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Effect of Time of Tiller Separation on Grain Growth and Seed Yield of Transplant *Aman* Rice

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ABSTRACT

An experiment was carried out to study the effect of time of tiller separation on grain growth and yield of transplant *aman* rice. The experiment consisted of 3 times of tiller separation viz. tiller separation at 25 (T_1), 35 (T_2) and 45 (T_3) days after transplanting (DAT); and 5 levels of number of tillers kept hill^{-1} viz. intact hills (K_0), 1 tiller kept hill^{-1} (K_1), 2 tillers kept hill^{-1} (K_2), 3 tillers kept hill^{-1} (K_3) and 4 tillers kept hill^{-1} (K_4). The experiment was conducted in randomized complete block design with three replications. The unit plot size was 4 m × 2.5 m. With a few exceptions, the highest grain growth parameters like number of panicles hill^{-1}, dry weight panicle^{-1}, number of grains panicle^{-1}, dry weight grain^{-1} and grain growth rate were observed when tillers were separated at 25 DAT but the lowest values were found at 45 DAT. The grain growth rate decreased with the advance of time. The highest grain yield (5.25 t ha^{-1}) was obtained from tillers separated at 25 days after transplanting (DAT) but the lowest values (4.13 t ha^{-1}) were recorded when tillers were separated at 45 DAT. The maximum grain yield (5.88 t ha^{-1}) was found in intact hills, while the lowest values (2.64 t ha^{-1}) were obtained when 1 tiller kept hill^{-1}.

Keywords: Tiller separation, number of tillers kept hill^{-1}, grain growth, yield and transplant *aman* rice

INTRODUCTION

Crop losses due to flash flood or late flood are regular feature in Bangladesh. Devastating flood destroys valuable crops especially transplant *aman* rice. Farmers cannot re-transplant their *aman* rice after the decline of flood water in the early or mid September due to unavailability of seedlings. If available, seedlings are either too young or too old to produce good crop. Thus shortage of seedlings is a great problem in this situation. Separated tillers of transplant *aman* rice from a field not affected by flood may be used as seedlings to rehabilitate the damage of rice. Double transplanting practice has also been suggested for transplant *aman* areas where transplanting is delayed due to flood water innundation. In rice many of the late tillers do not

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produce panicles due to higher population (Hanada, 1979). Removal of some tillers from the mother hill could make room for future development of the remaining tillers attached with the mother hill. Separated tillers can be used as tiller seedling to replant a new area, especially during insufficiency of seedling after post flood or other natural hazards. In such a situation the technique of transplanting of splitted tillers collected from the unaffected crop may be a viable alternative for growing a post flood transplant *aman* crop (Mridha *et al.*, 1991). Tiller separation or tiller removal or plant thinning is sometimes practiced in Bangladesh (Hossain *et al.*, 1988), especially in post flood situation but scientific information in this regard is not available. Tolerance of mother plants to tiller separation as influenced by time of tiller separation and number of tillers to be kept with mother plant, needs to be tested so that their growth and yield are not adversely affected. The time tiller of separation is of prime importance for vegetative propagation in rice because early or late tiller separation adversely affects the seed growth and yield of crop. That is why, we can say that tiller separation from the mother plant may be an important aspect of research regarding vegetative propagation and using of separated tillers as seedlings for transplant *aman* rice cultivation under Bangladesh condition. Therefore, the present experiment was undertaken to observe the effect of time of tiller separation on the grain growth and yield performance of transplant *aman* rice.

MATERIALS AND METHODS

The field experiment was conducted at the Agronomy Field Laboratory, University of Rajshahi from June to November 2008, with a view to find out the effect of time of tiller separation on the grain growth and yield performance of transplanted *aman* rice cv. BRRI dhan32. The experiment consisted of (factor A) 3 times of tiller separation viz. tiller separation at 25 (T_1), 35 (T_2) and 45 (T_3) days after transplanting (DAT); and (factor B) 5 levels of number of tillers kept hill^{-1} viz. intact hills (K_0), 1 tiller kept hill^{-1} (K_1), 2 tillers kept hill^{-1} (K_2), 3 tillers kept hill^{-1} (K_3) and 4 tillers kept hill^{-1} (K_4). The experiment was laid out in a randomized complete block design with three replications. The size of each unit plot was 10 m^2 (4.0 m $\times$ 2.5 m) and the space between replications and plots were 1.0 m and 0.5 m respectively. Total numbers of plots were 45 in the experiment. The experimental plots were fertilized with urea, triple superphosphate (T. S. P.), muriate of potash and gypsum at the rate of 150, 100, 70 and 60 kg ha^{-1}, respectively. The whole amount of triple super phosphate, muriate of potash, gypsum and 1/3 of urea were applied as basal dose at final land preparation. The rest 2/3 amount of urea was applied as top dressing in two equal splits. The first split was applied at 25 DAT and the second one at the active tillering stage at the 45 DAT. Forty days old seedlings were transplanted on 24th July, 2008 with three seedlings maintaining 20 cm $\times$ 15 cm space between the lines and hills, respectively. Tiller separation was done at 25, 35 and 45 DAT by hand pulling keeping 1, 2, 3 and 4 tillers hill^{-1} as per treatment. Besides, there were intact hills from which no tiller was separated. Intercultural operations were done as and when necessary. Data were recorded on grain growth and grain yield characters. The data were analyzed statistically and adjudged the mean differences by Duncan`s New Multiple Range Test (DMRT) (Gomez and Gomez, 1984) with the help of computer package MSTAT-C.

RESULTS AND DISCUSSION

Results revealed that number of panicles hill^{-1} increased progressively with the advancement of time and development stages. It was observed that the highest number of panicles hill^{-1} was produced from 7 to 35 DAA at 7 days interval when tillers were separated at 25 DAT which was statistically identical to the tiller separation at 35 DAT in 28 DAA. On the other hand, the lowest number of panicles hill^{-1} was produced when tillers were separated at 45 DAT at all the sampling dates (Table 1). In case of late tiller separation, mother plant could not compensate the production of highest no. of panicles hill^{-1} due to the emulation shock at growth stage. Number of panicles hill^{-1} gradually decreased as tiller separation was delayed. Patoary (2005) found the same results. There was a significant effect of number of tillers kept hill^{-1} on the number of panicles hill^{-1}. The highest number of panicles hill^{-1} was produced in intact hills at all the sampling dates from 7 to 35 DAA at 7 days interval but the lowest number of panicles hill^{-1} was produced at all the sampling dates when 1 tiller kept hill^{-1} (Table 2).

Table 1: Effect of time of tiller separation on number of panicles hill^{-1} and dry weight panicle^{-1} at different days after anthesis (DAA)

Number of tillers separation (DAT)	Number of panicles hill^{-1}					Dry weight panicle^{-1}(g)				
	7DAA	14DAA	21DAA	28DAA	35DAA	7DAA	14DAA	21DAA	28DAA	35DAA
T_1	5.51a	7.58a	8.60a	8.96a	9.09a	0.56a	0.99	1.88a	2.27a	2.39a
T_2	4.99b	6.47b	8.13b	8.47a	8.56b	0.51b	0.97	1.83ab	2.12b	2.24b
T_3	4.09c	5.11c	6.20c	6.62b	6.64c	0.48c	0.86	1.75b	1.96c	2.06c
LSD	0.304	0.354	0.436	0.518	0.432	0.319	NS	0.08528	0.1150	0.1276
CV (%)	6.20	9.50	5.65	6.41	7.28	5.80	16.81	6.27	5.31	5.68

*In a column, figures having similar letter(s) do not differ significantly whereas the figures with dissimilar letter(s) differ significantly as per DMRT; NS = Not significant; DAT = Days after transplanting; T_1 = Tiller separated at 25 DAT, T_2 = Tiller separated at 35 DAT and T_3 = Tiller separated at 45 DAT

The increase in dry weight panicle^{-1} occurred progressively with the advance of time up to 28 DAA. After that the rate of increase in dry weight panicle^{-1} occurred very slowly. From the result it was observed that at all the sampling dates (7, 14, 21, 28 and 35 DAA) the highest dry weight panicle^{-1} was found when tillers were separated at 25 DAT and the lowest dry weight panicle^{-1} was found when tillers were separated at 45 DAT (Table 1). Number of tillers kept hill^{-1} influenced the dry weight panicle^{-1} significantly at different sampling dates (7, 14, 21, 28 and 35 DAA). At 7 DAA, The maximum dry weight panicle^{-1} was recorded in intact hills at all sampling dates but the minimum dry weight panicle^{-1} showed no distinct pattern to number of tillers kept hill^{-1}(Table 1). Results exposed that the number of grains panicle^{-1} increased progressively with the advancement of time up to 35 DAA but after 28 DAA the rate of increase in the number of grains panicle^{-1} occurred very slowly. It was observed that the maximum number of grains panicle^{-1} was produced at all the sampling dates when tillers were separated at 25 DAT which was statistically identical to all the sampling dates when tillers were separated at 35 DAT.

Table 2: Effect of number of tiller kept hill^{-1} on number of panicles hill^{-1} and dry weight panicle^{-1} at different days after anthesis (DAA)

No. of tillers separation (DAT)	Number of panicles hill^{-1}					Dry weight panicle^{-1} (g)				
	7DAA	14DAA	21DAA	28DAA	35DAA	7DAA	14DAA	21DAA	28DAA	35DAA
K_0	7.33a	8.741a	10.15a	10.35a	10.37a	0.62a	1.29a	2.02a	2.27a	2.37a
K_1	3.30d	4.52d	5.67d	6.00d	6.11d	0.51bc	0.77bc	1.81bc	2.18a	2.19ab
K_2	3.74c	5.22c	6.63c	7.00c	71.67c	0.52b	0.97b	1.91ab	2.21a	2.32a
K_3	4.81b	6.78b	7.67bc	8.26b	8.27b	0.46d	0.94b	1.68c	1.97b	2.09b
K_4	5.15b	6.67b	8.11b	8.45b	8.60b	0.47cd	0.72c	1.69c	1.95b	2.07b
LSD	0.393	0.4568	0.5633	0.6693	0.5572	0.4119	0.2060	0.1485	0.1459	0.1648
CV (%)	6.20	9.50	5.65	6.41	7.28	5.80	16.81	6.27	5.31	5.68

*In a column, figures having similar letter(s) do not differ significantly whereas the figures with dissimilar letter(s) differ significantly as per DMRT; NS = Not significant; DAT = Days after transplanting; K_0 = Intact hill, K_1 = 1 tiller kept hill^{-1}, K_2 = 2 tillers kept hill^{-1}, K_3 = 3 tillers kept hill^{-1} and K_4 = 4 tillers kept hill^{-1}

On the other hand, the lowest number of grains panicle^{-1} was produced at all the sampling dates when tillers were separated at 45 DAT (Table 3). Results showed that tiller separation at later stage caused a reduction in number of grains panicle^{-1}. These results were in agreement with the results of Patoary (2005), who observed highest number of grains panicle^{-1} when tillers were separated at 20 DAT. The number of grains panicle^{-1} varied significantly due to number of tillers kept hill^{-1} at all the sampling (14, 21, 28 and 35 DAA). At 14 DAA, The highest number of grains panicle^{-1} was found in intact hills at all the sampling (14, 21, 28 and 35 DAA). With a few exceptions, the lowest number of grains panicle^{-1} was produced when 2 tillers kept hill^{-1}. These results are partially supported by Alim *et al* (2008) (Table 4).

Number of sterile spikelets panicle^{-1} differed significantly due to time of tiller separation at all the DAA except 7 DAA. At 14 DAA, the highest number of sterile spikelets panicle^{-1} (103.6) was recorded when tillers separated at 45 DAT while the lowest one (88.29) was found when tillers separated at 25 DAT which was statistically identical with tillers separated at 35 DAT (93.18). At 21 DAA, the highest number of sterile spikelets panicle^{-1} (52.89) was obtained when tillers separated at 45 DAT while the lowest one was found when tillers separated at 25 DAT (41.11). At 28 DAA and 35 DAA, the highest number of sterile spikelets panicle^{-1} (35.04 and 30.59 respectively) was recorded when tillers separated at 45 DAT which was statistically identical with 35 DAT (33.71 and 29.99 respectively) but the lowest number of sterile spikelets panicle^{-1} (30.29 and 27.75 respectively) was recorded when tillers separated at 25 DAT (Table 3).

Table 3: Effect of time of tiller separation on number of grains panicle^{-1} and number of sterile spikelets painicle^{-1} at different days after anthesis (DAA)

No. of tillers separation (DAT)	Number of grains panicle^{-1}					Number of sterile spikelets painicle^{-1}				
	7DAA	14DAA	21DAA	28DAA	35DAA	7DAA	14DAA	21DAA	28DAA	35DAA
T_1	-	26.04a	85.91a	97.00a	100.0a	115.23	88.29b	41.11c	30.29b	27.75b
T_2	-	25.39a	81.69a	93.76a	96.14a	115.57	93.18b	47.82b	33.71a	29.99a
T_3	-	20.62b	75.19b	86.80b	90.24c	112.40	103.6a	52.89a	35.04a	30.59a
LSD	-	1.488	5.560	6.034	5.386	-	5.680	3.00	2.230	1.716
CV (%)	-	6.14	6.81	9.46	7.59	5.15	6.92	7.29	8.69	5.78

*In a column, figures having similar letter(s) do not differ significantly whereas the figures with dissimilar letter(s) differ significantly as per DMRT; NS = Not significant; DAT = Days after transplanting; T_1 = Tiller separated at 25 DAT, T_2 = Tiller separated at 35 DAT and T_3 = Tiller separated at 45 DAT

Number of sterile spikelets panicle^{-1} were significantly influenced by the number of tillers kept hill^{-1} at different sampling dates such as 7, 14, 21, 28 and 35 DAA. At 7 DAA, the highest number of sterile sipkelets panicle^{-1} (124.1) was found in intact hills and the lowest number of sterile spikelets panicle^{-1} (107.8) was found when 2 tillers kept hill^{-1} which was statistically identical to 1, 3 and 4 tillers kept hill^{-1} (110.2, 114.3 and 115.6 respectively). At 14 DAA, the highest number of sterile sipkelets panicle^{-1} (109.2) was found when 3 tillers kept hill^{-1} while the lowest number of sterile spikelets panicle^{-1} (87.78) was found when 2 tillers kept hill^{-1} which was statistically identical to 1 and 4 tillers kept hill^{-1} and intact hills (93.00, 94.59 and 90.54 respectively).

At 21 DAA, the highest number of sterile sipkelets panicle^{-1} (52.07) was found when 3 tillers kept hill^{-1} while the lowest number of sterile spikelets panicle^{-1} (44.15) was found when 2 tillers kept hill^{-1} which was statistically identical to 1, 4 tillers kept hill^{-1} and intact hills. At 28 DAA, the highest number of sterile sipkelets panicle^{-1} (35.52) was recorded when 4 tillers kept hill^{-1} which was statistically identical to 1 and 2 tillers kept hill^{-1} and intact hills (33.70, 32.44 and 34.00 respectively). Finally at 35 DAA, the highest number of sterile spikelets panicle^{-1} (31.78) was found when 4 tillers kept hill^{-1} while the lowest one (25.78) was found when 3 tillers kept hill^{-1} (Table 4).

Table 4: Effect of number of tiller kept hill^{-1} on number of grains panicle^{-1} and number of sterile spikelets painicle^{-1} at different days after anthesis (DAA)

Number of tillers separation (DAT)	Number of grains panicle^{-1}					Number of sterile spikelets painicle^{-1}				
	7DAA	14DAA	21DAA	28DAA	35DAA	7DAA	14DAA	21DAA	28DAA	35DAA
K_0	-	37.81a	90.074a	99.22a	101.6a	124.1 a	87.78 b	47.52 b	34.00 a	30.31 ab
K_1	-	16.22c	80.684b	88.89bc	91.82b	110.2 b	93.00 b	45.56 b	33.70 a	30.02 ab
K_2	-	24.37b	76.178b	85.26c	88.70b	107.8 b	90.54 b	44.15 b	32.44 a	29.31 b
K_3	-	17.48c	77.814b	96.22ab	99.86a	114.3 b	109.2 a	52.07 a	29.41 b	25.78 c
K_4	-	24.20b	79.888b	93.00abc	95.28ab	115.6 b	94.59 b	46.67 b	35.52 a	31.78 a
LSD	-	1.921	-	7.789	6.954	7.674	7.332	3.873	2.878	2.216
CV (%)	-	16.22c	80.684b	88.89bc	91.82b	110.2 b	93.00 b	45.56 b	33.70 a	30.02 ab

*In a column, figures having similar letter(s) do not differ significantly whereas the figures with dissimilar letter(s) differ significantly as per DMRT; NS = Not significant; DAT = Days after transplanting; K_0 = Intact hill, K_1 = 1 tiller kept hill^{-1}, K_2 = 2 tillers kept hill^{-1}, K_3 = 3 tillers kept hill^{-1} and K_4 = 4 tillers kept hill^{-1};

Table 5 showed that dry weight grain^{-1} was influenced significantly due to time of tiller separation at all the sampling dates except 35 DAA. The increase in dry weight grain^{-1} occurred progressively with the advance of time up to 35 DAA. From the result it was observed that at all the sampling dates (14, 21 and 28 DAA), the statistically identical dry weight grain^{-1} was obtained when tillers were separated at 25, 35 and 45 DAT respectively.

Table 5: Effect of time of tiller separation and number of tiller kept hill^{-1} on dry weight grain^{-1}, grain growth rate at different days after anthesis (DAA) and seed yield

Number of tillers separation (DAT)	Dry weight grain^{-1} (g)					Grain growth rate (g grain^{-1} day^{-1})				Yield (t ha^{-1})
	7DAA	14DAA	21DAA	28DAA	35DAA	7-14DAA	14-21 DAA	21-28 DAA	28-35 DAA	
T_1	-	0.016a	0.018a	0.020a	0.020	0.222	0.0363a	0.0202a	0.00674b	5.25a
T_2	-	0.015a	0.018a	0.019a	0.020	0.216	0.0392a	0.0170a	0.00961ab	4.76b
T_3	-	0.014a	0.0167a	0.018a	0.019	0.209	0.0404a	0.0181a	0.0178a	4.13c
LSD	-	0.00258	0.00258	0.01009	NS	0.01045	0.01009	0.01009	0.01009	0.2533
CV (%)	-	8.32	6.06	7.08	4.98	7.28	5.78	6.77	9.86	8.34

*In a column, figures having similar letter(s) do not differ significantly whereas the figures with dissimilar letter(s) differ significantly as per DMRT; NS = Not significant; DAT = Days after transplanting; T_1 = Tiller separated at 25 DAT, T_2 = Tiller separated at 35 DAT and T_3 = Tiller separated at 45 DAT

Dry weight grain^{-1} was influenced significantly due to number of tillers kept hill^{-1} at different sampling dates (14, 21 and 28 DAA) except 35 DAA. The maximum dry weight grain^{-1} (0.017 g, 0.019 g and 0.020 g) was recorded at 14, 21 and 28 DAA respectively in intact hills, while the minimum dry weight grain^{-1} (0.013 g, 0.017 g and 0.018 g) was recorded when 1, 2 and 3 tiller kept hill^{-1} respectively (Table 6).

Table 6: Effect of number of tiller kept hill^{-1} on dry weight grain^{-1}, grain growth rate at different days after anthesis (DAA) and seed yield

No. of tiller kept hill^{-1}	Dry weight grain^{-1} (g)					Grain growth rate (g grain^{-1} day^{-1})				Yield (t ha^{-1})
	7DAA	14DAA	21DAA	28DAA	35DAA	7-14 DAA	14-21 DAA	21-28 DAA	28-35 DAA	
K_0	-	0.0168a	0.0188a	0.0199a	0.0203	0.2389a	0.03000b	0.01698a	0.007289a	5.85a
K_1	-	0.0132c	0.0172bc	0.0188b	0.0197	0.1896c	0.05683a	0.02097a	0.01269a	3.69c
K_2	-	0.0143bc	0.0169c	0.0186b	0.0196	0.2158b	0.03523b	0.02334a	0.01526a	4.62b
K_3	-	0.0151b	0.0174bc	0.0186b	0.0195	0.2163b	0.03477b	0.01476a	0.01317a	4.62b
K_4	-	0.0152b	0.0178b	0.0189b	0.0198	0.2171b	0.03634b	0.01602a	0.00856a	4.78b
LSD	-	0.01009	0.01009	0.01009	NS	0.01303	0.01303	0.01303	0.1303	0.3270
CV (%)	-	8.32	6.06	7.08	4.98	7.28	5.78	6.77	9.86	8.34

*In a column, figures having similar letter(s) do not differ significantly whereas the figures with dissimilar letter(s) differ significantly as per DMRT; NS = Not significant; DAT = Days after transplanting ; K_0 = Intact hill, K_1 = 1 tiller kept hill^{-1}, K_2 = 2 tillers kept hill^{-1}, K_3 = 3 tillers kept hill^{-1} and K_4 = 4 tillers kept hill^{-1}

Grain growth rate varied significantly due to time of tiller separation at all the DAA except the 7-14 DAA. The grain growth rate decreased with the advance of time. At 7-14 DAA, grain growth rate (0.222 g day^{-1}) was highest when tillers separated at 25 DAT while the lowest one (0.209 g day^{-1}) was observed when tiller separated at 45 DAT. At 14-21 and 21-28 DAA, statistically identical grain growth rate was observed when tillers separated at 25, 35 and 45 DAT. At 28-35 DAA, grain growth rate was maximum when tiller separated at 45 DAT while the minimum one (0.006740 g day^{-1}) was obtained when tillers separated at 25 DAT (Table 5). Number of tillers kept hill^{-1} significantly influenced the grain growth rate. Within the period of 7-14 DAA, the maximum grain growth rate (0.2389 g day^{-1}) was observed in intact hills while the minimum one (0.1896 g day^{-1}) was observed when 1 tiller kept hill^{-1}. During the period of 14-21 DAA, the maximum grain growth rate (0.05683 g day^{-1}) was observed when 1 tiller kept hill^{-1} while statistically identical grain growth rate was observed when 2, 3, 4 tillers kept hill^{-1} and in intact hills. During the period of 21-28 DAA and 28-35 DAA, 1, 2, 3, 4 tillers kept hill^{-1} and intact hills showed the statistically identical grain growth rate (Table 6). The results showed that there is significant differences in grain yield due to time of tiller separation. The highest grain yield (5.25 t

ha^{-1}) was obtained when tillers were separated at 25 DAT while the lowest grain yield (4.13 t ha^{-1}) was obtained when tillers were separated at 45 DAT (Table 5). When tiller separation was done at early stage i. e. 25 DAT then the crop were very young so they easily recovered their mechanical injury caused by separation and the crop received relatively more time for their growth, development and grain filling and thus the grain yield was increased.

The results are in agreement with those of Khan (2008), Mollah *et al* (1992) and Patoary (2005), who also reported that tiller separation in late vegetative stage reduced grain yield. Number of tillers kept $hill^{-1}$ had significant effect on grain yield. The results show that the highest grain yield (5.8 t ha^{-1}) was obtained from intact hills. On the other hand, the lowest grain yield (3.69 t $ha^{-1)}$ was found when 1 tiller kept $hill^{-1}$(Table 6). Improvement of yield components e.g. number of effective tillers $hill^{-1}$, and number of grains $panicle^{-1}$ were mainly responsible for the increased grain yield in intact hills. Rahman (2001), Patoary (2005) and Khan (2008) also obtained the highest grain yield in intact hills of rice.

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