



Full Length Article

Influence of Different Nitrogen Levels on the Performance of Four Aromatic Rice Varieties

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ABSTRACT

A field experiment was conducted to evaluate the effect of different nitrogen levels on the performance of four rice varieties in transplanted aman (monsoon) season. Aromatic rice varieties included BRRI dhan 38, Kalizira, Badshabhog and Tulsimala, while nitrogen was applied at 30, 60, 90 and 120 kg ha⁻¹. Performance of different varieties was different. All the yield contributing characters differed significantly due to variety. Kalizira produced the maximum number of grains per panicle (135.90). Among the varieties, BRRI dhan 38 gave the maximum grain yield (4.00 t ha⁻¹). Different nitrogen rates also significantly affected the aromatic rice varieties. All the yield components were significantly increased up to 90 kg N ha⁻¹. Nonetheless, maximum grain yield (3.62 t ha⁻¹) was observed from 60 kg N ha⁻¹. The combination of varieties and nitrogen rates also affected the plant characters and yield components of aromatic rice, which ultimately affected the yield and it was observed that in combination the variety BRRI dhan 38 was more responsive to nitrogen to produce better yield.

Key Words: Aromatic rice; Nitrogen; Tiller; Grain yield

INTRODUCTION

Rice is the staple food of Bangladesh. About 80% of total cropped area of this country is used for rice production, with annual production of 43.72 million metric tons (IRRI, 2006) from an area of 11.05 million ha. The average yield of rice in Bangladesh is 3.90 t ha⁻¹ (BRRI, 2007), which is about 50% less than the world average yield (FAOSTAT, 2007). In Bangladesh, more than four thousand landraces of rice are adopted in different parts of this country. Some of these are unique for quality traits including fineness, aroma, taste and protein contents (Kaul *et al.*, 1982). But most high quality cultivars are low yielding (Shakeel *et al.*, 2005).

Among the rice varieties, aromatic rice is popular in Asia and gained wider acceptance in Europe and the United States because of their aroma, flavor and texture. Aromatic varieties fetch higher price in rice market than the non-aromatic ones. Demand for aromatic rices in recent years has increased to a great extent for both internal consumption and export (Das & Baqui, 2000).

Most of the aromatic rice varieties in Bangladesh are traditional type, photoperiodsensitive and are grown during transplanted aman season in the rainfed lowland ecosystem (Islam *et al.*, 1996). The yield of aromatic rice is lower (Gangaiah & Prasad, 1999) but its higher price and low cost of cultivation generated higher profit margins than other varieties (Farook *et al.*, 1999).

Nitrogen plays a key role in rice production and it is required in large amount. Nitrogen is the most important limiting nutrient in rice production and has heavy system

losses when applied as inorganic sources in puddled field (Fillery *et al.*, 1984). Nitrogen has a positive influence on the production of effective tillers per plant, yield and yield attributes (Jashim *et al.*, 1984; BRRI, 1990). It is necessary to find out the suitable rate of nitrogen fertilizer for efficient management and better yield of rice.

A suitable combination of variety and rate of nitrogen is necessary for better yield (BRRI, 1990). There is a heavy demand of aromatic fine rice in the world. Enough information on their varietal performance and nitrogen response are sporadic and scattered. Extensive research is necessary to find out appropriate variety and optimum rate of nitrogen to obtain satisfactory yield and quality of these rice varieties. The present study was conducted to identify the suitable aromatic rice variety and to determine the optimum rate of nitrogen fertilizer for the aromatic fine rice cultivation.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy farm of Bangladesh Agricultural University, Mymensingh, Bangladesh during the period from July to December, 2005. The experimental field was located at 90°33' E longitude and 23°77' N latitude about 18 m above the sea level. The climate of the area was sub-tropical. The soil of the experimental site was clay loam with a pH of 5.47-5.63. Four aromatic rice varieties viz. BRRI dhan 38, Kalizira, Badshabhog and Tulsimala were used in this study. Four different nitrogen doses were as 30, 60, 90 and 120 kg ha⁻¹.

The experiment was laid out in randomized completely block design (RCBD) with three replications.

Seed of the rice varieties were sown in the seed bed on July 2, 2005. Thirty five days old seedlings of all four varieties were transplanted at the spacing of 25×15 cm with 3 seedlings per hill on August 7, 2005. Land was fertilized with 60, 80, 45 and 5 kg P_2O_5 , K_2O , S and Zn per hectare, respectively. The entire amount of these nutrients was applied during final land preparation. Nitrogen was applied as per treatment. Intercultural operations were done as per recommendation. Weeding was done manually at 20, 40 and 60 DAT. Pest management was done properly. The crop was harvested on December 12, 2005. Five hills (excluding border hill) were selected randomly from each unit plot and uprooted before harvesting for recording data on yield related traits and yield. Grain yield was adjusted to 14% moisture content. The data were analysed following analysis of variance (ANOVA) technique and mean differences were adjusted by the multiple comparison test (Gomez & Gomez, 1984) using the statistical software MSTATC v.1.2, while means were compared using Duncan's New Multiple Range Test

RESULTS AND DISCUSSION

Plant and yield contributing characters. Results revealed that plant height of different varieties was significantly different (Table I). Maximum plant height was found from the variety Tulsimala (153.00 cm), which was significantly differed from the other varieties. While lowest plant height was observed in the variety BRRi dhan 38. Variation of plant height might be due to the differences in their genetic make-up. Shamsuddin *et al.* (1988) observed variable plant heights among the varieties. Hossain *et al.* (2005) also found the lowest plant height from BRRi dhan 38 among eight different aromatic rice varieties of Bangladesh. Significance differences were also observed for producing total tiller number of tillers, panicle bearing tillers and non-bearing tillers. Maximum number of total tillers was observed in BRRi dhan 38, however Tulsimala produced the lowest numbers of tiller. Bearing tillers was found to be highest from the variety Kalizira, which was statistically identical with Badshahog (Table I). The highest number of non-bearing tillers was produced by Badshahog, which was followed by Tulsimala whereas Kalizira produced the lowest number of non-bearing tillers. The reduction of number of tillers was due to tiller mortality in the vegetative stages. Naher (1995) and Basher (2001) observed similar findings. The length of panicle was significantly affected by variety. Longest panicles (25.84 cm) were observed in BRRi dhan 38. Whilst shortest panicles (20.95 cm) were recorded in Tulsimala. The highest number of sterile spikelets was found from Badshahog, whereas BRRi dhan 38 had the lowest number of sterile spikelets. Maximum grain weight was observed from BRRi dhan 38, which was statistically different from others varieties (Table I). The

lowest weight of grain was observed from Kalizira.

Different doses of nitrogen fertilizer also significantly affected the plant characters and yield attributes of aromatic rice. Tallest plants (146.5 cm) were observed from 120 kg N ha^{-1} , which was statistically different from other doses (Table II). The increase in plant height was due to various physiological processes including cell division and cell elongation of the plant. Zhilin *et al.* (1997) stated that plant height is increased significantly due to nitrogen application. Number of tillers was also significantly affected by nitrogen levels, where 120 kg N ha^{-1} produced the highest number of tillers. In this study the bearing tillers $hill^{-1}$ was not significantly affected by different N doses, whereas non-bearing tillers was affected significantly by these treatments. It was observed that the longest panicle (23.19 cm) was found at 60 kg N ha^{-1} , which was followed by 90 Kg N ha^{-1} . Grain per panicles and 1000-grain weight were not significantly affected by N doses but the sterile spikelets were significantly reduced by excess nitrogen doses after 30 kg ha^{-1} . The maximum sterile spikelets per panicle were observed from 120 kg N ha^{-1} (Table II).

The combined effect of variety and nitrogen significantly affected the plant characters and yield attributes of aromatic rice in this study (Table III). It was observed that the interaction of the variety Tulsimala and 120 kg N ha^{-1} (V_4N_4) produced the tallest plant, where BRRi dhan 38 with 30 kg N ha^{-1} gave the lowest plant height. The number of tillers was found to be highest with the interaction of BRRi dhan 38 and 120 kg N ha^{-1} (V_1N_4). Panicle bearing tillers were not significantly affected by different treatment combinations. However, the number of non-bearing tillers was significantly affected by treatment combination and V_3N_3 as well as V_3N_1 produced the maximum non-bearing tillers in this study. It was due to more sterility of rice varieties with these treatments. Grains per panicle were highest with V_2N_2 , which was significantly superior to other treatment combinations. Sterile spikelets were statistically similar with different treatment combinations between variety and nitrogen. Maximum 1000-grain weight was observed from V_1N_3 , which was statistically at par with V_1N_4 and V_1N_2 , whereas V_2N_3 produced the lowest grain weight.

Yield and harvest index. Grain yield differed significantly due to variety (Table IV). It was evident from the result that the highest grain yield ($4.00 t ha^{-1}$) was achieved from BRRi dhan 38, which was statistically identical to Badshahog. The lowest grain yield ($3.07 t ha^{-1}$) was obtained from Kalizira, which was statistically identical to Tulsimala. The probable reasons for higher grain yield of BRRi dhan 38 might be due to its long panicles and heavy grains. Straw yield was affected significantly by different varieties in this study (Table IV). However, numerically the highest and the lowest straw yield (6.06 & $5.47 t ha^{-1}$) were obtained from Badshahog and BRRi 38, respectively which was mainly due to the variation in plant height. The biological yield was significantly affected by variety. The highest biological

Table I. Plant characters and yield attributes of aromatic rice as affected by different varieties

Varieties	Plant height (cm)	No. of tiller hill ⁻¹	Bearing tillers hill ⁻¹	Non-bearing tillers hill ⁻¹	Panicle length (cm)	Grains panicle ⁻¹	Sterile spikelets panicle ⁻¹	1000-grain weight (g)
BRR1 dhan 38 (V ₁)	121.63 d	15.72 a	5.32 c	1.91 b	25.84 a	83.37 b	13.05 d	21.71 a
Kalizira (V ₂)	145.90 b	13.00 c	11.72 a	1.58 c	21.55 c	135.90 a	14.85 b	12.22 c
Badshabhog (V ₃)	138.30 c	14.56 b	11.09 ab	2.26 a	20.95 d	135.10 a	14.28 c	13.54 b
Tulsimala (V ₄)	153.00 a	12.01 d	10.36 b	2.19 a	21.55 c	139.40 a	15.71 a	13.18 b
S _x	1.04	0.21	0.40	0.06	0.06	3.56	0.05	0.24
CV (%)	2.57	5.12	15.66	10.37	1.88	9.97	11.26	5.36

Means separation in columns followed by the same letter(s) are not significantly different at P≤0.05

Table II. Plant characters and yield attributes of aromatic rice as affected by different nitrogen doses

Nitrogen levels	Plant height (cm)	No. of tiller hill ⁻¹	Bearing tillers hill ⁻¹	Non-bearing tillers hill ⁻¹	Panicle length (cm)	Grains panicle ⁻¹	Sterile spikelets panicle ⁻¹	1000-grain weight (g)
30 kg ha ⁻¹ (N ₁)	133.00 d	12.64 c	9.15	2.10 a	22.59 c	116.5	14.32 c	14.74
60 kg ha ⁻¹ (N ₂)	138.00 c	13.41 b	9.86	1.75 b	23.19 a	130.1	14.09 d	15.23
90 kg ha ⁻¹ (N ₃)	141.40 b	14.34 a	9.81	2.00 a	22.81 b	125.8	14.57 b	15.27
120 kg ha ⁻¹ (N ₄)	146.5 a	14.90 a	9.69	2.14 a	22.58 c	121.5	14.90 a	15.41
S _x	1.04	0.21	-	0.06	0.06	-	0.05	-
CV (%)	2.57	5.12	15.66	10.37	1.88	9.97	11.26	5.36

Means separation in columns followed by the same letter(s) are not significantly different at P≤0.05

Table III. Plant characters and yield attributes of aromatic rice as affected by the combined effect of variety and nitrogen doses

Variety × Nitrogen	Plant height (cm)	No. of tiller hill ⁻¹	Bearing tillers hill ⁻¹	Non-bearing tillers hill ⁻¹	Panicle length (cm)	Grains panicle ⁻¹	Sterile spikelets panicle ⁻¹	1000-grain weight (g)
V ₁ N ₁	116.4h	14.70cde	5.19	1.96bc	25.15c	70.65h	13.08	20.59b
V ₁ N ₂	119.9h	15.13bc	6.91	1.72cd	25.85b	89.17g	12.75	21.64ab
V ₁ N ₃	123.3gh	16.20ab	4.84	1.78cd	25.98b	87.49g	13.03	22.65a
V ₁ N ₄	127.0gh	16.86a	4.35	2.20ab	26.39a	86.16g	13.34	21.97a
V ₂ N ₁	137.1d-g	12.20ij	10.40	2.20ab	21.75h	122.4e	15.58	12.23fg
V ₂ N ₂	143.5b-e	12.50hij	11.46	1.14e	22.02gh	147.4a	15.19	12.51efg
V ₂ N ₃	148.9bcd	13.47fgh	12.74	1.40de	21.35i	145.9a	15.86	11.96g
V ₂ N ₄	154.0ab	13.83d-g	12.27	1.60cd	21.07ij	127.8de	16.20	12.19fg
V ₃ N ₁	134.5efg	13.60e-h	11.46	2.47a	22.55f	137.1bc	14.06	13.39def
V ₃ N ₂	137.7c-f	14.47c-f	10.26	1.74cd	23.65d	138.5abc	13.87	13.76d
V ₃ N ₃	139.0c-f	14.76cd	11.26	2.47a	22.88e	133.6bcd	14.36	13.51de
V ₃ N ₄	142.0b-e	15.40bc	11.39	2.34a	22.25g	131.2cd	14.83	13.52de
V ₄ N ₁	143.9b-e	10.07k	9.53	1.74cd	20.92j	135.7bcd	14.56	12.77d-g
V ₄ N ₂	151.0abc	11.53j	10.80	2.40a	21.25h	145.4a	14.55	13.03d-g
V ₄ N ₃	154.3ab	12.93ghi	10.40	2.20ab	21.00hi	136.1bc	15.03	12.96d-g
V ₄ N ₄	162.9a	13.52fgh	10.73	2.40a	20.62j	140.7ab	15.25	13.96cd
S _x	5.04	0.41	-	0.12	0.10	3.80	-	0.45
CV (%)	2.57	5.12	15.66	10.37	1.88	9.97	11.26	8.76

Means separation in columns followed by the same letter(s) are not significantly different at P≤0.05

yield (9.47 t ha⁻¹) was obtained from Badshabhog, which was statistically similar to BRR1 dhan 38 (9.44 t ha⁻¹), while lowest biological yield (8.82 t ha⁻¹) was achieved from Kalizira, which was statistically identical with Tulsimala (Table IV). Different aromatic rice varieties showed significant differences for harvest index. The highest harvest index (42.37%) was obtained from BRR1 dhan 38, because it produced lower straw yield due to its shorter plant and highest grain yield. It was statistically at par with Badshabhog (39.72%). While the lowest harvest index was obtained from Kalizira, which was similar to Tulsimala (36.08%).

Different levels of nitrogen had significant effect on grain yield (Table V). Maximum grain yield (3.62 t ha⁻¹) was achieved from 60 kg N ha⁻¹, which was statistically identical with 90 and 120 kg N ha⁻¹. The lowest grain yield (3.17 t ha⁻¹) was obtained from 30 kg N ha⁻¹. It revealed that excess N rates do not give extra benefit regarding to grain

yield to aromatic rice. Further increase of N slowly decrease the yield due to excessive plant growth and crop lodging, which resulted number of non-bearing tillers hill⁻¹ and sterile spikelets panicle⁻¹. Straw was increased with the increase of nitrogen rate and the differences were statistically significant (Table V). The highest straw yield was produced by applying 120 kg N ha⁻¹, whereas the lowest was found from 30 kg N ha⁻¹. The highest biological yield was also produced by 120 kg N ha⁻¹, because this rate of N produced higher grain yield as well as straw yield in this study (Table V). Harvest index of different aromatic rice was significantly affected by N rates. Application of 60 kg N ha⁻¹ showed the highest HI, which was statistically identical with 30 and 90 kg N ha⁻¹. The lowest HI was found in case of 120 kg N ha⁻¹, which was identical with 30 kg N ha⁻¹.

The interaction effect of varieties and nitrogen rates also significantly affected the grain yield (Table VI). The

Table IV. Yield and harvest index of aromatic rice as affected by different varieties

Variety	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
BRR1 dhan 38 (V ₁)	4.00 a	5.47	9.45 a	42.37 a
Kalizira (V ₂)	3.07 b	5.78	8.80 b	34.83 b
Badshahog (V ₃)	3.75 a	6.06	9.48 a	39.72 a
Tulsimala (V ₄)	3.10 b	5.89	8.89 b	36.08 b
S _x	0.12	-	0.15	1.16
CV (%)	11.51	10.83	5.78	10.50

Means separation in columns followed by the same letter(s) are not significantly different at $P \leq 0.05$

Table V. Yield and harvest index of aromatic rice as affected by different nitrogen doses

Nitrogen	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
30 kg ha ⁻¹ (N ₁)	3.17 b	5.04 c	8.21 d	38.24 ab
60 kg ha ⁻¹ (N ₂)	3.62 a	5.74 b	8.95 c	40.28 a
90 kg ha ⁻¹ (N ₃)	3.59 a	5.87 b	9.44 b	39.23 a
120 kg ha ⁻¹ (N ₄)	3.53 a	6.52 a	10.02 a	35.24 b
Levels of significance	0.05	0.01	0.01	0.05
S _x	0.12	0.14	0.15	1.16
CV (%)	11.51	10.83	5.78	10.50

Table VI. Yield and harvest index of aromatic rice as affected by the combined effect of variety and nitrogen doses

Variety×Nitrogen	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
V ₁ N ₁	3.62 bcd	4.80	8.42	42.60 ab
V ₁ N ₂	4.07 a	5.20	9.27	43.93 a
V ₁ N ₃	4.11 a	5.71	9.75	42.15 abc
V ₁ N ₄	4.17 a	6.16	10.33	40.15 bcd
V ₂ N ₁	2.56 g	5.12	7.68	33.34 fg
V ₂ N ₂	3.40 cde	3.35	8.75	38.65 cde
V ₂ N ₃	3.30 de	5.92	9.22	35.82 ef
V ₂ N ₄	3.04 e	6.70	9.64	31.52 g
V ₃ N ₁	3.90 ab	5.08	8.98	43.38 ab
V ₃ N ₂	3.80 abc	6.65	9.12	41.65 abc
V ₃ N ₃	3.95 ab	5.86	9.81	40.30 a-d
V ₃ N ₄	3.35 de	6.62	9.97	33.54 fg
V ₄ N ₁	2.62 fg	5.14	7.76	33.67 fg
V ₄ N ₂	3.22 de	5.76	8.65	36.90 def
V ₄ N ₃	3.00 e	5.97	8.97	38.67 cde
V ₄ N ₄	3.57 bcd	6.58	10.15	35.10 efg
S _x	0.16	-	-	1.34
CV (%)	11.51	10.83	5.78	10.50

Means separation in columns followed by the same letter(s) are not significantly different at $P \leq 0.05$

highest grain yield (4.17 t ha⁻¹) was observed from BRR1 dhan 38 and 120 kg N ha⁻¹ (V₁N₄), which was statistically similar with V₁N₂ and V₁N₃. The lowest grain yield was produced by the combined effect of Kalizira and 30 kg N ha⁻¹. Straw yield and biological yield were not significantly affected by the combined effect of varieties and N. However, the highest straw yield and biological yield was observed from the treatment V₂N₄ and V₁N₄, respectively (Table VI). Harvest index was significantly affected by the combined effect, where the highest HI (43.93%) was obtained from the combination of BRR1 dhan 38 with 60 kg N ha⁻¹. The lowest HI (31.52%) was found from the treatment combination of Kalizira and 120 kg N ha⁻¹.

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