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Sulphur nutrition of aromatic rice

M. N. Yasmin, M. P. Anwar, M. Begum, M. M. Islam and Z. Sultana
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract: A high yielding aromatic rice variety BRRI dhan38 and a local one Chiniguda were grown with 0, 5, 10, 15 and 20 kg S ha^{-1} at the Agronomy Field Laboratory, Department of Agronomy, Bangladesh Agricultural University, Mymensingh during *aman* season (July to December) of 2007 following randomized complete block designed experiment with three replications to study the sulphur requirements of aromatic rice. Variety significantly influenced all the yield contributing characters and yield of aromatic rice. Local variety Chiniguda produced higher grain yield (2.87 t ha^{-1}) than high yielding variety BRRI dhan38 (2.00 t ha^{-1}). Yield contributing characters like no. of effective tillers $hill^{-1}$and grains per $panicle^{-1}$ were increased gradually with increased level of S but 1000-grain weight was unaffected. Grain yield (2.54 kg ha^{-1}) was gradually increased upto 10 kg S ha^{-1} and thereafter no increment was recorded. Chiniguda interacted favourably with 10 or 15 or 20 kg S ha^{-1} to produce the highest grain yield. Therefore, local aromatic rice variety Chiniguda may be cultivated with 10 kg S ha^{-1} in late T. *aman* season for higher yield.
Key words: Sulphur level, variety, aromatic rice and grain yield.

Introduction

In Bangladesh, rice can be categorized into coarse, medium and fine based on physical and chemical properties of grain. More than four thousand local landraces of rice have been adopted in different parts of the country. Some of them are very popular for their fineness and aroma, for example, Kataribhough, Kalizira, Basmati, Chiniguda etc. Bangladesh Rice Research Institute (BRRI) has developed some high yielding aromatic rice varieties, among them BRRI dhan34 and BRRI dhan38 are noteworthy. The yield of aromatic rice is lower than that of coarse and medium rice. Aromatic rice grows moderately well under lower input level. (Gangaiah and Prasad, 1999). The aromatic rice is the highly valued rice commodity due to having small grain, pleasant aroma and soft texture upon cooking (Dutta *et al.*, 1998). Besides, the price of 1 kg aromatic fine rice is Tk. 70-80 where as 1 kg coarse milled rice is Tk. 30-40. That is why, cultivation of aromatic rice in the country is economically profitable.

Sulphur is an essential macronutrient and increasingly being recognized as the fourth major nutrient after nitrogen (N), phosphorus (P) and potassium (K) (Tandon, 1995). In the recent past, the soils of Bangladesh were reported to be deficient in N, P and to some extent K content. Farmers were using these elements through fertilizers. But, recently advanced researches have indicated the deficiency of other nutrients like S. In recent years S deficiency has been receiving sufficient attention as a major limiting factor for wet land rice. Sulphur deficiency affects not only yield but also protein quality through its effect on the synthesis of certain amino acids like cystine, cysteine, methionine and also plant hormones and some vitamins. Sulphur deficiency can alone reduce crop yields by 10-20% (Bhuiyan and Shah, 1990). The major causes of sulphur deficiency in Bangladesh are intensive cropping with high yielding varieties of different crops, long term water logging due to wet land culture, shifting toward virtually sulphur free fertilizer, depletion of soil organic matter, loss of sulphur by leaching in high rainfall areas and leaching in light textured soils under flood irrigation. The increasing sulphur deficiency in wetland rice has become one of the major constraints in achieving self-sufficiency in rice production in Bangladesh. Unless this deficiency is recovered through sulphur application, optimum gains from investment on fertilizer can not be assured and sustainable agricultural development can not be guaranteed (Haque, 1999). In view of the above facts a study was, therefore, undertaken to find out the comparative performance of two aromatic rice varieties BRRI dhan38 and Chiniguda and to identify the suitable dose of sulphur for getting higher yield of aromatic rice.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the *aman* season (July to December) of 2007 to evaluate the influence of sulphur fertilization on the productivity of local and high yielding aromatic rice varieties. The experimental soil belongs to the Sonatala Series of the dark grey flood plain soil type under the old Brahmaputra Flood Plain Agro ecological zone (AEZ 9). The soil of the experimental field was more or less neutral in reaction with pH value 6.70, low in organic matter content (1.20%), (BARC, 1997) and general fertility level of the soil was also low. Available sulphur content of the experimental field is 14.31 ppm (Islam, 2007). The experiment comprised of two aromatic rice varieties viz., BRRI dhan38 (high yielding) and Chiniguda (local), and five levels of S viz. 0, 5, 10, 15 and 20 kg ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The size of unit plot was 2.5m × 2.0m. Thirty day old seedlings of both the varieties were transplanted on 23 August 2007 at the rate of 3 seedlings $hill^{-1}$ with 25cm × 15cm spacing. Each plot was fertilized with TSP and MOP @ 100 and 70 kg ha^{-1}, respectively during final land preparation, and urea @ 150 kg ha^{-1} was top dressed in three equal splits at 15, 30 and 45 days after transplanting (DAT). Sulphur was applied as basal in the form of gypsum as per treatments. Necessary intercultural operations were done in order to ensure and maintain the normal growth of the crop. At

maturity, five hills (excluding border hills) were randomly selected and uprooted from each unit plot for recording data on different crop characters on 9 December 2007. Grain and straw yields were recorded from central 1 m^2 area. Data were collected on several parameters like plant height, number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, 1000-grain weight, grain yield, straw yield and harvest index. Data were compiled and tabulated in proper form for statistical analysis. Data were analyzed using Analysis of Variance (ANOVA) technique with the help of computer package programme MSTAT, and mean differences were adjudged by Duncan's Multiple Range Test.

Results and Discussion

Effect of Variety

Variety exhibited significant influence on the yield contributing characters and yield of aromatic rice (Table 1). Between the varieties the performance of Chiniguda was better with respect to plant height (119.86 cm), no. of effective tillers $hill^{-1}$ (11.22) and no. of grains $panicle^{-1}$ (148.47). On the other hand, BRRI dhan38 performed better regarding panicle length (25.21 cm) and 1000-grain weight (21.26g).The differences in above-mentioned parameters between the varieties might be due to the variation in their genetic make-up. However, varietals differences regarding different yield contributing characters have been reported by several researchers at home and abroad. Liza *et al.* (2004) reported variable plant height and 1000-grain weight, Chowdhury *et al.* (1993) found variable no. of effective tillers $hill^{-1}$, Idris and Matin (1990) recorded variable panicle length and Singh and Gangwar (1989) reported variable no. of grains $Panicle^{-1}$ among the varieties. Grain yield, the additive result of the yield contributing characters was recorded higher in Chiniguda (2.86 t ha^{-1}) than BRRI dhan38 (2.00 t ha^{-1}). Higher grain yield of Chiniguda was mostly the outcome of higher number of effective tillers $hill^{-1}$, grains $panicle^{-1}$ and heavier seeds. A difference in grain yield among varieties was also reported by Anwar *et al.* (1999) and Prasad and Umar (1993). Chiniguda produced higher straw yield (3.85 t ha^{-1}) than BRRI dhan38 (2.93 tha^{-1}) and harvest index also was calculated higher in Chiniguda (42.69%) than in BRRI dhan38 (40.43%). Local variety Chiniguda outyielded high yielding variety BRRI dhan38 which might be due to late transplanting and, therefore, in case of planting in late August local variety may be considered as a better option.

Table 1. Effect of variety on different crop characters of fine rice

Variety	Plant height at harvest (cm)	Effective tillers $hill^{-1}$ (no.)	Non-effective tillers $hill^{-1}$ (no.)	Panicle length (cm)	Grains $panicle^{-1}$ (no.)	Sterile spikelets $panicle^{-1}$ (no.)	1000- grain weight (g)	Grain yield (t ha-1)	Straw yield (t ha-1)	Harvest index (%)
BRRI dhan38	104.00	9.17	3.18	25.21	134.64	20.23	21.26	2.00	2.93	40.43
Chiniguda	119.86	11.22	4.58	20.82	148.47	14.06	17.61	2.86	3.85	42.69
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
$S_{\bar{x}}$	0.69	0.21	0.08	0.27	1.47	0.28	0.74	0.04	0.06	0.45
CV (%)	2.41	8.26	8.17	4.58	4.67	6.46	3.49	6.50	7.49	4.25

Figures in column having similar letter (s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT. CV = Coefficient of variation.

Effect of Sulphur level

Level of Sulphur exerted significant influence on all the parameters except panicle length, 1000-grain weight and harvest index of aromatic rice (Table 2). Plant attained the maximum height (115.60cm) with 20 kg S ha^{-1} which was statistically identical with 15 kg S ha^{-1}, and the minimum height (109.15 cm) was obtained from 0 kg S ha^{-1}. The present study shows that plant height increased due to application of sulphur and the plant was greatly boosted up. These results completely concurred with those of Li-Yu and Li-Yu (1999) who reported that in rice, application of S increased plant height. The variation in number of effective tillers $hill^{-1}$ due to different sulphur levels also followed the same trend, which closely resembles to the findings of Liza *et al.* (2004). Number of grains $panicle^{-1}$ was also found to be increased gradually with the increase in sulphur level. The highest number of grains $panicle^{-1}$ (149.82) was produced from 20 kg S $ha^{-1}$and the lowest one (129.53) was recorded from control treatment. This finding is in agreement with that of Liza *et al.* (2004). No. of sterile spiklets $panicle^{-1}$ was decreased with the application of Sulphur. The highest no. of sterile spiklets (18.52) was recorded in control (0 kg S ha^{-1}) treatment but lowest one (16.23) was found from 20 kg S ha^{-1}. Sulphur level failed to influence the 1000-grain weight significantly. Results showed a significant difference among sulphur levels in respect to grain yield of aromatic rice. Grain yield ranged from 2.12 to 2.62 t ha^{-1}, and was found to be increased with the increasing level of sulphur. The highest grain yield (2.62 t ha^{-1}) was obtained from 20 kg S ha^{-1} which was statistically similar to 15 kg S ha^{-1} (2.58 t ha^{-1}) and 10 kg S ha^{-1} (2.54 t ha^{-1}) and the lowest one (2.12 t ha^{-1}) was obtained from control treatment (0 kg S ha^{-1}). Increase in grain yield due to application of sulphur was mainly due to improvement of yield contributing characters i.e. number of effective tillers $hill^{-1}$ and number of grains

panicle^{-1}. These results are in agreement with the findings of Raju and Reddy (2001) who observed a significant improvement in grain yield of rice due to application of sulphur. Straw yield was also significantly influenced by level of sulphur. Twenty kg S ha^{-1} produced the highest straw yield (3.70 t ha^{-1}) which was statistically identical with those produced by 15 kg and 10 kg S ha^{-1}, and the lowest one (3.00 t ha^{-1}) was recorded from control treatment. Islam *et al.* (1990) also reported that S application significantly increased the straw yield of rice.

Table 2. Effect of sulphur level on different crop characters of fine rice varieties

Level of Sulphur (kg ha^{-1})	Plant height at harvest (cm)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
0	109.15b	9.16c	3.20c	22.65	129.53d	18.52a	19.21	2.12b	3.00c	40.86
5	109.23b	9.33c	3.77b	22.87	139.62c	17.13b	19.29	2.29b	3.29bc	41.15
10	110.55b	9.50c	3.96ab	22.92	144.03b	17.05b	19.53	2.54a	3.45ab	41.26
15	115.13a	10.63b	4.23a	23.25	144.74b	16.52b	19.54	2.58a	3.50ab	42.19
20	115.60a	12.37a	4.27a	23.40	149.82a	16.23b	19.63	2.62a	3.70a	42.33
Level of significance	0.01	0.01	0.01	NS	0.01	0.05	NS	0.01	0.01	NS
$S_{\bar{x}}$	1.10	0.34	0.12	-	2.33	0.45	-	0.06	0.10	-
CV (%)	2.41	8.26	8.17	4.58	4.67	6.46	3.49	6.50	7.49	4.25

Figures in column having similar letter (s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT. NS = Not significant, CV = Coefficient of variation.

Effect of interaction

The interaction between variety and sulphur level significantly affected plant height, no. of effective tillers hill^{-1}, grains panicle^{-1}, sterile spikelets panicle^{-1} and grain yield, but panicle length, 1000-grain weight, straw yield and harvest index were found unaffected (Table 3). Chiniguda grown with 15 kg S ha^{-1} produced the tallest plant (121.26 cm), while BRRI dhan38 produced the shortest one (98.13 cm) when grown without sulphur fertilizer (control). The highest no. of effective tillers hill^{-1} (13.40) was obtained from the treatment combination Chiniguda × 20 kg S ha^{-1}. BRRI dhan38 grown with no sulphur (control) produced the lowest no. of effective tillers hill^{-1} (7.33). BRRI dhan38 in combination with any level of sulphur (except control) produced statistically similar and the maximum no. of grains panicle^{-1}. On the other hand, BRRI dhan38 grown under control (0 kg S ha^{-1}) produced the minimum no. of grains panicle^{-1} (123.53). The maximum no. of sterile spikelets panicle^{-1} (21.36) was recorded from the interaction between BRRI dhan38 and 20 kg S ha^{-1} statistically followed by the interaction of BRRI dhan38 × 15 kg S ha^{-1} (20.87), BRRI dhan38 × 10 kg S ha^{-1} (19.69) and BRRI dhan38 × 5 kg S ha^{-1} (20.13). Chiniguda interacted favorably with 20 kg S ha^{-1} to produce the highest grain yield (3.08 t ha^{-1}), which was statistically similar to those produced by the interactions of Chiniguda × 15 kg S ha^{-1} (3.00 t ha^{-1}) and Chiniguda × 10 kg S ha^{-1} (2.91 t ha^{-1}). Results reveal that local variety Chiniguda yielded the highest when grown with 20 or 15 or 10 kg S ha^{-1}. BRRI dhan38, on the other hand, produced the lowest yield when grown with 0 or 5 kg S ha^{-1}. Therefore, local variety Chiniguda appears to be better than high yielding variety BRRI dhan38 in terms of yield under the condition where S fertilizer is not applied.

Table 3. Combined effect of variety and level of sulphur on different crop characters of fine rice

Interaction (Variety× Level of sulphur)	Plant height at harvest (cm)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$V_1 \times S_0$	98.13c	7.33f	2.46f	24.39	123.53e	19.09b	21.07	1.66e	2.50	39.38
$V_1 \times S_5$	100.03c	8.53ef	3.20e	25.76	137.46d	20.13ab	21.13	1.83e	2.83	39.87
$V_1 \times S_{10}$	102.46c	9.26de	3.33e	24.88	133.69c	19.69ab	21.31	2.16d	3.00	39.92
$V_1 \times S_{15}$	109.00b	9.40d	3.73de	25.64	138.09c	20.87ab	21.41	2.16d	3.08	41.72
$V_1 \times S_{20}$	110.40b	11.3bc	3.20e	25.38	140.43c	21.36a	21.39	2.16d	3.25	41.26
$V_2 \times S_0$	118.26a	9.06de	3.93cd	20.91	135.53d	16.17c	17.36	2.58c	3.50	42.34
$V_2 \times S_5$	120.33a	10.1cd	4.33bc	19.93	145.56cd	14.13de	17.43	2.75bc	3.75	42.44
$V_2 \times S_{10}$	118.63a	11.67b	4.60b	20.95	150.61b	14.41cd	17.74	2.91ab	3.92	46.62
$V_2 \times S_{15}$	121.26a	11.86b	4.73b	20.85	151.40b	13.37de	17.66	3.00ab	3.92	42.66
$V_2 \times S_{20}$	120.80a	13.40a	5.33a	21.41	159.28a	12.23e	17.87	3.08a	4.17	43.39
Level of significance	0.05	0.01	0.05	NS	0.05	0.05	NS	0.05	NS	NS
S_X	1.55	0.48	0.18	-	3.30	0.64	-	0.09	-	-
CV (%)	2.41	8.26	8.17	4.58	4.67	6.46	3.49	6.5	7.49	4.38

Figures in column having similar letter (s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT. V_1 = BRRI dhan38, V_2 = Chiniguda, NS = Not Significant, CV = Co-efficient of variation.

The study reveals that local variety Chiniguda outyielded high yielding variety BRRI dhan38 when transplanted at late August. Moreover, Chiniguda is a very popular aromatic variety and, therefore, its market price is a bit higher than that of BRRI dhan38. Though 10, 15and 20 kg S ha^{-1} produced the highest and statistically similar grain yield, therefore, 10 kg S ha^{-1} may be considered as the economically viable option. It may, therefore, be suggested that local variety Chiniguda fertilized with 10 kg S ha^{-1} along with recommended NPK fertilizers might be the right choice for the farmers in late August planted T. *aman* rice.

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