

## Effect of Chloride and Bicarbonate on Sulphur Uptake and Dry Matter Yield of Raya

R S Malik, S P S Karwasra and A P Khera

Department of Soils, Haryana Agricultural University, Hissar - 125 004 India

**Abstract** A pot culture experiment with sandy soil low in available S was conducted to study the effect of anion application on S uptake and dry matter yield of Raya. Sulphur application @  $30 \mu\text{g g}^{-1}$  increased the dry matter yield of raya (*Brassica juncea* Coss) var. RH-30. The deleterious effect of Cl and  $\text{HCO}_3$  anions was only visible at higher dose of S. High dose of anions reduced the dry matter yield at all S levels. Sulphur uptake was positively correlated with yield and S concentration in raya irrespective of the salts applied.

**Key words** Sulphur anions interaction, Raya yield, S uptake.

Oilseed crops are known to respond to sulphur application (Singh & Singh 1978). Chloride and bicarbonate inhibit the absorption of S and affect its availability in a number of crops. Leggett and Epstein (1956) reported that cations affect the absorption of anions by affecting the charges on the root surface depending upon the binding energy and valency of the particular cations, while anions affect on the absorption of anions alongwith carriers for entry into the roots. The light textured soils of arid and semi-arid regions of Haryana are low in available S (Aulakh *et al* 1977) and cultivated for raya crop, irrigated with under ground water containing  $46 \text{ meq L}^{-1}$  chloride and  $1.6 \text{ meL}^{-1}$  of bicarbonate. The present study was thus undertaken to find out the effect of Cl and  $\text{HCO}_3$  application on the yield and uptake of S by raya.

### Materials and Methods

Bulk surface (0-15 cm) soil sample from Ustip-samant, having silt (4.1%), clay (6.8%), pH (8.1), EC ( $0.1 \text{ dS m}^{-1}$ ), total S ( $28 \mu\text{g g}^{-1}$ ), water soluble  $\text{HCO}_3$  ( $0.9 \text{ me L}^{-1}$ ), water soluble Cl ( $0.9 \text{ me L}^{-1}$ ) and low in available nutrients (N = 35.0, P = 6.0, K = 95.0 and morgan's S =  $5.3 \mu\text{g g}^{-1}$ ) was collected from a cultivated field of village Rawalwas, district Hissar, Haryana. Four Kg air dried, 2 mm passed soil was filled in 20 cm diameter polyethylene lined earthen pots. Sulphur @ 0, 30, 60 and  $90 \mu\text{g g}^{-1}$  was applied through  $\text{K}_2\text{S}_0_4$  (solution). In one set of the

experiment, Cl and in another  $\text{HCO}_3$  were added, through their respective Na salts in aqueous solution containing anions  $0.20$  and  $40 \text{ me L}^{-1}$ . To each pot,  $60 \mu\text{g g}^{-1}$  of N (urea),  $30 \mu\text{g g}^{-1}$  of  $\text{P}_2\text{O}_5$  ( $\text{KH}_2\text{PO}_4$ ) and  $5 \mu\text{g g}^{-1}$  Zn ( $\text{ZnCl}_2$ ) were added uniformly. Each treatment was replicated thrice and pots were set in completely randomized design (CRD) in the glass house. Arrangement was changed after 15 days to remove the shadow/place-ment effect. Ten seeds of raya (*Brassica juncea* Coss), cv. RH-30, were sown in each pot at optimum moisture conditions. After germination, four healthy seedlings were allowed to grow upto pod initiation stage. Sulphur free deionized water was used for irrigation and irrigated as and when needed. The harvested plants were washed first with deionized water and then thrice with distilled water. Plant samples were first dried in glass house and later on in oven at  $70^\circ\text{C}$  for 48 h. Both fresh and dry matter yield were recorded. The 0.5 g plant material was digested in diacid mixture of  $\text{HNO}_3$ - $\text{HClO}_4$  (4:1) and the S content in plant samples was estimated following the method of Chesin and Yien (1950).

### Results and Discussion

A critical perusal of data in table 1 reveals that where sulphur was not applied, the increasing levels of Cl increased the dry matter yield of raya and when S was applied, the yield increased

**Table 1** Effect of chloride and bicarbonate application on dry matter yield, sulphur concentration and uptake by raya

Anion me L <sup>-1</sup>	Doses of S ( $\mu\text{g g}^{-1}$ )				Mean
	0	30	60	90	
<b>Dry matter yield (g pot<sup>-1</sup>)</b>					
Chloride					
0	4.4	9.0	9.3	9.4	8.0
20	5.7	9.1	8.2	8.1	7.7
40	5.4	6.6	6.1	6.2	6.0
Mean	5.1	8.2	7.8	7.9	
CD 5%	Cl = 0.4	S = 0.5	Cl × S = 0.9		
Bicarbonate					
0	4.4	9.0	9.3	9.4	8.0
20	5.0	8.7	8.6	7.7	7.5
40	4.8	6.2	6.2	7.1	6.0
Mean	4.7	7.9	8.0	8.0	
CD 5%	HCO <sub>3</sub> = 0.7	S = 0.8	HCO <sub>3</sub> × S = 1.4		
<b>Sulphur concentration (%)</b>					
Chloride					
0	0.01	0.40	0.33	0.38	0.28
20	0.03	0.35	0.39	0.50	0.31
40	0.05	0.48	0.39	0.41	0.33
Mean	0.03	0.41	0.37	0.43	
CD 5%	Cl = 0.01	S = 0.02	Cl × S = 0.03		
Bicarbonate					
0	0.01	0.40	0.33	0.38	0.38
20	0.03	0.38	0.33	0.31	0.23
40	0.08	0.26	0.37	0.48	0.29
Mean	0.04	0.31	0.34	0.39	
CD 5%	HCO <sub>3</sub> = 0.02	S = 0.02	HCO <sub>3</sub> × S = 0.04		
<b>Sulphur uptake (mg pot<sup>-1</sup>)</b>					
Chloride					
0	1.14	37.52	30.51	36.47	26.41
20	2.34	32.05	32.23	41.60	27.05
40	3.21	32.05	23.68	23.54	21.12
Mean	2.23	33.87	28.80	34.53	
CD 5%	Cl = 1.32	S = 1.53	Cl × S = 2.65		
Bicarbonate					
0	1.14	37.52	30.51	36.47	26.41
20	2.27	24.42	29.01	24.38	20.02
40	4.02	17.28	23.12	34.38	19.70
Mean	2.47	26.40	27.54	31.74	
CD 5%	HCO <sub>3</sub> = 1.12	S = 1.30	HCO <sub>3</sub> × S = 2.25		

tremendously and the most effective level was  $30 \mu\text{g S g}^{-1}$  but beyond this, change was not significant. The decrease in yield was significant only after  $20 \text{ me L}^{-1}$  of Cl and  $\text{HCO}_3$ , which may be due to the fact that Cl was complimentary to S at low levels and antagonised at higher levels of S (Zhukov & Repyakh 1966). Therefore, it is clear that till the S need of the crop was met, the two anions reflect their deleterious effect. Wallace *et al.* (1982) also found slightly higher yield with Cl application in *Atriplex polycarpa*, when  $30 \mu\text{g g}^{-1}$  graded level of S was applied. Similar results were also obtained when S was applied in combination with bicarbonate. Therefore, chloride/ bicarbonate application in combination with S resulted in significant reduction in the yield beyond their levels of  $20 \text{ me L}^{-1}$  at all levels of S except at zero level.

The S content of plants consistently increased with each increase in the Cl content of soil and upto  $30 \mu\text{g g}^{-1}$  of S level beyond which increase was not significant (Table 1). Singh and Singh (1978) also observed increase in S content of raya seedlings with increasing level of Cl and S.

Bicarbonate application reduced the S content of plant upto  $30 \mu\text{g g}^{-1}$  sulphate S but at higher S level the S concentration was not affected, rather it increased considerably. The result suggest that application of  $\text{HCO}_3$  at lower level of S is more deleterious as compared to Cl application due to antagonism between  $\text{HCO}_3$  and S at their low levels. Chao (1960) also found that OH and  $\text{HCO}_3$  decreased sulphate absorption by increasing the equilibrium pH of soil suspension.

Increase in S uptake of plants was observed only upto  $20 \text{ me L}^{-1}$  of Cl application at all S levels, but

application of  $40 \text{ me L}^{-1}$  of Cl showed reverse trend (Table 1). In case of bicarbonate treatments, S uptake increased at all levels of S when  $\text{HCO}_3$  was not applied but with an increase in  $\text{HCO}_3$  levels, S uptake decreased at all levels of S. The S uptake also found correlated with S content and dry matter yield of raya. As the S content or yield increased, the S uptake also increased and vice versa.

Significant correlation were found between concentration and uptake (0.943 and 0.964 for Cl and  $\text{HCO}_3$ ), yield and uptake (0.753 and 0.801 for Cl and  $\text{HCO}_3$ ) but non significant between S content and yield.

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