



Effect of Graded Levels of Sulphur on Growth and Yield Attributes of Two Sesame (*Sesamum indicum*) Varieties at Two Different Soil Sulphur Status

L. Venkatakrishnan^{1*}, M. R. Backiyavathy¹, S. Meena¹, T. Kalaiselvi² and D. Amirtham²

¹Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore, India.

²Department of Agricultural Microbiology and Department of Food Processing and Post-Harvest Technology, TNAU, Coimbatore, India.

Authors' contributions

This work was carried out in collaboration among all authors. Authors LV and MRB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SM and TK managed the analyses of the study. Author DA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Field experiment was conducted at farmer's field in Coimbatore District of Tamil Nadu with two different soil sulphur status *i.e.*, soil with sufficient and deficient levels of sulphur status in order to study the response of graded doses of sulphur on two different sesame varieties. The experiment was laid out in split plot design with two factors *viz.*, Two sesame varieties (TMV 7 - Black var., SVPR 1 - White var.) and Six sulphur levels (0, 20, 30, 40, 50, 60 kg S ha⁻¹). Application of 30 and 50 kg S ha⁻¹ at sulphur sufficient and sulphur deficient soils has increased the plant height at VS and FS, at harvest the highest plant height was recorded. Whereas, other important traits like number of branches per plant, number of capsules per plant, length of capsule and dry matter accumulation has registered the highest response for sulphur application at 30 kg ha⁻¹ which was

*Corresponding author: E-mail: krishnann93@gmail.com;

on par with higher doses in sulphur sufficient soil and in case of deficient soil significant response was observed till 50 kg S ha⁻¹. Among the two varieties, TMV 7 has performed better when compared with SVPR 1.

Keywords: Sulphur levels; soil sulphur status; growth and yield attributes.

1. INTRODUCTION

Globally India holds a premier position in cultivation of oilseed crops in terms of area (26.00 million ha) and production (30.00 million tonnes) of oilseeds out of which 72% is under rainfed areas. Oilseeds production in the country during 2017-18 (as per 4th Advance Estimates) is estimated at 31.31 million tonnes which is marginally higher than the production of 31.28 million tonnes during 2016-17. However, the production of oilseeds during 2017-18 is higher by 1.76 million tonnes than the average (2012-13 to 2016-17) oilseeds production with a significant increase by 70.84 million tonnes over 2016-17. The per capita consumption which was 15.80 kg per person per annum during 2012-13 increased to 19.30 in 2017-18. In addition, demand for edible oils in both quantity and quality is growing due to population growth, which was 1.21 billion in 2011 [1] and now reaches above 1.25 billion [2]. Considering the growing domestic demand for edible oils it has now been planned to achieve a production of 45.64 million tonnes from nine annual oilseed crops by 2022-23, expecting an additional production of about 15.58 million tonnes over and above the 30.06 million tonnes production during QE 2016-17. Thus, the availability of total vegetable oil from domestic production of nine annual oilseed crops would be about 13.69 mts by 2022 (at 30 per cent recovery) as against the current annual output of about 7.0 mts.

Among the oilseed crops, sesamum is one of the most important oil seed crop belonging to Pedaliaceae family and extensively grown in different parts of the world and it (occupies fourth position) ranks fourth among oil seed crops in the world. Sesamum is a versatile crop with a diversified use of high-quality edible oils that (which) contains vitamins, amino acids and polyunsaturated fatty acids. (And also sesamum seeds are rich in) In sesamum seeds, linoleic and oleic acids are the prime factor which is responsible for oil consistency [3].

Generally, Sulphur (S) requirement by crops is equal to that of phosphorus[4] which plays a vital role in the plant metabolism, indispensable for

the synthesis of essential oils [5] constituent of a number of organic compounds [6], oil storage organs particularly oil glands i.e., glyoxysomes [7] and vitamin B₁ [8]. Also (serves) serves as a component of plant amino acids, proteins, vitamins and enzyme structures. It has been observed that increasing sulphur application increases oil content/ yield, protein, and glucosinolates of canola seeds [9]. Sulphur has been reported to influence the productivity of oil seed and total oil content [10]. In addition, the continuous application of NPK fertilizers contributes to a sulfur deficiency along with a great deal of organic matter deficiency, making the situation worse for oilseed crops.

In view of the aforesaid background, the present study was proposed to trace the superior level of sulfur recommendation for the improvement of yield and quality of sesamum.

2. MATERIALS AND METHODS

Field experiments were conducted at two different locations of Coimbatore district with two sulphur status in soil i.e., a soil with sufficient and deficient levels of sulphur status in order to study the response of graded doses of sulphur on two different sesamum varieties in a split plot design. The field experiments were conducted at farmer's holdings in Selambanur (Latitude: 10.995069 and Longitude: 76.788893) and Puthur (Latitude: 10.979436 and Longitude: 76.836387) village of Thondamuthur block of Coimbatore district from Feb-2019 to July-2019 and Mar-2019 to Aug-2019 respectively. The treatment structure comprised six levels of sulphur using gypsum as the sole source (0, 20, 30, 40, 50 and 60 kg S ha⁻¹) along with recommended fertilizer dose which were replicated three times in a split plot design (Main plot – sesamum varieties, Sub plot-‘S’ Levels). The data on various parameters were analyzed statistically using the AgRes statistical software (Pascal Intel Software Solutions). Wherever the treatment differences were found significant, critical differences (CD) were worked out at 5% level of significance with mean separation by least significant difference and denoted by symbol (* for 5% and ** for 1%). Simple

correlation was worked out between different parameters to know the relationship exists among them [11].

3. RESULTS AND DISCUSSION

3.1 Plant Height

Graded levels of sulphur application at increasing rate showed significant effect on plant height at all the growth stages. The highest plant height recorded at VS, FS stages of sesamum varieties with 50 kg S ha⁻¹ which was on par with 40 and 30 kg S ha⁻¹ and with respect to HS the maximum plant height was recorded with application of 50 kg S ha⁻¹ irrespective of the varieties at sulphur deficient soil (Table 1). At harvest stage among the varieties TMV 7 recorded the maximum plant height of 149.6 cm and 150.8 cm at sulphur sufficient and deficient conditions with which was significantly superior over SVPR 1. The significant increase in plant height with sulphur application may be attributed to the fact that sulphur promotes cell division, cell elongation and setting of cell structure [12], root growth and development of plants thus enhances the extraction of nutrients and moisture from soil more efficiently, which leads to leading to better growth and development of plants. This result is in accordance with the findings of [13-18].

3.2 Number of Branches per Plant

Graded levels of sulphur application had increased the number of primary branches at vegetative stages. The highest numbers of primary branches were recorded with sulphur application of 30 and 50 kg S ha⁻¹ at respective soils. Sulphur application of 30 and 50 produced more primary branches in TMV 7 (8.80 and 8.90) at sulphur sufficient and deficient soils. Among the treatment and varietal effects TMV 7 and sulphur application at 50 kg ha⁻¹ in sulphur deficient soil has shown the significant interaction effect (Fig. 1). The increase in number of branches might be due to the beneficial effect of sulphur on various metabolic activities and also sulphur increases the chlorophyll content, there by the photosynthetic efficiency of the plant will increase and aids in production of more branches. The present findings are in close agreement with [19].

3.3 Number of Capsules per Plant

Linear increase in number of capsules per plant was recorded with increasing amount

of sulphur application up to 50 kg S ha⁻¹ in sulphur deficient soil and 30 kg S ha⁻¹ in sufficient soil (Fig. 2). Among the varieties, black coated seed variety TMV 7 recorded the maximum number of capsules per plant (91.3 & 92.30) at both soil sulphur statuses (Fig. 2). The improved growth due to S fertilization coupled with increased photosynthesis on one hand and greater mobilization of photosynthates towards strong sink *i.e.*, reproductive structures, for significant increase in yield and yield attributes. Supply of sulphur in adequate amount also helps in the development of floral primordia *i.e.* reproductive parts, which results in the development of capsules and seeds in plants. Similar findings have also been reported earlier by [20,21] in sesame.

3.4 Length of Capsules

Statistically significant variation was recorded for sulphur management on length of capsule (Fig. 3). The length of capsule was found to be increased with sulphur application of 30 and 50 kg ha⁻¹ in white sesame recording (3.26 & 3.35 cm) in sulphur sufficient and deficient soils which was higher than black sesame variety. This might be due to higher growth parameters ascribed to addition of gypsum source favored availability of sulphur compared to without sulphur application and easy availability of sulphate (SO₄⁻²) sulphur present in gypsum [22].

3.5 Dry Matter Production

At all the growth stages, the data obtained on Dry matter production showed significant effect due to the application of different levels of sulphur. Maximum dry matter production per plant was recorded at vegetative, flowering and harvest stages of sesamum varieties with application of 30 kg S ha⁻¹ at sulphur sufficient soil and 50 kg S ha⁻¹ at sulphur deficient soil, irrespective of the varieties (Table 2). At flowering stage, among the treatments, sulphur application at 50 kg ha⁻¹ at sulphur deficient soil has recorded the highest dry matter accumulation per plant (TMV 7) which was superior over SVPR 1. Sesame plants adequately absorbed and stored sulphur for their growth, physiological process and maintained maximum biomass production, also the enhanced photosynthetic rate is one of the major factors for higher biomass production in crops [23].

Table 1. Effect of graded levels of sulphur application on plant height (cm) of sesamum varieties at different growth stages

S - Sufficient soil	Plant height (cm)																	
	Vegetative Stage						Flowering stage						Harvest stage					
	S - Sufficient soil			S - Deficient soil			S - Sufficient soil			S - Deficient soil			S - Sufficient soil			S - Deficient soil		
Treatment	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean
T ₁ - Absolute Control	14.20	12.30	13.25	11.30	10.10	10.70	90.10	88.10	89.10	86.20	78.30	82.25	118.20	100.56	109.38	110.40	94.70	102.55
T ₂ - RDF alone	19.50	15.30	17.40	15.60	14.30	14.95	95.10	92.20	93.65	98.30	85.40	91.85	128.60	111.10	119.85	118.20	106.81	112.51
T ₃ - RDF+ S ₂₀ kg ha ⁻¹	24.90	20.30	22.60	20.10	18.40	19.25	102.90	98.10	100.50	104.40	90.30	97.35	134.40	116.40	125.40	129.30	116.78	123.04
T ₄ - RDF+ S ₃₀ kg ha ⁻¹	30.80	26.10	28.45	25.90	21.40	23.65	111.30	104.30	107.80	110.40	96.10	103.25	142.40	124.30	133.35	137.80	123.57	130.69
T ₅ - RDF+ S ₄₀ kg ha ⁻¹	33.10	28.10	30.60	30.40	26.30	28.35	114.10	107.10	110.60	115.90	105.30	110.60	145.19	132.40	138.80	144.40	130.80	137.60
T ₆ - RDF+ S ₅₀ kg ha ⁻¹	35.30	30.10	32.70	35.80	31.20	33.50	117.50	111.20	114.35	120.30	114.90	117.60	149.60	139.60	144.60	150.80	139.35	145.08
T ₇ - RDF+ S ₆₀ kg ha ⁻¹	34.20	29.40	31.80	34.30	30.30	32.30	116.60	110.20	113.40	119.10	112.20	115.65	148.30	137.56	142.93	147.70	134.12	140.91
Mean	27.43	23.09		24.77	21.71		106.80	101.60		107.80	97.50		138.10	123.13		134.09	120.88	
	SEd	CD		SEd	CD		SEd	CD		SEd	CD		SEd	CD		SEd	CD	
V	0.18	0.80		0.25	1.09		1.11	4.79		0.23	1.03		0.73	3.15		0.27	1.18	
T	0.45	0.94		0.32	0.66		1.78	3.67		1.68	3.47		2.10	4.33		1.75	3.62	
V at T	0.62	1.42		0.48	1.30		2.58	6.41		2.21	4.62		2.84	6.29		2.31	4.84	
T at V	0.64	1.33		0.45	0.93		2.51	5.19		2.37	4.90		2.96	6.12		2.48	5.11	

Table 2. Effect of graded levels of sulphur application on dry matter production of sesamum varieties at different growth stages

S - Sufficient soil	Dry matter production (g per plant) (gplant ⁻¹)																	
	Vegetative Stage						Flowering stage						Harvest stage					
	S - Sufficient soil			S - Deficient soil			S - Sufficient soil			S - Deficient soil			S - Sufficient soil			S - Deficient soil		
Treatment	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean	TMV 7	SVPR 1	Mean
T ₁ - Absolute Control	2.12	2.08	2.10	2.05	2.00	2.03	4.69	4.52	4.61	4.67	4.49	4.58	7.32	7.25	7.29	6.05	6.10	6.08
T ₂ - RDF alone	2.29	2.32	2.31	2.53	2.36	2.45	5.21	5.05	5.13	5.01	4.82	4.92	7.88	7.78	7.83	6.63	6.49	6.56
T ₃ - RDF+ S ₂₀ kg ha ⁻¹	2.85	2.81	2.83	2.87	2.68	2.78	5.98	5.63	5.81	5.29	5.11	5.20	9.41	9.34	9.38	7.75	7.53	7.64
T ₄ - RDF+ S ₃₀ kg ha ⁻¹	3.37	3.31	3.34	3.18	3.00	3.09	6.79	6.47	6.63	5.51	5.43	5.47	10.89	10.81	10.85	8.70	8.59	8.65
T ₅ - RDF+ S ₄₀ kg ha ⁻¹	3.52	3.43	3.48	3.49	3.31	3.40	6.92	6.68	6.80	6.84	5.65	6.25	11.00	10.95	10.98	9.69	9.63	9.66
T ₆ - RDF+ S ₅₀ kg ha ⁻¹	3.71	3.55	3.63	3.80	3.62	3.71	7.03	6.86	6.95	7.18	7.00	7.09	11.11	11.09	11.10	11.96	11.68	11.82
T ₇ - RDF+ S ₆₀ kg ha ⁻¹	3.60	3.45	3.53	3.65	3.49	3.57	6.91	6.71	6.81	7.06	6.86	6.96	10.90	10.86	10.88	10.44	10.31	10.38
Mean	3.07	2.99		3.08	2.92		6.22	5.99		5.94	5.62		9.79	9.73		8.75	8.62	
	SEd	CD		SEd	CD		SEd	CD		SEd	CD		SEd	CD		SEd	CD	
V	0.02	0.10		0.03	0.13		0.12	0.52		0.06	0.25		0.12	0.52		0.14	0.60	
T	0.03	0.06		0.04	0.10		0.15	0.31		0.06	0.12		0.15	0.31		0.11	0.23	
V at T	0.04	0.12		0.07	0.17		0.23	0.62		0.10	0.28		0.23	0.62		0.20	0.64	
T at V	0.04	0.08		0.06	0.14		0.21	0.44		0.08	0.18		0.21	0.44		0.15	0.32	

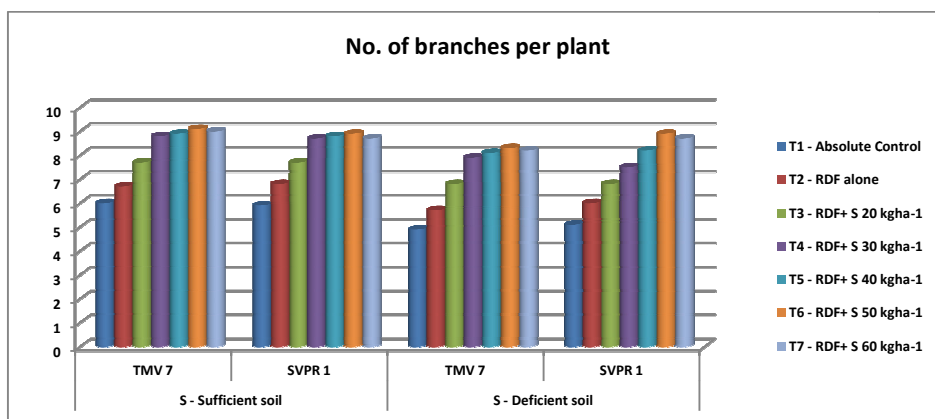


Fig. 1. Effect of sulphur application on number of branches per plant

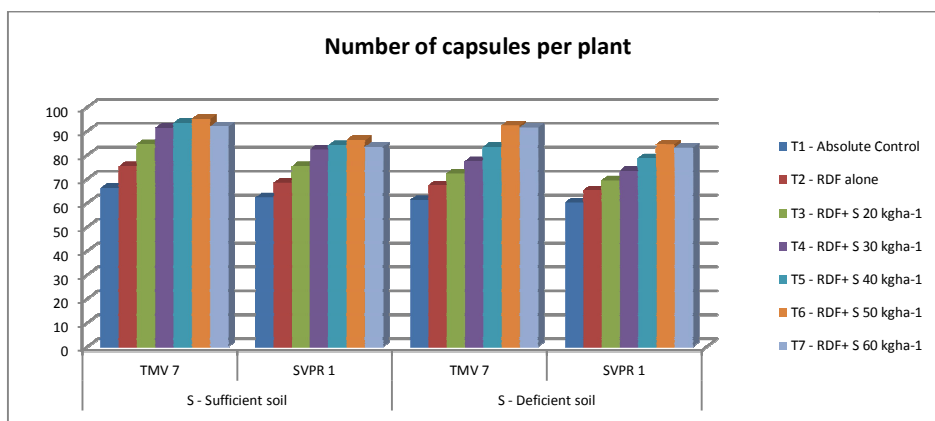


Fig. 2. Effect of sulphur application on number of capsules per plant

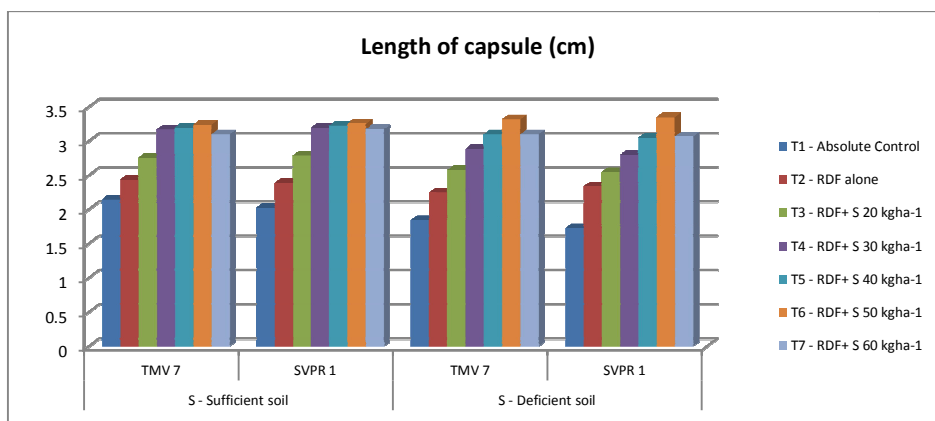


Fig. 3. Effect of sulphur application on length of capsules

4. CONCLUSION

Based on the experiment conducted at two different soil sulphur status with two different sesamum varieties it is concluded that TMV 7

proves to be better responding variety than that of SVPR 1 by applying sulphur @ 30 and 50 kg ha⁻¹ at sulphur sufficient and deficient soils. The results indicated that supplementation of sulphur nutrition in sulphur deficient soil proven to be

responding better for the growth and development of sesamum crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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