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Research Article

EFFECT OF NUMBER OF SEEDLINGS HILL^{-1} AND RATE AND TIME OF NITROGEN APPLICATION ON THE YIELD OF LATE TRANSPLANT AMAN RICE (cv. BR23)

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Abstract

A field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to examine the effect of number of seedlings hill^{-1} and rate and time of nitrogen application on the yield of late transplant *Aman* rice (cv. BR23). The experiment comprised three levels of number of seedlings hill^{-1} viz. 2, 4, and 6, three nitrogen rates viz. 0, 60 and 120 kg N ha^{-1} and three levels of time of nitrogen application viz. nitrogen application in two equal splits at 15 DAT and early tillering stage (ET); nitrogen application in three equal splits at 15 DAT, ET and panicle initiation (PI) stage; nitrogen application in four equal splits at 15 DAT, ET, PI and flowering (F) stages. The experiment was laid out in a randomized complete block design with three replications. Number of effective tillers hill^{-1}, grain yield and straw yield were the highest when 6 seedlings were transplanted hill^{-1} while all yield contributing characters, grain and straw yields were the highest at 120 kg N ha^{-1}. In case of interaction, the highest grain yield was recorded in combination of 6 seedlings hill^{-1} × 120 kg N ha^{-1} and 120 kg N ha^{-1} × three times of nitrogen applications (15 DAT + ET + PI). The highest number of effective tillers hill^{-1} and grain yield were recorded in 6 seedlings hill^{-1} × 120 kg N ha^{-1} × three times N application (15 DAT + ET + PI) and thus this practice appears as the promising one for late transplant *Aman* rice (cv. BR23) cultivation.

Key words: Late transplant *Aman* rice; seedling hill^{-1}; N rate; time of application; yield

Introduction

Bangladesh is a flood prone country and often partial or complete damage of transplant *Aman* rice occurs due to flash flood and late severe flood. About 20% of the transplant *Aman* rice are often suddenly submerged by flash flood every year due to heavy rainfall during wet season. Sometimes flood water does not recede until 15 September. On the other hand, partial or complete damage of transplant *Aman* rice often occurs due to late severe flood in September. The optimum transplanting time of transplant *Aman* rice is 15 July to 15 August. But it is reported that about 50% of the total transplant *Aman* rice area is planted late in Bangladesh due to unfavorable climate (flood and drought), non-availability of inputs at proper time and unplanned cropping pattern (BRRI, 1987). BRRI (1981) also reported that about 30-40% area under transplant *Aman* rice is planted late beyond optimum time due to delayed harvest of *Aus* rice and jute crop coupled with the associated turn-around time. Under these circumstances, yield loss of transplant *Aman* rice may be compensated by cultivating suitable rice cultivars with appropriate agronomic practices.

Rice cultivar BR23 developed by the Bangladesh Rice Research Institute has good photoperiod sensitivity and it can be transplanted late even up to last week of September, which keeps a high margin in comparison to the indigenous as well as the other modern transplant *Aman* rice cultivar. In spite of its photoperiod sensitivity and capability to grow under late transplanted condition, BR23 when transplanted late in September has a poor opportunity to produce enough tillers before reaching its reproductive phase. So it is necessary to compensate yield loss due to late transplanting through proper agronomic management.

Optimum number of seedlings transplanted hill^{-1}, rate and time of nitrogen application are the key determinants to improve yield components and yield of transplant *Aman* rice. Adequate number of seedlings hill^{-1}may enable the rice plant to grow properly by utilizing radiant energy, nutrient, space and water and also reduce the seedling cost of farmers. Excess number of seedlings hill^{-1} may produce higher number of tillers hill^{-1} resulting in mutual shading and lodging and thus favours the production of more straw instead of grain. Chowdhury *et al.* (1993) reported that number of seedlings hill^{-1} influenced the yield components and yield of rice as they compete among themselves. Sarkar *et al.* (2011) reported that 2 tiller seedlings transplanted hill^{-1} appeared to be enough for the cultivation of transplant *Aman* rice (cv. BR23) in respect of grain yield. Cultivar BR23 appeared to be resistant to tiller separation leaving behind only two tillers hill^{-1} (Paul *et al.*, 2002). Proper dose and timing of nitrogen application reduce the loss of nitrogen in rice fields. Efficient fertilizer management gave higher yield of crops and reduced fertilizer cost (Hossain and Islam, 1986). To increase nitrogen use efficiency and reduce yield gap of modern rice cultivars, the right form of nitrogenous fertilizer and appropriate timing of application are very important (Kirttania *et al.*, 2013). Therefore, the present study was undertaken to examine the effect of number of seedlings hill^{-1}, rate and time of nitrogen application on the yield of late transplant *Aman* rice (cv. BR23).

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University Mymenshingh. The experimental belongs to the old Brahmaputra floodplain (AEZ 9) with medium topography and loamy texture having pH 6.5. The experiment comprised three levels of number of seedlings hill^{-1} viz. 2, 4, and 6 seedlings hill^{-1}, three nitrogen rates viz. 0, 60 and 120 kg N ha^{-1}, three levels of time of nitrogen application viz. nitrogen application in two equal splits at 15 DAT and early tillering stage (ET); nitrogen application in three equal splits at 15 DAT, ET and panicle initiation stage (PI); nitrogen application in four equal splits at 15 DAT, ET, PI and flowering stages (F). The experiment was laid out in a randomized complete block design with three replications. The size of each unit plot was 4.0 m x 2.5 m. Thirty-day old seedlings were transplanted on 25 September. The land was fertilized with urea as per treatment specification. Triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied in all plots at the rate of 125, 67, 60 and 10 kg ha^{-1}, respectively at final land preparation. Other intercultural operations were done when necessary. Four hills were randomly selected (excluding boarder hills) prior to harvest to record the data on crop characters and yield contributing characters. The crop of individual plot was separately harvested at full maturity. The grain and straw yield for each plot were recorded after proper threshing, cleaning and sun drying. Grain yield was converted to t ha^{-1} at 14% moisture basis. The collected data were statistically analyzed and mean differences were compared by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Effect of number of seedlings hill^{-1}

Number of effective tillers hill^{-1} was significantly affected by the number of seedlings hill^{-1}. The highest number of effective tillers hill^{-1} was produced (11.11) by transplanting 6 seedlings hill^{-1} followed by 2 seedlings hill^{-1} (9.41) and the lowest number of effective tillers hill^{-1} was produced (9.33) when 4 seedlings hill^{-1} was transplanted. The highest number of grains panicle^{-1} was recorded in 2 seedlings hill^{-1} (87.01) followed by 4 seedlings hill^{-1} (84.53) and the lowest one was recorded in 6 seedlings hill^{-1}(83.01). The highest grain yield (3.73 t ha^{-1}) and straw yield (4.83 t ha^{-1}) were obtained from 6 seedlings hill^{-1} which were statistically identical to 4 seedlings hill^{-1}, while the lowest grain (3.49 t ha^{-1}) and straw (4.43 t ha^{-1}) yields was recorded in 2 seedlings hill^{-1} (Table 1). Production of more effective tillers hill^{-1} was mainly responsible for this increased grain and straw yields in 6 seedlings hill^{-1}. Similar results was reported by Bhowmik *et al.* (2012). The maximum harvest index (44.21%) was obtained from 2 seedlings hill^{-1} followed by 6 seedlings hill^{-1} (43.82%) and the lowest harvest index (43.27%) was found in 4 seedlings hill^{-1}. As a photosensitive variety cv. BR23 get short time for proper vegetative growth because of late transplanting and thus 2 seedlings transplanted hill^{-1} produced lower straw yield and higher harvest index compared to other treatments.

Table 1: Effect of number of seedlings hill^{-1} on yield and yield components of late transplant *Aman* rice (cv. BR23)

Number of seedlings	Effective tillers hill^{-1} (no.)	Grains panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index
2 seedlings hill^{-1}	9.41b	87.01a	22.74	3.49b	4.43b	44.21a
4 seedlings hill^{-1}	9.33b	84.53b	21.78	3.58ab	4.74a	43.27b
6 seedlings hill^{-1}	11.11a	83.01c	22.32	3.73a	4.83a	43.82c
Level of significance	0.01	0.01	NS	0.01	0.01	0.01
$S\bar{x}$	0.068	0.156	-	0.066	0.037	0.187

Means in a column having the same letter(s) do not differ significantly as per DMRT.
NS = Not significant.

Effect of Nitrogen rate

Nitrogen rate had significant effect on yield components and yield of late transplant *Aman* rice. The highest number of effective tillers hill^{-1} (11.49), grains panicle (91.42), 1000-grain weight (23.38), grain yield (4.07 t ha^{-1}) and straw yield (5.55 t ha^{-1}) were produced when fertilized with 120 kg N ha^{-1} followed by 60 kg N ha^{-1} and the lowest values were recorded in control (no nitrogen application) (Table 2). Grain yield progressively increased with the increase of nitrogen rate and reached the maximum at 120 kg N ha^{-1} indicating that cv. BR23 was responsive to higher rate of nitrogen even under late transplanted condition. The increase of grain yield occurred due to significant increase of number of effective tillers hill^{-1}, number of grains panicle^{-1} and 1000-grain in 120 kg N ha^{-1}. On the other hand, reduction of aforesaid yield component due to application of less nitrogen (60 kg N ha^{-1}) and control treatment were mainly responsible for the reduced grain yield in these treatments. The increase of grain yield of rice by nitrogen application is in agreement with the findings of many researchers (Sing and Sing, 1998; Islam *et al.*, 2014; Jisan *et al.*, 2014 and Ray *et al.*, 2015). The highest harvest index was obtained in control condition (0 kg N ha^{-1}) which gradually decreased with the increase of N application and reached at the lowest one at 120 kg N ha^{-1}. In control condition vegetative growth of rice was drastically reduced and produced the lowest straw yield which resulted in the highest harvest index.

Table 2: Effect of rate of nitrogen on the yield and yield components of late transplant *Aman* rice (cv. BR23)

Nitrogen rate (kg ha^{-1})		Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
0 kg N ha^{-1}		8.54c	78.66c	21.21c	3.06c	3.64c	45.65a
60 kg N ha^{-1}		9.83b	84.47b	22.24b	3.66b	4.82b	43.21b
120 kg N ha^{-1}		11.49a	91.42a	23.38a	4.07a	5.55a	42.48c
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01
S$\overline{X}$		0.068	0.156	0.281	0.066	0.037	0.187

Means in a column having the same letter(s) do not differ significantly as per DMRT.
NS = Not significant.

Table 3: Effect of time of nitrogen application on the yield and yield components of late transplant *Aman* rice (cv. BR23)

Time of N application	Effective tillers hill^{-1}(no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest. index (%)
l5 DAT + ET	10.10a	85.01b	22.19	3.53	4.48c	44.23a
15 DAT+ET+PI	10.34a	86.10a	22.22	3.67	4.60b	44.55a
15 DAT+ET+PI+F	9.41.b	83.41c	22.42	3.59	4.93a	42.52b
Level of significance	0.01	0.01	NS	NS	0.01	0.01
S$\overline{X}$	0.068	0.156		-	0.037	0.187

Means in a column having the same letter(s) do not differ significantly as per DMRT.
NS = Not significant.
DAT= Days after transplanting
ET = Early tillering
PI= Panicle initiation
F = Floweing

Table 4: Effect of interaction between number of seedlings hill^{-1} and nitrogen rate on the yield and yield component of late transplant Aman rice (cv. BR23)

Number of seedlings hill^{-1} × Rate of N	Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
2 seedlings hill^{-1} × 0 kg N ha^{-1}	8.53f	82.37e	21.30	2.98d	3.54e	45.71
2 seedlings hill^{-1} × 60 kg N ha^{-1}	8.94e	85.97c	22.85	3.57c	4.63d	43.51
2 seedlings hill^{-1} × 120 kg N ha^{-1}	10.77bc	92.70a	24.07	3.91bc	5.13b	43.40
4 seedlings hill^{-1} × 0 kg N ha^{-1}	7.88g	77.82f	20.81	3.06d	3.67e	45.44
4 seedlings hill^{-1} × 60 kg N ha^{-1}	9.65d	84.38d	21.51	3.64c	4.89c	42.69
4 seedlings hill^{-1} × 120 kg N ha^{-1}	10.47c	91.39ab	21.52	4.05ab	5.67a	45.80
6 seedlings hill^{-1} × 0 kg N ha^{-1}	9.22e	75.79g	21.52	3.14d	3.71e	45.80
6 seedlings hill^{-1} × 60 kg N ha^{-1}	10.89b	83.07e	22.36	3.78bc	4.94c	43.44
6 seedlings hill^{-1} × 120 kg N ha^{-1}	13.22a	90.18b	23.07	4.27a	5.85a	42.23
Level of significance	0.01	0.01	NS	0.05	0.01	NS
$S\bar{x}$	0.118	0.549	-	0.114	0.064	-

Means in a column having the same letter(s) do not differ significantly as per DMRT.
NS = Not significant.

Table 5: Interaction between number of seedlings hill^{-1} and time of nitrogen application on the yield and yield components of late transplant Aman rice (cv. BR23)

Number of seedlings Hill^{-1} × Time of N application	Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
2 seedlings hill^{-1} × (15 DAT +ET)	9.59d	87.07	22.56	3.43	4.32	44.32
2 seedlings hill^{-1} × (15 DAT+ET+PI)	9.44de	88.45	22.76	3.56	4.26	45.54
2 seedlings hill^{-1} × (15 DAT+ET+PI+F)	9.21e	85.51	22.90	3.47	4.71	42.75
4 seedlings hill^{-1} × (15 DAT+ET)	9.73d	84.72	21.75	3.53	4.54	43.90
4 seedlings hill^{-1} × (15 DAT+ET+PI)	9.49de	85.82	21.57	3.63	4.72	43.71
4 seedlings hill^{-1} × (15 DAT+ET+PI+F)	8.78f	83.07	22.01	3.58	4.98	42.21
6 seedlings hill^{-1} × (15 DAT+ET)	10.99b	83.23	22.25	3.64	4.57	44.48
6 seedlings hill^{-1}× (15 DAT+ET+PI)	12.08a	84.15	22.34	3.82	4.82	44.38
6 seedlings hill^{-1} × (15 DAT+ET+PI+F)	10.26c	81.66	22.36	3.72	5.10	42.61
Level of significance	0.01	NS	NS	NS	NS	NS
$S\bar{x}$	0.118	-	-	-	-	-

Means in a column having the same letter(s) do not differ significantly as per DMRT.
NS =Not significant.
DAT = Days after transplanting
ET = Early tillering
PI = Panicle initiation
F = Floweing

Table 6: Effect of interaction between nitrogen rate and time of nitrogen application on the yield and yield components of late transplant Aman rice (cv. BR23)

Rate of N (kg ha^{-1}) × Time of N application	Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
0 kg N ha^{-1}× (15 DAT + ET)	8.55c	78.67g	21.28	3.06e	3.64f	45.66a
0 kg N ha^{-1} × (15 DAT+ET+PI)	8.53e	78.676g	21.18	3.06e	3.64f	45.66a
0 kg N ha^{-1} × (15 DAT+ET+PI+F)	8.55e	78.64g	21.17	3.06e	3.64f	45.63a
60 kg N ha^{-1} × (15 DAT+ET)	10.09c	84.21e	22.12	3.57d	3.58e	43.83bc
60 kg N ha^{-1} × (15 DAT+ET+PI)	10.06c	85.61d	22.21	3.75bcd	4.77d	44.07b
60 kg N ha^{-1} × (I5 DAT+ET+PI+F)	9.33d	83.60f	22.39	3.66cd	5.11c	41.74d
120 kg N ha^{-1} × (15 DAT+ET)	11.67b	92.14b	23.16	3.37abc	5.22bc	43.21c
120 kg N ha^{-1} × (15 DAT+ET+PI)	12.43a	94.14a	23.28	4.20a	5.39b	43.19bc
120 kg N ha^{-1} × (15DAT+ET+PI+F)	10.36c	88.00c	12.71	4.06ab	6.04a	40.19e
Level of significance	0.0	0.01	NS	0.05	0.01	0.01
$S\bar{x}$	0.118	0.270	-	0.114	0.064	0.324

Means of column having the same letter(s) do not differ significantly as per DMRT.
NS = Not significant.
DAT= Days after transplanting
ET = Early tillering
PI= Panicle initiation
F = Floweing

Table 7. Effect of interaction of number of seedlings hill^{-1}, nitrogen rate and time of nitrogen application on the yield and yield components of late transplant Aman rice (cv. BR23)

Number of seedlings hill^{-1} × Nitrogen rate (kg ha^{-1}) × Time of N application	Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$S_1 \times N_0 \times T_1$	8.47jk1	82.37	21.48	2.98	3.55j	45.72
$S_1 \times N_0 \times T_2$	8.5 ik	82.35	21.22	2.98	3.54j	45.71
$S_1 \times N_o \times T_3$	8.61j	82.39	21.21	2.98	3.55j	45.70
$S_1 \times N_1 \times T_1$	8.96ij	85.94	22.37	3.45	4.45i	43.75
$S_1 \times N_1 \times T_2$	8.89ij	87.50	22.84	3.71	4.42hi	44.61
$S_1 \times N_1 \times T_3$	8.98ij	84.47	23.34	3.52	4.84gh	42.16
$S_1 \times N_2 \times T_1$	11.34cd	92.91	23.84	3.84	4.99efg	43.50
$S_1 \times N_2 \times T_2$	10.94cde	95.51	24.23	4.00	4.64ghi	46.31
$S_1 \times N_2 \times T_3$	10.03fg	89.69	24.15	3.90	5.76b	40.39
$S_2 \times N_o \times T_1$	7.93klm	77.74	20.81	3.06	3.67j	45.45
$S_2 \times N_o \times T_2$	7.84m	77.65	20.80	3.06	3.68j	45.46

Number of seedlings hill-1 × Nitrogen rate (kg ha-1) × Time of N application	Effective tillers hill-1 (no.)	Grains panicle-1 (no.)	1000-grain weight (g)	Grain yield (t ha-1)	Straw yield (t ha-1)	Harvest index (%)
$S_2 \times N_o \times T_3$	7.861m	78.08	20.83	3.05	3.67j	45.42
$S_2 \times N_1 \times T_1$	10.38ef	84.05	21.61	3.58	4.69ghi	43.31
$S_2 \times N_1 \times T_2$	9.74gh	85.73	21.43	3.71	4.77ghi	43.77
$S_2 \times N_1 \times T_3$	8.84ij	83.37	21.50	3.63	5.28def	41.00
$S_2 \times N_2 \times T_1$	10.88de	92.37	22.84	3.95	5.26def	42.95
$S_2 \times N_2 \times T_2$	10.89de	94.07	22.47	4.12	5.72bc	41.91
$S_2 \times N_2 \times T_3$	9.63gh	87.75	23.70	4.06	6.05ab	40.20
$S_3 \times N_o \times T_1$	9.24hi	75.91	21.56	3.14	3.71j	45.82
$S_3 \times N_o \times T_2$	9.25hi	76.01	21.53	3.13	3.71j	45.80
$S_3 \times N_o \times T_3$	9.18hi	75.46	21.47	3.13	3.72j	45.78
$S_3 \times N_1 \times T_1$	10.93cd	82.65	22.38	3.68	4.61hi	44.43
$S_3 \times N_1 \times T_2$	11.56c	83.61	22.35	3.84	4.93fgh	43.84
$S_3 \times N_1 \times T_3$	10.17fg	82.97	22.35	3.83	5.28de	42.57
$S_3 \times N_2 \times T_1$	12.81b	91.13	22.81	4.11	5.41cd	43.19
$S_3 \times N_2 \times T_2$	15.45a	92.84	23.14	4.48	5.82b	43.51
$S_3 \times N_2 \times T_3$	11.42cd	86.57	23.27	4.21	6.32a	39.99
Level of significance	0.01	NS	NS	NS	0.05	NS
$S\bar{x}$	0.205	-	-	-	0.111	-

Means of column having the same letter(s) do not differ significantly as per DMRT.
NS = Not significant.
DAT = Days after transplanting

S1 = 2 seedlings hill-1	T1 = 15 DAT + ET	N1 = 0 kg N ha-1	ET = Earlytillering
S2 = 4 seedlings hill-1	T2 = 15 DAT + ET + PI	N2 = 60 kg N ha-1	PI= Panicle itiation
S3 = 6 seedlings hill-1	T3 = 15 DAT + ET + PI + F	N3 = 120 kg N ha-1	F = Floweing

Effect of Time of N Application

Number of effective tillers hill-1 and grains panicle-1 were significantly affected by the time of nitrogen application. The highest number of effective tillers hill-1 (10.34) was produced when the crop was fertilized with nitrogen in three equal splits at 15 DAT, early tillering (ET) and panicle initiation (PI) stages which was as good as two equal split at 15 DAT and ET and the lowest one (9.41) was obtained in four equal splits of N application at 15 DAT, ET, PI and F stages. While the highest number of grains panicle (86.10) was obtained in three equal splits application of N at 15 DAT, ET and PI stages followed by two equal splits of N at 15 DAT and ET and the lowest one (83.41) was recorded in in four equal splits at 15 DAT, ET, PI and F stages. These results are in agreement with that of Rao *et al.* (1996). The highest straw yield (4.93 t ha-1) was obtained from application of nitrogen in four equal splits at 15 DAT, ET, PI and F stages followed by (4.60 t ha-1) three equal splits of N at 15 DAT, ET and PI stages and the lowest straw yield (4.48 t ha-1) was recorded in two equal splits of N at 15 DAT and ET stage. The highest harvest index (44.55%) was obtained in three equal splits of N at 15 DAT, ET and PI stages which was statistically identical to two equal splits of N at 15 DAT and ET stage (44.23%) and the lowest harvest index (42.52%) was recorded in four equal splits of N at 15 DAT, ET, PI and F stages (Table 3).

Interaction Effect

Yield components and yield of late transplant *Aman* rice was influenced by various interactions of number of seedlings hill-1, and rate and time of N application (Table 4-7). The highest number of effective tillers hill-1 was found in the interaction of 6 seedlings hill-1 × 120kg N ha-1, 6 seedlings hill-1 × 3 times N application (15 DAT + ET + PI), 120kg N ha-1 × 3 times N application (15 DAT + ET + PI) and in the treatment combination of 6 seedling hill-1, 120 kg N ha-1 and 3 times of N application (15 DAT + ET+ PI) while the lowest number effective tillers hill-1 were recorded in 2 seedlings hill-1 × 0 kg N ha-1, 4 seedlings hill-1 × 4 times of N application (15 DAT + ET + PI + F), 0 kg N ha-1 × 3 times N application (15 DAT + ET + PI) and the treatment combination of 4 seedling hill-1× 0 kg N ha-1 3 times N application (15 DAT + ET + PI) (Table 7). The highest grains panicle-1were found in 2 seedlings hill-1 × 120kg N ha-1 and in combination of 120 kg N ha-1 × 3 times N application (15 DAT + ET + PI) while the lowest number of grains panicle-1were found in 6 seedlings hill-1 × 0 kg N ha-

^{1} and 0 kg N ha^{-1} 3 times N application (15 DAT + ET + PI) (Table 6). In case of interaction between number of seedlings hill^{-1} and nitrogen rate, the highest grain yield (4.27 t ha^{-1}) was recorded in 6 seedlings hill^{-1} × 120 kg N ha^{-1} which was as good as 4seedlings hill^{-1} × 120kg N ha^{-1}, while in case of interaction between nitrogen rate and time of nitrogen application the highest grain yield (4.20 t ha^{-1}) was recorded in the combination of 120 kg N ha^{-1} × 3 times N application (15 DAT + ET + PI) which was as good as 120 kg N ha^{-1} × 4 times N application (15 DAT+ET+PI+F) and 120 kg N ha^{-1} × 2 times N application (15 DAT + ET). The lowest grain yield was found in 2 seedlings hill^{-1} × 0 kg N ha^{-1} and 0 kg N ha^{-1} × 2 times N application (15 DAT + ET)(Table 6). The highest straw yield was recorded in 6 seedlings hill^{-1} × 120kg N ha^{-1}, 120 kg N ha^{-1} × 4 times N application (15 DAT + ET + PI + F) and 6 seedlings hill^{-1} × 120kg N ha^{-1}× 4 times N application (15 DAT + ET + PI + F) while the lowest straw yield was recorded in 2 seedlings hill^{-1} × 0 kg N ha^{-1} and 0 kg N ha^{-1} x 2 times N application (15 DAT+ET) and 2 seedlings hill^{-1} × 0 kg N ha^{-1} x 3 times N application (15 DAT + ET + PI) (Table 7). Thakur (1993) obtained increased straw yield of rice with increasing nitrogen level. Islam *et al.* (1990) also reported similar results. The highest and the lowest harvest index were obtained in 0 kg N ha^{-1} x 2 times N application (15 DAT + ET) and 120 kg N ha^{-1} × 4 times N application (15 DAT +ET + PI + F), respectively (Table 6).

On the basis of data shown in Table 1-7, it can be concluded that for appreciable grain yield late transplanted *Aman* rice (cv. BR23) can be grown by transplanting 4 or 6 seedlings hill^{-1}, fertilized with 120 kg N ha^{-1} and 3 times N application at 15 DAT, early tillering (ET) and panicle initiation (PI) stages.

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