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RESPONSE OF NITROGEN AND PLANT SPACING OF TRANSPLANTED AMAN RICE

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Abstract

An experiment was conducted during July-December 2001 at the Agronomy field laboratory, Bangladesh Agricultural University, Mymensingh to study the effect of nitrogen levels and plant spacing on the yield and yield contributing characters of transplant Aman rice (var. BRRI Dhan 31). Five levels of nitrogen (0, 50, 100, 150, 200 kg N/ha) and three spacings (25 cm x 20 cm, 25 cm x 15 cm, 25 cm x 10 cm) were included as treatment variables. A gradual increase in panicle length (24.50 cm), grains/panicle 110) and grain yield (4.91 t/ha) were observed with the increase in nitrogen levels upto 150 kg/ha and declined thereafter. Thousand-grain weight was not significantly influenced by application of different levels of nitrogen. The maximum grain yield (4.22 t/ha) was observed at the spacing 25 cm x 10 cm closely followed by 25 cm x 15 cm (4.21 t/ha). Wider spacing (25 cm x 10 cm) produced the tallest plant (108.38 cm), but significantly highest tllers/hill (8.06) and grains/panicle was recorded from (25 cm x 20 cm). Plant spacing had also no significant effect on 1000-grain weight. The interaction effects of nitrogen and plant spacing was significant in panicle length, grains/panicle, and grain yield. The higher grain yield (5.00 t/ha) was recorded from the treatment combination of 150 kg N/ha with 25 cm x 15 cm spacing, but statistically identical to same N dose with other two spacings. Response of grain yield to added N was quadratic. The optimum doses were found to be 132 kg N/ha for 25 cm x 20 cm, 119 kg N/ha for 25 cm, and 177 kg N/ha for 25 cm x 10 cm spacing, yielding 4.38, 4.63 and 4.75 t/ha, respectively.

Key Words : Nitrogen, plant spacing, *aman* rice.

Introduction

Bangladesh grows rice (*Oryza sativa* L.) as a main foodgrain crop. It is grown in more than hundred countries of the owrld and is the staple food for 60% of the world population (Khush and Chowdhury, 1991). It provides about 70% of the calories consumed by 130 million people of Bangladesh. It constitutes about 90% of foodgrains and covers about 80% of total cropped area of the country (AIS, 1996). However, the potential for increasing rice production strongly depends on the ability to integrate a better crop management for the different varieties into existing cultivation systems (Mikkelsen *et al.*, 1995). A higher output unit area also demands considerable amounts of external inputs, such as fertilizers.

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Nitrogen is the most essential element in determining the yiedl potential of rice and nitrognous fertilizer is one of the major inputs to rice production (Mae, 1997). Almost every farmer has tendency to apply costly N fertilizer exces to get a desirable yield of Aman rice (Saleque *et al.*, 2004), but imbalance use of N fertlizer causes harm to the crop and decreases grain yield.

Plant spacing is an another important factor, which plays a significant role on growth, development, and yield of rice at its optimum level beside it, which provides scope to the plants for efficient utilization of solar radiation and nutrients (Miah *et al.*, 1990). Closer spacing hampers intercultural operations and as such more competition arises among the plants for nutrients, air, and light. As a result, plant becomes weaker, thinner and consequently reduces yield. Under closer plant spacing, farmers can not get desired hills/unit area which also ultimately reduces yield. Therfore, proper manipulation of planting density may lead to increase the economic yield of T. Aman rice. The present investigation was carried out to investigate the yield response of T. Aman rice in relation to nitrogen levels and plant spacing

Materials and Method

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from July to December 2001. The soil of the experimental field was silty loam in texture and slightly acidic in reaction (pH 6.5) with low organic matter content (1.23%). The total nitrogen, available phosphorus, available sulphur, and exchangeable potassium were 0.129%, 13.2 ppm, 16 ppm, and 0.22 meq/100g soil. The total rainfall during the crop season was 989 mm and the maximum and minimum air mean temperature recorded 30.6 and 22.7^0C, respectively.

The treatments comprised of five levels of nitrogen (0, 50, 100, 150 and, 200 kg N/ha) and three plant spacings (25 cm x 20 cm, 25 cm x 15 cm, and 25 cm x 10 cm). The experiment was laid out in a factorial randomized complete block design with three replications. The size of unit plot was 4.0 m x 2.5 m. Rice seeds (var. BRRI dhan 21) were raised in well prepared seed bed. Before raising seeds in the nursery, seeds were water soaked for 24 hours and these were kept in jute bags in dark conditions. After sprouting, the seeds were sown in wet seed bed on 19 July 2001. Thirty-five day old seedlings were uprooted carefully from the nursery and transplanted (2-3 seedlings/hill) on the well puddled experimental plots on 6 August 2001. Fertilizers were applied @ 100, 70, 60, and 10 kg/ha of P, K, S, and Zn through triple super phosphate (TSP), muriate of potash (MoP), gypsum, and zinc sulphate ($ZnSO_4$). The whole amount of TSP, MoP, gypsum, and $ZnSO_4$ were applied at the time of final land preparation. The whole amount of urea was top-drssed in 3 equal instalments at 15, 30, and 50 days after transplants. Irrigation along with other intercultural operations were done as and when required. The crop of individual plots were separately harvested at full maturity on 20 November 2001. Data on plant height, number of total and effective tillers/hill, panicle length, number of grains/panicle, and weight of 1000-grain were collected from five sample plants of each plot. The grain weight for each plot were recorded after proper drying in sun. The collected data were statistically analyzed and mean differences was compared by Duncan's New Multiple Range Test (DMRT).

Results and Discussion

Results of the present study regarding the influence of nitrogen levels and plant spacing and their interactions on the yield and yield components of transplanted Aman rice have been presented in Table 1 and 2.

Effect of nitrogen: Plant height, number of effective tillers/hill, panicle length, grains/panicle, 1000-grain weight, and grain yield/ha were significantly, influenced by different levels of nitrogen. Thousand grain weight remained unaltered due to N fertilizer application (Table 1). Plant height increased with the increasing rates of nitrogen upto 200 kg/ha and it was found significantly higher from the other levels of nitrogen. The shortest plant (100.72 cm) was found in the control plot (without N). Nitrogen induced maximum vegetative growth with higher rates of N. Similar results were also reported by Navin *et al.* (1996). Number of effective tillers/hill followed a pattern similar to that obtained for plant height. Panicle length increased with the increase of nitrogen rate upto 150 kg N/ha and thereafter declined. The longest panicle (24.50 cm) was observed when 150 kg N/ha was applied and the shortest (18.15 cm) from control. Nitrogen nutrient takes part in panicle formation as well as panicle elongation and for this reason, panicle length increased with the increase of N-fertilization upto 150 kg/ha. The highest number of grains/panicle (109.79) was obtained at 150 kg/ha, which was significantly different from other N levels. Nitrogen helped in proper filling of seeds which resulted higher produced plump seeds and thus the number of grains/panicle. The lowest number of grains/panicle (99.41) was obtained from 0 kg N/ha.

Grain yield of T. Aman rice increased gradually with the increasing levels of nitrogen upto 150 kg N/ha, but at higher rates (200 kg/ha), grain yield tended to decrease. The highest grain yield (4.91 t/ha) was obtained at 150 kg N/ha and the lowest (3.31 t/ha) from 0 kg N/ha. Similar trend was also observed by Haider *et al.* (1988). The yield difference between the highest and the lowest yielding treatments was 48%. The yield advantage of N application upto 150 kg/ha was mainly due to improvement of yield components viz., panicle length and number of grains/panicle. Response function, established from the yield and N data was quadratic in nature according to the equation $Y= a+bx+cx^2$. The common equation for all N obtained was $y = 3.174+0.022x-0.0007x^2$. The co-efficient of determination (R^2) indicating that 85% of the total variation in the yield can be attributed to the variation in N alone.

Effect of plant spacing: Plant spacing significantly influenced the plant height, number of effective tillers/hill, panicle length, grains/ panicle, and grain yield/ha. Plant spacing did not show any significant variation in respect of 1000-grain weight (Table 1). Sparsely populated plants (25 cm x 20 cm) were the tallest and the shortest from densely populated plants. Plant height at 25 cm x 15 cm and 25 cm x 10 cm spacing were statistically identical. Number of effective tillers/hill was significantly highest (8.06) at the spacing of 25 cm x 15 cm. The lowest (7.48) effective tillers/hill was obtained at 25 cm x 20 cm spacing, which was statistically identical with 25 cm x 10 cm. Plant spacing had also significant effect on panicle length. Longest panicle (21.62 cm) was observed at 25 cm x 15 cm spacing and it was statistically identical with 25cm x 10cm spacing. The shortest panicle (20.44cm) was observed from 25cm x 20cm spacing. Number of grains/panicle decreased with closer and wider spacing did not vary and were at par. However, the highest grains/panicle (106.11) was observed from the spacing 25cm x 15cm. Plant spacing had significant effect on grain yield/ha (Table 1). Grain yield increased from 3.90 t/ha to 4.22 t/ha with the decrease in plant spacing. Higher grain yield (4.22 t/ha) was obtained at closer spacing (25cm x 10cm) followed by 25cm x 15cm (4.21 t/ha) and the lowest (3.90 t/ha) from 25 cm x 20 cm. The contribution of closer spacing for higher yield was strongly supported by Azad *et al.* (1995), Padmajarao (1995) and Islam *et al.* (1994). The increase in grain yield with increasing plant spacing upto 25 cm x 15 cm might be attributed to higher number effective tillers/hill and grains/pancle.

Table 1. Effect of nitrogen and plant spacing on the yield and yield components of transplanted Aman rice (Mymensingh, 2001).

Treatment	Plant height (cm)	Effective tillers/hill (no.)	Panicle length (cm)	Grains/ panicle (no.)	Wt of 1000-grain (g)	Grain yield (t/ha)
N level (kg/ha)						
0	100.72e	5.90e	18.15e	99.41e	23.90	3.31d
50	103.50d	6.54d	19.65d	102.54d	26.41	3.75c
100	105.45c	7.55c	22.45b	107.38b	24.60	4.41b
150	109.13b	8.92b	24.50a	109.79a	25.32	4.91a
200	112.98a	9.61a	20.95c	104.05c	24.96	4.17bc
CV (%)	1.27	3.65	2.38	3.63	4.65	8.06
Plant spacing (cm)						
25×20	108.38a	7.48b	20.44b	103.57b	24.81	3.90b
25×15	106.10b	8.06a	21.62a	106.11a	24.92	4.21a
25×10	104.58b	7.57b	21.36a	104.23b	25.38	4.22ab
CV (%)	1.27	3.56	3.28	3.63	4.65	8.06

Interaction effect of nitrogen and plant spacing: Interaction of plant spacing and nitrogen levels showed significant influence on panicle length, number of grains/panicle, and grain yield/ha. Plant height, number of effective tillers/hill, and 1000-grain weight were not found significant due to plant spacing and nitrogen fertilizer. From Table 2, it was evident that significantly the longest panicle (25.39 cm) was obtained from 25 cm x 15 cm with 150 kg N/ha and it was statistically identical with spacing 25 cm x 10 cm (24.60 cm). Plants grown at any plant spacing without N fertilizer produced shortest panicle. The maximum number of grains/panicle (112.50) obtained by the treatment combination 25cm x 15cm spacing with 150 kg N/ha, which was significantly higher than other treatment combinations. The lowest number of grains/panicle was given by 0 kg N/ha irrespective of plant spacing. Grain yield/ha increased with increasing level of nitrogen upto 150 kg/ha irrespective of plant spacing. The spacing 25cm x 15cm accompanied with 150 kg N/ha gave the highest yield (5.00 t/ha), but it was statistically to those of N dose with 25cm x 20cm and 25cm x 10cm spacing. Generally grain yields were less in control N treatment irrespective of plant spacing. Regression analysis was done to quantitfy the relationship between grain yield and applied nitrogen fertilizers irrespective of plant spacing (Fig. 1). The quadratic equation for each plant spacing obtained form the regression analysis was:

$y = 2.990 + 0.00008\ x^2$, $R^2 = 0.75$ (for 25 cm x 20 cm)
$y = 3.350 + 0.0215x - 0.00009\ x^2$, $R^2 = 0.84$ (for 25 cm x 15 cm)
$y = 3.180 + 0.0177x - 0.00005\ x^2$, $R^2 = 0.93$ (for 25 cm x 10 cm)

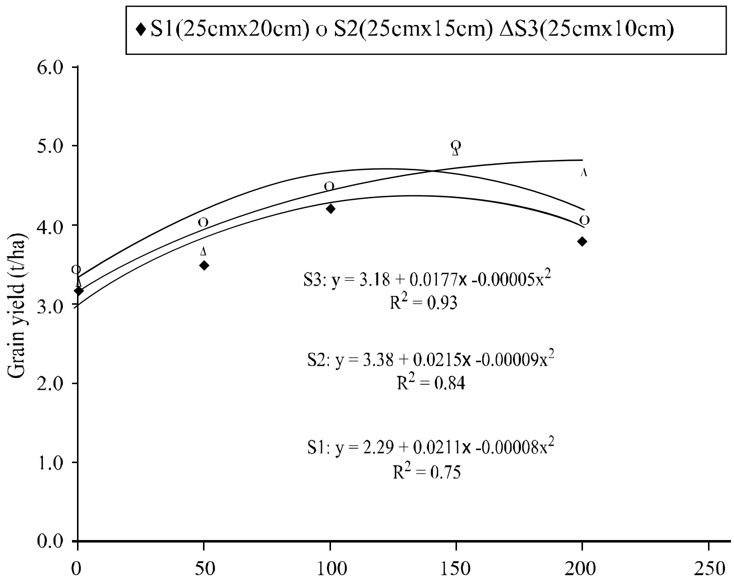

Fig. 1. Relationship between grain yield & nitrogen level irrespective of plant spacing of T. *anan* rice.

Table 2. Interaction effect of nitrogen levels and plant spacing on the yield and yield attributes of transplanted Aman rice.

N level (kg/ha)	Spacing (cm)	Plant height (cm)	No. of effective tillers/hill	Panicle length (cm)	No. of grains/ panile	Wt of 1000-grain (g)	Grain yield (t/ha)
0	25×20	102.53	5.80	18.10ij	99.10g	21.86	3.18f
	25×15	100.46	6.10	17.30j	99.98g	25.15	3.45f
	25×10	99.16	5.80	19.04ij	99.15g	24.78	3.30f
50	25×20	104.56	6.34	18.84ij	101.45b	26.06	3.51ef
	25×15	103.66	7.00	20.44fg	103.31e	25.76	4.06d
	25×10	102.26	6.40	19.68gh	102.87e	27.42	3.68e
100	25×20	107.33	7.30	21.80def	106.05cd	25.66	4.23cd
	25×15	105.40	7.90	23.11cd	109.50b	22.87	4.48c
	25×10	103.63	7.40	22.44cde	106.60c	25.26	4.51bc
150	25×20	112.03	8.80	23.52bc	108.31b	24.75	4.80ab
	25×15	108.33	9.10	25.39a	112.50a	24.73	5.00a
	25×10	107.03	8.80	24.60ab	108.56b	26.48	4.95ab
200	25×20	115.46	9.20	14.46gh	102.92e	25.75	3.80de
	25×15	112.66	10.10	21.84de	105.25d	26.08	4.05d
	25×10	110.83	9.50	21.06efg	103.98e	23.05	4.68ab
CV (%)	1.27	1.27	3.6	3.28	3.63	4.65	8.06

Mean values in a column having same or without letter(s) do not differ significantly at 5% level of probability.

The result indicated that the grain yield was increased with the increase of nitrogen application upto a certain limit irrespective of plant spacing. The value R^2 (0.75 to 0.93) indicated that 75 to 93% of the total variation in grain yield at different spacings would be explained by the variation in applied nitrogen fertilizer. From these equations, the maximum estimated yield of 25 cm x 20 cm. 25 cm x 15 cm, and 25 cm x 10 cm spacing were 4.38, 4.63, and 4.75 t/ha at 132.119 and 177 kg N/ha, respectively.

The result of the study realized that 150 kg t/ha with spacing 25 cm x 15 cm gave higher grain yield (5.0 t/ha) but from regression analysis also showed similar result of same spacing with 119 kg/ha. So, optimum grain yield could be obtained from spacing 25 cm x 15 cm with N level varied from 119 to 150 kg/ha depending upon soil fertility.

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