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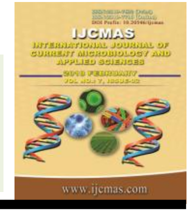

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Effect of Sources and Levels of Sulphur on Growth, Yield and Quality of Summer Sesame under South Gujarat Condition (*Sesamum indicum* L.)

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ABSTRACT

A field experiment was conducted during *summer* season of 2015-16 at the Hill millet research station N.A.U., waghai, with twelve treatment combinations consisting of three sources of sulphur *viz.*, A_1: Elemental sulphur, A_2: Gypsum and A_3: Ammonium sulphate and four levels of sulphur *viz.*, S_0: 0 kg ha^{-1}, S_1: 10 kg ha^{-1}, S_2: 20 kg ha^{-1}, S_3: 30 kg ha^{-1} were evaluated with factorial randomized block design with three replications. Almost all the growth, yield (828.72, 824.73 kg ha^{-1}) and quality attributes were significantly highest recorded with application of ammonium sulphate (A_3) source and 30 kg ha^{-1} (S_3) levels of sulphur, while maximum BCR was recorded with source like ammonium sulphate (A_3) and in levels of sulphure gave higher benefit with (S_2), (S_3) treatment.

Introduction

Sesame (*Sesamum indicum* L.) is also popularly known as sesame, til, simsim, benised, gingelly, gergelim, *etc*. Africa has been considered as the centre of origin of this crop (Joshi, 1961). It is generally cultivated throughout the year, *i.e.*, during *Kharif*, semi *Rabi* and *Summer* as a sole as well as mixed/inter crop. It is one of the most preferred oilseed crops under rainfed condition even with low yield level because of its higher price and good quality oil. Sesame is known as "The queen of the oilseed crops" due to excellent quality of its oil, flavor, taste and softness. It is considered to have both nutritional and medicinal values. Sulphur plays a remarkable role in protein metabolism. It is required for the synthesis of proteins, vitamins and chlorophyll and also S containing amino acids such as cystine, cysteine and methionine which are essential components of protein. Among the sulphur supplying sources, gypsum and elemental sulphur are being abundantly used in sulphur deficient soils. The response of sesame to sulphur for producing higher yield was up to 40 kg ha^{-1} according to Nagawani *et al.*, (2001) and Kathiresan (2002). Sulphur application not only improved the grain yield but also improved the quality of crops. Use of high analysis sulphur free fertilizers, heavy sulphur removal by the crops under intensive cultivation and neglect of sulphur replenishment contributed to widespread sulphur deficiencies in arable soils. Hence, this study was attempted to study the importance of sulphur in realizing the better growth, yield and quality of sesame crops.

Materials and Methods

A field experiment was conducted during *summer* season of the year 2015-16 at the Hill millet research station N.A.U., Waghai (Dangs), Gujarat. The soil of experimental field was clayey in texture, low in available nitrogen (197.26 kg ha^{-1}) and available phosphorus (30.93 kg ha^{-1}) and high in available potassium (369.80 kg ha^{-1}). Twelve treatment combinations consisting of three levels of sulphur *viz.*, A_1: Elemental sulphur, A_2: Gypsum and A_3: Ammonium sulphate and four levels of sulphur *viz*., S_0: 0 kg ha^{-1}, S_1: 10 kg ha^{-1}, S_2: 20 kg ha^{-1}, S_3: 30 kg ha^{-1} were evaluated with factorial randomized block design with three replications. Sesame variety GT-2 was selected for the investigation as test crop.

Furrow was opened manually in each plot by keeping spacing 45 cm between two rows. Recommended dose of fertilizer 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 (0, 10, 20, 30 kg ha^{-1}) of different sources of sulphur (elemental sulphur, gypsum and ammonium sulphate) 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 20th February, 2016 and harvested on 6th june, 2016, observation on seed yield and stalk yield were estimated at harvest and expressed as mean.

Results and Discussion

Growth and yield attributes

Plant population, Plant height (30 DAS), No. of capsule, No. of seed capsule, were not significantly influenced due to application of different sources of sulphur. Treatment A3: Ammonium sulphate recorded significantly higher plant population (at harvest), plant height (60, at harvest), no of branches (30, 60, at harvest), capsule length, seed yield but it was significantly at par with treatment A2: Gypsum. Increased in plant height might be due to more synthesis of amino acids in chlorophyll content in growing region and improving the photosynthetic activity. This was evidenced through the studies of Debye and Khan (1993). Among the sulphur carriers, Ammonium sulphate proved better for obtaining higher seed yield which might be due to its higher solubility (Venkatesh *et al.*, (2002), Patel *et al.*, (2002) and Verma *et al.*, (2012). might be attributed to better availability of Sulphur to plant at different crop growth stages and thus enhanced the yield attributes. These results are in accordance with the finding of Duhoon *et al.*, (2005).

Plant population, Plant height (30 DAS), No. of capsule, No. of seed capsule, stalk yield were not significantly influenced due to application of different levels of sulphur. Treatment S3: 30 kg S ha^{-1} recorded significantly higher plant population (at harvest), plant height (60, at harvest), no of branches (30, 60, at harvest), capsule length, seed yield but it was significantly at par with treatment S2: 20 kg S ha^{-1}. Increase in plant height may be due to better nutritional environment for plant growth at active vegetative stages as a result of improvement in root growth, cell multiplication, elongation and cell expression in the plant body, which ultimately increased the plant height (Table 1).

Table.1 Growth attributes of sesame under sources and levels of sulphur

Treatments	Plant population		Plant height (cm)			Number of branches plant^{-1}		
	Initial	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Sources of Sulphur								
A_1: Elemental sulphur	35.37	32.21	33.92	59.92	86.08	4.00	8.23	13.26
A_2: Gypsum	36.41	34.25	35.50	64.38	91.00	4.60	8.97	14.30
A_3: Ammonium sulphate	37.44	36.28	37.08	68.84	95.91	5.20	9.71	15.34
S.Em. $\pm$	0.68	0.77	0.96	1.82	2.51	0.12	0.27	0.41
C.D. at 5%	NS	2.27	NS	5.35	7.36	0.36	0.80	1.20
Levels of Sulphur								
S_0: 0 kg ha^{-1}	35.43	32.32	34.00	60.17	85.76	4.03	8.27	13.32
S_1 : 10 kg ha^{-1}	35.77	33.00	34.53	61.65	87.59	4.23	8.52	13.67
S_2 : 20 kg ha^{-1}	37.04	35.49	36.47	67.11	94.36	4.97	9.42	14.93
S_3: 30 kg ha^{-1}	37.38	36.17	37.00	68.59	96.26	5.17	9.67	15.28
S.Em. $\pm$	0.78	0.89	1.11	2.10	2.90	0.14	0.31	0.47
C.D. at 5%	NS	2.62	NS	6.17	8.50	0.42	0.92	1.39
C.V. %	6.43	7.81	9.37	9.81	9.55	9.23	10.50	9.92
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table.2 Yield attributes of sesame under sources and levels of sulphur

Treatments	No. of capsule plant^{-1}	Capsule length (cm)	No. of seeds capsule^{-1}	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
Sources of Sulphur					
A_1: Elemental sulphur	35.33	4.41	49.68	685.21	1610.35
A_2: Gypsum	36.80	5.63	50.94	756.96	1727.17
A_3: Ammonium sulphate	38.27	6.84	52.20	828.72	1843.98
S.Em. $\pm$	1.04	0.15	0.93	22.56	57.51
C.D. at 5%	NS	0.43	NS	66.17	168.69
Levels of Sulphur					
S_0: 0 kg ha^{-1}	35.41	4.48	49.75	689.19	1616.84
S_1 : 10 kg ha^{-1}	35.90	4.88	50.17	713.11	1655.78
S_2 : 20 kg ha^{-1}	37.70	6.37	51.71	800.81	1798.55
S_3: 30 kg ha^{-1}	38.19	6.77	52.13	824.73	1837.49
S.Em. $\pm$	1.20	0.17	1.07	26.05	66.41
C.D. at 5%	NS	0.49	NS	76.41	NS
C.V. %	9.81	9.00	6.32	10.32	11.53
Interaction	NS	NS	NS	NS	NS

Table.3 Quality and economics of sesame under sources and levels of sulphur

Treatments	Oil content (%)	Protein content (%)	Oil yield (kg ha^{-1})	Protein yield (kg ha^{-1})	Gross realization (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net realization (₹ ha^{-1})	BCR
Sources of Sulphur								
A_1: Elemental sulphur	43.32	16.88	296.83	115.66	29018	19526	9492	1.48
A_2: Gypsum	45.83	17.63	346.91	133.45	32005	17606	14399	1.81
A_3: Ammonium sulphate	48.33	18.38	400.52	152.31	34992	17786	17206	1.96
S.Em. ±	0.60	0.10	14.68	4.70	-	-	-	-
C.D. at 5%	1.75	0.30	43.04	13.79	-	-	-	-
Levels of Sulphur								
S_0: 0 kg ha^{-1}	43.46	16.92	299.52	116.61	29184	17006	12178	1.71
S_1 : 10 kg ha^{-1}	44.30	17.17	315.90	122.44	30180	17656	12524	1.70
S_2 : 20 kg ha^{-1}	47.36	18.08	379.26	144.78	33830	18306	15525	1.84
S_3: 30 kg ha^{-1}	48.19	18.33	397.43	151.17	34826	18956	15870	1.83
S.Em. ±	0.69	0.12	16.95	5.43	-	-	-	-
C.D. at 5%	2.02	0.34	49.70	15.92	-	-	-	-
C.V. %	4.52	1.99	14.61	12.18	-	-	-	-
Interaction	NS	NS	NS	NS	-	-	-	-

Significant increase in plant height with application might be attributed to indirect involvement of sulphur in the photosynthesis process of plants (Patil *et al.,* 2014). The bioactivity of sulphur might have played important role in improving yield attributes like capsule per plant, length of capsule and there by seed yield per plant ultimately increase in seed and stalk yield. This finding was reported by Raja *et al.*, (2007) (Table 2).

Quality parameters and economics

An application of sulphur with treatment A_3 (Ammonium sulphate) resulted in higher oil content and oil yield. Similar result was reported by Tomar (2012). Protein content and protein yield of sesame were influenced significantly by the different sources of sulphur. Sulphur applied as A_3 (Ammonium sulphate) were resulted in significantly highest protein content (18.38 %) and protein yield (152.31 kg ha^{-1}), Although, the three sources are containing SO_4, when Gypsum is applied to soils, the presence of free Ca^{++} ions in soil solution reduces its solubility as a result of common ion effect. Similar increase in protein content due to sulphur application through Ammonium sulphate was observed by Ventakesh *et al.*, (2002) Sulphur applied at 30 kg ha^{-1}resulted in highest oil content 48.19 % and protein content 18.33 %, respectively, which was at par with application of S_2 (20 kg S ha^{-1}) (Table 3). It might be due to involvement of sulphur in the synthesis of fatty acids and also increase protein quality through the synthesis of certain amino acids such as cysteine and methionine. It is evident from the result that sulphur had remarkable influence on protein and oil content. Similar finding was also reported by Havlin *et al.*, 1999. The maximum gross realization of (₹ 34992 ha^{-1}), net realization of (₹ 17206 ha^{-1}) and BCR of (1.96) were secured with application of A_3 (Ammonium sulphate) and with application of S_3 (30 kg S ha^{-1}) got maximum gross realization of (₹ 34826 ha^{-1}), net realization of (₹ 15870 ha^{-1}). This might be due to more availability of sulphur through Ammonium sulphate which has increased the seed yield, stalk yield and quality of Sesame. These results are in accordance with the finding of Verma *et al.*, (2012) and Ravi *et al.*, (2008).

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