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ORIGINAL RESEARCH ARTICLE

Effect of age of seedlings on the performance of drought tolerant *Aman* rice cultivars

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ABSTRACT

An experiment was conducted at the Field Laboratory of the Department of Agriculture, Noakhali Science and Technology University (NSTU), Sonapur, Noakhali, from July 2017 to December 2017 to study the effect of variety and age of seedling on yield performance of drought tolerant transplant *aman* rice. The experiment consisted of three varieties viz. BINA dhan7, BRRI dhan56 and BRRI dhan71 and five different ages of seedling viz.15 days old, 20 days old, 25 days old, 30 days old, and 35 days old. The experimental design was randomized complete block design (RCBD) with three replications. Among the three varieties, BRRI dhan71 produced the highest grain yield (5.567 t ha^{-1}) and the lowest grain yield (4.975 t ha^{-1}) was obtained from BRRI dhan56. Among the five ages of seedlings, the highest grain yield (5.502 t ha^{-1}) was obtained from 35 days old seedling and the lowest grain yield (5.092 t ha^{-1}) was obtained from 15 days old seedling. In case of interaction between variety and spacing, the highest grain yield (5.723 t ha^{-1}) was obtained from BRRI dhan71 with 35 days old seedling and the lowest (4.730 t ha^{-1}) was obtained from BRRI dhan56 with 15 days old seedling. The result reveals that relatively older seedlings (35-days old) produce higher grain yield compared to the younger ones.

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INTRODUCTION

Bangladesh is an agro based country and most of the economic activities of this country depend on agriculture. Agriculture in Bangladesh is dominated by rice cultivation. Rice (*Oryza sativa* L.) is the major cereal crop and staple food of Bangladesh. It is the extensively cultivated crop for half of the world's population (FAO, 2010). On the basis of volume of production, *Aman* rice is the second largest rice crop in the country while *Boro* rice holds the first position. In the Financial Year 2015-16, the total *Aman* rice production has been estimated 1,34,83,437 metric tons which is 2.22% higher than that of the previous year and it covers 55,90,340 hectares of land area. In 2014-15, the total *Aman* rice production was 1, 31, 90, 163 metric tons. In the Financial Year 2015-16, the average yield rate of *Aman* rice has been estimated 2.412 metric tons per hectare which is 1.13% higher than that of last year (BBS, 2016).

When rainfall is normally low, Bangladesh experiences a dry period for several months in every year. However, in the pre-monsoon (March–May) and post-monsoon (October-November) periods, drought mostly affects this country. More than 40% damage to broadcast *Aus* can be caused due to a strong drought. It causes significant destruction to the trans-plant *aman* crop, during the kharif season, in approximately 2.32 million ha every year. In the rabi season, about 1.2 million ha of agricultural land face droughts of different magnitudes (Dey *et al*., 2011). In Bangladesh, unlike most of the rain-dependent rice varieties planted in the *aman* monsoon season occurring from

July to November, BINA dhan7, BRRI dhan56 and BRRI dhan71 remain healthy under drought, which can occur at the end of the season, because these varieties take a shorter time to mature than other popular local varieties.

Optimum age of seedling is an important factor in order to get maximum yield. When seedlings of optimum age are transplanted in the right time, it ensures proper tillering and normal growth of rice plant. Healthy seedlings of optimum age also give better rice yield. It also has an influence on plant height, panicle length, grains per panicle and other yield contributing characters. The general performance of crop is retarded due to the use of over aged seedlings and it also reduces the yield of crop (Bozorgi *et al*., 2011). Therefore, the present study was undertaken to determine the optimum age of seedlings for drought tolerant, short duration, high yielding *T. Aman* rice cultivars.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Field Laboratory of the Department of Agriculture, Noakhali Science and Technology University (NSTU), Sonapur, Noakhali, from the period from July 2017 to December 2017. The experimental field belongs to the agro-ecological zone of the Young Meghna Estuarine Floodplain (AEZ-18). The experiment field was almost level land having sandy loam soil and was moderately alkaline. The soils become saline in dry season.

Experimental treatments and design

The experiment consisted of three varieties viz. BINA dhan7, BRRI dhan56 and BRRI dhan71 and five different ages of seedling viz.15 days old, 20 days old, 25 days old, 30 days old, 35 days old. The experimental design was randomized complete block design (RCBD) with three replications. The size of the unit plot was 4.0 m × 2.5 m, having an area of 10 m^2. Fifteen treatment combinations were randomly assigned in each replication. Thus the total number of unit plot was 45. A spacing of 1.0 m and 0.5 m was maintained in between the replications and unit plot, respectively.

Experimental and field conditions

The collected seeds were soaked in the water for 24 hours. Then they were taken out of water, covered with wet gunny bags and kept for sprouting. After 48 hours the seeds were started sprouting and after 72 hours almost all seeds were sprouted. At the Field Laboratory of Department of Agriculture, NSTU, Noakhali, seedlings were raised in a well prepared nursery bed. A power tiller was used to open the experimental land. Later on, the land was prepared by ploughing and cross-ploughing and subsequently leveled by laddering. All weeds and stubble were removed from the land by hand. The field was fertilized with urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate at the rate of 180, 100, 60, 70 and 8 kg ha^{-1} respectively. The uprooting of seedlings was done carefully from the nursery bed. The nursery bed was slightly irrigated before uprooting the seedlings for easier uprooting. Uprooted seedlings were transplanted in the unit plots on 29th July (15 days old), 3rd August (20 days old), 8th August (25 days old), 13th August (30 days old) and 18th August (35 days old) 2017 respectively maintaining spacing of 25 cm × 15 cm (Row to row and Plant to plant) at the rate of 2-3 seedlings per hill. Weeding and gap filling was done as a part of intercultural operations in order to ensure and maintain the normal growth of the crop.

Data collection and analysis

The crop was harvested at full maturity. The date of harvesting was confirmed when 90% of the grain became golden yellow in color. For recording data, five hills (excluding border hills) were selected randomly from each unit plot. The harvested crop was threshed by 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. Data recorded for yield and yield contributing characters were compiled and tabulated in proper form for statistical analyses. MSTAT–C computer package programme developed by Russel (1986) was used to analyze the variance. Among the treatments, the mean differences were adjudged by DMRT test (Gomez and Gomez, 1984a, b).

RESULTS AND DISCUSSION

Effect of variety on yield and yield components of drought tolerant transplant *aman* rice

The effect of variety on yield and yield contributing characters of drought tolerant transplant *aman* rice has been presented in Table 1. The plant height was significantly influenced by varieties. The tallest plant (124.9cm) was obtained from BRRI dhan71 and the shortest (105.0cm) one was from BINA dhan7. Zubaer *et al*. (2007) and Uddin *et al*. (2010) also found variation in plant height due to the effect of varieties. This variation in plant height is probably due to the genetically make-up of the varieties. Number of total tillers $hill^{-1}$ was significantly influenced by varieties. The highest number of total tillers $hill^{-1}$ (13.79) was found in BINA dhan7 and the lowest number (10.04) was found in BRRI dhan71. Wu *et al*. (1998) noticed that total tillers $hill^{-1}$ differed significantly among the varieties in Aman season. Number of effective tillers $hill^{-1}$ was significantly influenced by varieties. The highest number of effective tillers $hill^{-1}$ (13.33) was found in BINA dhan7 and the lowest number (9.787) was observed in BRRI dhan71. Number of non-effective tillers $hill^{-1}$ was non-significantly influenced by varieties. The highest number of non-effective tillers $hill^{-1}$ (0.8200) was found in BRRI dhan56 and the lowest number (0.700) was observed in BINA dhan7. Significant differences in number of tillers $hill^{-1}$ in 17 rice varieties were found by Mondal *et al*. (2005). Differences in the production of total tillers and effective tillers $hill^{-1}$ might be due to genetic variation, physiological functions and growth characters of the cultivars under study (Islam *et al*., 2017). The panicle length was significantly influenced by variety. The

longest panicle (27.02 cm) was found in BRRI dhan71 and the shortest (25.58) was in BRRI dhan56. The number of grains panicle^{-1} was significantly affected by varieties. The highest (163.3) number of grains panicle^{-1} was obtained by BRRI dhan56 and the lowest (120.9) number of grains per panicle was recorded by BINA dhan7. Variety had significant effect on number of sterile spikelet panicle^{-1}. The highest (34.45) was recorded from BRRI dhan71 and the lowest number of sterile spikelet panicle^{-1} (21.28) was produced by BINA dhan7. Chowdhury *et al*. (1993) reported differences in number of sterile spikelets panicle^{-1} due to varietal differences.

Thousand grains weights is an important character which determines the yield per hectare. There was significant variation in number of 1000-grains weight. The highest 1000-grains weight (23.73 g) was recorded from BRRI dhan71 and the lowest (22.68 g) was recorded from BINA dhan7. Grain yield varied significantly among the varieties. BRRI dhan71 produced the highest grain yield (5.567 t ha^{-1}). The lowest grain yield (4.975 t ha^{-1}) was obtained from BRRI dhan56. Islam *et al.* (2017) also found significant variations in grain yield among the cultivars due to the effect of varieties. The variety had no significant effect on straw yield. The maximum straw yield (6.14 t ha^{1}) was obtained from BRRI dhan71 and the lowest straw yield (5.703 t ha^{-1}) was obtained from BINA dhan7. There was no significant variation among the varieties on harvest index. The highest harvest index (48.38 %) was obtained from BINA dhan7 and the lowest highest harvest (45.71%) was from BRRI dhan56.

Table 1. Effect of variety on yield and yield components of drought tolerant transplant *aman* rice.

Variety	Plant Height (cm)	Total tillers hill^{-1} (number)	Effect tillers hill^{-1} (number)	Non Effect tillers hill^{-1} (number)	Panicle^{-1} length (cm)	Grains panicle^{-1} (number)	Sterile spikelet panicle^{-1} (number)	1000 Grains weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
BINAdhan7	105.0 c	13.79 a	13.33 a	0.7000	25.89 b	120.9 b	21.28 c	22.68 b	5.327 a	5.703	48.38
BRRIdhan56	118.8 b	10.52 b	10.31 b	0.8200	25.58 b	163.3 a	28.57 b	22.70 b	4.975 b	6.020	45.71
BRRIdhan71	124.9 a	10.04 b	9.787 b	0.7667	27.02 a	156.4 a	34.45 a	23.73 a	5.567 a	6.140	47.73
LS	**	**	**	NS	**	**	**	**	**	NS	NS
CV (%)	6.31	9.29	9.36	29.39	2.92	13.25	27.43	2.56	6.58	11.61	5.48

Note: In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT) ** = Significant at 1% level of probability, NS= Not significant and LS= Level of significance.

Table 2. Effect of age of seedling on yield and yield components of drought tolerant transplant *aman* rice.

Age of seedlings	Plant Height (cm)	Total tillers hill^{-1} (number)	Effect tillers hill^{-1} (number)	Non Effect tillers hill^{-1} (number)	Panicle^{-1} length (cm)	Grains panicle^{-1} (number)	Sterile spikelet panicle^{-1} (number)	1000 Grains weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
15 days old	117.4	10.71 bc	10.42 bc	0.7889	25.03 c	143.6	25.38	22.94	5.092	5.833	46.65
20 days old	116.4	10.16 c	9.956 c	0.7444	26.23 b	149.3	25.98	22.96	5.254	5.917	47.21
25 days old	118.8	11.58 ab	11.31 ab	0.8111	27.02 a	146.2	34.33	22.80	5.290	6.122	46.50
30 days old	114.8	12.60 a	12.09 a	0.7667	26.09 b	145.1	28.84	22.99	5.309	6.050	46.99
35 days old	113.7	12.20 a	11.93 a	0.7000	26.44 ab	150.0	25.98	23.50	5.502	5.850	49.02
LS	NS	**	**	NS	**	NS	NS	NS	NS	NS	NS
CV (%)	6.31	9.29	9.36	29.39	2.92	13.25	27.43	2.56	6.58	11.61	5.48

Note: In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT) ** = Significant at 1% level of probability, NS= Not significant and LS= Level of significance.

Effect of age of seedling on yield and yield components of drought tolerant transplant *aman* rice

The effect of age of seedling on yield and yield components of drought tolerant transplant *aman* rice has been presented in Table 2. The plant height was not significantly influenced by the age of seedling of transplanting. Plant height was highest (118.8cm) in case of 25 days age of seedling of transplanting and lowest (113.7cm) in case of 35 days old. This might be due to the fact that optimum age of seedling of transplanting (which in this case was 25 days aged seedling) helped crop to complete its vegetative phase in favorable climatic condition. The number of total tillers hill^{-1} was significantly influenced by the age of seedling of transplanting. The number of total tillers hill^{-1} was highest (12.60) in case of 30 days age of seedling of transplanting and the lowest number (10.16) was found in case of 20 days age of seedling of transplanting. The result showed that relatively older seedlings produce more tiller than younger seedlings. Number of effective tillers hill^{-1} was significantly influenced by the age of seedling of transplanting. It was observed that the highest number of effective tillers hill^{-1}(12.09) was found when 30 days old seedlings are transplanted and the lowest number of effective tillers hill^{-1} (9.956) was produced when 20 days old seedlings were transplanted. Sarker *et al.* (2012) also found significant influence in total tillers hill^{-1} and effective tillers hill^{-1} due to the effect of age of seedling. Number of non-effective tillers hill^{-1}was not significantly influenced by the age of seedling of transplanting. It was observed that the highest number of non-effective tillers hill^{-1}(0.8111) was found when 25 days old seedlings were transplanted and the lowest number of non-effective tillers hill^{-1} (0.7000) was found when 35 days old seedlings were transplanted. The length of panicle was significantly influenced by age of seedling of transplanting. It was observed that the longest panicle (27.02) was found when 25 days old seedlings were transplanted and the shortest panicle (25.03) was found when 15 days old seedlings were transplanted. Sarker *et al.* (2012) reported that panicle length varied significantly due to the effect of age of seedling. The number of grains panicle^{-1}was not significantly affected by the age of seedling of transplanting. The highest number of grains panicle^{-1} (150.0) was obtained when 35 days old seedlings were transplanted and the lowest (143.6) was from 15 days old. Age of seedling had no significant effect on number of sterile spikelets panicle^{-1}. The highest number of sterile spikelets panicle^{-1} (34.33) was recorded in case of 25 days old seedling of transplanting and the lowest (25.38) was recorded in case of 15 days old seedling of transplanting. Weight of thousand grains was not significant influenced by the age of seedling. The highest 1000-grains weight (23.50 g) was recorded on 35 days old and the lowest1000-grains weight (22.94 g) was recorded on 15 days old. Mobasser *et al.* (2007) reported that seedlings age had no significant effect on grains panicle^{-1}, sterile spikelets panicle^{-1} and 1000-grains weight. Grain yield was not significantly affected by different ages of seedlings. The highest grain yield (5.502 t ha^{-1}) was recorded when 35 days old seedlings were transplanted and the second highest grain yield (5.309 t ha^{-1}) was recorded on 30 days old. The lowest grain yield (5.092 t ha^{-1}) was obtained when 15 days old seedlings were transplanted. Shahani *et al.* (1983), Chandra and Manna (1988), Ali and Rahman (1992) and Paul (1994) stated that age of seedlings had no significant effect on grain yield. Straw yield was not significantly affected by the age of seedlings. The highest straw yield (6.122 t ha^{-1}) was recorded from 25 days old seedlings of transplanting and the lowest (5.833 t ha^{1}) was obtained from 15 days old seedlings of transplanting. Age of seedlings had no significant effect on harvest index. The highest harvest index (49.02%) was from 35 days old seedling of transplanting and the lowest harvest index (46.50%) was from 25 days old seedling of transplanting.

Interaction effect of variety and age of seedlings on yield and yield components of drought tolerant transplant *aman* rice

The interaction effect of variety and age of seedlings on yield and yield contributing components of drought tolerant transplant *aman* rice has been presented in Table 3. Plant height was not significantly affected by the interaction between variety and age of seedling of transplanting. The tallest plant (127.3cm) was observed from BRRI dhan71 both at 20 days old and 25 days old and the shortest (101.9cm) plant height was observed from BINA dhan7 at 35 days old seedlings of transplanting. Number of total tillers hill^{-1}was not significantly affected by the interaction between variety and age of seedling of transplanting. Highest number of total tillers hill^{-1} (15.20) was observed in BINA dhan7 at 35 days of age of seedling of transplanting and the lowest number (8.800) was observed in BRRI dhan71 at 20 days old. Number of effective tillers hill^{-1}was not significantly affected by the interaction between variety and age of seedling of transplanting. Highest number of effective tillers hill^{-1} (14.80) was observed in BINA dhan7 when 35 days old seedlings were transplanted and the lowest number (8.733) was observed in BRRI dhan71 when 20 days old seedlings were transplanted. Number of non-effective tillers hill^{-1} was not-significantly affected by the interaction between variety and age of seedling of transplanting. Highest number of non-effective tillers hill^{-1} (1.000) was observed in BRRI dhan56 when 35 days old seedlings were transplanted and the lowest number (0.4333) was observed in BINA dhan7 when 35 days old seedlings were transplanted. The length of panicle was not significantly influenced by the interaction between variety and age of seedling of transplanting. It was observed that the longest panicle (28.17 cm) was found in BRRI dhan71 when 25 days old seedlings were transplanted and the lowest number (24.67 cm) was observed in BRRI dhan56 when 20 days old seedlings were transplanted. Non-significant variation was observed in number of filled grains per panicle due to interactional effect. The highest (174.7) number of grains per panicle was recorded in BRRI dhan56 with 35 days old seedlings and the lowest (108.3) was recorded in BINA dhan7 with 35 days old seedlings. There was no significant variation in the number of sterile spikelets panicle^{-1} due to the interactional effect. The highest number of sterile spikelets panicle^{-1} (43.13) was recorded in BRRI

dhan71 with 25 days old and the lowest number of sterile spikelets panicle^{-1} (17.07) was found in BINA dhan7 with 35 days old seedlings of transplanting. 1000-grains weight was not significantly influenced by the interaction of variety and age of seedlings. The highest (24.22 g) 1000-grains weight was recorded in BINA dhan7 with 35 days old and lowest (22.0 g) was recorded in BINA dhan7 with 20 days old seedlings of transplanting. The grain yield was not significantly influenced by the interaction of variety and age of seedlings. The highest grain yield (5.723 t ha^{-1}) was obtained from BRRI dhan71 with 35 days old and the lowest (4.730 t ha^{-1}) was obtained from BRRI dhan56 with 15 days old seedlings of transplanting. Effect of interaction of variety and age of seedlings on straw yield was not significant. The highest straw yield (6.750 t ha^{-1}) was recorded in BRRI dhan71 with 25 days old and the lowest (5.167 t ha^{-1}) was found in BRRI dhan56 with 25 days old seedlings of transplanting. Harvest index was not significantly influenced by the interaction between variety and age of seedling. The highest harvest index (52.10%) was obtained from BRRI dhan71 with 35 days old and the lowest (44.07%) was obtained from BRRI dhan56 with 15 days old seedlings of transplanting.

Table 3. Interaction effect of variety and age of seedlings on yield and yield components of drought tolerant transplant *aman* rice.

Interactions	Plant Height (cm)	Total tillers hill^{-1} (number)	Effect tillers hill^{-1} (number)	Non Effect tillers hill^{-1} (number)	Panicle^{-1} length (cm)	Grains panicle^{-1} (number)	Sterile spikelet panicle^{-1} (number)	1000 Grains weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
D_1V_1	104.6	12.93	12.60	0.7667	25.03	124.2	24.87	22.43	5.157	5.450	48.59
D_1V_2	122.2	10.00	9.733	0.8000	24.67	156.9	18.80	22.81	4.730	6.017	44.07
D_1V_3	125.5	9.200	8.933	0.8000	25.40	149.7	32.47	23.59	5.390	6.033	47.28
D_2V_1	104.9	11.13	10.80	0.7333	26.50	125.4	22.73	22.00	5.107	5.300	49.05
D_2V_2	117.1	10.53	10.33	0.8667	25.20	165.9	20.60	23.10	5.120	6.417	44.55
D_2V_3	127.3	8.800	8.733	0.6333	27.00	156.7	34.60	23.79	5.537	6.033	48.03
D_3V_1	109.0	14.93	14.47	0.7667	25.83	132.5	22.47	22.10	5.493	6.450	46.11
D_3V_2	120.1	10.20	10.00	0.7333	27.07	159.5	37.40	22.89	4.807	5.167	48.17
D_3V_3	127.3	9.600	9.467	0.9333	28.17	146.6	43.13	23.42	5.570	6.750	45.23
D_4V_1	104.7	14.73	14.00	0.8000	26.00	113.9	19.27	22.67	5.260	5.250	50.05
D_4V_2	118.9	11.27	10.87	0.7000	25.07	159.3	29.27	22.37	5.053	6.283	44.89
D_4V_3	120.6	11.80	11.40	0.8000	27.20	161.9	38.00	23.94	5.613	6.617	46.02
D_5V_1	101.9	15.20	14.80	0.4333	26.07	108.3	17.07	24.22	5.620	6.067	48.11
D_5V_2	115.5	10.60	10.60	1.000	25.90	174.7	36.80	22.35	5.163	6.217	46.85
D_5V_3	123.9	10.80	10.40	0.6667	27.35	167.0	24.07	23.93	5.723	5.267	52.10
LS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	6.31	9.29	9.36	29.39	2.92	13.25	27.43	2.56	6.58	11.61	5.48

Note: V_1=BINA dhan7, V_2= BRRI dhan56, V_3= BRRI dhan71, D_1=15 days old, D_2=20 days old, D_3=25 days old, D_4=30 days old and D_5=35 days old seedlings, NS= Not significant and LS= Level of significance.

Conclusion

The result indicated that most of the yield and yield contributing characters of drought-tolerant transplant *Aman* rice cultivars performed better when relatively older (35 days old) seedlings were transplanted. BRRI dhan71 with 35 days old seedlings produced the highest grain yield of 5.725 t ha^{-1} which was statistically identical to all other combinations used for this experiment including BINA dhan7 with 35 days old seedlings (5.620 t ha^{-1}) and BRRI dhan71 with 30 days old seedlings (5.613 t ha^{-1}). But, BRRI dhan71 with 35 days old seedlings performed well in the field throughout the whole growing period. Therefore, it can be concluded that 35 days old seedlings of BRRI dhan71 are the better choice to get maximum grain yield.

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