J. Environ. Sci. & Natural Resources, **9(1): 41-45, 2016** ISSN 1999-7361

Yield Performance of Fine Aromatic Rice in Response to Variety and Level of Nitrogen

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during June to December 2014 with a view to finding out the effect of variety and level of nitrogen on the yield performance of fine aromatic rice. The experiment consisted of three varieties viz. Kalizira, Binadhan-13 and BRRI dhan34, and six levels of nitrogen viz. 0, 30, 60, 90 kg N ha^{-1}, USG 1.8 g 4 $hills^{-1}$ (55 kg N ha^{-1}) and USG 2.7 g 4 $hills^{-1}$ (80 kg N ha^{-1}). The experiment was laid out in a randomized complete block design with three replications. Variety, level of nitrogen and their interaction significantly influenced the yield of aromatic rice. The highest grain yield (3.33 t ha^{-1}) was obtained from Binadhan-13 followed by BRRI dhan34 (3.16 t ha^{-1}) and the lowest grain yield was found in Kalizira (2.11 t ha^{-1}). In case of N, the tallest plant (140.3 cm), highest number of effective tillers $hill^{-1}$ (11.40), grains $panicle^{-1}$ (152.8), and grain yield (3.32 t ha^{-1}) were obtained when fertilized with USG 1.8 g 4 $hills^{-1}$ and the lowest values were found in 0 kg N ha^{-1}. Therefore, Binadhan-13 fertilized with USG 1.8 g 4 $hills^{-1}$ (55 kg N ha^{-1}) appeared as the promising practice for appreciable grain yield.

Key words: Aromatic rice, Nitrogen level, Variety, Yield

Introduction

Rice (*Oryza sativa* L.) is the staple food of more than half of the world's population. Among the leading rice growing countries of the world, Bangladesh ranks fourth in both rice area and production (BRRI, 2007). About 75.61% of cropped area of Bangladesh is used for rice production, with annual production of 33.83 million tons from 11.41 million hectares of land (BBS, 2013). Aromatic and non-aromatic rice varieties are grown in Bangladesh and each of them possesses some special characteristics. The grain of some varieties are very small, some are fine, some of them are of different colors and some of them have special appeal for their aroma. Aroma development in rice grain is influenced by both genetic and environmental factors. The biochemical basis of aroma was identified as 2-acetyl-1-pyrroline (Tanchotikul and Hsieh, 1991). Aromatic rice is also named as scented rice or fragrant rice because of its natural chemical compounds which give it a distinctive scent or aroma when cooked. Aromatic rice commands a higher price than non-aromatic rice. Thus, aromatic or scented rice plays a vital role in international rice trading. Bangladesh has a bright prospect for export of fine rice thereby earning foreign exchange (Islam *et al.,* 2012). Fine rice is mainly used by the people for the preparation of palatable dishes like *polau, khir, firny and jarda.* The demand of aromatic rice in this country is increasing due to its special appeal for aroma and acceptability although grain yield is low. Aromatic rice is the most highly valued rice commodity in Bangladesh agricultural trade markets having small grain pleasant aroma with soft texture upon cooking (Dutta *et al*., 1998). However, the price of fine rice, especially the aromatic rice is 2-3 times higher than that of coarse rice (Biswas *et al.,* 1992). Though yield is low but it requires less input compared to coarse rice. The reasons for low yield are mainly associated with lack of improved varieties and judicial nitrogen application.

Nitrogen is the major essential plant nutrient and key input, which can augment production of rice to a great extent. It is one of the most mobile plant nutrients in the soil and it has been found to be deficit in most agricultural soils of Bangladesh. However, the nature and magnitude of nitrogen loss largely depend upon the source of N fertilizer and method of N fertilizer application. Urea is usually applied as prilled urea and its N use efficiency is only 25-30% and rest 70-75% is lost after application (BRRI, 2008) but urea super granules save 30% more N than prilled urea (Savant *et al.,* 1991). Proper dose and appropriate form of N fertilization is an important management practice which can increase the yield of rice. Yield components, grain and straw yields of rice were increased due to judicious N fertilization (Kumar *et al.,* 1996; Jisan *et al.,* 2014; Islam *et al.,* 2014; Bony *et al.,* 2015). The present study was undertaken to find out the yield performance of fine aromatic rice in response to variety and level of nitrogen.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during June to December 2014 to find out the yield performance of aromatic rice in response to variety and level of nitrogen. The experiment comprised three varieties viz. Kalizira, Binadhan-13 and BRRI dhan 34 and six levels of nitrogen viz. 0, 30, 60, 90 kg N ha^{-1}, USG 1.8 g 4 $hills^{-1}$ (55 kg N ha^{-1}) and USG 2.7 g^{-1} 4 $hills^{-1}$ (80 kg N ha^{-1}). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The plot size was 4.0m × 2.5m. Thirty days old seedlings were transplanted on 7 July 2014 at three seedlings $hill^{-1}$ with the spacing of 25cm × 15cm. At the time of final land preparation each unit plot was fertilized with TSP, MoP, Gypsum and $ZnSO_4$ @ 100, 70, 60 and 12 kg ha^{-1}, respectively. Urea was

applied in three equal installments at 10, 30 and 50 DAT. Intercultural operations such as gap filling, weeding, drainage and pest management were done as and when necessary. The crop was harvested at maturity on 30 November 2014. The data on different agronomic characters were recorded from the randomly selected five hills (excluding border hills and central 1m × 1m harvested area) in each plot. The crop was harvested at full maturity and threshed. Grains were cleaned and sundried to a moisture content of 14%. Finally the grain and straw yields were converted to t ha^{-1}. Harvest index (%) was calculated using the following formula:

$$\text{Harvest index} = \frac{\text{Economic yield (grain yield)}}{\text{Biological yield (grain yield + straw yield)}} \times 100.$$

The collected data were analyzed statistically using the "analysis of variance" technique and mean differences among the treatments were adjudged by using the Duncun's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Varietal performance

Crop characters, yield components and yield of fine aromatic rice were significantly influenced by variety (Table 1). The tallest plant (137.9 cm) was found in Kalizira which was statistically identical with Binadhan-13 (135.9 cm) and the shortest plant (125.3 cm) was found in BRRI dhan34. Due to varietal difference plant height differed significantly as was reported elsewhere (Tyeb *et al.,* 2013; Sarkar *et al.,* 2014; Islam *et al.*, 2014, Jisan *et al*., 2014; Bony *et al*., 2015). The highest number of total tillers $hill^{-1}$ (11.84), effective tillers $hill^{-1}$ (11.84), longest panicle (24.59 cm), highest number grains $panicle^{-1}$ (151.9), 1000-grain weight (13.56g), grain yield (3.33 t ha^{-1}) and straw yield (5.25 t ha^{-1}) were found in Binadhan-13 and the lowest number of total tillers $hill^{-1}$ (10.36), effective tillers $hill^{-1}$ (8.707), shortest panicle (22.90), grain yield (2.11 t) and straw yield (4.66 t ha^{-1}) were obtained from Kalizira. The variation of different yield components, grain and straw yields among the varieties were probably due to heredity or varietal characters. Similar agreements were reported by Sarkar *et al.* (2014) and Ray *et al.* (2015). The highest number of sterile spikelets $panicle^{-1}$ (23.75) was found in Kalizira and the lowest one (9.01) was found in Binadhan-13. Varietal variation regarding sterile spikelets might be due to their difference in genetic make-up. The highest harvest index (39.14 %) was obtained from BRRI dhan34 which was statistically identical with Binadhan-13 and the lowest one (31.08%) was recorded in Kalizira. Jisan *et al.* (2014) and Sarkar *et al.* (2014) reported that variety has significant influence on harvest index

Effect of level of nitrogen

Crop characters, yield components and yield of fine aromatic rice were significantly influenced by nitrogen level (Table 2). Different levels of nitrogen fertilizer had significant effect on plant height. The maximum plant height (140.3 cm) was recorded when fertilized with USG 1.8 g/ 4 hills and the lowest one (118.1 cm) was obtained in control plots (0 kg N ha^{-1}). The highest number of total tillers $hill^{-1}$ (12.83), effective tillers $hill^{-1}$ (11.40), grains $panicle^{-1}$ (152.8), grain yield (3.32 t ha^{-1}) and straw yields (5.56 t ha^{-1}) were obtained with USG 1.8 g/ 4 hills and the lowest number of total tillers $hill^{-1}$ (7.58), effective tillers $hill^{-1}$ (6.36), grains $panicle^{-1}$ (113.8), grain yield (1.82 t ha^{-1}) and straw yield (3.69 t ha^{-1}) were found in control plots. Nitrogen helped in proper filling of grains which resulted in higher plump grains and thus number of grains increased $panicle^{-1}$ (Jisan *et al.,* 2014). The highest number of sterile spikelets $panicle^{-1}$ (25.04) was obtained in control plots and the lowest number of sterile spikelets $panicle^{-1}$ (14.65) was obtained when fertilized with USG 1.8 g/ 4 hills which was at par with 90 kg N ha^{-1} and USG 2.7 g/ 4 hills. The increased grain yield with USG 1.8 g/ 4 hills (55 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. Application of USG increased number of effective tillers $hill^{-1}$ and grains $panicle^{-1}$ which ultimately resulted in the increase of grain yield. Zannat *et al.* (2014) reported similar results.

Interaction effect of variety and level of nitrogen

Interaction between variety and level of nitrogen significantly influenced crop characters, yield components and yield of rice (Table 3). Plant height showed statistically insignificant interaction effect between the variety and level of nitrogen. However, virtually the tallest plant (145.06 cm) was recorded in Kalizira with USG 1.8 g 4 $hills^{-1}$ and shortest plant (108.08 cm) was found in BRRI dhan34 with 0 kg N ha^{-1}. The highest number of total tillers $hill^{-1}$ (13.26) was found in Binadhan-13 with USG 2.7 $g^{-4\ hills}$ and the lowest number of total tillers $hill^{-1}$ (7.13) was found in the combination Kalizira with 0 kg N ha^{-1}). The highest number of effective tillers $hill^{-1}$ (12.96), 1000-grain weight (13.96g), grain yield (3.82 t ha^{-1}) and straw yield (5.91 t ha^{-1}) were found in Binadhan-13 with USG 1.8 $g^{-4\ hills}$ and the lowest number of effective tillers $hill^{-1}$ (5.13), grains $panice^{-1}$ (100.4), 1000-grain weight (11.05 g), grain yield (1.42 t ha^{-1}) and straw yield (3.23 t ha^{-1}) were found in the combination of Kalizira with 0 kg N ha^{-1}. The highest number of non-effective tillers $hill^{-1}$ (2.93), sterile spikelets $panicle^{-1}$ (35.43) was observed in Kalizira with 0 kg N ha^{-1} and the lowest values were obtained in Binadhan-13 with USG 1.8 g 4 $hills^{-1}$. The highest harvest index (40.63%) was recorded in BRRI dhan34 with USG 1.8 g 4 $hills^{-1}$ and the lowest one (29.68%) was obtained in Kalizira with 30 kg N ha^{-1}. Harvest index differed due to combined effect of variety and nitrogen level was also reported elsewhere (Islam *et al.,* 2012; Jisan *et al*., 2014; Bony *et al.,* 2015)

Table 1. Effect of variety on yield components and yield of fine aromatic rice

Variety	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Kalizira	137.9a	10.34c	8.70c	1.655a	22.90b	129.3c	23.75a	12.10 b	2.11c	4.66c	31.08b
Binadhan-13	135.9a	11.84a	10.93a	0.9150b	24.59a	151.9a	9.01c	13.56 a	3.33a	5.25a	38.57a
BRRI dhan34	125.3b	10.80b	9.253b	1.543a	23.92a	146.1b	21.21b	13.48 a	3.16b	4.86b	39.14a
$S\bar{x}$	1.31	0.117	0.093	0.073	0.291	0.973	0.307	0.188	0.031	0.032	0.274
Level of significance	**	**	**	**	**	**	**	**	**	**	**
CV (%)	4.16	4.54	4.10	22.55	5.20	2.90	7.26	6.13	4.72	2.82	3.21

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

Table 2. Effect of level of nitrogen on yield components and yield of fine aromatic rice

Nitrogen doses	Plant height (cm)	Number of total tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Panicle length (cm)	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
N_0	118.1d	7.58e	6.36e	1.22cd	21.95b	113.8d	25.04a	12.40	1.82e	3.69e	32.80c
N_1	129.3c	10.20d	9.09d	1.11d	23.89a	140.2c	18.85b	13.13	2.76d	4.79d	36.13b
N_2	134.4bc	11.45c	10.16c	1.28bcd	24.64a	145.5b	18.64b	12.91	2.97c	4.99c	36.76ab
N_3	137.9ab	11.76bc	10.15c	1.617a	24.36a	150.6a	15.40c	12.94	3.17b	5.25b	37.36a
N_4	140.3a	12.83a	11.40a	1.43abc	24.29a	152.8a	14.65c	13.41	3.32a	5.56a	37.05ab
N_5	138.2ab	12.17b	10.61b	1.55ab	23.68a	151.7a	15.39c	13.50	3.18b	5.24b	37.46 a
$S\bar{x}$	1.85	0.166	0.132	0.103	0.412	1.38	0.435	0.267	0.045	0.846	0.387
Level of significance	**	**	**	**	**	**	**	NS	**	**	**
CV (%)	4.16	4.54	4.10	22.55	5.20	2.90	7.26	6.13	4.72	2.82	3.21

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

N_0 = 0 kg N ha^{-1} N_3 = 90 Kg N ha^{-1}

N_1 = 30 Kg N ha^{-1} N_4 = USG 1.8 g/ 4 hills
N_2 = 60 Kg N ha^{-1} N_5 = USG 2.7 g/ 4 hills

Table 3. Effect of interaction between variety and level of nitrogen on yield components and yield of fine aromatic rice

Interaction (Variety × level of Nitrogen)	Plant height (cm)	Number of total tillers $hill^{-1}$	Number of effective tillers $hill^{-1}$(no.)	Number of non-effective tillers $hill^{-1}$ (no.)	Panicle length (cm)	Number of grains $panicle^{-1}$	Number of sterile spikelets $panicle^{-1}$	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1 x N_0	120.56	7.50hi	5.13j	2.37bc	20.62	100.4 j	35.43a	11.05	1.42h	3.23m	30.54ef
V_1 x N_1	135.18	9.16g	8.52g	0.64gh	22.39	129.9gh	24.95c	11.92	1.95g	4.62ij	29.68f
V_1 x N_2	140.12	10.51ef	9.78def	0.73gh	23.64	134.5fg	22.68cde	11.97	2.08g	4.79hij	30.28ef
V_1 x N_3	143.13	11.25cde	9.85def	1.40def	23.89	136.7fg	19.88fg	12.08	2.40f	5.09efg	32.04cde
V_1 x N_4	145.06	12.60ab	9.67ef	2.93a	23.55	140.9ef	18.90fg	12.98	2.42f	5.32cde	31.27def
V_1 x N_5	143.32	11.15de	9.29f	1.86cde	23.30	133.4fg	20.69ef	12.63	2.39f	4.93fgh	32.65bcd
V_2 x N_0	125.60	8.130h	7.50h	0.63gh	22.15	125.9h	12.45h	13.13	2.12g	4.06k	34.29b
V_2 x N_1	132.00	11.29cde	10.20de	1.09fg	25.40	150.3cd	9.02ij	13.68	3.23de	5.16def	38.47a
V_2 x N_2	137.29	12.15bc	11.51bc	0.64gh	26.23	154.2bcd	10.00i	13.48	3.52bc	5.35cd	39.72a
V_2 x N_3	140.58	12.76ab	11.25c	1.51def	24.93	160.1ab	8.15ij	13.68	3.68abc	5.42bc	40.44a
V_2 x N_4	140.82	13.26a	12.96a	0.30h	24.97	157.3abc	7.36j	13.42	3.82a	5.91a	39.26a
V_2 x N_5	139.08	13.45a	12.13b	1.32ef	23.85	163.6a	7.120j	13.96	3.62abc	5.61b	39.22a
V_3 x N_0	108.06	7.13i	6.45i	0.68gh	23.07	115.2i	27.24b	13.02	1.92g	3.80l	33.56bc
V_3 x N_1	120.84	10.16f	8.56g	1.60def	23.88	140.3f	22.59de	13.78	3.10e	4.60j	40.25a
V_3 x N_2	125.70	11.68cd	9.19fg	2.49ab	24.05	147.6de	23.24cd	13.29	3.27de	4.85ghi	40.27a
V_3 x N_3	130.09	11.28cde	9.34f	1.94cd	24.26	154.9bcd	18.17g	13.07	3.45cd	5.26cde	39.61a
V_3 x N_4	134.96	12.63ab	11.56bc	1.07fg	24.35	160.1ab	17.68g	13.83	3.73ab	5.45bc	40.63a
V_3 x N_5	132.21	11.90bcd	10.42d	1.48def	23.89	158.2ab	18.35fg	13.92	3.54bc	5.20cde	40.52a
$S\bar{x}$	3.20	0.288	0.228	0.178	0.714	2.38	0.752	0.461	0.077	0.080	0.671
Level of significance	NS	*	**	**	NS	*	**	NS	**	*	**
CV (%)	4.16	4.54	4.10	22.55	5.20	2.90	7.26	6.13	4.72	2.82	3.21

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
V_1 = Kalizira V_2 = Binadhan-13 V_3 = BRRI dhan34

N_0 = 0 kg N ha^{-1}, N_1 = 30 Kg N ha^{-1}, N_2 = 60 Kg N ha^{-1}, N_3 = 90 Kg N ha^{-1}, N_4 = USG 1.8 g 4 $hills^{-1}$ and N_5 = USG 2.7 g 4 $hills^{-1}$

Conclusions

From the results it can be concluded that Binadhan-13 fertilized with USG 1.8 g 4 $hills^{-1}$ (55 kg N ha^{-1}) appears to be the promising practice to obtain the highest grain yield.

References

BBS (Bangladesh Bureau of Statistics). 2013. The Yearbook of Agricultural Statistics of Bangladesh. Stat. Div., Minis. Plan. Govt. Peoples Repub., Bangladesh, Dhaka. 71p.

Biswas, S. K.; Banu, B.; Kabir K. A.; Begum, F. and Choudhury, N. H. 1992. Physicochemical properties of modern and local rice varieties of Bangladesh. *Bangladesh Rice J.,* 3(1&2):128-131.

Bony, M. H.; Paul, S. K.; Kader, M. A. and Sarkar, M. A. R. 2015. Yield performance of *Boro* rice in response to USG. *J. Bangladesh Agril. Univ.,* 13 (1):13-17.

BRRI (Bangladesh Rice Research Institute). 2007. *Adunik Dhaner Chash* (in Bengali). 14th Edn. Bangladesh Rice Res. Inst., Joydebpur, Gazipur. pp. 17-30.

BRRI (Bangladesh Rice Research Institute). 2008. *Adunik Dhaner Chash* (in Bengali). 14th Edn. Bangladesh Rice Res. Inst., Joydebpur, Gazipur. pp. 38-39.

Dutta, R. K.; Lahiri, B. P. and Mia, M. A. D. 1998. Characterization of some aromatic rice cultivars in relation to their physio-chemical quality of grains. *Indian J. Plant Physiol.,* 3(1):61-64.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedure for Agricultural Research. Intl. Rice Res. Inst., Philippines, John Wiley and Sons. New York, Chichester, Brisbane, Toronto, Singapore. 680 p.

Islam, M. S.; Sarkar, M. A. R.; Uddin, S. and Parvin, S. 2012. Yield of fine rice varieties as influenced by integrated management of poultry manure, urea super granules and prilled urea. *J. Environ. Sci. & Natural Resources,* 5(1):129-132.

Islam, M. S.; Paul, S. K. and Sarkar M. A. R. 2014. Varietal performance of modern transplant *Aman* rice subjected to level of nitrogen application. *J. Bangladesh Agril. Univ.,* 12(1):55-60.

Jisan, M. T.; Paul, S. K. and Salim, M. 2014. Yield performance of some transplant *Aman* rice varieties as influenced by different level of nitrogen. *J. Bangladesh Agril. Univ.,* 12(2):321-324.

Kumar, V. J. F.; Balasubramania, M. and Jesudas, D. M. 1996. Application of different froms of urea for rice. *J. Indian Soc. Soil Sci.,* 44(20):267-270.

Ray, S.; Sarkar, M. A. R.; Paul, S. K.; Islam, A. K. M. M. and Yeasmin, S. 2015. Variation of growth, yield and protein content of transplant *Aman* rice by three agronomic practices. *Agril. Biol. Sci. J.,* 1 (4):167-176.

Savant, N. K.; Dhane, S. S and Talashilkar, S. C. 1991. Fertilizer News. International Fertilizer Development centre, muscle Shoals, Alabama, USA. 36(3):19-25.

Sarkar, S. K.; Sarkar M. A. R.; Islam N. and Paul S. K. 2014. Yield and quality of aromatic fine rice as affected by variety and nutrient management. *J. Bangladesh Agril. Univ.,* 12(2):279–284.

Tanchotikul, U. and Hsieh, T. C. Y. 1991. An improved method for quantification of 2-acetyl-1-pyrroline a popcorn-like aroma, in aromatic rice by high-resolution gas chromatography/ mass chromatography/ selected ion monitoring. *J. Agric. Food Chem,.* 39:944-947.

Tyeb, A.; Paul, S. K. and Samad, M. A. 2013. Performance of variety and spacing on the yield and yield contributing characters of transplanted *Aman* rice. *J. Agrofor. Environ.,* 40(4):595-597.

Zannat, S. T.; Paul, S. K. and Salam, M. A. 2014. Effect of weeding regime and nitrogen management on the performance of transplant aromatic *Aman* rice (cv.Binadhan-9). *Bangladesh J. Seed Sci. & Technol.,* 18(1 & 2):29-34.