EFFECT OF ROW ARRANGEMENT, AGE OF TILLER SEEDLING AND NUMBER OF TILLER SEEDLINGS PER HILL ON PERFORMANCE OF TRANSPLANT AMAN RICE

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ABSTRACT

The experiment was conducted to observe the effect of row arrangement, age of tiller seedlings and number of tiller seedlings hill^{-1} on the vegetative characters, yield and yield contributing characters of transplant aman rice. The experiment consisted of three levels of row arrangement viz. single row (row spacing 25cm), double row (row spacing 25-10-25cm)and triple row (row spacing 25-10-10-25cm), two types of tiller seedlings viz. 25 days and 35 days old; and three levels of number of tiller seedling hill^{-1} viz. 2, 4 and 6 seedlings hill^{-1}. The experiment was laid out in a three factor Randomized Complete Block Design with three replications. The highest plant height, number of effective tillers hill^{-1}, effectivity index of tillers, number of grains panicle^{-1} and harvest index were found in single row arrangement compared to double and triple row arrangements but number of total spikelets panicle^{-1} and grain yield were highest in double row arrangement. The highest number of non-bearing tillers hill^{-1}, number of total tillers hill^{-1} and number of sterile spikelets panicle^{-1} were found in triple row arrangement compared to single and double row arrangements. The highest plant height, effectivity index of tillers, number of grains panicle^{-1}, grain yield, harvest index and sterility percentage were found by transplanting 25-day old tiller seedlings. Number of total tillers hill^{-1}, non-bearing tillers hill^{-1}, straw yield and sterility percentage were highest by transplanting 35-day old tiller seedlings. Plant height, harvest index, grain yield and panicle length were highest when 2 tiller seedlings were transplanted hill^{-1}. Number of total tillers hill^{-1} and number of non-bearing tillers hill^{-1} were highest when 6 tiller seedlings were transplanted hill^{-1}.Transplanting in single and double row arrangements emerged out as a promising practice. This practice improved yield of transplant aman rice. Twenty five day old tiller seedlings was found to be suitable in respect of grain yield and 2 tiller seedlings hill^{-1} appeared to be enough for the cultivation of transplant aman rice.

Key words: *Row arrangement, tiller seedling, transplant aman rice*

INTRODUCTION

Rice crop damages are very common in Bangladesh due to early or late floods. In flood prone areas, farmers cannot re-transplant the affected land due to unavailability of seedlings. If available, they are often too young or very old which give very low yield. It is essential to know the performance of separated tillers obtained from an unflooded land as seedlings for transplant aman (photosensitive, short day and rain fed transplanted rice grown in the rainy season) rice in flood affected land after the recession of flood water. This technique of transplanting of separated tillers may be a promising alternative for growing post-flood transplant aman rice (Mridha *et al*., 1991; Siddique *et al*., 1991). Biswas and Salokhe (2001) suggested that in some flood-prone lowlands, where the transplanted crop is damaged by natural hazards, vegetative propagation using tillers separated (maximum 4 tillers hill^{-1}) from the previously established

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transplanted crop is also reported that vegetative tillers gave a higher yield than nursery seedlings transplanted on the same date. Paul *et al*. (2002) reported that tillers can be separated at 25 or 35 days after transplanting (DAT) without hampering grain yield.

Row arrangement of transplant aman rice may have a remarkable influence on its growth and yield contributing characters. Age of tiller seedlings as like as normal seedlings also the important determinant of late transplanted rice cultivation. Optimum number of tiller seedlings may enable the rice plant to grow properly both in its aerial and underground parts by utilizing maximum radiant energy, nutrients, space, air, and water more efficiently, which ultimately may lead to enhancement of yield. For achieving improved higher yield unit^{-1} area, improved cultural practices like row arrangement, age of tiller seedlings, and number of seedlings hill^{-1} are very important for transplant aman rice especially under late transplanted condition.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University Mymensingh, Bangladesh. The experimental site belongs to the Sonatola Soil Series of Old Brahmaputa Floodplain (AEZ 9) having non calcareous dark grey floodplain soil. The land was medium high with sandy loam texture having pH 5.9-6.5. A modern high yielding variety of transplant aman rice BR23 (Dishari) was used as the test crop in the experiment. The experiment consisted of three levels of row arrangement viz. single row (row spacing 25cm), double row (row spacing 25-10-25cm), triple row (row spacing 25-10-10-25cm), two types of tiller seedlings viz. 25 days and 35 days old, and three levels of tiller seedling hill^{-1} viz. 2, 4 and 6 seedlings hill^{-1}. There were 18 treatment combinations. The experiment was laid out in a three factor Randomized Complete Block Design with three replications. The area of each unit plot was 4.0m x 2.5m. Tillers were separated from 25 and 35 days after transplanting from previously transplanted rice field and then transplanted in the main field according to experimental treatments. The experimental plots were fertilized with Urea, Triple Super phosphate (TSP), Muriate of Potash (MoP), Gypsum and Zinc sulphate at the rate of 200, 160, 140, 60 and 10kg ha^{-1}, respectively. The entire amounts of TSP, MoP, Gypsum and Zinc sulphate were applied at final land preparation. Urea was top dressed in three installments at 10 days after transplanting, tillering stage and panicle initiation (PI) stage. Yield components (effective tiller hill^{-1}, number of grains panicle^{-1} and thousand grain weight) were recorded from ten randomly selected hills in each unit plot from the sampling area excluding border rows. The crop was harvested at maturity from a harvest area of 2.5m x 2.0m in the middle portion of each unit plot. The grains and straws were sun dried and adjusted to 14% moisture. Yields of the sample area were the converted to ton per hectare. Sterility percentage, effectivity index and harvest index were calculated with the following formula.

Sterility of grain (%) = (Number of sterile spikelet panicle^{-1}/ Number of total spikelets panicle^{-1}) x100

Affectivity index (%) = (Number of effective tiller hill^{-1} /Number of total tiller hill^{-}1) x100

Harvest index (%) = (Grain yield/Biological yield) x 100Where, Biological yield = Grain yield + Straw yield

Data were analyzed using “Analysis of Variance Technique and the differences among treatment means were adjusted by Duncan’s Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Row arrangement

Plant height, number of effective tillers $hill^{-1}$ and number of non-bearing tillers $hill^{-1}$ were significantly affected by row arrangements. The tallest plant and number of effective tillers $hill^{-1}$ were found in single row arrangement while the shortest plant and the highest number of non-bearing tillers were found in triple row arrangement. Plant height and effective tillers $hill^{-1}$ in single row arrangement were similar to that of double row arrangement (Table 01 and Table 03). The lowest number of effective tillers $hill^{-1}$ was produced in triple row arrangement. Production of effective tillers $hill^{-1}$ decreased and the number of non-bearing tillers increased with the increase of number of rows $unit^{-1}$ area. Similar results were reported elsewhere (Karmakar *et al*., 2002; Paul *et al*., 2002; Dutta *et al*., 2003 and Hossain *et al*., 2003). Number of grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, total spikelets $panicle^{-1}$ and sterility percentage were also affected by row arrangements. More grains were found in double row arrangement, which was identical to single row arrangement. Triple row arrangement produced less number of grains $panicle^{-1}$ than double and single row arrangements. Maximum sterile spikelets $panicle^{-1}$ and higher sterility percentage were recorded in the triple row arrangement. Similar results were reported by Hossain *et al*. (2003). The highest number of total spikelets were found in double row arrangements which was identical to single row arrangement while less number of total spikelet $panicle^{-1}$ were produced in triple row arrangement (Table 03). In double and single row arrangements more effective tillers $hill^{-1}$ and grains $panicle^{-1}$ were produced due to availability of sufficient light, air, water and nutrients as plant population was lower than that of triple row arrangement. Competition among plants for various growth factors in the densely transplanted crop as in triple row arrangement resulted in slow growth of plant, reduction in the production of effective tillers $hill^{-1}$, increased non-bearing tillers $hill^{-1}$, reduced panicle length, less number of grains $panicle^{-1}$, maximum sterile spikelets $panicle^{-1}$ and thus increased sterility percentage. In the triple row arrangement, growth and yield parameters were adversely affected due to competition among the plants for space, light, air, water and nutrients. Harvest index was also significantly affected by row arrangements. The highest harvest index was found in single row arrangement. However, there was no significant difference in harvest index between single and double row arrangement. The lowest harvest index was found in triple row arrangement (Table 03). Harvest index could be increased when more conversion of biological matter to economic yield occurred. Here, there was no significant difference in grain yield and biological yield due to different row arrangements. Apparently, almost similar grain yield was obtained in single row and double row arrangements, but biological yield was increased in triple row arrangement. Therefore, decreased biological yield was the main reason for the increased of harvest index in the single row arrangement.

Age of tiller seedlings

Age of tiller seedlings an important determinant as like as nursery seedling for the production of transplant aman rice. Plant height at harvest, number of non-bearing tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$ and sterility percentage were affected by age of tiller seedlings. The tallest plant, the longest panicle and more number of grains $panicle^{-1}$ were found when age of tiller seedlings was 25 days compared to 35 days old seedlings. The non-bearing tillers and the highest sterility percentage was observed by transplanting 35-day old tiller seedlings while the lowest number was observed when 25-day old tiller seedlings were transplanted (Table 01). The tallest plant, the longest panicle and the highest number of grains panicle^{-1} were produced when 25-day old tiller seedlings were transplanted due to longer vegetative period. Plant height, panicle length and grains were decreased with the increase of age of tiller seedlings. Due to older tiller seedling (35 days) and short duration for vegetative period plants rapidly switched over to reproductive phase leaving behind many tillers non-bearing. Older tiller seedlings get less time for their proper vegetative development and rapidly entered into the reproductive phase producing shorter panicles, decreased number of grains panicle^{-1}and increased sterility percentage. Grain yield and straw yield were significantly influenced by the age of tiller seedlings. The highest grain yield was obtained when 25-day old tiller seedlings were transplanted compared to older seedlings. The highest straw yield was recorded when 35-day old tillers were planted (Table 03). The crop of 35-day old tiller seedlings received less time for their growth, development and filling of grains and resulted in the reduced grain yield. On the other hand, the crop of 25-day old tiller seedlings received relatively more time for their growth, development and grain filling and resulted in the increased grain yield. In this case the yield components were improved and sterility percentage was decreased which were mainly responsible for the improvement of grain yield. Findings of the experiment indicated that age of tiller seedling influenced tiller production, growth and grain formation of rice. Mejos and Pava (1980) reported no significant difference in number of effective tillers, number of grains panicle^{-1} and grain yield due to age of tillers seedlings. These results were contradictory to the present findings. They observed that the number of days to heading, flowering and maturity were significantly lower with increasing age of tiller seedling. Biswas *et al*. (1987) found the highest grain yield by transplanting tiller seedlings which were separated from mother plants 35 days after transplanting. BRRI (1988) reported that tiller could be separated at 30-40 days after transplanting (DAT). Paul *et al*. (2002) reported that cultivar BR23 appeared to be resistant to tiller separation and tillers could be separated at 25 or 35 DAT without hampering grain yield. Harvest index was also significantly influenced due to age of tiller seedlings. The highest harvest index was obtained when 25-day old tiller seedlings were planted while the lowest one was found in the crop of 35-day old tiller seedlings (Table 3). There was no significant difference in biological yield due to age of tiller seedlings. As there was a significant decrease in grain yield in the crop of 35-day old tiller seedlings compared to the crop of 25-day old tiller seedlings and as there was no significant decrease in biological yield due to age of tiller seedlings (Table 3), therefore, increase in grain yield was the main reason for the increase of harvest index in the crop of 25-day old tiller seedlings.

Number of tiller seedlings hill^{-1}

Plant height, non-bearing tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length, grains panicle^{-1} and grain yield were significantly influenced by number of tiller seedlings hill^{-1}. The tallest plant and highest number of non-bearing tillers hill^{-1} were found when 2 tiller seedlings hill^{-1} were planted. The shortest plant was found at 6 tiller seedlings hill^{-1}. However transplanting of 4 tiller seedlings hill^{-1} was as good as 6 tiller seedlings hill^{-1} in respect of plant height (Table 01). Plant height decreased with increasing the number of

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The lowest non-bearing tillers produced when 2 tiller seedlings hill^{-1} were transplanted. It was observed that increasing the number of tiller seedlings hill^{-1} increased the number of non-bearing tillers in transplant aman rice, number of tiller seedlings hill^{-1} is suggested to be decreased. Paul *et al*. (2002) reported that the highest number of effective tillers hill^{-} grains panicle^{-1} and grain yield were obtained when 2 tillers were kept hill^{-1} during tiller separation. The longest panicles were produced when 2 tiller seedlings hill^{-1} were transplanted. Panicle length was progressively reduced when number of tiller seedlings hill^{-1} was increased. The shorter panicles were produced in crops with 6 tiller seedlings hill^{-1} (Table 03). Karmakar *et al*. (2002) reported that length of panicle was reduced gradually with increasing number tiller seedling hill^{-1}. Intra-tiller seedling competition for various growth factors in a hill resulted in the reduced panicle length. The highest grain yield was obtained when 2 tiller seedlings were transplanted hill^{-1}. The lowest grain yield was obtained when 6 tiller seedlings were transplanted hill^{-1} (Table 03). However, 4 tiller seedlings was as good as 6 tiller seedlings hill^{-1}. Biswas and Salokhe (2002) reported that transplanting 2 clonal tillers hill^{-1} resulted in almost the same yield as 3 clonal tillers and 4 clonal tillers hill^{-1}. They also mentioned that higher densities of clonal tillers transplanted hill^{-1} gave lower panicle number and grain weight. Intra-tiller seedlings competition for nutrients, light, air and water in a hill resulted in the reduced grain yield when 6 tiller seedlings were transplanted hill^{-1}. Harvest index was also significantly affected by number of tiller seedlings hill^{-1}. The highest harvest index was found when 2 tiller seedlings were transplanted hill^{-1}. The lowest harvest index was found when 6 tiller seedlings were transplanted hill^{-1} which was identical to the crop of 4 tiller seedlings transplanted hill^{-1}. There was no significant difference in biological yield due to number of tiller seedlings hill^{-1} but significantly the highest grain yield was observed when 2 tiller seedlings were transplanted hill^{-1} compared to 4 tillers seedlings transplanted hill^{-1} compared to 4 tiller seedlings hill^{-1} and 6 tiller seedlings hill^{-1}. Therefore, increased grain yield was the main reason for the increase of harvest index when 2 tiller seedlings were transplanted hill^{-1}.

Plant density in transplant aman rice culture is contributed by the number of seedlings hill^{-1}. The number of tillers and their growth is greatly affected by both quantitatively and qualitatively by number of seedlings hill^{-1} and number of tiller seedling as well. The excess or least number of tiller seedlings hill^{-1} may adversely affect the normal physiological activities of the rice plant. When planted 6 tiller seedlings hill^{-1}, they produced higher number of tillers hill^{-1}resulting in mutual shading and lodging and thus favour the production of more straw instead of grain. The least number of tiller seedlings hill^{-1} may cause insufficient tiller growth thus keeping air, space and nutrients in soil.

Table 01. Effect of row arrangements, age of tiller seedlings and number of tiller seedlings hill^{-1} on the vegetative characters

Treatments	Plant height at harvest (cm)	Number of total tillers hill^{-1}	Number of non-bearing tillers hill^{-1}	Straw yield (t ha^{-1})
Row arrangements				
Single row	129.71a	12.72	3.24b	4.81
Double row	130.67a	13.08	3.37b	5.30
Triple row	126.83b	12.86	4.58a	5.51
Age of tiller seedlings				
25	130.60a	12.41b	3.17b	4.81b
35	127.54b	13.36a	4.28a	5.61a
Number of tiller seedlings hill^{-1}				
2	131.49a	12.50b	3.26b	4.98
4	127.95b	13.05a	4.05a	5.23
6	127.78b	13.10a	3.87a	5.43

Figures in a column under each factor of treatment having the same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT.

Table 02. Interaction between row arrangements and age of tiller seedlings on the vegetative characters

Row arrangement	Age of tiller seedlings (day)	Plant height at harvest (cm)	Number of total tillers hill^{-1}	Number of non-bearing tillers hill^{-1}	Straw yield (t ha^{-1})
Single row	25	131.45	12.47cd	2.91	4.23
	35	127.97	12.97bc	3.56	5.39
Double row	25	132.60	12.23d	2.64	4.46
	35	128.74	13.93a	4.10	5.73
Triple row	25	127.75	12.45bcd	3.97	5.35
	35	125.92	13.18b	5.19	5.72

Figures in a column under each parameter having the same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT.

Table 03. Effect of row arrangement, age of tiller seedlings and number of tiller seedlings hill^{-1} on the reproductive characters, yield and yield components of transplant aman rice

Treatments	Number of effective tillers hill^{-1}	Effectivity index of tillers (%)	Panicle length (cm)	Number of total spikelets panicle^{-1}	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	Sterility (%)	Weight of 1000 grains (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Row arrangement											
Single row	9.48a	74.80a	27.56	169.09ab	139.89a	29.20b	17.22b	3.85	3.85	8.66	0.45a
Double row	9.71a	74.63a	27.97	173.61a	143.58a	30.03b	17.36b	4.11	4.11	9.41	0.44a
Triple row	8.28b	64.64b	27.48	164.91b	131.19b	33.71a	20.49a	3.74	3.74	9.28	0.41b
Age of tiller seedlings											
25	9.24	74.67a	27.98a	170.79b	140.99a	29.79	17.47b	26.40	4.13a	8.94	0.46a
35	9.08	68.05b	27.36b	167.61a	135.44b	32.17	19.24a	25.98	3.68b	9.29	0.40b
Number of tiller seedlings hill^{-1}											
2	9.24	74.02	27.94a	170.67	141.08	29.59	17.39	26.41	4.21a	9.19	0.46a
4	9.01	69.33	27.85a	168.83	137.26	31.57	18.71	26.25	3.78b	9.01	0.42b
6	9.23	70.72	27.12b	168.10	136.32	31.78	18.96	25.92	3.72b	9.15	0.41b

Figures in a column under each factor of treatment having the same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT.

Table 04. Interaction between age of tiller seedlings and number of tiller seedlings hill^{-1} on the reproductive characters, yield and yield components of transplant aman rice

Age of tiller seedlings (Days)	Number of tiller seedlings hill^{-1}	Number of effective tillers hill^{-1}	Effectivity index of tillers (%)	Panicle length (cm)	Number of total spikelets panicle^{-1}	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	Sterility (%)	Weight of 1000 grains (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
25	2	8.89	74.58	27.85ab	17.84	142.87	28.97	16.93	26.54	4.31	9.02	0.48
	4	9.18	73.78	27.82ab	17.58	141.37	30.20	17.57	26.55	4.22	8.91	0.48
	6	9.57	75.64	28.26a	168.95	138.74	30.21	17.90	26.12	3.84	8.89	0.44
35	2	9.51	73.47	28.93a	169.50	139.28	30.22	19.86	26.27	4.10	9.36	0.44
	4	8.84	64.87	26.87c	166.07	133.15	32.93	19.85	25.94	3.33	9.10	0.37
	6	8.89	65.81	27.18bc	167.25	133.89	33.36	20.02	25.72	3.6	9.42	0.38

Figures in a column having the same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly as per DMRT.

seedlings were transplanted hill^{-1} compared to 4 tiller seedlings hill^{-1} and 6 tiller seedlings hill^{-1}. Therefore, increased grain yield was the main reason for the increase of harvest index when 2 tiller seedlings were transplanted hill^{-1}.

Plant density in transplant aman rice culture is contributed by the number of seedlings hill^{-1}. The number of tillers and their growth is greatly affected by both quantitatively and qualitatively by number of seedlings hill^{-1} and number of tiller seedling as well. The excess or least number of tiller seedlings hill^{-1} may adversely affect the normal physiological activities of the rice plant. When planted 6 tiller seedlings hill^{-1}, they produced higher number of tillers hill^{-1}resulting in mutual shading and lodging and thus favour the production of more straw instead of grain. The least number of tiller seedlings hill^{-1} may cause insufficient tiller growth thus keeping air, space and nutrients in soil.

Interactions

Panicle length was significantly influenced by interaction between age of tiller seedlings and number of tiller seedlings hill^{-1}. The longest panicles were produced when 35-day old tiller seedlings were transplanted with 2 tiller seedlings hill^{-1}. Similar result was found when 25-day old tiller seedlings were planted with 6 tiller seedlings hill^{-1}. The shortest panicle length was found when 35-day old tiller seedlings were transplanted with 4 tiller seedlings hill^{-1} (Table 04).

CONCLUSION

From the findings of the present study it appears that transplant aman rice can be grown in both single and double row arrangements in order to obtain proper vegetative growth and yield. Twenty five day old tiller seedlings were found to be suitable in respect of vegetative characters, reproductive characters and grain yield of transplant aman rice. Two tiller seedlings hill^{-1} should preferably be transplanted for the cultivation of transplanted rice.

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