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Performance of local aromatic rice varieties under different fertilizer management practices

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Abstract: The experiment was conducted at the Hajee Mohammad Danesh Science and Technology University Farm, Dinajpur, Bangladesh during July to December of 2008 to observe the influence of organic, inorganic and integrated management of fertilizers on the yield and yield contributing characteristics of local aromatic rice. The experiment was laid out in a randomized complete block design with three replications. The experiment comprised of five treatments viz., control (no fertilizer), recommended dose of chemical fertilizers (NPKSZn), well-decomposed cow dung @ 5 t ha^{-1}, well-decomposed cow dung @ 5 t ha^{-1} + recommended dose of chemical fertilizers (NPKSZn), well-decomposed cow dung @10 t ha^{-1}, well-decomposed cow dung @10 t ha^{-1}+ recommended dose of chemical fertilizers (NPKSZn) and five local aromatic rice varieties namely, Kataribhog, Badshabhog, Radhunipagal, Kalizera and Shakhorkora. All the fertilizer treatments produced significantly higher grain yield than control treatment. Growth attributes of aromatic rice such as tillers $hill^{-1}$, fertile tillers $hill^{-1}$, panicle length and grains $panicle^{-1}$ showed higher value with the incorporation of cow dung in combination with recommended dose of chemical fertilizers. Grain yield differed significantly among the varieties. Cow dung @ 5 t ha^{-1} in combination with recommended chemical fertilizers (NPKSZn) produced the highest grain yield.
Key words: Fertilizer, Cow dung, Yield, Aromatic rice.

Introduction

The organic fertilizer is traditionally an important source for supplying nutrients for rice cultivation in Bangladesh but use of inorganic fertilizers has increased dramatically, whereas utilization of organic fertilizers decreased. Higher yields depend on rational and effective application of chemicl fertilizers (Plucknett *et al.,* 1986).The application of farmyard manure meets N requirement, provides micronutrients and modifies soil physical properties and thus favours rice production and probably it may affect the quality of rice. Moreover, use of farmyard manure not only acts as a source of N and other nutrients but also increases the efficiency of applied nitrogen. Organic matter measures determines the fertility and nutrient status of a soil. Most of the tropical and sub-tropical regions including Bangladesh are deficient in organic matter. The maintenance of soil organic matter in around 2.5% to 3.0 % is desirable for satisfactory crop yield. A good soil should have organic matter content of about 2.5% (BARC, 1997). Aromatic rice is rated best in quality and fetches much higher price than high quality non-aromatic rice in the domestic and international market. The demand of aromatic rice for internal consumption and also for export is increasing day by day (Das and Baqui, 2000). Dinajpur region is a native area of some indigenous aromatic rice cultivars. About 30% of rice land in Dinajpur is covered by aromatic rice varieties during *'Aman'* season (Baqui *et al.* 1997). Due to low yield and limited market facilities farmers seem to have little interest to continue growing these aromatic rice cultivars. Farmer's observation at present day is that aromatic rice gradually losing their aroma and other qualities due to lack of organic matter in soil and more use of chemical fertilizers. Use of judicious combination of organic and inorganic fertilizer is very important for tropical country like Bangladesh (Khan *et al.,* 1986). This will ultimately economize fertilizer use and maintain soil productivity and yield. The information is limited on varietal quality responses to different organic and inorganic fertilizers with their interactions particularly in respect of yield of aromatic rice varieties. Therefore, the present investigation was aimed to study the effects of different organic and inorganic fertilizers on grain yield of aromatic rice varieties.

Materials and Methods

The experiment was conducted at the Hajee Mohammad Danesh Science and Technology University Farm, Dinajpur, Bangladesh during July to December of 2008. The experimental site was a medium high land with sandy loam soil having a pH value of 6.0. The experiment was laid out in a randomized complete block design with three replications. The experiment consisted of five fertilizer treatments viz., Control (T_1), Recommended dose of NPKSZn fertilizers (T_2), well-decomposed cow dung @ 5 t ha^{-1} (T_3), well-decomposed cow dung @ 5 t ha^{-1} + recommended dose of chemical fertilizers (NPKSZn)(T_4), well-decomposed cow dung @10 t ha^{-1} (T_5), well-decomposed cow dung @10 t ha^{-1}+ recommended dose of chemical fertilizers (NPKSZn) (T_6) and five local aromatic rice varieties namely, Kataribhog (V_1), Badshabhog (V_2) Radhunipagal(V_3), Kalizera(V_4), Shakhorkora (V_5). The unit plot size was 4.0m X 2.5m. According to the experimental specification, no fertilizer was used under control treatment (T_1). P, K, S and Zn were applied as basal through TSP 65 kg, MOP 110 kg, gypsum 87 kg and $ZnSO_4$ 2.25 kg ha^{-1} at final land preparation. Well decomposed sun dry cow-dung @ 5 and 10 t ha^{-1} was mixed in the specific plots at the time of final land preparation. Nitrogen was applied in the form of urea @ 138 kg ha^{-1} in two equal splits at 20 and 45 days after transplanting. Thirty-day-old seedlings were transplanted in the plots at a spacing of 20 cm X 15 cm using 3 seedlings $hill^{-1}$ on 15 July 2008. All other cultural practices were done uniformly as per recommendation. Whole plots were harvested to obtain grain yield.

Results and Discussion

Plant height was significantly influenced by fertilizer treatment. The tallest plant (148.2 cm) was found with well-decomposed cow dung @10 t ha^{-1}+ recommended dose of chemical fertilizers (NPKSZn) (T_6). The lowest plant height (134.3cm) was observed in control treatment (T_1). The tallest plant with recommended dose of NPKSZn + cow dung @10 t ha^{-1} might be due to sufficient supply of nutrients to crop. This result agreed with the findings of Hossain *et al.* (1997) and Sarkar *et al.* (2004).The highest number of total tillers $hill^{-1}$ (8.18) was

observed with cow dung @ 5 t ha^{-1}+ recommended dose of chemical fertilizers (T_4) and lowest (7.47) observed under control treatment (T_1) which was statistically similar to cowdung @ 10 t ha^{-1} (T_5) (Table1). This result agreed with that of Ahmed and Rahman (1991).The highest fertile tillers hill^{-1} (7.20) was observed with cow dung @5 t ha^{-1}+ recommended dose of chemical fertilizers (T_4). The lowest number of fertile tillers hill^{-1} (6.83) was found in control treatment (T_1) (Table 1).

Table 1. Effect of fertilizer dose on the yield and yield contributing characteristics of aromatic rice varieties

Treatment	Yield and yield components								
	Plant height (cm)	Total tillers/ hill	Fertile tillers/hill	Panicle length(cm)	Spikelets panicle^{-1}	Grains panicle^{-1}	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T1	134.3e	7.47c	6.83c	22.93b	110.2d	96.99d	11.89b	1.61f	3.60d
T2	142.2b	7.97b	7.04b	23.12a	121.0b	99.26b	11.90b	2.11c	4.13b
T3	136.7d	7.48c	7.00b	22.95b	113.8c	98.05c	12.29a	1.79e	3.76c
T4	142.8b	8.18a	7.20a	23.01ab	123.6a	100.6a	12.52a	2.36a	4.28ab
T5	138.6c	7.55c	7.06b	23.05ab	114.7c	98.38c	12.39a	1.95d	3.82c
T6	148.2a	7.85b	7.07b	22.99b	125.2a	100.1ab	12.55a	2.23b	4.4a
CV (%)	1.41	3.46	2.18	0.68	1.91	1.19	2.72	6.65	5.07
Level of significance	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01

Figures in a column followed by different letters differ significantly but with common letter (s) do not differ significantly at 5% level of probability
Note: T_1= Control (No fertilizer), T_2= Recommended dose (NPKSZn), T_3= Cow dung (5t/ha), T_4= Cow dung (5t/ha) + Recommended dose (NPKSZn), T_5= Cow dung (10t/ha), T_6= Cow dung (10t/ha) + Recommended dose (NPKSZn)

Number of spikelets panicle^{-1} was significantly influenced due to fertilizer treatment. The highest number of spikelets panicle^{-1} (123.6) was observed in cow dung @5 t ha^{-1}+ recommended dose of chemical fertilizers (T_4). The lowest number of spikelets panicle^{-1} (110.2) was obtained from control treatment (T_1) (Table 1).The highest grains panicle^{-1} (100.6) was recorded in cow dung @5 t ha^{-1}+ recommended dose of chemical fertilizers (T_4) and it was statistically similar to cow dung @10 t ha^{-1}+ recommended dose of chemical fertilizers (T_6). Lowest number of grains panicle^{-1} (96.99) was found in control treatment (T_1) (Table 1).Grain yield was significantly affected due to fertilizer treatments. The application of cow dung @5 t ha^{-1}+ recommended dose of chemical fertilizers (T_4) showed a positive effect on the yield components of aromatic rice. This treatment significantly increased fertile tillers hill^{-1} which might have the contribution to highest grain yield (2.36 t ha^{-1}) (Table 1). This might be due to the continuous release of nutrients from manure to supply the requirement of rice plants (Sarkar *et al*., 2004 and Balasubramaniyan, 2004). Reduction of grain yield in control treatment might be attributed due to significant reduction in fertile tillers hill^{-1} and grains panicle^{-1}.The highest straw yield (4.4 t ha $^{-1}$) was obtained with cow dung @10 t ha^{-1}+ recommended dose of chemical fertilizers. The lowest straw yield (3.60t ha^{-1}) was found in control treatment(T_1). Plant height significantly influenced due to variety. The tallest plant (145.9 cm) was produced by Kataribhog and shortest plant (132.5cm) was observed in Shakorkora (Table 2). Lodging of the local varieties at mature stage was observed due to higher plant height. A tallest plant is more susceptible to lodging and less responsive to nitrogen (Yoshida, 1981).The highest number of total tillers hill^{-1} (8.13) was observed in Shakorkhora. The highest number of fertile tillers hill^{-1} (7.45) was found in Kataribhog (Table 2). Length of panicle was significantly influenced by variety. Highest panicle length (24.36 cm) was observed in Radhunipagal which was statistically similar to Kalizera (Table 2).

Table 2. Effect of varieties on the yield and yield contributing characteristics of aromatic rice

Variety	Yield and yield components								
	Plant height (cm)	Total tillers hill^{-1}	Fertile tillers hill^{-1}	Panicle length (cm)	Spikelets panicle^{-1}	Grains panicle^{-1}	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
V_1	145.9a	7.73b	7.45a	22.55c	114.0d	97.22d	13.59b	2.55a	4.54a
V_2	138.2c	7.38c	7.13b	23.50b	119.7c	101.3c	9.89e	2.00b	4.03b
V_3	145.4a	7.67b	6.73c	24.36a	123.6a	107.3a	11.02d	1.72d	3.97b
V_4	140.3b	7.84b	7.00b	24.30a	122.1b	104.5b	13.87a	1.94b	4.06b
V_5	132.5d	8.13a	6.85d	20.34d	110.9e	84.2e	12.91c	1.82c	3.39c
CV(%)	1.41	3.46	2.18	0.68	1.91	1.19	2.72	6.65	5.07
Level of sig.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Figures in a column followed by different letters differ significantly but with common letter (s) do not differ significantly at 5% level of probability
Note: V_1= Kataribhog, V_2= Badshabhog, V_3= Radhunibhog, V_4= Kalijera, V_5= Shakhorkhora

Highest number of spikelets panicle^{-1} (123.6) was observed in Radhunipagal and lowest number of spikelets panicle^{-1} (114.0) was observed in Kataribhog (Table 2).Significant variation was observed due to variety on grains panicle^{-1}. Highest number of grains panicle^{-1} (107.3) was observed in Radhunipagal and lowest number grains panicle^{-1} (97.22) was observed in Kataribhog (Table 2). Significant variation of individual grain weight was

observed among the tested varieties. Heaviest grain was found in Kalizera and the weight was less in Badshabhog (Table 2). Among the tested varieties the Kataribhog produced the highest grain yield (2.55t ha^{-1}) and it might be due to the contribution of higher number of fertile tillers $hill^{-1}$. The lowest grain yield (1.82t ha^{-1}) was obtained from Shakhorkora (Table.2).The highest straw yield (4.54t ha^{-1}) was obtained from Kataribhog and the lowest straw yield (3.93t ha^{-1}) was obtained from Shakhorkora (Table 2).

The interaction effect of fertilizer and variety was significant in respect to plant height, total tillers $hill^{-1}$, fertile tillers $hill^{-1}$, Panicle length, Spikelets $panicle^{-1}$, Number of grains $panicle^{-1}$, thousand grain weight, grain yield and straw yield (Table 3). Highest grain yield (3.0 t ha^{-1}) was observed in Kataribhog when recommended NPKSZn fertilizers were applied with cow-dung @ 5 t ha^{-1} and lowest grain yield (1.37t ha^{-1}) was observed in Radhunipagal under control treatment (Table 3). Local variety is more responsive to organic fertilizer in respect of growth and yield. On the other hand local variety was susceptible to lodging due to sole application of inorganic fertilizer. Therefore, it is concluded that cow dung @ 5 t ha^{-1} with recommended dose of NPKSZn fertilizers may be used to get maximum yield of local aromatic rice.

Table3. Interaction effect of fertilizer and variety on the yield and yield contributing characteristics of aromatic rice

Treatment	Yield and yield components								
	Plant height (cm)	Total tillers $hill^{-1}$	Fertile tillers $hill^{-1}$	Panicle length (cm)	Spikelets $panicle^{-1}$	Grains $panicle^{-1}$	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T1 V1	139.0 i-k	7.4 g-j	6.7 g-l	22.47 f	110.2 k	95.7 j	13.32 bc	2.03e-i	4.23eg
T1 V2	130.6 o	7.06 j	6.53 i	23.23 d	115.6 ij	100.1 fg	9.52 k	1.55l-o	3.63ij
T1 V3	140.3 h-j	7.57 e-j	6.93 d-g	24.5 a	116.4 hj	104.4bc	10.67 gh	1.370	3.43jk
T1 V4	134.5 m-n	7.37 h-j	6.70 g-i	24.17 b	111.2 k	1.2.2 df	13.36 bc	1.56l-o	3.70hj
T1 V5	127.2 p	7.93 c-f	7.3 a-c	20.27 gh	97.4 m	82.53 e	12.6 de	1.52m-o	3.0l
T2 V1	151.6 bc	7.8 d-h	6.97 d-g	22.9 e	115.3 ij	97.17 hj	13.28 bc	2.71b	4.6ac
T2 V2	140.5 h-j	7.7 d-i	6.73 f-i	23.6 e	120.4 fh	101.3 cf	9.55 jk	2.08eh	4.03dh
T2 V3	146.1 d-f	8.03 b-e	7.10 c-e	24.33 ab	126.4 ce	108.3 a	10.78 fg	1.84h-k	4.23
T2 V4	140.4 h-j	7.9 c-g	6.97 d-g	24.27 ab	127.0 bd	105.2 bc	13.4 bc	2.03ei	4.3ef
T2 V5	132.3 n-o	8.4 bc	7.43 ab	20.5 g	115.7ij	84.33 kl	12.5 e	1.88gi	3.5j
T3 V1	141.5 g-j	7.13 j	6.70 g-i	22.4 f	112.4 jk	96.67 ij	13.78 ab	2.25ce	4.37bd
T3 V2	133.2 m-o	7.17 j	6.6 h-i	23.6 c	118.6 gi	101.2 ef	9.86 ik	1.84hk	3.93fi
T3 V3	142.3 g-i	7.4 g-j	6.9 c-h	24.27 ab	120.0 fh	105.2 bc	11.03 fg	1.46no	3.6if
T3 V4	136.4 k-m	7.9 c-g	7.4 a-b	24.2 ab	115.2ij	103.3 ce	13.85 ab	1.76j-m	3.8hj
T3 V5	130.1 o-p	7.8 d-h	7.4 a-b	20.3 gh	102.5 e	83.93 kl	12.93 ef	1.61ko	3.1hj
T4 V1	144.3 e-g	7.23 a	7.33 a-c	22.47 f	116.5 hj	98.8 gh	13.8 ab	2.99a	4.8a
T4 V2	142.2 g-i	7.57 e-j	6.83 e-h	23.5 3c	122.6 eg	102.2 df	10.13 hj	2.38cd	4.23eg
T4 V3	148.4 c-d	8.0 c-f	7.2 b-d	24.3 ab	128.2 bc	110.3 a	11.23 fg	2.07eh	4.4bd
T4 V4	143.9 e-h	7.9 c-h	7.1 c-e	24.40 ab	130.2 ac	106.3 b	14.32 a	2.24ce	4.33ce
T4 V5	135.2 l-n	8.2 bd	7.53 a	20.40 g	120.4 fh	85.60 k	13.13 cd	2.10eh	3.63ij
T5 V1	143.4 f-h	7.33 h-j	6.70 g-i	22.5 f	113.2 jk	96.37 j	13.5 bc	2.45c	4.5ac
T5 V2	135.6 k-n	7.2 i-j	6.77 f-i	23.5 ec	118.0 hi	101.3 cf	10.07 ik	1.94fj	3.9gi
T5 V3	143.4 f-h	7.3 h-j	7.00 d-f	24.37 ab	120.2 fh	1.6.1 b	11.13 fg	1.63kn	3.77hj
T5 V4	138.2 j-i	7.97 e-f	7.33 a-c	24.4 ab	116.4 hj	103.7 cd	14.14 a	1.92fj	3.8hj
T5V5	132.2 n-o	7.97 c-f	7.5 a	20.47 g	105.6 e	84.47 kl	13.10 cd	1.78il	3.13kl
T6V1	155.3 a	7.5 f-j	6.70 g-i	22.51 f	116.2 hj	98.63 gi	13.85 ab	2.85ab	4.73ab
T6V2	147.1 d-e	7.57 e-j	6.93 d-g	23.53 c	122.9 cf	101.9 df	10.20 hi	2.17df	4.47ac
T6V3	152.1 a-b	7.7 d-i	6.87 e-h	24.40 ab	130.6 ab	109.3 a	11.30 f	1.95f-j	4.4bd
T6V4	148.3 c-d	8.0 c-f	7.30 a-c	24.37 ab	132.6 a	106.2 b	14.17 a	2.12eg	4.43ac
T6V5	138.1 j-l	8.5 b	7.53 a	20.10 h	123.6 df	84.37 kl	13.23 bc	2.05eh	3.97ei
CV(%)	1.41	3.46	2.18	0.68	1.91	1.19	2.72	6.65	5.07
Level of sig.	0.01	0.01	0.01	0.05	0.01	NS	NS	NS	0.01

Figures in a column followed by different letters differ significantly but with common letter (s) do not differ significantly at 5% level of probability
Note: T_1= Control (No fertilizer), T_2= Recommended dose (NPKSZn), T_3= Cow dung (5t/ha), T_4= Cow dung (5t/ha) + Recommended dose (NPKSZn), T_5= Cow dung (10t/ha), T_6= Cow dung (10t/ha) + Recommended dose (NPKSZn); V_1= Kataribhog, V_2= Badshabhog, V_3= Radhunibhog, V_4= Kalijera, V_5= Shakhorkhora

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