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COMPARISON OF TWO SOURCES OF SULFUR ON THE GROWTH AND YIELD OF RICE

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Two sources, namely, gypsum and ammonium sulfate were tested on the growth and yield of rice on a loamy soil (pH 6.9) in a net house. S from each source was found to increase significantly (p=0.05) the production of rice indicating the deficit of this nutrient in that soil. 40 kg S ha^{-1} as gypsum and ammonium sulfate caused an increase of about 129 % (9.30 g pot^{-1}) and 186 % (13.42 g pot^{-1}) in straw and 145 % (9.54 g pot^{-1}) and 188 % (12.36 g pot^{-1}) in grain over the control. Similar reflection was obtained at the highest dose of the S fertilizers so far yields of straw and grain are concerned. However, no significant difference was found between 40 and 80 kg S ha^{-1} as gypsum. The number of tillers $plant^{-1}$, panicle pot^{-1} and percent filled grain significantly increased with increasing amount of sulfur, irrespective of the sources of sulfur used. Best performances were observed at the higher dose of the fertilizer in most of the cases. The uptake of N, P, K, S and Ca in the rice plant was found to increase significantly with dose of S, irrespective of the sources and followed the similar trends of straw and grain yields of rice. The results suggest that the S fertilizer as ammonium sulfate, instead of gypsum, was more effective to promote the growth and yield of the crop.

Keywords: Ammonium sulfate; Gypsum; Nutrient uptake; Rice; Yield.

Introduction

Emergence in taking care of our valuable soils for crop production could be the main theme of the agriculturist at the present state of time. The unwise application of chemical fertilizers without testing the soils turns them permanently unproductive. The need of S in various cropping systems has translated into greater demand for S fertilizers. In recent years, deficiency of S has been more common in Bangladesh. This is attributed to i) intensive cropping systems and higher yielding varieties and hybrids that result in more S removal from the soil each year; ii) higher analysis fertilizers that contain little or no S; iii) less deposition from the atmosphere; and iv) declining levels of organic matter[1]. The SRDI, Bangladesh, staff has reported a markable deficiency in sulfur content in the agricultural land of the northern side of the country. It could be happen due to the continuous depletion of organic matter from the subsequent land and/ or getting silted with less amount of organic matter in their sedimentation materials. Accumulation of sulfur in the soils mainly depends on the extent of decomposition of organically bond sulfur compounds. In China, Shihua and Wenqiang[2] reported that high crop yield remove significant amount of S. They also added that most high-analysis fertilizes, which used to contain S, now no longer have any. Thus, S deficiency was more common in the middle and lower reach of the Yangtze river than it once was. Gypsum is the most common source of S fertilizer mainly applied in Bangladesh. However, review of literature showed that no such judicial application of S fertilizer is still being followed by the farmers. So, a pot experiment was designed to evaluate the efficiency of sulfur as gypsum and ammonium sulfate on growth and yield of high yielding variety of rice (IRRI-11).

Materials and Methods

The experimental soil was taken from Sonatola series under the upazila of Ghatail, district of Tangail. According to USDA Taxonomic classification, the soil belongs to inceptisols order and aquept suborder. The pH value[3] and organic matter[4] status of the soil were found to be 6.9 and 1.13%, respectively. The available N[3] and P[5] were 17 and 20.5 mg kg^{-1}, respectively. Exchangeable K, Ca and Mg[3] were 0.04, 0.35 and 0.30 c mol kg^{-1}, respectively. The available B[6] (hot water extract), exchangeable Mn[3] and available S[7] were recorded to be 0.2, 4.1 and 24 mg kg^{-1}, respectively.

Two kg of the soil (0-15 cm) was taken in each of the bottom sealed plastic pot. Soil in each pot was treated with a basal dose of N (100 kg N ha^{-1}) as urea, P (90 kg P ha^{-1}) as TSP and K (80 kg K ha^{-1}) as MP fertilizers. N was given in potted soil in three equal splits.

Five doses of S (0, 10, 20, 40 & 80 kg S ha^{-1}) from two sources such as gypsum ($CaSO_4.2H_2O$) and ammonium sulfate {$(NH_4)_2SO_4$} were applied. The amounts of sulfur were uniformly mixed with the soil in the form of water solution. All the treated pots were kept in the net house following a randomized block design with three replications. Necessary cultural practices were done as and when required. Two hills comprising three uniform healthy seedlings were allowed to grow in each pot up to maturity.

Plant height was recorded after 15 days of interval from the date of transplantation of rice seedlings up to 90 days. Tillers were recorded at the maturity stage of the plant. Grains and shoots were harvested carefully and weights were estimated.

Plant samples were digested with H_2SO_4 and N, P, K, and Ca contents were determined by Kjeldahl distillation, colorimetrically, flame photometrically and atomic absorption spectrophotometricaly[8]. Plant samples were digested separately with HNO_3 and $HClO_4$ mixture[3] and S content was determined turbiditically[7]. Least significant difference (LSD) of the treatments and correlation co-efficient between uptake of nutrients and yield of grain were calculated by standard methods.

Results and Discussion

Height and tiller number : The data measured regarding the plant height and tiller number have been presented in Table 1. The results revealed that the height of the rice plants showed a notable increase with growing period provided with gypsum and ammonium sulfate up to the maturity of the plant. However, the increase was very limited at the later phase of the growth. The plants significantly showed an increase in height with increasing amount of the fertilizer in most of the samplings irrespective of the S sources (Table 1). The maximum height of the plants were recorded at 40 kg S ha^{-1} (51 cm) followed by 20 kg S ha^{-1} (44 cm) in the pots treated with gypsum. However, maximal height was obtained at 80 kg S ha^{-1} (59 cm) followed by 40 kg S ha^{-1} (54 cm) at 90 DAT when S was added as ammonium sulfate.

In case of tiller productions, the similar trend was observed as in the case of height of the rice plants (Table 1). The highest number of tiller plant^{-1} (2.33 tiller plant^{-1}) was recorded at 40 kg S ha^{-1} from gypsum. 80 kg S ha^{-1} from ammonium sulfate produced 2.83 tiller plant^{-1} at the maximum (Table 1). On the other hand, added calcium along with 40 kg S ha^{-1} from gypsum showed the optimum increment in the growth and tiller number of rice. However, further addition of Ca with the 80 kg S ha^{-1} as gypsum decreased the growth and tiller production. Similar nature of decreasing tendency at higher dose of gypsum over mustard growth, siliqua plant^{-1} and number of seed plant^{-1} was reported by Singh and Bairathi[9] in the calcarious soils. Results significantly showed that a general increase in number of panicles plant^{-1} with increasing level of the added fertilizer from both the sources. Lower doses of the fertilizer showed a decrease in percent filled grains when compared with the control, though not significantly. However, the effect was overcome at the higher level of the fertilizers.

Panicles and percent filled grains: The highest number of panicles pot^{-1} and percentage of filled grain were measured in the treatment of ammonium sulfate receiving 80 kg S ha^{-1} (1) panicles plant^{-1} and 78%) followed by 40 kg S ha^{-1} form gypsum (11 panicles plant^{-1} and 71%). However, due to 40 kg S ha^{-1} as gypsum, straw and grain yields were recorded as 129 and 145 %; and for 80 kg S ha^{-1} as ammonium sulfate, the yields were 236 and 214%, respectively over the control. Comparison of the highest yields of straw and grain, ammonium sulfate caused 183 and 147% more production than those of gypsum.

Yield of straw and grain: The results presented in Table 2 showed that the yield of straw and grain of rice were significantly ($p=0.05$) increased with both the added S fertilizers and their effects were found to be similar to the trends for height and tiller production of the crop. Straw and grain yield increased significantly with the increasing rate of S up to 40 and 80 kg ha^{-1} as gypsum and ammonium sulfate, respectively. The highest straw and grain yield of 9.33 and 9.62 g pot^{-1} were recorded at 80 kg S ha^{-1} from gypsum. However, these highest yields were very close to those obtained at 40 kg S ha^{-1} and the differences were found to be statistically insignificant. The results of the present investigation is in good agreement with the findings of Anwar *et al.*[10] who conducted an experiment on the calcareous brown flood plain soils of Jessore. They reported that the grain yield of mustard was significantly higher and was the best at 30 kg S ha^{-1}, after which the declining tendency was recorded. Ismunadji[11] also observed that the yield and yield components of low land rice increased significantly due to application of 40 kg S ha^{-1}. The highest yield of straw (16.98 g pot^{-1}) and grain (14.02 g pot^{-1}) of rice was recorded at 80 kg S ha^{-1} from ammonium sulfate. The results are in well accordance with the report of Soepardi *et al.*[12], who showed that rice yield increased by increasing rate of sulfur application up to 72 kg S ha^{-1} in Palermo, South Sulawesi, Indonesia.

Nutrient uptake (N, P, K, S and Ca) : The uptakes of N, P,K, S and Ca of the rice plant have been determined

Table 1. Influence of two sources of sulfur on the height and tiller number of rice plant.

Source of S	Treatments kg S ha^{-1}	Plant height (cm) Days						Tiller $plant^{-1}$
		15	30	45	60	75	90	
Gypsum	0	14	22	31	40	46	47	1.83
	10	13	16	27	40	42	43	2.17
	20	14	16	29	41	42	44	1.70
	40	16	20	29	47	49	51	2.33
	80	15	21	31	44	50	50	1.89
LSD at 5% level		1.6	NS	NS	4.4	4.2	4.0	0.22
Ammonium Sulfate	10	15	20	29	43	46	47	2.00
	20	14	19	30	47	49	51	2.17
	40	16	18	31	46	50	54	2.33
	80	15	18	33	48	50	59	2.83
LSD at 5% level		NS	NS	3.0	4.0	4.0	4.2	0.29

Table 2. Influence of two sources of sulfur on the yield and yield components of rice plant.

Source of S	Treatments kg S ha^{-1}	Panicle pot^{-1} Nos.	Wt. of straw g pot^{-1}	Wt. of grain g pot^{-1}	Filled grain %
Gypsum	0	9	7.20	6.56	64
	10	10	5.61	4.69	50
	20	9	7.72	5.38	53
	40	11	9.30	9.54	71
	80	12	9.33	9.62	69
LSD at 5% level		0.98	1.10	1.35	7
Ammonium Sulfate	10	10	10.76	10.33	71
	20	11	11.01	11.62	68
	40	10	13.42	12.36	69
	80	17	16.98	14.02	78
LSD at 5% level		1.10	1.72	1.36	7

Table 3. Influence of two sources of sulfur on the nutrient uptake by rice plants.

Source of S	Treatments kg S ha^{-1}	Nutrient uptake (mg pot^{-1})				
		N	P	K	Ca	S
	0	110	7	43	36	17
	10	140	10	72	56	23
Gypsum	20	159	17	122	63	26
	40	200	26	187	102	30
	80	139	26	187	98	26
LSD at 5% level		21.2	2.4	19.4	7.8	1.6
r value		0.41	0.93	0.93	0.99	0.50
	10	211	30	216	93	19
	20	239	32	229	98	21
Ammonium Sulfate	40	308	43	306	132	28
	80	351	58	414	178	33
LSD at 5% level.		29.5	6.0	42.5	18.4	3.2
r value		0.96	0.96	0.96	0.96	0.87

and the results thus obtained are presented in Table 3. Results showed that the uptake of these nutrients by rice plant increased significantly with amount of S added, irrespective of the sources applied. Best performances was observed when 40 and 80 kg S ha^{-1} as gypsum and ammonium sulfate were added, respectively, so far N,P,K,S and Ca accumulation was concerned. Application of 80 kg S ha^{-1} as gypsum was found to be ineffective to promote the uptake of P and K by the plants and was found to be statistically identical with 40 kg S ha^{-1} (Table 3).

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