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Effect of Timing of Nitrogen Application on the Growth and Yield of Separated Tillers of Transplant Aman Rice

[1]M.R. Alam, [1]M.A.R. Sarkar, [3]K.M. Khalequzzaman, [2]Md. Nazrul Islam,
[2]M.K. Anam and [4]Md. Abdur Rahim
[1]Department of Agronomy, [2]Seed Pathology Laboratory,
Bangladesh Agricultural University, Mymensingh, Bangladesh
[3]Plant Pathology Division, Agricultural Research Station, BARI, Bogra, Bangladesh
[4]OFRD, Agricultural Research Station, BARI, Bogra, Bangladesh

Abstract: The experiment was conducted to find the effect of different cultivars and time of nitrogen application on the growth and yield of separated tillers of transplant aman rice. Tillers of three rice cultivars (BRRI Dhan 32, BR 23 and BR 22) and five timings of nitrogen application were used as treatments. The individual effect of var. BR 23 and the three equal splits of application of nitrogen as basal, at early tillering and at panicle initiation stages gave the best results on plant height, no. of tillers hill^{-1}, no. of leaves hill^{-1}, leaf area index, no. of grains panicle^{-1}, weight of 1000 grains, grain yield, straw yield, biological yield and harvest index having 121.21 and 122.54 cm, 9.10 and 9.26, 36.72 and 39.91, 4.92 and 4.68, 118.60 and 118.50, 23.98 and 22.33 g, 4.55 and 4.79 t ha^{-1}, 6.15 and 6.60 t ha^{-1}, 10.70 and 11.40 t ha^{-1}, 42.62 and 41.24 %, respectively. The interaction effect of var. BR 23 and T_2 was the highest on these parameters. Rice var. BR 23 and three splits of nitrogen application may be used for increasing growth and yield of separated tillers of transplanted aman rice.

Key words: Separated tillers, nitrogen, growth and yield, transplanted aman rice

Introduction

Rice is the principle food crop of Bangladesh feeding almost hundred percent of its population. It covers about 25.36 million acres of land in Bangladesh (Anonymous, 2001). Rice is grown in Bangladesh under diverse ecosystems subjected to irrigated, rainfed and deep-water conditions in three distinct seasons, namely aus, aman and boro. Among the three distinct rice groups, transplant aman rice covers the largest area of about 14.35 million acres with a production of 8.85 million tons of rice average yield being 1.64 ton/hectare (Anonymous, 2001). In Bangladesh, crop losses due to flood and natural calamities. Late flood affects on transplanted aman rice. In this flood season, seedlings of transplant aman rice are not readily available, but quite a large area of cultivated land remain fallow. Transportation of seedlings from one place to an other is not possible within this short period. So, farmers often can not replant the flood-affected land due to unavailability of seedlings. If available, seedlings are either too young or too old to produce a good crop. Thus limitation of seedlings is a great problem in this situation. Transplantation of separated tillers obtained from other transplant aman crop growing on comparatively high land area could be a remedy to overcome this loss of transplant aman rice. This technique of transplanting of separated tillers may be a promising alternative for growing a post flood transplant aman crop (Mridha *et al.*, 1991; Siddique *et al.*, 1991). Timing of nitrogen application is an important aspect of over all nitrogen management in rice field from its efficient utilization point of view. Proper timing of nitrogen application reduces the loss of nitrogen in rice field. Efficient fertilizer management gave higher yield of crops and reduced the fertilizer cost (Hossain and Islam, 1986). From the above facts, the present study was undertaken with the objectives: I) to find out the effect of different cultivars on the growth and yield of separated tillers of transplant aman rice, ii) to observe the influence of time of nitrogen application on the growth and yield of separated tillers of transplant aman rice.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Bangladesh, Mymensingh from June to December, 1999. The experiment consisted of separated tillers of three cultivars of transplant aman rice and five times of nitrogen application. The treatments were as follows: Tillers of three cultivars (BRRI Dhan 32, Tillers of BR 23 and Tillers of BR 22) and five timings of nitrogen application. These were:

T_1= 1/2 as basal + 1/2 at early tillering stage
T_2= 1/3 as basal + 1/3 at early tillering stage + 1/3 at panicle initiation stage
T_3= 1/2 at early tillering stage + 1/2 at panicle initiation stage
T_4= 1/2 at early tillering stage + 1/2 at flowering stage
T_5= 1/4 as basal + 1/4 at early tillering stage + 1/4 at panicle initiation stage + 1/4 at flowering stage

The experiment was laid out in randomized complete block design (RCBD) with four replications. Seeds of the rice cultivars were collected from the Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. The sprouted seeds were sown in the wet nursery bed. Irrigation was given and weeds were removed from the nursery bed as and when necessary. The experimental land was fertilized with triple superphosphate, muriate of potash, gypsum and zinc sulphate at the rate of 140, 100, 60 and 10 kg ha^{-1}, respectively. The entire amount of triple superphosphate, muriate of potash, gypsum and zinc sulphate were broadcasted and incorporated into the soil at final land preparation. Nitrogen was applied as per experimental specification in the form of urea. Tillers were separated on 30 days after transplanting from previously transplanted rice field and then transplanted in the main field according to experimental treatments. Number of seedlings/hill was three with 25 cm spacing between rows and 15 cm spacing between hills in each row. Data were recorded on plant height (cm), number of tillers/hill, number of leaves/hill, leaf area index, number of grains/panicle, weight of 1000 grains (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%). Leaf area index (LAI) was calculated by the following standard formula (Radford, 1967, Hunt, 1978) as shown below:

$$LAI = \frac{\text{Leaf area}}{\text{Ground area}},$$

$$\text{Biological Yield} = \text{Grain yield} + \text{straw yield}$$

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

The collected data were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done by split plot design with the help of computer package MSTAT programme. The mean differences among the treatment mean were tested with Duncan's New multiple range test (DMRT) and least significant difference (LSD) test where necessary (Gomez and Gomez, 1984).

Results and Discussion

Effect of cultivars on growth characters at 75 days after transplanting (DAT), yield and yield attributes of separated tillers of transplanted aman rice are presented (Table 1). Plant height was not significant at 75 DAT. The tallest (121.21 cm) and the shortest (119.17 cm) plants were recorded in BR 23 and BRRI dhan 32, respectively. Probably the genetic make-up of the cultivars was responsible for the variation in plant height. Shamsudding *et al.* (1988) also observed variation in plant height due to varietal differences. Anonymous (1991) also reported that plant height differed among varieties. Significant difference on the number of tillers/hill was observed among the cultivars. BR 23 showed maximum (9.10) tillers/hill and BRRI dhan showed minimum (8.34). Number of leaves/hill was significantly affected by cultivars. Maximum (36.72) and minimum (30.15) was found in BR 23 and BRRI dhan, respectively. Cultivars had significant effect on leaf area index (LAI). The highest (4.92) and lowest (3.47) LAI was observed in BR 23 and BRRI dhan, respectively. Cultivars showed significant effect on the number of grains per panicle. BR 23 produced maximum number of grains per panicle (118.60) and BRRI dhan produced minimum (100.40). The variation in number of grains per panicle with different cultivars was also reported by Singh and Gangwer (1989). Results showed that cultivars had significant effect on weight of 1000 grains. Maximum (23.98 g) weight of 1000 grains was observed in BR 23 and minimum (22.04 g) was in BR 22. Shamsuddin *et al.* (1988) and Refey *et al.*

Table 1: Effect of cultivars on growth characters at 75 DAT and yield and yield attributes of separated tillers of transplant aman rice

	Growth characters at 75 DAT				Yield and yield attributes					
Cultivars	Plant height (cm)	No. of tillers/hill	No. of leaves/hill	Leaf area index	No. of grains/panicle	Weight of 1000 grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
BRRI Dhan 32	119.17	8.34c	30.15b	3.47c	100.40b	22.55c	3.75b	5.99	9.75b	38.33b
BR 23	121.21	9.10a	36.72a	4.92a	118.60a	23.98a	4.55a	6.15	10.70a	42.62a
BR 22	120.31	8.60c	36.71a	4.47b	118.00a	22.04b	3.73b	6.04	9.78b	38.04b
F-test	NS	0.01	0.01	0.01	0.01	0.01	0.01	NS	0.01	0.01

Table 2: Effect of timing of nitrogen application on growth characters at 75 DAT and yield and yield attributes of separated tillers of transplant aman rice

	Growth characters at 75 DAT				Yield and yield attributes					
Timing of nitrogen application	Plant height (cm)	No. of tillers/hill	No. of leaves/hill	Leaf area index	No. of grains/panicle	Weight of 1000 grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	120.63	8.78b	33.10c	4.00c	114.20ab	22.08	3.86c	5.85b	9.71c	39.83a
T_2	122.54	9.26a	39.91a	4.68a	118.50a	22.33	4.79a	6.60a	11.40a	41.24a
T_3	120.01	9.06ab	31.21c	4.23b	108.40bc	22.14	4.09b	6.00b	10.09bc	40.49a
T_4	116.45	8.66b	32.28c	4.18b	105.60c	22.13	3.05d	5.77b	8.81cd	35.13b
T_5	121.48	8.87b	36.11b	4.35b	115.60a	22.26	4.26b	6.09ab	10.36b	41.63a
F-test	NS	0.01	0.01	0.01	0.01	NS	0.01	0.01	0.01	0.05

Table 3: Interaction effect of timing of nitrogen application and cultivars on growth characters at 75 DAT and yield and yield attributes of separated tillers of transplant aman rice

	Growth characters at 75 DAT				Yield and yield attributes					
Timing of nitrogen application	Plant height (cm)	No. of tillers/hill	No. of leaves/hill	Leaf area index	No. of grains/panicle	Weight of 1000 grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
BRRI Dhan 32										
T_1	121.06	8.25def	33.81f	3.70e	100.81	20.12	3.51h	6.22	9.74	36.49
T_2	124.18	8.29def	39.81bcd	3.27f	106.24	20.15	4.59bc	6.49	11.08	41.40
T_3	119.71	9.38bcd	34.81f	3.30f	102.57	20.49	3.63gh	5.75	9.39	38.82
T_4	114.53	8.00ef	33.63fg	3.71e	95.56	21.16	2.74i	5.34	8.08	33.63
T_5	116.37	7.76f	34.69f	3.35f	96.91	20.83	4.30cde	6.17	10.47	41.28
BR 23										
T_1	115.83	8.88cde	36.56ef	4.50d	122.97	24.19	4.40bcd	6.30	10.70	41.10
T_2	123.72	10.09ab	43.63a	5.80a	124.95	24.28	5.22a	6.50	11.72	44.56
T_3	120.91	8.97cde	41.25abc	4.48d	107.16	24.19	4.77b	6.12	10.88	43.89
T_4	119.33	8.67def	30.95g	4.31d	112.67	23.62	3.95efg	5.65	9.59	41.23
T_5	126.26	8.88cde	43.63a	5.50b	125.12	23.64	4.44bcd	6.20	10.64	42.30
BR 22										
T_1	125.06	9.21bcd	38.50cde	3.80e	118.81	21.97	3.67gh	5.05	8.72	41.89
T_2	119.73	9.39 bcd	41.05abc	4.29c	124.35	22.56	4.58bc	6.82	11.40	37.74
T_3	119.43	10.63a	42.06ab	4.92c	115.51	21.75	3.88fgh	6.12	10.00	38.75
T_4	115.51	9.30bcd	37.69de	4.52d	108.60	21.61	2.48i	6.32	8.80	30.52
T_5	121.81	9.97abc	41.19abc	4.20d	124.80	22.30	4.07def	5.90	9.99	41.29
F-test	NS	0.05	0.01	0.01	NS	NS	0.01	NS	NS	NS

NS= Not significant Means having same letter(s) in a column do not differ significantly at P > 0.01

T_1= 1/2 basal + 1/2 at early tillering stage.

T_2= 1/3 as basal + 1/3 at early tillering stage + 1/3 at panicle initiation stage.

T_3= 1/2at early tillering stage + 1/2 at panicle initiation stage.

T_4= 1/2 at early tillering stage + 1/2 at flowering stage.

T_5= 1/4 as basal + 1/4 at early tillering stage + 1/4 at panicle initiation stage + 1/4 at flowering stage.

(1989) who reported that weight of 1000 grains differed among the varieties. The effect of cultivars on grain yield was statistically significant. Higher grain yield was in the cultivar of BR 23. BRRI dhan 32 produced the second highest yield which was similar to BR 22. Grain yield differences might be due to genetic characteristics of the cultivars. Anonymous (1995) reported that variable grain yields were obtained among varieties. However, grain yield differences due to varieties were also reported by Kumber and Sonar (1978). Straw yield was not significantly affected by cultivars. Those cultivars produced similar straw yields. The effect of cultivars on biological yield was statistically significant. The highest biological yield was statistically significant. The biological yield was recorded in BR 23 and the lowest biological yield was recorded in BRRI dhan 32. BR 23 produced the highest grain and straw yields which resulted in the highest biological yield. Cultivars differed significantly in respect of harvest index. The highest harvest index was observed in BR 23 and the lowest harvest index was observed in BR 22. The highest grain/straw ratio in BR 23 might have resulted in the highest harvest index.

Effect of timing of nitrogen application on growth characters at 75 days after transplanting (DAT), yield and yield attributes of separated tillers of transplant aman rice are presented in Table 2. Plant height was not significantly affected by timing of nitrogen application. Variation of number of tillers per hill to timing of nitrogen application was statistically significant. Maximum and minimum number of tillers per hill were when nitrogen was applied in 1/3 basal+ 1/3 early tillering(ET)+ 1/3 at panicle initiation(PI) and 2 at ET+ 1/2 flowering, respectively. Akanda *et al.* (1986) reported that N in three doses such as 20 kg as basal, 40 kg at active tillering and 20 kg at panicle initiation gave the highest number of total tillers per hill. The effect of timing of nitrogen application on number of leaves per hill was statistically significant. Maximum and minimum number of leaves per hill was the highest and lowest when N was applied in 1/3 basal+ 1/3 (ET)+ 1/3 at (PI) and 2 at ET+ 1/2 flowering, respectively. Leaf area index was significantly affected by the timing of nitrogen application. Maximum LAI was recorded in 1/3 basal+ 1/3 ET+ 1/3 at PI and minimum was in 2 basal+ 1/2 at ET. Effect of nitrogen with respect to number of grains panicle^{-1} was found to be significant. Maximum number of grains panicle^{-1} was produced when nitrogen was applied in three equal splits as basal, at ET and at PT stages. Minimum number of grains panicle^{-1} was obtained in two-split application of nitrogen at ET and flowering stages. Ghosh and Chatterjee (1981) reported that application of nitrogen, half at planting and the other half at tillering increased the number of grains panicle^{-1}. The effect of timing of nitrogen application with respect to 1000-grains weight was found to be statistically non-significant. Grain yield was significantly influenced by the timing of nitrogen application. The highest grain yield was produced when nitrogen was applied in three equal splits as basal, at early tillering and at panicle initiation stages. The lowest grain yield obtained from two splits of nitrogen application at early tillering and at flowering stages. These findings are in agreement with that of Raju and Reddy (1989), who reported that nitrogen application in three split dressings (25% at basal+ 25% at tillering+ 50% at panicle initiation) produced the highest grain yield. Nair and Guatam (1992) found that yield was higher when 60 kg N was applied (50% at transplanting+ 25% at tillering+ 25% at panicle initiation stages). The effect of timing of nitrogen application was found to be highly significant in respect of straw yield. The highest straw yield was produced when nitrogen was applied in three equal splits as basal, at ET and at PI stages. The lowest straw yield was obtained from nitrogen application in two equal splits at early tillering and at flowering stages. Paturde and Rahate (1986) reported that straw yield was the highest due to application in split doses of 40 kg N ha^{-1} at transplanting, 20 kg ha^{-1} at panicle initiation and 20 kg N ha^{-1} at the heading stages. Biological yield varied significantly due to timing of nitrogen application. The highest biological yield was the recorded when nitrogen was applied in three equal splits as basal, at early tillering and at panicle initiation stages. The lowest biological yield was obtained when nitrogen was applied in two equal splits at early tillering and flowering stages. Nitrogen application in three equal splits influenced grain yield and straw yields which in turn increased biological yield. Harvest index was significantly affected by timing of nitrogen application. The highest harvest index was recorded when nitrogen was applied in three equal splits as basal, at early tillering, at panicle initiation stages and at flowering stages.

It may be concluded that the var. BR 23 and the three equal splits of application of nitrogen as basal, at early tillering and at panicle initiation stages (T_2) gave better results on plant height, no. of tillers hill^{-1}, no. of leaves hill^{-1}, leaf area index, no. of grains panicle^{-1}, weight of 1000 grains, grain yield, straw yield, biological yield and harvest index. So, rice var. BR 23 and three splits of nitrogen application may be used for increasing growth and yield of separated tillers of transplanted aman rice (Table 3).

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