seedlings. The highest grain yield (2.634 t/ha) was obtained from 27 days old seedlings, and highest harvest index (33.88%) was obtained from 22 days old seedlings. The lowest grain yield (2.429) was obtained from 24 days old seedlings, and the lowest panicle length (13.753 cm), harvest index (30.467%), and the minimum number of effective tillers/hill (13.753) were obtained from 30 days old seedlings. The lowest straw yield (5.075 t/ha) and plant height (93.16 cm) were obtained from 22 days old seedlings. In case of interaction, the highest plant height (104.667 cm) and the harvest index (34.86%) were observed in BRRI dhan83 at 27 days old seedlings. The highest straw yield (5.805 t/ha) was observed in BRRI dhan65 at 30 days old seedlings. The maximum number of effective tillers/hill (18.519) was observed in BRRI dhan83 at 24 days old seedlings. The highest grain yield (2.94 t/ha) was observed in BRRI dhan83 at 22 days old seedlings. The lowest plant height (80.67 cm) was observed in BRRI dhan65 at 27 days old seedlings. The minimum number of total tillers/hill (17.01) was observed in BRRI dhan83 at 22 days old seedlings; lowest panicle length (20.78 cm), minimum number of grains/panicle (68.07) were observed in BRRI dhan65 at 24 days old seedlings; 1000 grains weight (22.76 g), the lowest grain yield (2.18 t/ha) were observed in BRRI dhan83 at 24 days old seedlings; the lowest straw yield (4.54 t/ha) was observed in BRRI dhan65 at 22 days seedlings old and lowest harvest index (29.09%) were observed in BRRI dhan65 at 30 days old seedlings. Based on the above results, it may be concluded that almost all of the yield and yield contributing characters of T. Aus rice performed best under the interaction between age of seedlings 22 days old seedlings and the variety BRRI dhan85.

INTRODUCTION

Bangladesh is an agrarian country. About 76% of the people live in rural areas, and 47.5% of the total manpower is involved in agriculture. In Bangladesh, agriculture contributes 19.3% of the gross domestic product (GDP) of the country [1]. Bangladesh has a long history of rice cultivation. Rice is grown throughout the country except in the southeastern hilly areas. The agroclimatic conditions of the country are suitable for growing rice year-round. However, the national average rice yield is much lower (2.94 t/ha) than that of other rice-growing countries [2]. During the years 2017-18, in Bangladesh, rice covered an area of 11620 thousand hectares with a production of 36279 thousand metric tons. Boro rice covers 4862 thousand hectares with a production of 19576 thousand metric tons. Aman rice covers 5683 thousand hectares with a production of 13993 thousand metric tons. Aus rice covers 1075 thousand hectares with a production of 2710 thousand metric tons. Here we see that Boro rice contributes 54%, Aman rice 39%, and Aus rice contribute only 7% of total rice production. Aus rice cultivation is neglected in our country it occupied only 9% of total rice-growing area in 2017. Due to rapid population growth and urbanization, cultivated land is gradually decreasing, demanding increased output to keep pace with the population increase. In Bangladesh, the yield of the present high-yielding rice varieties has reached a plateau, and plant types with higher yield potential are now needed to overcome this yield stagnation and meet the demands of the ever-increasing population. Among the different components of agronomy packages for rice cultivation, the date of transplanting is one of the important factors as early or late planting the rice plants may face different types of abiotic stress.

Aus rice has been contributing to food production in addition to other two rice crops (Aman and Boro) until mid-1980s. Aus rice began to lose its importance as farmers slowly started shifting to cultivation of irrigated Boro rice encouraged by its higher yields. The acreage during the Aus season dwindled around 10 lakh ha now, in 30 lakh ha in early 1980s. The word Aus has been derived in the Sanscrit Ashu meaning quick or early. Its life span is very short, only 90-120 days where Boro rice requires 150-200 days. Aus rice is grown under rain-fed conditions where water is not controlled by levees around the land. The topography varies mainly in highland to medium highland and requires less irrigation because of monsoon during its growth period. The Aus crop has to encounter a lot of adverse conditions. The season starts with scorching sun with sporadic drought at the beginning. Some years

the field goes so dry having no rain for few months before sowing. By nature, the Aus rice is tolerant to drought at the vegetative stage and high temperature at the reproductive stage.

The reason behind the falling of Aus rice production is unavailability of land as its seed sowing or transplanting period falls during the March and April months when Boro rice remains in the field. Farmers are not getting enough time and land to grow Aus rice. Also, severe insect pest infestation and birds attack cause huge damage to yield in Aus season. Another important reason for low yield of rice is the age of seedlings that are used for cultivation. The yield of transplant Aus rice can be increased with improved cultivation practices like proper age of seedlings. The use of seedlings in the same source having the same sowing date first transplanted at optimum date and thereafter at different dates is termed as staggered planting of rice seedlings having different ages. Transplanting of healthy seedlings of optimum age ensures better rice yield. When seedlings are transplanted at right time, tillering and growth proceed normally. Seedlings age is an important factor due to its tremendous influence on plant height, tiller production, panicle length, grains per panicle and other yield contributing characters some short-duration T. Aus rice varieties (viz. BRRI dhan65, BRRI dhan83) are not only photo insensitive, but also salt-tolerant [3,4].

Choosing optimum date of transplanting for high-yielding cultivars occupies an important part of high production package [5]. Different authors used different planting dates to check contrasting temperature regimes, precipitation, and growth periods in various T. Aus rice varieties [6-8]. They concluded that late transplanting date coincided reproductive phase with temperature stress. But early planting could not be possible all the time due to existing cropping patterns, climate change, and socio-economic conditions. The study was undertaken to observe the performance, the effects of different planting dates, and the interaction effect of different T. Aus rice varieties in respect of yield. With the increasing rate of our population growth, we have to ensure proper utilization of land to increase rice production. In this case of optimum age of seedlings is an important factor.

MATERIALS AND METHODS

The experiment was carried out in the Agriculture Field Laboratory, Noakhali Science and Technology University, Noakhali during the period from April to July 2019. Particle size constitution of the soil of that site is Sand: Silt: Clay = 40%: 40%: 20%. The soil type is loam with organic matter (0.68%), with total nitrogen of 0.04 g/kg, available P of 27.79 µg/g, and available K of 0.18 meq/100 g soil with soil is pH value 7.5. The soil index was determined before rising of seedlings. The average annual temperature is 25.6°C and the average annual rainfall is about 3,302 mm.

The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The size of the unit plot was 3m × 2m with an area of 6m2. Each of the replications represented a block in the experiment. Four treatment combinations were randomly assigned in each replication. Thus, the total number of the plot was 24 (3×2×4) for this experiment. The density of plant (156 plants/plot) was maintained in between the replications and unit plot respectively.

This experiment was conducted using 2 Aus varieties viz. BRRI dhan83 (V1) and BRRI dhan65 (V2). There were four treatments including T1 = 22 days old seedlings (12th May), T2 = 24days old seedlings (14th May), T3 = 27 days old seedlings (17th May), T4 = 30 days old seedlings (20th May).

Seeds were collected from Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. The experimental land was first opened with a tractor. Later on, the land was prepared by plowing and repeated plowing and subsequently leveled by laddering. Pre-germinated seeds were broadcasted uniformly in a well-prepared nursery bed on 20 April 2019. The basal dose of fertilizer was Triple superphosphate (TSP), Muriate of potash (MoP), and Gypsum at every plot uniformly 7 days before transplanting through broadcasting at a rate of 100kg, 70 kg, 60 kg ha-1 respectively. Urea was applied at a rate of 150 kg ha^{-1} by top dressing in three equal splits at 15, 25, and 35 days after transplanting (DAT). Uprooted seedlings were transplanted in the unit plots on 12th May, 14th May, 17th May, and 20th May 2019 respectively maintaining spacing of 25 cm × 15 cm (row to row and plant to plant) at the rate of 2-3 seedlings per hill.

Hand weeding was done at 15 and 30 days after transplanting (DAT). Artificial irrigation (5-6 times) were provided to the field as extreme drought condition exists in this season. At the milky stage of rice, plants were found to be attacked by Rice Bug. To control insect Malathion 57 EC and Virtako as per recommended dose were used. Birds attacked severely at maturity stage. It creates serious trouble and causes serious yield loss although scarecrow was used, it reduced intensity but failed to stop bird attack completely.

Five hills (excluding border hills) were selected randomly in each unit plot and uprooted before harvesting for recording data. After sampling, the experimental crop of each plot was harvested when about 80% of the grains became golden yellow. The harvested crop of each unit area was separately bundled, properly tagged, and then brought to the threshing floor. The harvested crop was threshed by a pedal thrasher. Grains were then sun-dried at 14% moisture level and cleaned. Straws were also sun-dried properly. Finally, straw and grain yield per plot were recorded and converted to ton per hectare.

Analysis of variance was done with the help of MSTAT-C computer package program. The mean differences among the treatments were adjudged by DMRT test [9].

RESULTS

Effect of variety on growth and yield attributes of T. Aus rice

The two varieties differ significantly in every growth parameter except panicle length, grain yield, straw yield, and harvest index (Table 1). BRRI dhan83 showed a plant height of 102.108 cm where 87.804 cm plant height was observed in BRRI dhan65. According to BRRI fact sheet in optimum condition, the average plant height of BRRI dhan83 and BRRI dhan65 is respectively 100-105 cm and 90-95 cm [10,11]. The highest total number of tillers hill-1 (21.212) was found in BRRI dhan65 and total number of tillers hill-1 in BRRI dhan83 was 18.956. The highest number of effective tillers hill-1 (17.562) was found in BRRI dhan65 where effective tillers hill-1 of BRRI dhan83 was 11.342. Significant variations in number of effective tillers $hill^{-1}$ among the different varieties were also reported by Islam et al. [12]. The highest panicle length (22.688 cm), number of grains panicle-1 (104.177), sterile grains panicle-1 (42.667), and 1000 grains weight (26.573 gm) were obtained from BRRI dhan83 and the lowest panicle length (21.308 cm), number of grains $panicle^{-1}$ (83.497), sterile grains $panicle^{-1}$ (33.317) and 1000 grains weight (23.610 gm) were obtained from BRRI dhan65. Significant variation in panicle length, number of grains $panicle^{-1}$ and 1000 grains weight were also reported by Mondal et al. [13] among four Aus rice varieties. Varietal differences might be occurred due to differences in genetic constituents.

Grain yield, straw yield, and harvest index were significantly influenced by variety (Table 1). The grain yield of BRRI dhan83 was 2.643 t ha^{-1} and grain yield of BRRI dhan65 was 2.431 t ha^{-1}. The highest grain yield in BRRI dhan83 might be due to the result of highest number of grains panicle-1 and 1000 grains weight. The significant difference in grain yield might be due to the genetic characteristics of varieties. Extreme birds attack impedes this experiment to get satisfactory grain yield. Straw yield of BRRI dhan83 was significantly higher 5.490 t ha^{-1} than BRRI dhan65 (5.136 t ha^{-1}). The highest straw yield obtained from BRRI dhan83 might be due to the huge variation in tillers $hill^{-1}$ between two varieties. Harvest index of 32.317% was obtained from BRRI dhan83 where harvest index of BRRI dhan65 was 32.068%. Variety had a great influence on harvest index as reported by Tyeb et al. [14].

Effect of different seedlings age on growth and yield attributes of T. Aus rice

Different seedlings age had significant effect on 1000 grains weight but plant height, total number of tillers $hill^{-1}$, effective tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, and sterile grains $panicle^{-1}$ remained non-significant in this experiment (Table 2). The highest plant height (98.16cm) was found in 24 days age-old of seedlings and the lowest plant height (92.71cm) in 27 days old of seedlings. This might be due to the fact that optimum age of seedlings (which in this case was 24 days aged seedlings) helped crop to complete its vegetative phase in favorable climatic conditions. Sarkar et al. [15] recorded more plant height (130.60 cm) at harvest in case of 25 days old seedlings while minimum of 127.54 cm was observed when seedlings of 35 days were transplanted. It was investigated that seedlings of 14 days age produced taller plants (89.50 cm) at harvest compared to older seedlings of 21 days [15]. The total maximum number of tillers/hill (21.046) was found in 24 days age of seedlings and the minimum number (18.13) was found in 22 days age of seedlings. Faghani et al. [16] found the significant effect of seedlings age on tillering pattern, maximum tillers/hill (16.3) were recorded by transplanting 25 days old seedlings while 35 days seedlings gave minimum tillers/hill (15.3). It was observed that the highest number of effective tillers/hill (15.347) was found when 24 days old seedlings were transplanted. Lowest number of effective tillers/hill (13.756) was produced when 30 days old seedlings are transplanted. Ali et al. reported more effective tillers/hill (24.9) when seedlings of 15 days age were transplanted while 30 days old seedlings gave minimum number of effective tillers (15.6) [17] (Ali et al., 2013). Sarkar et al. did not find a significant effect of seedlings age on effective tillers/hill. They recorded 9.24 and 9.08 effective tillers/hill in case of 25- and 35-days old seedlings which were statistically same. It was observed that younger seedlings of 14 days age produced more productive tillers/m2 (501) as compared to older seedlings which gave minimum (401) productive tillers/m2 observed that 4 weeks old seedlings produced more effective tillers/hill (8.26) while minimum number of effective tillers was obtained in 2 weeks old seedling [15].

Table 1. Effect of variety on growth and yield attributes of T. Aus rice

Variety	Plant height (cm)	Total no. of tillers $hill^{-1}$	Effective tillers $hill^{-1}$	Panicle length (cm)	Number of grains $panicle^{-1}$	Sterile grains $panicle^{-1}$	1000 grains weight (gm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
BRRI dhan83 (V_1)	102.108	18.956	11.34 2	22.688	104.177	42.667	26.573	2.643	5.490	32.317
BRRI dhan65 (V_2)	87.804	21.212	17.562	21.308	83.497	33.317	23.610	2.431	5.136	32.068
C.V. (%)	9.96	29.32	22.29	5.89	28.01	24.99	6.52	23.03	15.92	12.83
Level of Significance	**	**	**	**	**	ns	**	ns	ns	*

**=Significant at 1% level of probability, * =Significant at 5% level of probability, ns = Non-significant.

Table 2. Effect of different seedlings age on growth and yield attributes of T. Aus rice

Treatments	Plant height (cm)	Total no. of tillers $hill^{-1}$	Effective tillers $hill^{-1}$	Panicle length (cm)	Number of grains $panicle^{-1}$	Sterile grains $panicle^{-1}$	1000 grains weight (gm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
22 days old seedlings (T1)	93.163	18.137	14.542	22.229	95.446	37.740	24.662	2.597	5.075	33.882
24 days old seedlings (T2)	98.165	21.046	15.347	21.634	83.352	37.932	25.853	2.429	5.268	31.460
27 days old seedlings (T3)	92.714	20.111	14.167	22.282	96.556	37.333	25.257	2.634	5.243	33.258
30 days old seedlings (T4)	95.781	21.043	13.753	21.848	99.994	38.963	24.617	2.486	5.665	30.4676
C.V. (%)	9.96	29.32	22.29	5.89	28.01	24.99	6.52	23.01	15.92	12.83
Level of Significance	ns	ns	ns	ns	ns	ns	*	*	ns	ns

**=Significant at 1% level of probability, * =Significant at 5% level of probability, ns = Non-significant.

It was observed that the longest panicle length (15.374) was found when 24 days old seedlings are transplanted. The shortest panicle length (13.753) was produced when 30 days old seedlings are transplanted. Sarkar et al. [15] found significant effect of seedling age of panicle length, they recorded more panicle length (27.98 cm) in seedlings of 25 days age while minimum (27.36 cm) in older seedlings of 35 days. The highest number of grains panicle^{-1} (99.994) was obtained on 30 days old seedlings and the lowest (83.354) was produced on 24 days old seedlings. Ali et al. reported the significant effect of seedling age on number of filled grains panicle^{-1}, maximum number of filled grains (188) was obtained by transplanting younger seedlings (15 days) while minimum number of filled grains (170) was recorded using older seedlings of 30 days age [17]. The highest number of sterile spikelets per panicle (38.963) was recorded at 30 days old and the lowest (37.333) was recorded at 27 days old. Rahimpour et al. [18] checked the effect of seedlings age on rice cultivars and found the significant effect of seedlings age on number of spikelets/panicle. Maximum number of spikelets (114.6) was recorded with the seedlings of 27 days age while minimum (106.4) was recorded in case of 30 days old seedlings. The highest 1000 grains weight (25.853 g) was recorded on 24 days old and the lowest (24.617 g) weight of thousand grain on 30 days old. Biswas and Salokhe [19] and Tari et al. [20] stated that appropriate time of transplanting resulted in higher 1000 grain weight. The highest grain yield of (2.597 t/ha) was recorded on 22 days old seedlings. The lowest (2.429 t/ha) yield was obtained on 24 days old seedlings. Brar et al. [21] also reported significant effect of seedling age on paddy yield. According to their finding's younger seedlings of 30 days age produced more grain yield (6.82 t/ha) as compared to older seedlings of 60 days which produced minimum grain yield (6.47t/ha). The highest straw yield (5.665 t/ha) was recorded on 30 days old seedlings. The lowest (5.075 t/ha) was obtained on 22 days old seedlings. The highest (33.882%) on 22 days old seedlings and the lowest (30.467%) on 30 days old seedlings. Ginigaddara and Ranamukhaarachchi [22] reported maximum harvest index (0.51%) by transplanting 9 days old seedlings.

Interaction effect of variety and different seedlings age on growth and yield attributes of T. Aus rice

Interaction between variety had significant effect only on 1000 grains weight (Table 3). Highest weight of thousand grains (27.41 gm) was found in 27 days old seedlings for BRRI dhan83 (T3V1) and the lowest 1000 grains weight (22.767 gm) was observed in 30 days old seedlings of BRRI dhan65 (T4V2). The tallest plant 104.667 cm was observed in BRRI dhan83 at 27 days old seedlings (T3V1) and the shortest plant 80.672 cm was observed from BRRI dhan65 at 27 days old seedlings (T3V2). The highest total number of tillers hill^{-1} (22.889) was observed in BRRI dhan65 at 30 days old seedlings (T4V2) and lowest total number of tillers hill^{-1} (17.018) was observed in BRRI dhan83 at 22 days old seedlings (T1V1). Effective tillers hill^{-1} was remained non-significant by the interaction between variety and different age of seedlings. The highest number of effective tillers hill^{-1} (18.519) was observed in BRRI dhan65 at 24 days old seedlings (T2V2) and lowest effective tillers hill^{-1} (10.222) was observed in BRRI dhan83 at 27 days old seedlings (T3V1). The highest length of panicle (23.522 cm) was observed in BRRI dhan83 at 27 days old seedlings (T3V1) and the lowest length of panicle (20.780 cm) was observed from BRRI dhan65 at 24 days old seedlings (T2V2). The highest number of grains panicle^{-1} (120.765) was observed in BRRI dhan83 both at 30 days old seedlings (T4V1) and the lowest grains panicle^{-1} (68.074) was observed from BRRI dhan65 at 24 days old seedlings (T2V2). The maximum number of sterile grains panicle^{-1} (47.704) was observed in BRRI dhan83 at 30 days old seedlings (T4V1) and the lowest grains panicle^{-1} (30.222) was observed from BRRI dhan65 at 30 days old seedlings (T4V2).

Maximum grain yield (2.940 t ha-1) was observed in BRRI dhan83 at pre-emergence herbicide (T1V1) application and the lowest grain yield (2.181 t ha-1) was observed at 24 days old seedlings in BRRI dhan83 (T2V1). The maximum straw yield (5.805 t ha-1) was observed in BRRI dhan65 at post-emergence herbicide application (T4V2) and the minimum straw yield (5.199 t ha-1) was observed at 27 days old seedlings in BRRI dhan65 (T3V2). The maximum harvest index (34.86%) was observed in BRRI dhan83 at pre-emergence herbicide (T3V1) application and the minimum harvest index (28.493%) was observed at 24 days old seedlings in BRRI dhan83 (T2V1).

Table 3. Interaction effect of variety and different seedlings age on growth and yield attributes of T. Aus rice.

Interactions	Plant height (cm)	Total no. of tillers hill^{-1}	Effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Sterile grains panicle^{-1}	1000 grains weight (gm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
T1V1	98.909	17.018	12.575	22.569	89.977	35.989	25.867	2.940	5.607	34.073
T1V2	87.416	19.257	16.347	21.890	100.914	39.490	23.267	2.255	4.542	33.097
T2V1	102.738	20.610	12.176	22.487	98.630	44.419	26.403	2.181	5.539	28.493
T2V2	93.593	21.481	18.519	20.780	68.074	31.444	25.303	2.677	4.997	34.427
T3V1	104.667	19.000	10.222	23.522	107.333	42.556	27.410	2.845	5.288	34.860
T3V2	80.672	21.222	18.111	23.520	85.778	32.111	23.103	2.424	5.199	31.657
T4V1	102.118	19.198	10.395	22.175	120.765	47.704	26.467	2.604	5.524	31.840
T4V2	89.444	22.889	17.111	21.522	79.222	30.222	22.767	2.368	5.805	29.093
C.V. (%)	9.96	29.32	22.29	5.89	28.01	24.99	6.52	23.01	15.92	12.83
Level of significance	ns	ns	ns	ns	ns	ns	*	ns	ns	ns

* =Significant at 5% level of probability, ns = Non-significant.

CONCLUSION

Age of seedlings are always important for plant growth and to produce more yield of different rice varieties. Farmers hardly follow the appropriate methods of selecting the age of seedlings for each different rice varieties that's why Aus rice production in Bangladesh still falling behind. Bangladesh can easily uplift her production by emphasizing more research work on Aus rice by undertaking a focus on the performance, the effects of different planting dates, and the interaction effect of different Aus rice varieties in respect of yield. In this study among the tested different T. Aus rice varieties, based on the results, it may be concluded that almost all of the yield and yield contributing characters of T. Aus rice performed best under the interaction between 22 days old seedlings and the BRRI dhan85 rice variety. This experiment was also interrupted by extreme birds attack at the maturity stage and so impedes to get the desired yield, otherwise, there was a possibility to obtain outstanding yield in Aus rice. So, it is one of the captivating topics for the enthusiast researchers of Bangladesh to find out the most efficient seedling age in Aus rice which will ensure an economic rice production. In Bangladesh few studies have attempted to this topic, however, to attain a final decision more research work on Aus rice with the same treatment should be done in different Agro-ecological Zones (AEZs) of Bangladesh.

Conflict of Interest

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

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