Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal for Plant Sciences 3 (5): 597-601, 2004
ISSN 1682-3974

Interaction Effects of Sulphur and Phosphorus on Wetland Rice

[1]M.M. Ali, [2]M.S. Mian, [3]A. Islam, [2]J.A. Begum and [4]A.K.M. Ferdous
[1]Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
[2]Plant Pathology Division, Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh
[3]Soil Science Division, Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh
[4]Agricultural Advisory Society, Sreemongal, Sylhet, Bangladesh

Abstract: An experiment was conducted in the old Brahmaputra Floodplain soil at Bangladesh Agricultural University (BAU) farm with a view to studying the interaction effects of S and P on growth and yield of BRRI dhan29 rice variety. Ten fertilizer treatment combinations such as S_0P_0, S_0P_{35}, $S_{10}P_0$, $S_{10}P_{35}$, $S_{20}P_0$, $S_{20}P_{35}$, $S_{30}P_0$, $S_{30}P_{35}$, $S_{40}P_0$and $S_{40}P_{35}$ were tested. Sulphur was applied @ 0, 10, 20, 30 and 40 kg ha^{-1}, while phosphorus application rates were 0 and 35 kg ha^{-1}. The experiment was set up in a randomized complete block design with four replications. It was observed that the dry matter yield of rice plant at maximum tillering stage, grain and straw yields were significantly increased due to combined application of S and P ($S_{40}P_{35}$). This combination increased 20% higher dry matter, 61.1% higher grain yield and 65.1% higher straw yield than the control plot (S_0P_0). Nutrient concentrations and uptake by rice plants also increased with the treatment combination of $S_{40}P_{35}$. So this treatment combination was found suitable for growth and yield of BRRI dhan29 rice variety.

Key words: Interaction, sulphur, phosphorus, rice

INTRODUCTION

Sulphur (S) is a constituent of essential amino acids (cystein, methionineand cystine) involved in chlorophyll production and is thus required for protein synthesis and plant functions and structure. The effect of S deficiency on yield is more pronounced during vegetative growth e.g. reduced plant height and stunted growth, reduced number of tillers, fewer and shorter panicles, reduced number of spikelets per panicle etc[1]. Evidence showed that rice soils of Bangladesh are becoming deficient in S day by day[2,3]. Use of high analysis S-free fertilizers such as urea, triple super phosphate, muriate of potash and flooding of land causing S in reduced condition for a considerable period of time result in decreased available S in soil for crops. In addition to above-mentioned causes, the problem of S deficiency is further aggravated where phosphate fertilizer is used abundantly. Phosphorus being a stronger anion and with relative abundance compared to S, dislodges SO_4^{2-} from the exchange sites in soils and finally making sulphate available and labile to leaching loss along with percolated water.

Phosphorus is the second major element also widely deficient in Bangladesh soils. Two principal reason accounts for this. It is low supply in minerals comprising the parent materials of many soils and it is inclined to form compounds of very low solubility with other common ionic soil components. Since in many soils much of the available P is derived through the mineralization of organic matter, the repeated addition of P fertilizer appears to be the only satisfactory way of supplying plant needs for this very important nutrient. Phosphorus is intimately associated with all life processes and thus it is a vital constituent of every living cell. This element tends to be concentrated in the seed and stimulates early root formation and growth of the plant.

Balanced fertilization is a pre-requisite for obtaining optimum potentiality of high yield of rice. So to increase the production of rice, it is essential to find out optimum combination of S and P along with other nutrients. BRRI dhan29 is a new high yielding variety of rice grown in Boro season of the country. It is felt necessary to evaluate S and P requirement of this variety to asses its optimum growth and achievable yield potential under the agro-climatic condition on Non-Calcareous Dark Grey Floodplain soil of BAU farm. With the above views and objectives in mind, the present experiment was carried out at the BAU farm to investigate the interaction effects of S and P on growth and yield of BRRI dhan29, new high yielding variety of rice in Boro season.

Corresponding Author: Md. Salim Mian, Plant Pathology Division Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh E-mail: salimspml@yahoo.com

MATERIALS AND METHODS

The experiment was carried out during Boro season (dry season) in a typical rice growing soil of Bangladesh, located in the BAU farm at Mymensingh nearly 1 km away from the west of the Brahmaputra river. The soil type of the farm belongs to the Non-Calcareous Dark Grey Floodplain under Sonatola soil series. The reaction of the soil was around neutral (pH 6.8). The soil was silt loam in texture with total N 0.10%, available P 15.60 ppm, exchangeable K 0.21 me 100^{-1} g soil and available S 11.5 ppm. An analysis of the soil was done following some standard laboratory procedure. A modern rice variety BRRI dhan29 was selected as the test crop. The treatment consisted of 5 levels of S (0, 10, 20, 30 and 40 kg ha^{-1}) and two levels of P (0 and 35 kg ha^{-1}). There were 10 fertilizer treatment combinations as S_0P_0, S_0P_{35}, $S_{10}P_0$, $S_{10}P_{35}$, $S_{20}P_0$, $S_{20}P_{35}$, $S_{30}P_0$, $S_{30}P_{35}$, $S_{40}P_0$, and $S_{40}P_{35}$

Nitrogen and potassium fertilizers were applied as blanket dose one day prior to transplanting in all experimental plots @ 100 kg Nha^{-1} and 50 kg Kha^{-1} respectively. Urea, TSP, MP and Gypsum were used as the sources of N, P, K and S, respectively. The experiment was laid out in a Randomized Complete Block design with 4 replications of each treatment having unit plot size 10 m^2 (4 X 2.5 m). Nitrogen was applied in three equal splits, before transplanting at final land preparation, at active tillering stage at 30 days after transplanting and at the pre-booting stage. Forty-day old seedlings of BRRI dhan29 were transplanted maintaining a spacing of 20x20 cm. Necessary intercultural operations was done as and when required during growth period of crop.

Ten random hills were harvested from each plot at active tittering stage and dry matter yield was recorded after oven drying at 60-70°C for 72 h. Rice plants were harvested at maturity for grain and straw yield. Grain yield was recorded at 14% moisture content while straw yield was recorded as oven dry basis. The data was analyzed as per standard statistical procedures.

RESULTS AND DISCUSSION

Dry mater yield of rice plant at maximum tillering stage: The single effect of S on dry matter yield of rice plants at the maximum tillering stage was significant (Table 1). The increases in dry matter yield of rice plant over control were 18.31, 14.87, 9.09 and 4.95% under the treatments S_{40}, S_{30}, S_{20} and S_{10}, respectively. The highest dry matter yield (3436 kg ha^{-1}) was obtained with S_{40} treatment, which significantly differed from the rest of treatments. The single effect of P on dry matter yield of rice plant was also significant (Table 1), although the yield increase over the control was not very much. Padihar and Dikdshit[4] reported that the dry matter yield at the maximum tillering stage increased with increasing level of P application. The interaction effect of S and P on dry matter yield of rice plant was not significant (Table 1). The combined effect of S and P increased the dry matter yield of rice plant over control (Table 2). The highest yield (3456 kg ha^{-1}) of dry matter was found in $S_{40}P_{35}$ treatment which was statistically similar to $S_{40}P_0$, $S_{30}P_{35}$ treatments. The lowest dry matter yield (2880 kg ha^{-1}) was obtained in control treatment.

Table 1: Single effect of S and P on dry matter yield of rice plant at the maximum tillering stage

Treatments	Average yield (kg ha^{-1})	Increased over control (kg ha^{-1})	Increased over control (%)
S_0	2904c	-	-
S_{10}	3048d	144.0	4.95
S_{20}	3168c	264.0	9.09
S_{30}	3336b	432.0	14.87
S_{40}	3436a	532.0	18.31
Level of significance	**		
P_0	3150.6b	-	-
P_{35}	3206.4a	55.8	1.77
Level of significance	**		
S X P	NS		

** = 1% level of significance; NS = Not significant; Figures in a column with same letter (s) do not differ significantly.

Table 2: Interaction effect of S and P on dry matter yield of rice plant at the maximum tillering stage

Treatments	Dry matter yield of rice plant: Average yield (kg ha^{-1})	Increase over control (kg ha^{-1})	Increase over control (%)
S_0P_0	2880d	-	-
S_0P_{35}	2928cd	48	01.66
$S_{10}P_0$	3024c	144	05.00
$S_{10}P_{35}$	3072c	92	06.66
$S_{20}P_0$	3120c	240	08.33
$S_{20}P_{35}$	3216b	336	11.66
$S_{30}P_0$	3312b	432	15.0
$S_{30}P_{35}$	3360ab	480	16.66
$S_{40}P_0$	3417a	537	18.64
$S_{40}P_{35}$	3456a	576	20.00
Level of significance	**		
CV (%)	1.38		

** = 1% level of significance; Figures in a column with same letter (s) do not differ significantly.

Nutrient content and uptake by rice plant at maximum tillering stage: Nutrient content and uptake by rice plant are summarized in the Table 3 and 4. Results in Table 3 indicate that the single effect of different level of S on nutrient content and uptake by rice plant was statistically significant except P content. The highest N content (2.84%) was observed in S_{40} treatment, which was statistically similar to S_{30}, S_{20} and S_{10} treatments. Similar result was reported by Chowdhury[5]. The highest S content (0.215%) was observed in S_{40} treatment, which

Table 3: Single effect of S and P on nutrient content and uptake by rice plant at the maximum tillering stage

	Nutrient content (%)				Nutrient uptake (kg ha^{-1})			
Treatment	N	S	P	K	N	S	P	K
S_0	1.90b	0.106c	0.170	1.15d	22.97c	1.26d	2.069c	13.93e
S_{10}	2.60a	0.141bc	0.245	1.49c	31.80b	1.77c	3.000a	18.25d
S_{20}	2.50a	0.150b	0.230	1.72bc	32.01b	1.84c	3.200a	21.29c
S_{30}	2.61a	0.185ab	0.235	1.88ab	32.80ab	2.31b	2.940b	24.84b
S_{40}	2.84a	0.215a	0.245	2.15a	37.22a	2.81a	3.570a	28.11a
Level of significance	**	**	NS	**	**	**	**	**
P_0	1.70	0.153	0.208	1.68	30.78	1.95	2.69	20.87
P_{35}	2.03	0.162	0.244	1.67	31.94	2.04	3.11	21.70
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS
S X P	NS	NS	NS	NS	NS	NS	**	NS

** = 1% level of significance; NS = Not significant; Figures in a column with same letter (s) do not differ significantly.

Table 4: Combined effect of S and P on nutrient content and uptake by rice plant at the maximum tillering stage

	Nutrient content (%)				Nutrient uptake (kg ha^{-1})			
Treatment	N	S	P	K	N	S	P	K
S_0P_0	1.78b	0.11ef	0.13bc	1.20ef	21.36d	1.38ef	1.56c	14.40ef
S_0P_{35}	2.01b	0.10f	0.21ab	1.10f	24.50d	1.31f	2.56b	13.41f
$S_{10}P_0$	2.65a	0.13de	0.24a	1.40def	31.80c	1.69def	2.88ab	16.06def
$S_{10}P_{35}$	2.55a	0.15bc	0.25a	1.58c-f	31.82c	1.87cde	2.86ab	19.71c-f
$S_{20}P_0$	2.58a	0.16bc	0.21a	1.80a-d	31.57c	1.95cd	2.84b	22.46bcd
$S_{20}P_{35}$	2.60a	0.14cd	0.25ab	1.64b-e	32.44bc	1.74c-f	3.30a	20.46cde
$S_{30}P_0$	2.68a	0.17b	0.23ab	1.91abc	33.44bc	2.12bc	2.87ab	23.83abc
$S_{30}P_{35}$	2.55a	0.20a	0.24ab	1.85a-d	32.06c	2.51ab	3.01ab	23.26abc
$S_{40}P_0$	2.60a	0.21a	0.22b	2.10ab	38.69ab	2.72a	3.30a	27.21ab
$S_{40}P_{35}$	2.96a	0.22a	0.27a	2.20a	39.07a	2.90a	3.85ab	29.04a
Level of significance	**	**	**	**	**	**	**	**
CV (%)	9.98	12.34	11.7	13.97	8.91	12.52	10.73	14.13

**= 1% level of significance; Figures in a column with same letter (s) do not differ significantly.

Table 5: Single effect of S and P on grain and straw yields of BRRI dhan29

	Average grain yield		Increase over control		Average straw yield		Increase over control	
Treatment	(kg ha^{-1})		kg ha^{-1}	%	(kg ha^{-1})		kg ha^{-1}	%
S_0	3124c		-	-	4024.5e		-	--
S_{10}	3435b		331	9.95	4498.0d		473.5	11.76
S_{20}	3831b		707	22.63	5091.0c		1066.5	26.50
S_{30}	4010b		886	28.36	5426.0b		1401.5	34.82
S_{40}	4660a		1536	49.16	6130.0a		2105.5	52.30
Level of significance		**				**		
P_0	3717.4		-	-	4889.2b		-	-
P_{35}	3906.6		189.2	5.08	51786a		289.4	5.91
Level of significance		**				**		
S X P		NS				*		

** = 1% level of significance; * = 5% level of significance; NS = Not significant; Figures in a column with same letter (s) do not differ significantly.

Table 6: Combined effect of S and P on nutrient content and uptake by rice plant at the maximum tillering stage

	Average grain yield		Increase over control		Average straw yield		Increase over control	
Treatment	(kg ha^{-1})		kg ha^{-1}	%	(kg ha^{-1})		kg ha^{-1}	%
S_0P_0	2995g		-	-	3840I		-	-
S_0P_{35}	3253f		258	8.61	4209h		369	9.60
$S_{10}P_0$	3390ef		395	13.18	4407g		567	14.76
$S_{10}P_{35}$	3480e		485	16.17	4589f		479	19.50
$S_{20}P_0$	3772d		777	25.94	4970e		1130	29.42
$S_{20}P_{35}$	3890cd		895	29.88	5212d		1372	35.72
$S_{30}P_0$	3935cd		940	31.38	5309d		1469	38.25
$S_{30}P_{35}$	4085c		1090	36.39	5543c		1703	44.34
$S_{40}P_0$	4495b		150	50.00	5920b		2080	54.16
$S_{40}P_{35}$	4825a		1830	61.10	6340a		2500	65.10
Level of significance		**				**		
CV (%)		2.90				1.45		

** = 1% level of significance; Figures in a column with same letter (s) do not differ significantly.

was followed by 0.185% in S_{30} treatment. Tewari *et al.*[6] reported that application of S increased the S content in lamina, shoot of rice plant. Incase of K content S_{40} treatment showed highest concentration of K (2.15%) followed by S_{30} (1.88%).

It was observed that N uptake by rice plant increased with increasing levels of sulphur and the highest N uptake was observed in S_{40} treatments (37.22 kg ha^{-1}), which was statistically similar to S_{30} treatment. The highest S uptake (2.81 kg ha^{-1}) was found in S_{40} treatment, which differed significantly from other treatments. Sachdev *et al.*[7] reported that application of S as gypsum increased S uptake by rice plant. Although the effect of S application on P content of rice plant was not significant but incase of P uptake the effect was significant and the highest P uptake (3.57 kg ha^{-1}) was obtained from S_{40} treatment, which was statistically similar to S_{20} and S_{10} treatments. The K uptake by rice plant was increased significantly with the increasing levels of applied S. The highest K uptake (28.11) kg ha^{-1}) was obtained in S_{40} treatment, which was statistically differed from all other treatments. The single effect of different levels of P on nutrient content and uptake by rice plant was not significant. Similarly, the interaction effect was not significant except P uptake (Table 3).

The combined effect of S and P found significant on both nutrient content and uptake by rice plant (Table 4). The highest N content (2.96%) and N uptake (39.07 kg ha^{-1}) was observed in $S_{40}P_{35}$ treatment. The N content was statistically similar with all other treatments except S_0P_{35} and the control treatment (Table 4). Incase of N uptake $S_{40}P_{35}$ and $S_{40}P_0$ treatments were statistically similar. The highest amount of S content (0.22%) and uptake (2.90 kg ha^{-1}) by rice plant was observed in $S_{40}P_{35}$ treatment. The S content and uptake was statistically similar in $S_{40}P_{35}$, $S_{40}P_0$ and $S_{30}P_{35}$ treatments. The highest P content (0.27%) was observed in $S_{40}P_{35}$ treatment, which was statistically similar to all other treatments except $S_{40}P_0$ and control treatments. The highest P uptake (3.85 kg ha^{-1}) was observed in $S_{40}P_{35}$ treatment, which was statistically similar to all other treatments except $S_{20}P_0$, S_0P_{35} and control treatments. The highest K content (2.20%) was observed in $S_{40}P_{35}$ treatment followed by $S_{40}P_0$, $S_{30}P_0$, $S_{30}P_{35}$ and $S_{20}P_0$ treatments. The highest K uptake (29.04 kg ha^{-1}) was found in $S_{40}P_{35}$ treatment and statistically similar results were observed in $S_{40}P_0$, $S_{30}P_{35}$ and $S_{30}P_0$ treatments (Table 4).

Grain yield: The grain yield was significantly influenced due to application of S and P fertilizers. The single effect of S on grain yield was significant and the highest grain yield (4660 kg ha^{-1}) was obtained with S_{40} treatment (Table 5). Increase in grain yield due to S application was reported by Nair and Gupta[8]. The single effect of P on grain yield was also significant (Table 5). Grain yield obtained 3906.0 kg ha^{-1} and 3717.4 kg ha^{-1} under the treatment P_{35} and P_0 respectively. The interaction effect of S and P on grain yield was not significant (Table 5) but the combined effect of S and P was significant (Table 6). The highest grain yield of 4825 kg ha^{-1} (61.1% increased over control) was recorded in $S_{40}P_{35}$ combined treatment, which was statistically different from all other treatments (Table 6).

Straw yield: The single effect of different levels of S on straw yield was significant (Table 5). The highest straw yield of 6130 kg ha^{-1} (52.3% increased over control) was recorded in S_{40} treatment. The single effect of P on straw yield was found significant (Table 5). The straw yield was recorded 5178.6 kg ha^{-1} and 4889.2 kg ha^{-1} under the P_{35} and P_0 treatment respectively. The straw yield increased due to P application was also reported by Mahajan *et al.*[9]. The interaction effect of S and P on straw yield was found significant (Table 5). The combined treatment effect of S and P on straw yield was also found significant (Table 6). The straw yield increased gradually over the control treatment. The highest straw yield of 6340 kg ha^{-1} (65.1% increased over control) was found in $S_{40}P_{35}$ treatment.

The overall results indicate that the application of S and P @ 40 kg ha^{-1} and 35 kg ha^{-1}, respectively can ensure good growth and reasonably high yield of BRRI dhan29 under the Brahmaputra Floodplain soil condition.

REFERENCES

1. Dobermann, A. and T.H. Frairhurst, 2000. Rice: Nutrient Disorders and Nutrient Management. 1st Edn. PPI, PPIC and IRRI.
2. Hussain, S.G., 1990. Sulphur in Bangladesh Agriculture. Sulphur in Agri., 14: 25-28.
3. Mazid, S.A., 1986. The Response of Major Crops to Sulphur in Soils of Bangladesh-An overview. Proc. International symposium on sulphur in agricultural soils. Bangladesh Agricultural Research Council. Dhaka, Bangladesh., pp: 18-45.
4. Padihar, S.K. and P.R. Dikshit, 1985. Nutrient composition and yield of rice at different levels of phosphorus and moisture. Oryza, India, 22: 17-22.
5. Chowdhury, A.R., 1996. Efficiency of different doses of pesticides along with NPK fertilizer on the growth, yield and mineral composition of two varieties of transplanted Aman rice at two stages of growth. MS Thesis, Chem. BAU, Mymensingh, Bangladesh.

6. Tewari, K.N., V. Nigam and A.N. Pathak, 1983. Effect of sulphur fertilization on yield response and sulphur and nitrogen composition of rice grown in the soils of Kanpur district. Indian J. Agril. Sci., 53: 812-819.
7. Sachdev, M.S., R.B. Mittal and P. Sachdev, 1983. Utilization of sulphur by rice from gypsum and its balance sheet in soil using S-35. Nuclear Agric. Biol., 6: 11-14.
8. Nair, M.G. and P.C. Gupta, 1981. Effect of sulphur on the yield, chlorophyll and nutrient content of rice in alkaline calcareous soils. Oryza, 18: 217-219.
9. Mahajan, J.P., R.P. Singh and A.K. Dwivedi, 1994. Utilization of fertilizer phosphorus by some rice varietie as influenced by phosphorus fertilization in black soil. J. Nuclear Agric. Bio., 23: 242-245.