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Effect of Sulphur Sources on pH, EC and Sodium Chloride Extractable Sulphur Content of *Goradu* Soil

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ABSTRACT

An incubation study was conducted for two months to determine changes in S availability due to application of 12, 24 and 36 kg/ha S through SNPK, K_2SO_4 and elemental-S in presence (30 kg/ha) and absence of lime application. Sodium chloride-extractable S increased with the advancement in period of incubation. Loamy sand rendered 12.4 per cent of its native S available merely by maintaining soil moisture at the field capacity. Amongst different S sources the percentages of mineralization of applied S were 92, 49 and 42 from K_2SO_4, SNPK and raw sulphur, respectively. The percentage of available S decreased with the increased rate of application. Lime application showed an overall improvement in the rate of oxidation (Key words: Sulphur availability; Sodium chloride-extractable S; Heat-soluble S; Sulphur sources.

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INTRODUCTION

Various forms of sulphur present in soil or supplemented through fertilizers undergo biochemical transformations and change to sulphate ion prior to its absorption by plant roots. With the introduction of high yielding varieties and heavy usage of S-free fertilizers, the available S content of the soil has been reduced considerably under intensive cropping (Anonymous, 1978-79). Sulphur status in the soil could be adequately maintained by liberal use of S-bearing fertilizers. The efficacy of different sources of S could be adjudged by studying the rate of mineralization of applied S.

MATERIALS AND METHODS

A soil incubation study was conducted for two months, with a view to know the changes in soil reaction, accumulation of salts and available S content of non-calcareous loamy sand of Anand, which had initial soil pH-7.4, EC-0.15 mmhos/cm and NaCl-extractable S17.0 ppm.

One kg soil was taken in a glass jar having 15 cm height and 10 cm internal diameter. The basal dose of N, P_2O_5 and K_2O applied at tne rate of 120, 60 and 120 kg/ha respectively in the form of solutions of urea, DAP and muriate of potash after taking into account the incidental additions of fertilizer ingredients through different sources was intimately mixed with soil. Twenty treatment combinations were tried comprising of three sources of S viz., SNPK (a new product from GSFC with percentage content of SO_4-17, N-18, P_2O_5-27 and K_2O-9) (F_1), K_2SO_4 (F_2), and elemental-S (F_3) all in amorphous forms; three levels of S application viz., 12 (S_1), 24 (S_2) and 36 kg/ha (S_3) in

presence (30 kg/ha $CaCO_3$) and absence of lime application along with two controls—without S application under both the stated series of lime. Each of the treatments was replicated twice. Moisture was maintained at 50 per cent of field capacity throughout the period of incubation. The jars were incubated at room temperature and soil samples were withdrawn periodically after 4(I_1), 15(I_2), 22(I_3), 30(I_4), 45(I_5) and 60(I_6) days of incubation. Soil samples were analysed for pH and EC (1 : 2.5) and NaCl extractable S (Chesnin and Yien, 1950), after the extraction of soil as proposed by Williams and Steinbergs (1959).

RESULTS AND DISCUSSION

Soil pH : In general, soil pH showed a decreasing tendency with advancement in time (Table 1). Obviously due to oxidation of applied S significant reduction of 0.1 unit was noted at I_2, I_4 and I_5 stages (Table 1). In contrast,

TABLE 1

Soil pH and EC (mmhos/cm) as influenced by period of incubation (I), sulphur sources (F), levels (S) and lime application (L).

Soil pH

I_1	I_2	I_3	I_4	I_5	I_6			L_0	L_1
7.7	7.5	7.6	7.5	7.4	7.5			7.2	7.9
F_0	F_1	F_2	F_3	S_0	S_1	S_2	S_3		
7.5	7.5	7.5	7.6	7.5	7.5	7.6	7.6		
			I	F	S		L		
S.Em. ±			0.027	0.014	0.014		0.011		
C.D. @ 5%			0.081	N.S.	N.S.		0.035		
			(0.1)*				(0.1)*		

*C.D. is rounded up.

Soil EC:

I_1	I_2	I_3	I_4	I_5	I_6			L_0	L_1
0.22	0.37	0.38	0.42	0.39	0.43			0.35	0.38
F_0	F_1	F_2	F_3	S_0	S_1	S_2	S_3		
0.34	0.37	0.38	0.36	0.34	0.37	0.37	0.38		
			I	F	S		L		
S.Em. ±			0.012	0.010	0.010		0.007		
C.D. @ 5%			0.03	N.S.	N.S.		0.02		

the effect of lime application was relatively more pronounced, which raised the soil pH from 7.2 to 7.9. Different sources and their levels did not alter the soil reaction significantly.

Electrical conductivity : Generally, the conductivity of soil increased significantly with the progress in period of incubation. As expected, application of lime as well as S resulted in higher accumulation of salts and thereby higher conductivity was noted. At the final stage of incubation, the concentration of salts was nearly double than that of the initial stage. While studying the profile characteristics, Aulakh and Dev (1976) have

reported that conductivity of a soil increased with increasing amount of $CaCO_3$ as well as higher accumulation of S-bearing salts on account of S-fertilization.

Sulphur availability: While carrying out S-fractionation for the soils of Kheda and Vadodara districts, Reddy and Mehta (1970) obtained the highest correlaion coefficient between heat-soluble S fraction and uptake of S by alfalfa and they have also stated that it provided satisfactory index of S availability in soils. Therefore, in order to assess available S content of soil, the heat-soluble S fraction (sometimes referred as NaCl-extractable S) was determined periodically in the present study. After slight depression initially under control, NaCl-extractable S increased significantly with time lag (Table 2). It is interesting to note that even when S

TABLE 2

Sodium chloride extractable-S (ppm) as influenced by period of incubation (I), sulphur sources (F), levels (S) and lime application (L).

	I_1	I_2	I_3	I_4	I_5	I_6	L_0	L_1
Control:	17.2	16.9	16.6	18.7	18.6	19.1		
Treated:	21.9	24.3	27.3	29.5	30.9	32.3	27.3	28.1
	F_0	F_1	F_2	F_3	S_0	S_1	S_2	S_3
	17.9	26.6	34.4	25.4	17.9	25.1	28.5	32.8
			I	F	S	L		
S. Em.±			0.60	0.42	0.42	0.23		
C.D. @ 5%			1.7	1.2	1.2	0.7		

was not supplemented the loamy sand was capable of rendering 12.4 per cent of its native S available in the period of two months by merely maintaining the soil-moisture at field capacity i.e. 50 per cent of the maximum water holding capacity. In general, availability of S was enhanced on account of S application with the advancement in period of incubation. During first 15 days (I_2) of incubation the percentage increased over initial status was nearly 43, which increased to 74 in next 15 days (I_4), and finally on the 60 th day of incubation the overall increase was to the extent of 90. Such increases were also recorded by Dhillon and Dev (1976), while studying the change in availability of S from $(NH_4)_2SO_4$, $CaSO_4.2H_2O$, and elemental-S.

Overall percentage improvement in S availabiltiy due to application of SNPK, K_2SO_4 and elemental-S was about 49, 92 and 42, respectively. The variation in the quantity of S rendered available from different S-sources could be attributed to thein differential solubilities in soil, which had ultimately affected the rate of mineralization.

As elemental-S has to undergo oxidation through microbial transformation prior to its availability, it requires relatively longer time, and consequently the available content was least in this case. Between K_2SO_4 and SNPK sources, the former containing larger proportion of soluble products yielded greater amount of SO_4-S ions in comparison to the latter. Results are in agreement with those of Vishniar and Santer (1957).

Among the levels of S application, obviously the higher rate of application yielded higher amount of available S.

The corresponding percentage increases over S_0 due to S_1, S_2 and S_3 levels of application were 40, 59 and 83, respectively. From incubation study, Dhillon and Dev (1976) reported that S-extractability increased significantly with increasing rate of S application. However, irrespective of sources if it is presumed that applied S remained available wholesomely throughout the period of incubation besides the native content, then in the present experiment there was actual reduction in S availability with increased rate of application. When S was supplemented at the rates of 12, 24 and 36 kg/ha equivalent to 16, 32 and 48 ppm So_4-S, respectively, the corresponding percentages of applied S rendered available were 74, 57 and 50.

Source × Lime (F × L) effect : The combined effect of different sources and liming was significant and indicated that the quantity of oxidized S improved due to liming under elemental S and SNPK by about 25 and 5 per cent, respectively, while it was reduced by 12 per cent in the case of K_2SO_4 (Table 3). However, within the sourses, K_2SO_4 proved to be the best as far as the availability of S was concerned. The quantity of heat-soluble S from K_2SO_4 was always greater than those ovserved under the other two sources in both the situations i.e. with or without lime application.

TABLE 3

Effects of S-sources with and without lime application as well as with levels of S on available S content (ppm) in soil.

	F_1	F_2	F_3	*Mean*
L_0	25.9	36.3	22.6	28.3
L_1	27.2	32.5	28.2	29.3
Mean	26.6	34.4	25.4	
S.Em. ±	0.60	C.D. @ 5%		1.7
S_1	22.5	29.1	23.5	25.1
S_2	25.4	34.8	25.4	28.5
S_3	31.8	39.4	27.4	32.8
Mean	26.6	34.4	25.4	
S.Em. ±	0.73	C.D. @ 5%		2.0

Source × Level (F × S) effect : The interaction between the kind of fertilizers and rate of application proved significant. As expected, the increased rate of application, irrespective of sources, gave higher quantity of available S in soil (Table 3). An increase in NaCl-extractable S with the increasing rate of S application was also noted by Dhillon and Dev (1976). Among sources, K_2SO_4 yielded maximum quantity of SO_4-S at each of the levels of application, while the other two behaved quite differently under different rates of application. The order for the sources on the basis of their performance in rendering SO_4-S available was K_2SO_4, SNPK and elemental S.

Besides, these two interactions, the combined effect of lime and of two groups viz. control and the rest on S availability was contrasting. When fertilizers were not applied i.e. under control liming showed reduction in S availability on account of rise in pH, while with fertilizers liming enhanced the availability. Other interaction effects viz. time x level, time x source, and time x source x level were not significant.

Thus, it can be said that irrespective of sources of S, the mineralization of SO_4-S increased progressively with the advancement in period of incubation. Among sources, K_2SO_4 proved to be the best as S rendered available was relatively more than those from elemental-S and SNPK. In order to attain proportionately larger oxidative effect at a given

time from raw S and SNPK, both of them should be applied well in advance under field conditions or 20-25 days earlier in a loamy sand maintained at field capactiy.

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