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Effect of nitrogen fertilizer and weed management on the yield of transplant *aman* rice

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Abstract

The research work was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during *aman* season from July to December, 2015 to study the effect of nitrogen fertilizer and weed management on the growth and yield of transplant *aman* rice cv. BRRI dhan46. The experiment consisted of four fertilizer treatments viz. 0 kg N ha^{-1} (N_0), 40 kg N ha^{-1}(N_1), 80 kg N ha^{-1}(N_2) and 120 kg N ha^{-1}(N_3) and four weeding treatments viz. one hand weeding at 20 DAT (W_1), two hand weedings at 20 and 35 DAT (W_2), three hand weedings at 20, 35 and 50 DAT (W_3), weeding by Japanese rice weeder twice at 20 and 35 DAT (W_4) and unweeded control (W_5). The experiment was laid out in randomized complete block design with three replications. The highest plant height (113.00 cm), number of total tillers hill^{-1} (8.74), number of effective tillers hill^{-1} (6.18), panicle length (21.98 cm), number of grains panicle^{-1} (114.20), grain yield (4.00 t ha^{-1}), straw yield (5.25 t ha^{-1}) and biological yield (9.25 t ha^{-1}) were recorded in N_2 (80 kg N ha^{-1}) treatment. The lowest plant height (106.00 cm), number of total tillers hill^{-1} (7.20), number of effective tillers hill^{-1} (5.00), panicle length (20.70 cm), number of grains panicle^{-1} (97.60), grain yield (3.52 t ha^{-1}), straw yield (4.46 t ha^{-1}) and biological yield (7.97 t ha^{-1}) were recorded from N_0 (No nitrogen fertilizer control) treatment. On the other hand, the highest grain yield 4.23 t ha^{-1} was observed in three weedings condition because of the highest number of effective tillers hill^{-1} (6.81), number of grains panicle^{-1}(111.10). The highest straw yield (5.51 t ha^{-1}) was also found in three weeding condition. The lowest grain yield (3.40 t ha^{-1}) was recorded in W_5 (unweeded control) treatment. The lowest straw yield (4.31 t ha^{-1}) was also observed in W_5 (unweeded control) treatment because of the smallest plant (106.97 cm) and lower number of total tillers hill^{-1} (7.20). Therefore, 80 kg N ha^{-1}along with three hand weedings at 20, 35 and 50 DAT may be used for obtaining the highest grain and straw yields of BRRI dhan46.

Introduction

Agriculture is the largest employment sector in Bangladesh. As of 2016, it employs 47% of the total labor force and comprises 16% of the country's GDP. The performance of this sector has an overwhelming impact on major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security. A plurality of Bangladeshis earns their living from agriculture. Rice is the dominant staple food for many countries of the world (Mobasser *et al*., 2007). It is also the most important food crop and a major food grain for more than one third of the world population (Zhao *et al*., 2011).

Nitrogen is the key element in the production of rice and gives by far the largest response. It is an essential plant nutrient that plays a significant role in growth, yield and quality of rice. The important role of nitrogen fertilizers in increasing rice yields has been widely recognized, particularly after the development of modern varieties. Nitrogen is an integral part of protoplasm, protein and chlorophyll and plays a remarkable role in increasing cell size which in turn increases yield. Excess amount of nitrogenous fertilizer results in lodging of plants, prolonging growing period, delayed in maturity, susceptibility to insect-pests and diseases and ultimately reduces yield (Uddin, 2003). Efficient fertilizer management gave higher yield of crop and reduced fertilizer cost (Hossain and Islam, 2006). Plant growth is seriously hampered when lower dose of nitrogen is applied, which drastically reduces the yield. It is also a fact that improper use of nitrogenous fertilizer, instead of giving yield advantage, may reduce the same. Many workers have reported a significant response of rice to nitrogen in different soils in Bangladesh (Bhuiya *et al*., 1989, Hussain *et al*., 1989 and Islam *et al*., 1990).

Weeds are one of the most important agricultural pests. Infestation of weed is one of the most important causes for low yield of rice. There is no doubt that maximum benefit from costly input like fertilizers and pesticides in rice can be fully derived when the crop is kept free from weed infestation. The edaphic and climatic conditions of the country are congenial for the growth of numerous species of obnoxious weeds, which lead to considerable

yield reduction. High competitive ability of weeds exerts a serious negative effect on crop production causing significant losses in crop yield (Mamun *et al.*, 1993).Poor weed control is one of the major factors for yield reduction in rice, the extent of which depends on type of weed flora and their intensity of infestation. Yield losses due to weed infestation are greater than the combined losses of insect pests and diseases. In Bangladesh, weed infestation reduces grain yield by about 70–80% in *aus* rice, 30–40% for transplanted (T) *aman* rice and 22-36% for modern *boro* rice cultivars (BRRI, 2008; Mamun, 1990). There are studies about nitrogen and weed management in T. *aman* rice but for a specific variety BRRI dhan46 it is rare. Thus the best weeding needs to be adopted by the farmers with a view to reducing weed infestation and maximizing rice yield. Considering mentioned points, the study was conducted to optimize nitrogen and weed management in transplant *aman* rice.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the period from July to December, 2015 to study the effect of nitrogen fertilizer and weed management on the growth and yield of transplant *aman* rice. The experimental site belongs to the Old Brahmaputra Floodplain Agro ecological Zone (AEZ-9). Non calcareous dark-grey floodplain soil is generally predominant in the site. The land type was medium high and the soil was silty loam in texture. The pH value of the soil was 6.8 and the soil is low in organic matter content. The variety BRRI dhan46 was used as the test crop in the experiment. BRRI dhan46 with photoperiod sensitivity is suitable for late transplanting in *aman* season after the recession of flood water. Its average grain yield is 4.7tha^{-1}. The experiment consisted of 4 levels of Nitrogen viz. 0 kg N ha^{-1} (N_0), 40 kg N ha^{-1} (N_1), 80 kg N ha^{-1} (N_2) and 120 kg N ha^{-1} (N_3) and five weeding treatments viz. One hand weeding at 20 DAT (W_1), two hand weedings at 20 and 35 DAT (W_2), three hand weedings at 20, 35 and 50 DAT (W_3), weeding by Japanese rice weeder twice at 20 and 35 DAT (W_4) and unweeded control (W_5). The experiment was laid out in a randomized complete block design with three replications. Each block was divided into twenty unit plots of size 4.0m×2.5m each. Thus, the total number of unit plot was 60 (20×3). The distance maintained between two unit plots was 0.5m and between blocks was 1m. Nitrogen was applied accordingly experimental specification in the form of urea at three splits application. Five hills were randomly selected and marked with the bamboo sticks in each unit plot excluding border rows to record the data on yield contributing characters and yield. Recorded data were analyzed statistically using "Analysis of Variance Technique and the differences among treatment means were adjudged by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effect of nitrogen fertilizer

Nitrogen fertilizer significantly influenced crop characters, yield and yield contributing characters of T. *aman* rice cv. BRRI dhan46. It was observed that 80 kg N ha^{-1}produced tallest plant (113.00cm), highest number of total tillers hill^{-1} (8.74) and highest number of effective tillers hill^{-1} (6.19). These findings corroborate with those reported by Uddin *et al.* (2013). N_0 (no nitrogen fertilizer control) treatment produced the shortest plant height (106.00 kg N ha^{-1}), lowest number of total tillers hill^{-1}(7.20) and lowest number of effective tillers hill^{-1}(5.00) (Table 1). It was observed that number of total tillers hill^{-1}decreased progressively with the decrease in the amount of nitrogen fertilizer and became lowest at N_0 (Control) treatment (Table 1). The highest number of grains panicle^{-1} (114.20) and highest weight of 1000-grains (25.85 g) was found in N_2 (80 kg N ha^{-1}) treatment and the lowest one was obtained from N_0 (no nitrogen fertilizer control) treatment (Table 1). Grain yield varied from 3.52 to 4.00 t ha^{-1}. The highest grain yield (4.00 t ha^{-1}) was obtained from N_2 (80 kg N ha^{-1}) treatment and the lowest one (3.52 t ha^{-1}) was obtained from N_0 (Control) treatment (Table 1). The second highest grain yield was found in N_3 (120 kg N ha^{-1}) treatment followed by N_1 treatment. The increased grain yield with 80 kg N ha^{-1} might be due to the cumulative effect of the highest number of effective tillers hill^{-1} and grains panicle^{-1} obtained from the supply of nitrogen for the plants. Similar results were found elsewhere (Singh *et al.,* 2000 and Salahuddin *et al.,* 2009). The highest straw yield (5.25 t ha^{-1}) was obtained from N_2 (80 kg N ha^{-1})treatment and the lowest one (4.46 t ha^{-1}) was obtained from N_0 (Control) treatment (Table 1). Application of nitrogenous fertilizer encouraged vegetative growth of rice in terms of plant height and number of total tillers hill^{-1}, which ultimately resulted in the increase of straw yield (Mishra *et al.,* 2003). The biological yield and harvest index also affected significantly due to application of nitrogenous fertilizer.

Effect of weed management

Weed management significantly influenced the crop characters, yield and yield contributing characters except plant height (Table 2). W_3 (three hand weedings at 20, 35 & 50 DAT) treatment showed superiority in terms of number of total tillers hill^{-1} (8.61), number of effective tillers hill^{-1} (6.81), panicle (21.92 cm), number of grains panicle^{-1} (111.10), 1000-grain weight (25.52 g) while the lowest values were in unweeded control plots. The highest grain yield (4.23 t ha^{-1}), straw yield (5.51 t ha^{-1}) and biological yield (9.74 t ha^{-1}) was obtained from W_3 (weeding at 20, 35 and 50 DAT) treatment. The weeds

competed with the crop plants for nutrition, water, air, sunlight and space thus reducing yield. The increased yield in weeded crops was contributed by higher number of effective tillers hill^{-1} and higher numbers of grains panicle^{-1} over no weeding treatments. This might be due to the fact that weeding kept the land clean and the soil was well aerated which facilitated the crop for better absorption of nutrients, moisture and solar radiation for higher yield. Effective weed management enhanced production of effective tillers hill^{-1}, grains panicle^{-1} which ultimately increased grain yield of rice. Therefore, rice should be kept weed free as much as possible through the life cycle to obtain good yield. Yield variations in rice due to weeding were also observed by many researchers (Chowdhury *et al*., 1994; Ahmed *et al*., 1998; Hossain *et al*., 2002; Islam *et al.,* 2003, Liu *et al.,* 2016).

Interaction effects of nitrogen fertilizer and weed management

Interaction effect of nitrogen fertilizer and weed management did not show significant effect on final plant height, panicle length, no. of grains panicle^{-1}, 1000-grain weight and harvest index. The highest number of total tillers hill^{-1} (9.44) and effective tillers hill^{-1} (7.83) was obtained from $N_2 \times W_3$ (80 kg N ha$^{-1}\times$ weeding at 20, 35 and 50 DAT) combination and the lowest one was observed in $N_0 \times W_5$ (no nitrogen fertilizer control × unweeded control) combination (Table 3). Grain yield of transplant aman rice cv. BRRI dhan46 was significantly influenced by the interaction between nitrogen fertilizer and weeding (Table 3). Grain yield varied from 3.25 to 4.50 t ha^{-1}. The highest grain (4.50 t ha^{-1}) and straw yield (6.10 t ha^{-1}) was obtained from $N_2 \times W_3$ (80 kg N ha^{-1} × weeding at 20, 35 and 50 DAT) combination and the lowest one was obtained from $N_0 \times W_5$ (no nitrogen fertilizer control × unweeded control) combination (Table 3).Biological yield was significantly influenced by the interaction between weeding and nitrogen fertilizer(Table 3). The highest biological yield (10.60 t ha^{-1}) was obtained from $N_2 \times W_3$ (80 kg N ha$^{-1}\times$ weeding at 20, 35 and 50 DAT) combination and the lowest one (7.35 t ha^{-1}) was obtained from $N_0 \times W_5$ (no nitrogen fertilizer control× unweeded control) combination (Table 3).

Table 1. Effect of nitrogen fertilizer on yield and yield contributing characters of T. *aman* rice cv. BRRI dhan46

Nutrient fertilizer	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
N_0	106.00b	7.19d	5.00d	23.42c	3.52d	4.46c	44.15a
N_1	108.90ab	7.78c	5.64c	24.10b	3.69c	4.91b	42.94 b
N_2	113.00a	8.74a	6.19a	25.85a	4.00a	5.25a	43.30ab
N_3	110.60a	8.19b	5.80b	24.54b	3.87b	5.05b	43.44ab
Level of sig.	**	**	**	**	**	**	*
CV (%)	4.87	2.61	3.57	3.57	2.33	3.69	2.70

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT),** =Significant at 1% level of probability; * =Significant at 5% level of probability. N_0 = Control; N_1 = 40 kg N ha^{-1}; N_2 = 80 kg N ha^{-1} and N_3 = 120 kg N ha^{-1}.

Table 2. Effect of weeding on yield and yield contributing characters of T. *aman* rice cv. BRRI dhan46

Weeding	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
W_1	109.03	7.72d	5.22d	24.10c	3.52 d	4.77c	42.50b
W_2	110.05	8.03c	5.40c	24.41bc	3.71c	4.90c	43.07ab
W_3	111.53	8.61a	6.81a	25.52a	4.23a	5.51a	43.49ab
W_4	110.56	8.32b	5.67b	25.10ab	4.01b	5.08b	44.12a
W_5	106.97	7.20e	5.19d	23.26d	3.40e	4.31d	44.10a
Level of sig.	NS	**	**	**	**	**	**
CV (%)	4.87	2.61	3.57	3.57	2.33	3.69	2.70

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT)

** =Significant at 1% level of probability; NS = Not significant.W_1 = One hand weeding at 20 days after transplanting (DAT); W_2 = Two hand weeding at 20 & 35 DAT; W_3 = Three hand weeding at 20, 35 & 50 DAT; W_4 = Weeding by Japanese rice weeder twice at 20 & 35 DAT and W_5 = Unweeded control.

Table 3. Interaction effects of nitrogen fertilizer and weeding on yield and yield contributing characters of T. *aman* rice cv. BRRI dhan46

Interaction (nitrogen fertilizer x weeding)	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$N_0 \times W_1$	106.10	7.11 j	4.89ij	22.89	3.37jk	4.30jk	43.94
$N_0 \times W_2$	107.30	7.33ij	4.89ij	23.62	3.40jk	4.48ij	43.20
$N_0 \times W_3$	108.20	7.78fgh	5.67def	24.77	3.87ef	4.83fgh	44.47
$N_0 \times W_4$	107.20	7.44hij	4.89ij	24.01	3.72fg	4.56hij	44.93
$N_0 \times W_5$	101.00	6.33k	4.67j	21.82	3.25k	4.10k	44.22
$N_1 \times W_1$	108.20	7.67ghi	5.11hi	23.69	3.45hij	4.72ghi	42.23
$N_1 \times W_2$	109.00	7.78fgh	5.44efh	23.75	3.57ghi	4.92efg	42.05
$N_1 \times W_3$	109.90	8.44cde	6.53c	24.88	4.19c	5.41bc	43.65
$N_1 \times W_4$	109.40	7.89fg	5.56deg	24.50	3.93e	5.16cdef	43.23
$N_1 \times W_5$	107.90	7.1j	5.56deg	23.67	3.35jk	4.35jk	43.53
$N_2 \times W_1$	111.70	8.33de	5.6def	26.00	3.68g	5.20cde	41.44
$N_2 \times W_2$	113.70	8.89b	5.78de	26.17	4.00de	5.15cdef	43.72
$N_2 \times W_3$	115.20	9.44a	7.83a	26.79	4.50a	6.10a	42.45
$N_2 \times W_4$	114.10	9.27a	6.33c	26.46	4.25bc	5.33cd	44.36
$N_2 \times W_5$	110.30	7.78fgh	5.33fgh	23.83	3.57ghi	4.46ij	44.50
$N_3 \times W_1$	110.10	7.78fgh	5.22ghi	23.81	3.59gh	4.87efh	42.40
$N_3 \times W_2$	110.20	8.11ef	5.49efg	24.11	3.86ef	5.05deg	43.32
$N_3 \times W_3$	112.80	8.78bc	7.22b	25.63	4.37ab	5.70b	43.40
$N_3 \times W_4$	111.40	8.67bcd	5.89d	25.43	4.13cd	5.27cd	43.94
$N_3 \times W_5$	108.70	7.60ghi	5.20ghi	23.73	3.42ij	4.33jk	44.13
Level of significance	NS	*	**	NS	*	*	NS
CV (%)	4.87	2.61	3.57	3.57	2.33	3.69	2.70

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).

** =Significant at 1% level of probability; * =Significant at 5% level of probability; NS = Not significant.N_0 = 0 kg N ha^{-1}(control); N_1 = 40 kg N ha^{-1}; N_2 = 80 kg N ha^{-1}and N_3 = 120 kg N ha^{-1}. W_1 = One hand weeding at 20 days after transplanting (DAT); W_2 = Two hand weedings at 20 & 35 DAT; W_3 = Three hand weedings at 20, 35 & 50 DAT; W_4 = Weeding by Japanese rice weeder twice at 20 & 35 DAT and W_5 = Unweeded control

Conclusion

For the result of the present study it can be concluded that 80 kg N ha^{-1} along with three hand weedings at 20, 35 and 50 DAT may be used to obtain the highest grain and straw yields of transplant *aman* rice cv. BRRI dhan46. Farmers will follow this suggestion because it will help them to obtain a satisfactory yield. It will also help to determine the optimum nitrogen level, to find out the appropriate weed control treatments and to find out the effect of interaction between nitrogen fertilizers and weed management on the growth and yield of transplant aman rice cv. BRRI dhan46.

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