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Performance of Late Transplant Aman Rice as Affected by Rate and Time of Nitrogen Application

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Abstract: The experiment was conducted to examine the effect of rate and time of nitrogen application and their interaction on late transplant aman rice (cv. BR23) and comprised of four nitrogen rates and five timing of nitrogen application. Application of N-fertilizer @ 100 kg ha^{-1} produced the highest plant height, number of bearing tillers hill^{-1}, panicle length, number of grains panicle^{-1}, number of sterile spikelets panicle^{-1},1000-grain weight, grain yield, straw yield and biological yield which were similar to that of the plants fertilized with 80 kg N ha^{-1}. Minimum values of the aforesaid parameters were observed in all plots when the crop was not fertilized with nitrogen. Nitrogen rate increased grain and straw yield up to the highest rate of nitrogen. The highest grain and straw yields were obtained from three equal split application of nitrogen at basal, early tillering and panicle initiation stages. Yield attributes like, number of total tillers hill^{-1}, number of bearing tillers hill^{-1}, panicle length, number of grains panicle^{-1}, biological yield and harvest index were also increased in three equal split application compared to two split application of nitrogen. Interaction between rate and time of nitrogen application also significantly influenced the number of tillers hill^{-1}, grain yield and harvest index. The highest grain yield obtained from the application of 100 kg N ha^{-1} in three equal splits at basal, early tillering and panicle initiation stages. Yield parameters were not significantly influenced by the interaction between rate and time of nitrogen application.

Key words: Performance, late transplant aman rice, rate and time of nitrogen application

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 is often suddenly submerged by flash flood every year due to heavy rainfall during wet monsoon. Anonymous (1988) reported that due to severe long-term flood damaged 8,32,029 acres of land in 47 districts of Bangladesh. Floodwater 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, non-availability of inputs at proper time and unplanned cropping pattern (Anonymous, 1987). Anonymous (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 can be compensated by cultivating suitable rice cv. BR 23 (Dishari) is such kind of late transplant HYV aman rice which can be transplanted late after the recession of flood water in late September with appreciable good yield.

For the cultivation of late transplant aman rice cultivars more emphasis should be given to develop suitable production technology. Normally late transplanting decreases yield irrespective of cultivars (Anonymous, 1992) but some modern cultivars have the ability to overcome this problem. Almost all indigenous aman rice varieties are photoperiod sensitive but poor in yield. All modern rice cultivars are not photoperiod sensitive. Although popular transplant aman cultivar BR10 and BR11 are photosensitive but can not be transplanted beyond last week of August due to their weakly little photoperiod sensitivity. Only few modern cultivars, such as BR22 and BR23 developed by the Bangladesh Rice Research Institute have good photoperiod sensitivity and that can be transplanted even up to last week of September, which keeps a high margin in comparison to the indigenous as well as the other modern t. aman varieties. Though BR23, a modern photoperiod sensitive cultivar, is recommended for late transplanting.

Nitrogen is a key nutrient element, which play a vital role in vegetative, development and yield of rice. The important role of nitrogenous fertilizers in increasing rice yield has been widely recognized, particularly after the development of modern varieties (De Datta *et al.*, 1974). An increase in the yield of rice by 70-80% may be obtained by proper application of nitrogen fertilizer (Anonymous, 1982). The soil sources may supply two- thirds of the nitrogen required by rice plants (Anonymous, 1978). Unfortunately, the nitrogen reserve of Bangladesh soil is very low due to warm climate accompanied by centuries of cultivation of same piece of land (Portech and Islam, 1984). Excess amount of nitrogen results in lodging of plant and reduction of yield. On the other hand, deficiency of nitrogen also hampers the production of rice.

Time of nitrogen application is an important aspect of overall nitrogen management in rice (Thakur, 1993). Proper timing of nitrogen application reduces the loss of nitrogen in rice fields. Efficient fertilizer management gave higher yield of crops and reduced fertilizer cost (Hossain and Islam, 1986). In order to obtain the maximum effect of nitrogen fertilizers it is not only important to resort to correct dose of the fertilizers but also to apply them in appropriate time. Appropriate timing of nitrogen application can appreciably reduce the nitrogen losses (Gaffer and Chand, 1988). Considering the late transplanting period, suitable management practices should be developed to increase the yield of rice. So this experiment was undertaken to see the performance of late transplanting aman rice as affected by rate and time of nitrogen application.

Materials and Methods

The study was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to December 1999. The treatments included in the study are; a) different rates of nitrogen (kg ha^{-1}) viz., 0, 40, 80 and 100; b) different times of split application of nitrogen viz., (I) application of N in three equal splits at basal (B), early tillering (ET) and panicle initiation (PI) stages, ii) application of N in two equal splits at basal and early tillering stages, iii) application of N in two equal splits at early tillering and panicle initiation stages, iv) application of N in two equal splits at early tillering and flowering (F) stages and v) application of N in four equal splits at basal, early tillering, panicle initiation and flowering stages. This experiment was laid out in a split- plot design, assigning N rate in the main plots and time of N application in the sub-plots. Land was

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thoroughly ploughed on 28 August 1999 and was puddled first with country plough on 10 September 1999 and second time on 18 September 1999 followed by laddering in order to level the soil, after a shower of rain. Weeds and stubble were removed from the land and it was made ready for transplanting of rice seedlings. The land was fertilized with urea as per treatment specification. In addition to urea other fertilizers like triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied in all plots of 100, 70, 60 and 10 kg ha^{-1}, respectively. The entire amount of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation. Different doses of urea was top dressed in different splits according to treatments. Forty-four days old seedlings were uprooted carefully and then transplanted in the main plot on 22 September 1999. Four seedlings were planted $hill^{-1}$ with 15 cm spacing between hills and 25 cm between the lines. Intercultural operations such as thinning, gapfilling, weeding, water management and plant protection measures were done as and when required for ensuring and maintaining the normal growth of the crop. After maturity, the crops were harvested on different dates. Five hills (excluding border hills and the hills at center which was kept for grain and straw yield measurement) were selected randomly from each experimental plot for recording of necessary data (yield and yield components).

The following data such as plant height, number of ear- bearing, non ear- bearing and total number of tillers $hill^{-1}$, panicle length, number of grains, sterile spikelets and total number of spikelets $panicle^{-1}$, 1000-grains weight, grain, straw and biological yield and harvest index were recorded.

The collected data were analyzed statistically following the ANOVA technique and mean differences of the treatments and their combinations were adjudged by Duncan's multiple range test (Gomez and Gomez, 1984).

Results and Discussion

The effect of nitrogen rate on all the parameters except no. of non bearing tillers $hill^{-1}$ and weight of 1000-grains under study was significant (Table 1). The tallest plant highest number of effective tillers $hill^{-1}$, number of sterile spikelets $panicle^{-1}$, panicle length and number of grains $panicle^{-1}$ were found when the crop was fertilized with 100 kg N ha^{-1} which were statistically similar to 80 kg N ha^{-1}. The lowest ones were produced when the crop was not fertilized with nitrogen. The highest grain yield was obtained from 100 kg N ha^{-1} which was contributed mainly by the higher number of ear bearing tillers $hill^{-1}$ and grains $panicle^{-1}$ and it was at par with 80 kg N ha^{-1}. The lowest grain yield was produced when the crop was not fertilized with nitrogen. Under late transplanted condition, aman rice gets less time for vegetative growth and it will rapidly switch over to reproductive phase due to its sensitivity to short day length. This is probably the main reason for no further increase of grain yield due to application of 100 kg N ha^{-1}. The result on grain yield is in partial agreement with the findings of Singh and Pillai (1994) who reported that increased doses of nitrogen increased grain yield significantly up to 90 kg ha^{-1} after which it declined. Likewise, the straw and biological yields increased with increasing nitrogen rate up to 100 kg ha^{-1}. This was similar to nitrogen application @ of 80 kg N ha^{-1}.

Table 1: Effect of nitrogen rate and time of nitrogen application at different growth stages on yield and yield components of BR23

Treatments	Plant height (cm)	No. of bearing tillers $hill^{-1}$	No. of non bearing tillers $hill^{-1}$	Total No. of tillers $hill^{-1}$	Panicle length (cm)	No. of grains $panicle^{-1}$	No. of sterile spikelets $panicle^{-1}$	Weight of 1000-grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Nitrogen rate (kg ha^{-1})												
0	95.45c	7.01c	3.02	9.79c	20.34c	61.77b	23.49c	23.89	2.03c	3.80c	5.83c	34.10b
40	100.3b	8.42b	2.63	11.26b	21.92b	64.44ab	28.33b	24.33	3.10b	4.70b	7.91b	40.47a
80	106.2a	9.12ab	3.04	12.75a	22.52ab	69.07a	33.43a	24.40	3.81a	5.56a	9.38a	40.66a
100	108.6a	9.56a	2.94	12.95a	22.97a	69.24a	34.12a	24.45	3.90a	5.66a	9.56a	40.60a
Sx	1.205	0.02	-	0.20	0.21	1.37	0.42	-	0.07	0.06	0.12	1.23
Level of significance	0.05	0.05	NS	0.05	0.05	0.05	0.05	NS	0.05	0.05	0.05	0.05
Time of N application												
B+ET+PI	102.3bc	9.50a	3.41a	12.47a	22.58a	75.25a	35.40a	24.52	3.81a	5.36a	9.17a	41.15a
B+ET	99.90d	8.02c	2.75bc	10.91b	21.62b	62.79c	27.74d	24.11	3.07c	4.75c	7.82c	38.92b
ET+PI	101.3cd	8.43bc	2.90b	11.88a	22.06ab	66.44b	29.31c	24.27	3.19c	4.87bc	8.05c	39.25b
ET+F	104.0ab	7.70c	2.39c	10.93b	21.32b	59.64d	25.62d	24.01	2.63d	4.52c	7.15d	35.40c
B+ET+PI+F	105.7a	8.99ab	3.07ab	12.26a	22.11ab	67.53b	31.13b	24.43	3.49b	5.16ab	8.65b	40.06ab
Sx	0.78	0.26	0.13	0.23	0.30	1.06	0.34	-	0.06	0.12	0.16	0.45
Level of significance	0.05	0.05	0.05	0.05	0.05	0.05	0.05	NS	0.05	0.05	0.05	0.05

Table 2: Effect of interaction between rate and time of N application on yield and yield components

Nitrogen (kg ha^{-1})	Time of N application	Plant height (cm)	No. of bearing tillers $hill^{-1}$	No. of non bearing tillers $hill^{-1}$	Total no. of tillers $hill^{-1}$	Panicle length (cm)	No. of grains $Panicle^{-1}$	No. of sterile spikelets $panicle^{-1}$	Weight of 1000-grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
0	B+ET+PI	96.36	8.27	3.39	9.72g	21.08	70.11	26.62hi	24.09	2.61gh	4.30	6.91	37.77cd
	B+ET	90.63	6.47	2.97	9.50g	19.91	56.66	22.49ki	23.75	1.96j	3.65	5.61	34.94d
	ET+PI	96.05	6.30	3.00	9.78g	20.59	62.88	23.37jk	23.89	2.16ij	3.85	6.01	35.76d
	ET+F	97.71	6.33	2.46	10.32e-g	19.33	56.46	21.14i	23.69	1.04k	3.13	4.17	25.11e
	B+ET+PI+F	96.48	7.67	3.26	9.65g	20.79	62.75	23.84jk	24.03	2.38hi	4.07	6.45	36.90d
40	B+ET+PI	97.93	9.27	2.88	11.95b-d	22.26	71.00	34.66c	24.55	3.46c-e	4.96	8.41	41.05b
	B+ET	97.78	8.07	2.27	10.84d-g	21.26	63.91	25.15ij	24.19	3.16ef	4.66	7.82	40.41bc
	ET+PI	97.88	8.67	2.73	11.63c-f	21.87	65.30	28.45gh	24.33	3.19ef	4.69	7.88	40.43bc
	ET+F	105.59	7.20	2.44	10.18fg	21.74	53.05	23.50jk	24.11	2.92fg	4.42	7.34	39.78bc
	B+ET+PI+F	102.21	8.93	2.80	11.70b-e	22.19	68.95	29.91fg	24.47	3.29d-f	4.79	8.08	40.67bc
80	B+ET+PI	106.92	10.13	3.43	14.00a	23.42	74.46	40.34a	24.70	4.16b	5.91	10.07	41.38b
	B+ET	103.85	8.46	2.97	11.55c-f	22.57	67.30	31.44ef	24.22	3.59cd	5.34	8.93	40.29bc
	ET+PI	103.86	9.07	3.03	12.95a-c	22.66	67.61	31.70d-f	24.40	3.69c	5.44	9.13	40.37bc
	ET+F	108.45	8.40	2.46	11.52c-f	21.65	66.26	31.08ef	24.10	3.51c-e	5.26	8.76	39.97bc
	B+ET+PI+F	108.03	9.53	3.29	13.75a	22.29	70.56	32.57de	24.58	4.12b	5.88	10.00	41.29b
100	B+ET+PI	107.83	10.34	3.91	14.20a	23.57	81.43	40.00ab	24.75	5.00a	6.28	11.28	44.38a
	B+ET	107.33	9.07	2.80	11.75b-e	22.46	63.26	31.87d-f	24.27	3.58cd	5.34	8.92	40.05bc
	ET+PI	107.49	9.67	2.84	13.15ab	23.09	69.77	33.73cd	24.45	3.71c	5.48	9.19	40.45bc
	ET+F	110.95	8.87	2.19	11.72b-e	22.54	62.80	26.78hi	24.15	3.06f	5.28	8.33	36.73d
	B+ET+PI+F	109.25	9.82	2.92	13.95a	23.16	67.86	38.21b	24.63	4.16b	5.91	10.06	41.37b
Sx		-	-	-	0.45	-	-	0.68	-	0.12	-	-	0.90
Level of significance		NS	NS	NS	0.05	NS	NS	0.05	NS	0.05	NS	NS	0.05

In a column, figures with the same letter or without letter do not differ significantly whereas figures with dissimilar letters differ significantly at $P \leq 0.05$ as per DMRT, NS = Non significant, B = Basal, ET = Early tillering stage, PI = Panicle initiation stage, F = Flowering stage, Sx = Standard error

However, the harvest index was the highest when nitrogen was applied @ of 80 kg ha^{-1} which was similar to 40 and 100 kg N ha^{-1}.

Yield and yield contributing characters like plant height, total number of tillers $hill^{-1}$, number of ear bearing tillers $hill^{-1}$, number of non ear bearing tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, grain yield, straw yield, biological yield and harvest index were significantly influenced by the time of nitrogen application and the highest values were obtained with three equal split application of nitrogen at basal, early tillering and panicle initiation stages which was followed by with four equal splits at basal, early tillering, panicle initiation and flowering stages. Nitrogen application in two equal splits at basal and early tillering stages and at early tillering and panicle initiation stages and at early tillering and flowering stages produced more or less similar results for all the parameters. Nitrogen application in three equal splits at basal, early tillering and panicle initiation stages and four equal splits at basal, early tillering, panicle initiation and flowering stages increased the efficiency of nitrogen utilization and resulted in higher yield of grain compared to nitrogen applied in two equal splits. Improvement of yield components such as number of ear bearing tillers $hill^{-1}$, number of grains $panicle^{-1}$ and weight of 1000-grains in the above treatments ultimately resulted in the higher yield of grains. The increased grain yield was contributed by such components. When nitrogen was applied in two splits at basal and early tillering stages plant from nitrogen deficiency at panicle initiation and flowering stages and hence vegetative and reproductive growth was hampered. Nitrogen applied at early tillering and panicle initial stages caused plants suffers from nitrogen deficiency at initial stage and as a result vegetative and reproductive growth was hampered. For all the above reasons grain yield was reduced due to nitrogen deficiency at those stages. Results revealed that nitrogen applied in three equal splits was more effective than two equal splits. Therefore, nitrogen should preferably be applied in three equal splits at basal, early tillering and panicle initiation stages for late transplant aman rice (cv. BR23). These results are in conformity with that of Islam *et al.* (1986) who obtained the highest grain yield from three splits of nitrogen. These results are also in agreement with that of Raju and Reddy (1989).

Among the yield and yield components, total number of tillers $hill^{-1}$, number of sterile spikelets $panicle^{-1}$, grain yield and harvest index were significantly influenced by the interaction between rate and time of nitrogen application (Table 2). Fertilization with 100 kg N ha^{-1} in three equal splits at basal, early tillering and panicle initiation stages gave the highest grain yield. The lowest grain yield was obtained from control treatments.

Fertilization of late transplant aman rice (cv. BR23) with 100 kg N ha^{-1} applied in three equal splits at basal, early tillering and panicle initiation stages emerged as a promising practice in terms of grain yield.

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