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INFLUENCE OF SULPHUR ON NUTRIENT CONTENT AND UPTAKE BY RICE AND ITS BALANCE IN OLD BRAHMAPUTRA FLOODPLAIN SOIL

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ABSTRACT

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The experiment was conducted on a Non-Calcareous Dark Gray Floodplain Soil (Sonatola series) of BAU farm, Mymensingh during Boro season of 2004. The soil was silt loam having pH 6.8, organic matter 1.62%, available S 9 ppm and available P 7.62 ppm. There were five treatments viz. T_0 (control), T_1 (10 kg Sha^{-1}), T_2 (20 kg Sha^{-1}), T_3 (40 kg Sha^{-1}) and T_4 (60 kg Sha^{-1}). A randomized complete block design was followed with four replications. All plots received an equal dose of N, P, K and Zn. The highest N, P, K and protein content was recorded from treatment T_2 (20 kg Sha^{-1}). On the other hand, the highest S, Ca and Mg content was recorded from treatment T_4 (60 kg Sha^{-1}). However, the application of S fertilizer significantly increased protein, N, P, K, S, Ca and Mg content as well as their uptake over control. The S balance was positive where S was added as treatment combination. Negative S balance was recorded where no S was added (control).

Key Words: Sulphur, nutrient uptake, floodplain soil

INTRODUCTION

Soil is the main source of plant nutrients. It supplies at least 16 nutrient elements to plants. Plant nutrients in soil whether naturally endowed or artificially maintained are major determinant of success or failure of a crop production system. Among the essential elements sulphur is very much beneficial for increasing the production of rice. Sulphur is one of the major essential nutrient elements to synthesis certain amino acids such as methionine, cystine, cysteine and some plant hormones; such as thiamine and biotin (De Datta, 1981).Recently, sulphur deficiencies in rice fields have been reported in different areas of Bangladesh. The practice of intensive cropping with modern varieties causes a marked depletion of inherent nutrient reserve in soils of Bangladesh. The nutrient depletion shows a risk of the prospect for higher crop production in this country. Sulphur deficiency in rice in Bangladesh was first detected at BRRI farm in Joydebpur in 1976 (Islam, 1978). Sulphur deficiency mainly arises under water-logged condition or in low land rice cultivation. Sulfur is reduced to a sulfide form under anoxic conditions in submerged paddy soils. Free hydrogen sulphide is generated and inhibits the rice root growth in paddy soils with low content of free iron oxide and high sulfate content. Sulphur content in soil should be estimated in the rice field to determine its proper quantity to be applied for maximizing grain yield and improving crop quality.

MATERIALS AND METHODS

The experiment was carried out during Boro season 2003-2004 at the Soil Science Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh . The experimental soil was Sonatala silt loam, a member of Hyperthermic Aeric-Haplaquept. Initial soil samples were collected from a depth of 0 to 15 cm from the soil surface, on December 2003 after harvest of T. Aman. The soil samples were air-dried, ground, and sieved through 1-mm (20-mesh) sieve. The composite sample was stored in a clean plastic bag for physical and chemical analysis. Some of the chemical properties and texture of the test soil are given in Table 1.

Table 1. Morphological, Physical and chemical properties of the experimental soil

General soil type	Non-calcareous Dark gray flood plain
Parent material	Brahmaputra river borne deposits
Agro Ecological Zone (AEZ)	Old Brahmaputra Flood Plain
Topography	Medium high land, fairly leveled
Flood level	Above flood level.
Soil colour	Grey
Drainage	Moderate
Vegetation	Rice Crop grown year round
Particle size analysis	
Sand (%) (2.0-0.02 mm)	20
Silt (%) (0.02 0.002 mm)	68
Clay (%) (<0.002 mm)	12
Soil textural type	Silt loam
Organic matter content (%)	1.62
pH	6.80
Total N (%)	0.12 (low)
Available P (ppm)	7.6 2 (Medium)
Available S (ppm)	9.00 (low)
Exchangeable K (me/100 g soil)	0.15 (low)

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. 0, 10, 20, 40 and 60 Kg S ha^{-1} were used as treatment combination in this experiment. Treatments were randomly distributed within the blocks. The unit plot size was 4m × 3m and the test variety was BRRI dhan 29. The crop was harvested at full maturity on May 23, 2004. The harvested crop of each plot was bundled separately and brought to the threshing floor. Grain and straw yields were recorded plot wise and expressed as t ha^{-1} on 14% moisture basis. The grain and straw samples were analyzed for the determination of N, P, K and S in the BARI, Soil Science laboratory following the respective methods.

RESULTS AND DISCUSSION

Effect of Sulphur on the Nutrient content of rice:

Nitrogen content

Nitrogen content in grain and straw varied due to sulphur application. The grain N content varied from 1.26% to 1.39% over the treatments (Table 2). The highest N content (1.39 %) in grain was found in the treatment T_2. It was noted that the maximum nitrogen content (0.83%) in straw was recorded due to 60 kg S ha^{-1} (T_4) application and the minimum (0.65%) was in control (T_0). The 0.76% and 0.78% nitrogen contents in straw were recorded by the application of 20 kg and 40 kg S ha^{-1}, respectively. Tiwari *et al.* (1983) and Sachdev *et al*. (1983) also reported that sulphur application increased nitrogen content in straw.

Phosphorus content

The P content in grain was significantly affected by the different treatments. The highest P content (0.38%) in grain was observed in treatment T_2 (Table 2), which was statistically similar to treatment T_3. The lowest P content (0.32%) in grain was observed in control treatment. Paliwat *et al*. (1992) observed that S application increased the P content of rice grain significantly. Phosphorus content in straw varied from 0.14% to 0.17%. The highest phosphorus content in straw (0.17%) was observed under the treatment T_2. The lowest concentration of phosphorus (0.14%) was observed under the treatment T_0.

Potassium content

The K content in grain ranged from 0.289 to 0.435% and in straw varied from 1.085% to 1.798% under different treatments (Table 2). The maximum K content was recorded in treatment T_2, which was statistically similar with treatment T_3 and T_4. The maximum K content in grain was 0.435% and the minimum K content was 0.289% under the treatment T_0 (control). The highest potassium content in straw (1.798%) was found under the treatment T_4 and the lowest (1.085%) in control treatment.

Sulphur content

Application of sulphur fertilizers significantly increased the S content in both grain and straw (Table 2).The grain sulphur content ranged from 0.086% to 0.108% and straw content varied from 0.07% to 0.107% (Table 2).The highest S content was found maximum in $T_{4,}$ which was the highest dose of sulphur fertilizer i.e. at the rate of 60 kg S ha^{-1} and the lowest sulphur content was found under the treatment T_0 (control). Tiwari *et al*. (1983) and Hoque and Eaqub (1984) reported that sulphur application increased its content in straw. The findings of the present study are in conformity with the results reported by Khan *et al*. (1992) and Mandata *et al*. (1994) who noted that concentration of S in rice plant increased with increasing rates of S application. Islam *et al*. (1987) reported that the highest S content in plant when 30 to 40 kg S ha^{-1} were added to the soil.

Calcium content

The calcium content in rice grain was 0.068% to 0.091% due to different rates of sulphur. On the other hand the highest calcium content was 0.091 % due to treatment T_4. The lowest calcium content was 0.068% because of treatment T_0. The calcium content in rice straw was 0.057% to 0.089% by reason of different rates of sulphur. The highest calcium content in straw was 0.089 % due to treatment T_4 and the lowest calcium content was 0.068% due to treatment T_0. Alameen (1989) also reported that application of sulphur increased calcium content.

Magnesium Content

The highest magnesium content was 0.113% in case of treatment T_4. The lowest magnesium content was 0.088% off treatment T_0. It was observed that treatment T_2 and T_3 are statistically similar. Alameen (1989) reported that sulphur application increased Magnesium content in rice grain. The highest magnesium content in straw was 0.104% from treatment T_2. The lowest magnesium content was 0.073% as a result of treatment $T_{0.}$

Protein content

It was observed from Table 2 that the protein contents of rice grain were significantly increased due to the application of different rates of sulphur. The highest protein content (8.70 %) was obtained by the application of 20-kg sulphur. But the lowest protein content (7.86%) was due to application of no sulphur (T_O). It was observed that treatments T_2 and T_3 were statistically similar with respect to protein contents. Alameen (1999) also showed that sulphur application increased protein content in the rice grain. From the observation it revealed on application of sulphur protein content increased in rice grain.

Table 2. Effect of different rates of Sulphur fertilization on the protein, N, P, K, S, Ca and Mg contents in grain and straw of Boro rice (cv. BRRI dhan29).

Treat - ment	Protein content (%)	N content (%)		P content (%)		K content (%)		S content (%)		Ca content (%)		Mg content (%)	
	Grain	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_0	7.86 c	1.26 c	0.65 c	0.32 c	00.14 c	0.29 c	1.09 e	0.086 c	0.073 e	0.068 d	0.057 e	0.088 c	0.073 d
T_1	8.17 b	1.31 b	0.68 c	0.35 b	0.15 b	0.30 b	1.12 d	0.102 b	0.08 d	0.078 c	0.060 d	0.105 b	0.086 c
T_2	8.70 a	1.39 a	0.76 b	0.38 a	0.17 a	0.44 a	1.44 c	0.106 a	0.087 c	0.085 b	0.083 c	0.107 b	0.104 b
T_3	8.50 a	1.36 a	0.78 b	0.37 a	0.16 b	0.43 a	1.56 b	0.107 a	0.096 b	0.089 a	0.087 b	0.109 ab	0.106 b
T_4	8.23 b	1.32 b	0.83 a	0.35 b	0.15 c	0.42 a	1.80 a	0.108 a	0.107 a	0.090 a	0.089 a	0.113 a	0.109 a
SE (±)	0.117	0.018	0.016	0.004	0.003	0.006	0.014	0.001	0.001	0.001	0.007	0.002	0.001
CV (%)	2.4	2.0	3.1	1.4	2.3	2.3	1.4	1.9	1.9	2.4	1.3	3.1	1.9

Figures having common letter(s) in a column are not significantly different by **DMRT** at 5% level.
SE = Standard error means, CV = Co-efficient of variation

Effect of sulphur fertilization on the nutrient uptake by rice plant.

Nutrient uptake by rice has been calculated from the data of nutrient concentration and crop yield. Total uptake of a nutrient is the sum of grain and straw uptake of that nutrient.

Nitrogen uptake

There was a significant effect of the treatments on N uptake by Boro rice (Figure 1). The highest N uptake by both grain and straw was observed in the T_2 treatment and the lowest N uptake was noted in the control treatment (T_0).

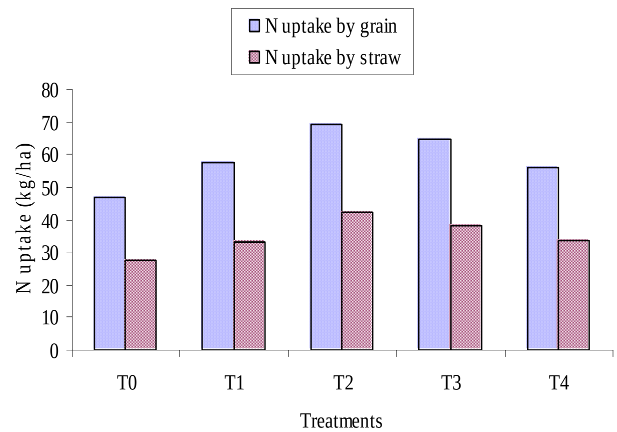

Fig.1. Effect of sulphur on nitrogen uptake by rice

Phosphorus uptake

P uptake by grain responded significantly owing to different rates of sulphur. The treatment T_2 showed the maximum (18.78 kg ha^{-1}) uptake of P and the treatment T_0 showed the minimum uptake (12.11kg ha^{-1}) of P by grain. In case of straw the maximum P uptake (9.19 kg ha^{-1}) was noted from treatmenT_2 and the lowest P uptake (5.87 kg ha^{-1}) from the control treatment (Figure 2).

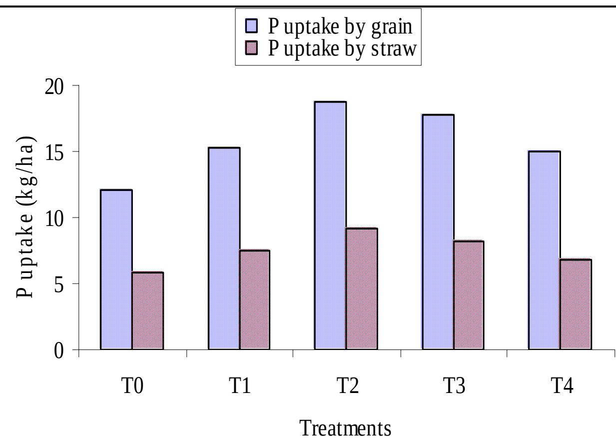

Fig. 2. Effect of sulphur on phosphorus uptake by rice

Potassium uptake

K uptake by grain ranged from 10.92 to 21.74 kg ha^{-1}. The highest K uptake was recorded in treatment T_2 and the lowest was in treatment T_0. The second highest K uptake (20.46 kg ha^{-1}) was observed from treatment T_3. In case of straw, highest K uptake was 84.56 kg ha^{-1} in treatment T_4 and the lowest 45.17 kg ha^{-1} in treatment T_0 application (Figure 3).

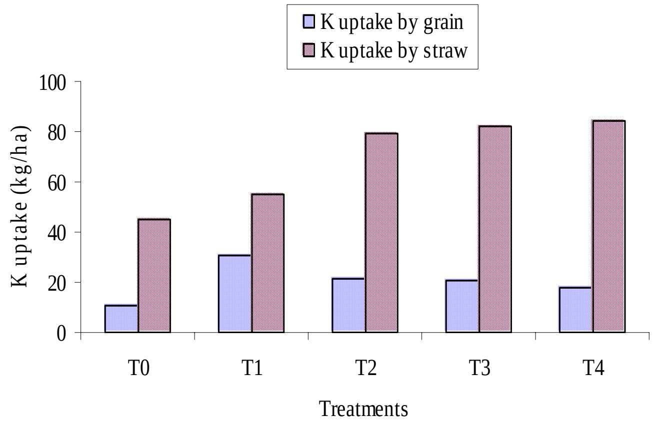

Fig. 3. Effect of sulphur on potassium uptake by rice

Sulphur uptake

The uptake of S by both grain and straw due to different treatments was significantly influenced. It appears from the Figure 4 that treatment T_3 recorded the highest S uptake by grain and straw and treatment T_0 (control) did the lowest. These results corroborates well with the findings of Islam *et al.*, (1997) and Poongothai *et a*l., (1999). They reported that application of S significantly increased S uptake by rice.

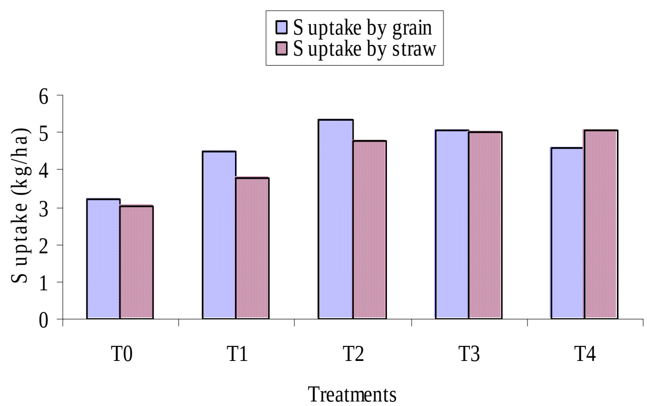

Fig.4. Effect of sulphur on sulphur uptake by rice

Sulphur balance in the Brahmaputra flood-plain soil

The sulphur uptake by the grain and straw due to different treatments are presented in the Table 3. The experimental soil was deficient in S. Thus the S uptake by plant varied due to different treatments and the S balance in the experimental soil are presented below. The S balance was positive where S was added as treatment combination. Negative S balance was recorded where no S was added (control).

Table 3. An apparent sulphur balance sheet for soil under Boro rice (BRRIdhan29)

Item		Treatment				
		T_0	T_1	T_2	T_3	T_4
Yield (t ha^{-1})	Grain	4.38	5.14	5.81	5.54	4.95
	Straw	5.43	6.32	7.38	6.95	6.21
S input (kg ha^{-1}) by fertilizer	Sulphur	0	10	20	40	60
Sulphur uptake (kg ha^{-1})	Grain	3.32	4.51	5.32	5.71	4.56
	Straw	3.01	3.79	4.77	5.03	5.04
Sulphur loss (kg ha^{-1})	S uptake (Grain + Straw)	6.33	8.30	10.09	10.74	9.60
Sulphur alance (kg ha^{-1})	S input - S uptake	- 6.33	+ 1.70	+ 9.91	+29.26	+50.40

REFERENCE

Alameen, M. 1989 Effect of sulphur and potassium on the growth yield and mineral contents in rice (T- Aman). M. Sc. Ag. thesis. Department of Agricultural chemistry, Bangladesh Agricultural University, Mymensingh: 69-76.

De Datta, S. K. 1981. Principles and Practices of Rice Production. A Wiley Inter. Science Publication. 348-419.

Hoque, M. S. and Eaqub, M. 1984. Study on zinc and sulphur deficiency in Bangladesh Soils. Annual Report. FAO(Food & Agriculture Org.) Project (1983-84).

Islam, A. J. M. A. 1978. Sulphur deficiency symptoms and corrective measures. In: Proc. S Nutrition in Rice: 20-28.

Islam, M. R., Risat, T. M. and Jahiruddin, M. 1997. Direct and resdual effects of S, Zn and B on yield, nutrient uptake in a rice-mustard cropping system J. Indian Soc. Soil Sci. 45 (1): 126-129.

Islam, R., Hossain, M. S. A., Howladar, A. S., Islam, A. R. and Haq, S.M.I. 1987. Effect of S on rice under flooded conduction. Int. J. Trop. Agric. 5 (2): 93-101.

Khan, H. R., Faiz, S. M.A., Islam, M. N., Adachi, T., and Ahmed, I. U. 1992. Effect of salinity, gypsum and Zn on mineral nutrition of rice. Int. J. Trop. Agric. 10(2): 147-156.

Mandata, S., Singh, R. P., Singh, B and Singh, M. 1994. Influence of S application of N. P and S content of plant and soil. Crop Res. Hisar. 7(1): 8-12.

Paliwat, A.K., Dikshit, P.R. and Rajput, R.P. 1992. Effect of nitrogen and sulphur on the nutrient content, yield and quality of rice. Agrochemica. 36(3): 205-211.

Sachdev,M. S.,Mittal, R. B. and Sachdev, P. 1983. Utilization of sulphur by rice grain, gypsum and its balance sheet in soil. Nuclear Agriculture and Biology. 6: 11-14.

Tiwari, K. N. Nigam, V. and Pathak, A. N. 1983 Evaluation of some soil test methods for diagnosing S deficiency in alluvial soils of Uttar Pradesh. J. Indian Soc. Soil Sci. 31: 245-249.