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RESEARCH PAPER

Nutrient content, uptake and fertility influenced by sources and levels of sulphur in *Kharif* sesame (*Sesamum indicum* L.)

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Abstract : An field experiment was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *Kharif* 2012. Total eight treatment combinations comprised of two sources of sulphur *viz.*, S_1=Elemental sulphur and S_2=Gypsum and four levels of sulphur *viz.*, L_1= 15 kg S ha^{-1}, L_2= 30 kg S ha^{-1}, L_3= 45 kg S ha^{-1} and L_4= 60 kg S ha^{-1} were tried in Randomized Block Design with factorial concepts with four replications. Sesame variety GT 2 was used as a test crop. The soil of the experimental field was loamy sand in texture, alkaline in reaction and soluble salt content under safe limit. It was low in organic carbon, available N and S; medium in available P_2O_5, K_2O and DTPA-extractable Fe and Zn and having sufficient DTPA-extractable Mn and Cu status. Application of 45 kg S ha^{-1} produced significantly higher seed (814 kg ha^{-1}) and stalk (1899 kg ha^{-1}) yields, over other levels of sulphur, however, it was statistically at par with 60 kg S ha^{-1}. Significantly higher content and uptake of N, P and S by seed and stalk and available S content in soil at harvest were recorded with 45 kg S ha^{-1}, however, this treatment was statistically comparable with 60 kg S ha^{-1}.

Key Words : Sulphur, Sesame, Nutrient content, Fertility

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INTRODUCTION

The oilseed crops play an important role in agriculture and industrial economy of our country. India occupies a very prominent place in the oilseed crops of the world as it produces a large variety of oilseed crops and rank first in respect to total area and production. In India, oilseed crops constitute the second largest agricultural produce next only to food grains and these are the important sources of our economy. India's contribution to the world oilseed production is still very low (9.54%) because of extremely low productivity of different oilseed crops.

Among the oilseed crops, sesame has the highest oil content of 46-64 per cent with 25 per cent protein (Goel and Sanjayakumar, 1994). In India, sesame crop occupy 10.90 lakh hectares area with total production of 8.10 lakh tonnes with an average productivity of 439 kg ha^{-1} (Anonymous, 2012). It is mainly grown in Gujarat, Uttar Pradesh, Madhya

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Pradesh, Karnataka, Orissa, Bihar, Jharkhand, Andhra Pradesh, Kerala and Tamil Nadu.

Sesame cultivation area has been increased in Gujarat because of its short duration nature, suitable in rainfed condition and high demand in the foreign market and comparatively high price. The productivity of sesame can be boosted up by adopting suitable agronomic practices, of the various agronomic factors known to augment the sesame yield, fertilizers play a vital role.

Oilseeds in general need more S as compared to other crops due to its pivotal role in synthesis of oil. The average S removal per ton of grain yield is 12 kg for oilseeds and 8 kg with pulses compared to 3-4 kg with cereals. Sulphur deficiency is becoming more critical with each passing year which is severely restricting crop yield, produce quality and nutrient use efficiency. With intensive agriculture and use of sulphur free fertilizers like urea, diammonium phosphate and muriate of potash coupled with high yielding varieties and reduction in use of organic manure and S containing insecticide resulted in S deficiency in many areas and are posing threats in realization and sustaining potential productivity of sesame. Sulphur, therefore, is now very much a part of balanced fertilization because in S deficient areas, applying N, P and K only, even at recommended rates cannot produce high yields unless S is also applied. Sulphur can be applied to the soil through any suitable S carriers *viz.*, gypsum, elemental sulphur, ammonium sulphate, potassium sulphate etc., the choice depending on crop, local availability, price and need for other nutrients. Among the sulphur supplying sources, gypsum and elemental sulphur are being abundantly used in sulphur deficient soils.

MATERIAL AND METHODS

A field experiment was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). The soil of experimental field was loamy sand in texture, alkaline in reaction and soluble salt content under safe limit. It was low in organic carbon, available N and S; medium in available P_2O_5, K_2O and DTPA-extractable Fe and Zn and having sufficient DTPA-extractable Mn and Cu status. The experiment comprised of eight treatments *viz.*, two sources of sulphur (elemental sulphur and gypsum) and four levels of sulphur (15, 30, 45 and 60 kg S ha^{-1}). The experiment with these treatments was laid out in Factorial Randomized Block Design with four replications. Sowing was done at the spacing of 45 cm row spacing with seed rate of 3 kg ha^{-1} at 3-5 cm depth and the variety used was GT 2. Recommended dose of fertilizer (RDF) used for sesame was 25:50:00 NPK ha^{-1} in the form of urea and DAP in all the experimental plots. The four levels (15, 30, 45 and 60 kg ha^{-1}) of different sources of sulphur (elemental sulphur and gypsum) were applied in combination to plots along the other fertilizers as per layout plant. Full dose of phosphorus, sulphur and nitrogen were applied at sowing. The crop was sown on 13th July, 2012 and harvested on 30 September 2012, observations on seed yield (kg ha^{-1}) and stalk (kg ha^{-1}) were estimated at harvest and expressed as mean. The concentration of the nutrients (N, P and S) determined in seed and stalk was expressed in per cent and the nutrients (N, P and S) uptake by seed and stalk was expressed in (kg ha^{-1}). To assess the nutrient status of soil at harvest available N, P and S as per standard analytical methods.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Seed and stalk yield :

The seed and stalk yields were not altered significantly by any of the source of sulphur. Thus, both the sources were found equally effective. This is attributed to similar response of both the sources on yield of sesame. These results are in agreement with the finding of Chauhan *et al.* (2002) in mustard, Patel *et al.* (2009) in groundnut, Geetha *et al.* (2010) in sunflower and Tianungsang and Gohain (2012) in rapeseed.

Seed and stalk yields were remarkably enhanced due to sulphur application. As the sulphur application raised, there was significant and progressive increase in seed and stalk yield of sesame up to 45 kg S ha^{-1} (L_3) and thereafter slightly decreased. The per cent increase in seed yield was 27.79 with L_3 level (45 kg ha^{-1}) over L_1 level (15 kg S ha^{-1}) whereas, the corresponding value for increase in stalk yield was 25.02 per cent. The observed significant increase in seed and stalk yields of sesame with S application might be due to fact that the soil of the experimental plot was deficient in available S and its application improved its availability in soil which might have enhanced growth and yield attributes and finally contributes the higher yield. Further, pronounce effect of sulphur on yield might be due to its multiple role in metabolism and essential constitute of amino acids and also improvement in vegetative structures, production of reproductive structures and assimilates thereby maintain balanced source sink. Moreover, cumulative effect of improvement in all the growth and yield attributes characters under S treated plots might have contributed for the increase in yields. The results are in the line with the reports of Chaudhari and Patel (2007), Patel *et al*. (2009), Kundu *et al.* (2010) and Vaghani *et al.* (2010) in sesame crop.

Content and uptake of nutrients :

The sources of sulphur could not reach the level of significance with respect to content and uptake of N, P and S by seed and stalk (Table 1 and 2). It indicated that sources of sulphur did not play a significant role in N, P and S content in seed and stalk. This is mainly due to even influence of sources on concentration of N, P and S in seed and stalk as well as seed and stalk yield. The results of present investigation are in close agreement with those reported by Patel *et al.* (2009) with respect to N and P uptake by seed and stalk of mustard and Patel *et al.* (2009) with respect to N, P and S uptake by summer groundnut.

The content and uptake of N, P and S by seed and stalk remarkably improved by sulphur application (Table 1 and 2). Application of S @ 45 kg ha^{-1} (L_3) being at par with 60 kg S ha^{-1} (L_4) registered significantly higher content and uptake of N, P and S by seed and stalk over its lower levels

Table 1 : Effect of sources and levels of sulphur on yield and nitrogen, phosphorus and sulphur content (%) in seed and stalk by sesame

Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Nitrogen content (%) in seed	Nitrogen content (%) in stalk	Phosphorus content (%) in seed	Phosphorus content (%) in stalk	Sulphur content (%) in seed	Sulphur content (%) in stalk
Sources of sulphur (S)								
S_1: Elemental sulphur	713	1684	3.34	1.20	0.98	0.50	0.98	0.84
S_2: Gypsum	772	1813	3.46	1.23	1.02	0.52	1.01	0.87
S.E. ±	21	46	0.05	0.02	0.02	0.01	0.01	0.01
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Levels of sulphur (L)								
L_1: 15 kg S ha^{-1}	637	1519	3.18	1.11	0.90	0.44	0.95	0.78
L_2: 30 kg S ha^{-1}	725	1710	3.37	1.20	0.99	0.50	0.98	0.84
L_3: 45 kg S ha^{-1}	814	1899	3.58	1.29	1.08	0.55	1.04	0.91
L_4: 60 kg S ha^{-1}	792	1866	3.49	1.26	1.04	0.53	1.02	0.89
S.E. ±	30	65	0.07	0.03	0.03	0.01	0.02	0.02
C.D. (P=0.05)	87	187	0.20	0.08	0.07	0.04	0.04	0.05
Interaction (S×L)								
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

Table 2 : Effect of sources and levels of sulphur on nitrogen, phosphorus and sulphur uptake (kg ha^{-1}) by seed and stalk and available nutrients at harvest

Treatments	Nitrogen uptake (kg ha^{-1}) by seed	Nitrogen uptake (kg ha^{-1}) by stalk	Phosphorus uptake (kg ha^{-1}) by seed	Phosphorus uptake (kg ha^{-1}) by stalk	Sulphur uptake (kg ha^{-1}) by seed	Sulphur uptake (kg ha^{-1}) by stalk	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available S (mg kg^{-1})
Sources of sulphur (S)									
S_1: Elemental sulphur	23.93	20.28	7.03	8.43	7.03	14.29	166.07	42.66	8.14
S_2: Gypsum	26.80	22.43	7.92	9.40	7.80	15.78	170.15	45.06	8.05
S.E. ±	0.99	0.85	0.30	0.36	0.30	0.62	2.42	0.93	0.17
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Levels of sulphur (L)									
L_1: 15 kg S ha^{-1}	20.25	16.93	5.71	6.76	6.07	11.91	160.12	41.07	6.90
L_2: 30 kg S ha^{-1}	24.44	20.56	7.15	8.56	7.12	14.42	168.01	43.13	7.74
L_3: 45 kg S ha^{-1}	29.16	24.51	8.79	10.45	8.43	17.20	171.03	46.21	8.50
L_4: 60 kg S ha^{-1}	27.62	23.43	8.24	9.90	8.04	16.61	173.28	45.04	9.24
S.E. ±	1.41	1.20	0.43	0.51	0.43	0.88	3.42	1.32	0.25
C.D. (P=0.05)	4.06	3.47	1.24	1.48	1.24	2.54	NS	NS	0.72
Interaction (S×L)									
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

of sulphur (15 and 30 kg ha^{-1}). An increase in N content in seed and stalk was 12.6 and 16.2 per cent, respectively due to 45 kg S ha^{-1} (L_3) over 15 kg S ha^{-1} (L_1). The corresponding values for P content in seed and stalk was 20.0 and 25.0 per cent.

The considerable increase in N and P content in seed and stalk due to S application might be due to favorable effect on availability of N and P in soil as well as synergistic effect of N and sulphur. These results are in line with those reported by Yasari *et al.* (2009) in mustard. A linear increase in S content in seed and stalk was noticed upto 45 kg S ha^{-1}. This might be due to better response of S to sesame crop grown under S deficient soils of the experimental plot. Such positive increase in S content in seed and stalk with S application has been reported by Jadav *et al.* (2010) and Vaghani *et al.* (2010) in sesame crop.

Application of S @ 45 kg ha^{-1} (L_3) being at par with 60 kg S ha^{-1} (L_4) resulted in significantly higher uptake of N, P and S by seed and stalk over its lower levels of sulphur (15 and 30 kg ha^{-1}). The increase in the uptake of N, P and S by seed due to 45 kg S ha^{-1} (L_3) was higher by 8.91, 3.08 and 2.36 kg ha^{-1}, respectively over 15 kg S ha^{-1} (L_1). The corresponding values for uptake of N, P and S by stalk were 7.58, 3.69 and 5.29 kg ha^{-1}.

A considerable increase in uptake of N, P and S by seed and stalk due to successive increase in S application as observed in present study might be due to the outcome of increased these nutrients (N, P and S) in seed and stalk as well as increased yield of seed and stalk. The beneficial effect of sulphur on uptake of N, P and S by seed and stalk has been reported by several workers (Patel *et al.*, 2009; Jadav *et al.*, 2010 and Vaghani *et al.*, 2010).

Post-harvest availability of soil nutrients :

The available N, P and S in the soil after harvest of crop were not changed due to sources of sulphur (Table 2). This can be ascribed to equal response of sources on seed and stalk yield of sesame. Similar findings have been reported by Singh and Singh (1975).

Available S status in soil at harvest remarkably improved by sulphur application (Table 2). Application of S did not show significant effect on available N and P_2O_5 status in soil after harvest of crop. Similar findings have been reported by Rajput (2012).

Addition of sulphur at each level significantly increased its availability in soil after harvest of crop. An increase in available S content in soil was the order of 1.34 fold with 60 kg S ha^{-1} over 15 kg S ha^{-1}. Positive effect of S on its content in soil at harvest is expected as the soil under investigation was low in available S (Table 2). The increase in available S status in soil with S fertilization might be due to higher rate of mineralization of nutrient, favorable condition for microbial activity as well as chemical activity improved the better growth of root. These results are in accordance with those reported by Vaghani *et al.* (2010); Najar *et al.* (2011) and Rajput (2012).

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