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Physiological growth, quality and economics of sesame (*Sesamum indicum* L.) as influenced by application of sulphur with use of farmyard manure

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Abstract
A field experiment was conducted at college farm, college of agriculture, Rajendranagar during kharif season of 2014 to study the effect of different levels of sulphur on physiological growth, yield quality and economics of kharif sesame with application of farmyard manure. The experiment was laid out in split-plot design with two main treatments *viz.*, M_1- RDF (40-60-40 kg NPK ha^{-1}), M_2- RDF along with application of 25% N through farmyard manure and three sub treatments *viz.,* S_1- 10 kg S ha^{-1}, S_2- 20 kg S ha^{-1} and S_3- 30 kg S ha^{-1}. Application of RDF along with 25 % N through FYM recorded highest physiological growth [Leaf area index (1.86), crop growth rate (6.98 g m^{-2} day^{-1}), relative growth rate (0.054 g g^{-1} day^{-1}) at 45 Days after sowing], quality [oil content (51 %), oil yield (321 kg ha^{-1}) and protein content (22.2 %)] and economics [gross returns (50480 Rs.), net returns (34470 Rs.) and B:C Ratio (3.15)] of sesame over application of RDF alone. Among sulphur levels application of 30 kg sulphur ha^{-1} recorded highest physiological growth [Leaf area index (1.89), crop growth rate (8.49 g m^{-2} day^{-1}), relative growth rate (0.051 g g^{-1} day^{-1})], quality [oil content (51%), oil yield (319 kg ha^{-1}) and protein content (22.2)] and economics [gross returns (50080 Rs.), net returns (35020 Rs.) and B:C Ratio (3.32)]of sesame over application of sulphur @ 10 and 20 kg ha^{-1}.

Keywords: Sesame, farmyard manure, sulphur, physiological growth, quality, economics

1. Introduction
Sesame is a versatile crop with high quality edible oil having diversified usage. Sesame contains 46-55% oil, 20-25% protein and also contains vitamins, amino acids and polyunsaturated fatty acids. Taste and odour of sesame oil is pleasant because of presence of aldehyde and acetylpyragin. It also contains more than 80% unsaturated fatty acid including large amount of oleic and linoleic acid.
The fact that crop deficiencies of sulphur have been reported with increase in frequency over the past several year greater attentions has been focused on the importance of sulphur in plant nutrition (Scherer, 2001) [10]. Sulphur nutrition plays an important role in improving the growth and productivity of Sesame (Saren *et al*., 2004) [9]. Moreover, continuous application of NPK fertilizers results in sulphur deficiency along with very much deficit of organic matter make the situation more worst for oilseed crops. Oilseed crops give significant results with sulphur use (Jadav *et al*., 2010) [3]. Additional sulphur application increased the seed and oil content of the sesame. Sesame has a high requirement for sulphur (Nagavani *et al*., 2010) [6]. Deficiency of organic matter making the situation even worst.

2. Material and Methods
2.1 Study sites
The present experiment on sesame was conducted during kharif season 2014 at College Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The soil of the experimental site was sandy loam in texture with pH of 7.9, electrical conductivity 0.41 dSm^{-1}, low in organic carbon (0.40 %), available nitrogen (175 kg ha^{-1}), medium in available phosphorus (36 kg ha^{-1}) and high in available potassium (342 kg ha^{-1}) and low in available sulphur (19.7 kg ha^{-1}). The experiment was laid out in a split-plot design with 6 treatments in each experiment comprised of two main plot treatments *i.e.*, M_1- Recommended Dose of Fertilizer and M_2- Recommended Dose of

Fertilizer along with 25% N through farm yard manure with three sub-plot treatments in each experiment *i.e.* three sulphur levels (10 kg ha^{-1}, 20 kg ha^{-1}and 30 kg ha^{-1}) replicated four times.

2.2 Method of data collection
2.2.1Physiological Growth Parameters
Leaf area index (LAI)

The LAI was determined at 15, 30, 45, 60 DAS and at harvest as per the formula suggested by Watson (1952) [15].

$$LAI = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Unit ground area (cm}^2\text{)}} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Crop growth rate (CGR)

CGR (g m^{-2} day^{-1}) is the rate of dry matter production per unit ground area per unit time and was calculated by using formula suggested by Watson (1952) [15].

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

W_1 = Total dry weight of plant (g) at time t_1

W_2 = Total dry weight of plant (g) at time t_2

$t_2 - t_1$ = time interval (days)

A = Land area (m^2)

Relative growth rate (RGR)

RGR (g g^{-1} day^{-1}) is the rate of increase in dry weight per unit time and was calculated by using the formula suggested by Radford (1967).

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1} \quad \ldots\ldots\ldots\ldots\ldots.. (3)$$

W_1 = Total dry weight of plant (g) at time t_1

W_2 = Total dry weight of plant (g) at time t_2

$t_2 - t_1$ = time interval (days)

3. Results and discussion
3.1 Physiological growth
3.1.1 Leaf area index
Increase in LAI was observed at all stages of plant growth with application of RDF along with 25% N through FYM. Leaf area index at 45 DAS found to be maximum (1.86) under M_2 *i.e.* application of RDF along with 25% N through FYM when compared to application of RDF alone (1.74) (Table 1). Rapid increase in the leaf area index of sesame under RDF along with 25% N through FYM might be due to beneficial effect of combined use of fertilizers and FYM, availability of macro and micronutrients and better microbial activity in the root zone of plant to support vegetative growth. Similar findings were reported by Tripathy and Bastia (2012) [13] and Barik and Fulmali (2011) [1].

Increase in LAI was observed at all stages of plant growth with application of S_3 *i.e.* 30 kg ha^{-1}. Highest leaf area index obtained in S_3 (1.89) and significantly superior over S_1 *i.e.* 10 kg S ha^{-1} (1.71) and S_2 *i.e.* 20 kg S ha^{-1} (1.79) at 45 DAS. The profound influence of S fertilization on these parameters could be attributed to its participation in the primary and secondary metabolism as constituent of various organic compounds that are vital for functioning of plant processes, which seems to have promoted meristematic activities causing higher apical growth and expansion of photosynthetic surface that is leaf area (Sharma, 2011) [11]. These results were corroborating the findings of Pavani *et al*. (2013) [7] and Saren *et al.* (2004) [9].

3.1.2 Crop growth rate
Increase in CGR was observed at all stages of plant growth with application of RDF along with 25% N through FYM. The crop growth rate of sesame crop was significantly more under RDF along with 25% N through FYM (6.98 g m^{-2} day^{-1}) as compared to RDF alone (5.25 g m^{-2} day^{-1}) at 30-45 DAS (Table. 2). Increase in the crop growth rate of sesame under RDF along with 25% N through FYM might be due to beneficial effect of combined use of fertilizers and FYM which helps to increase growth and development of sesame crop. Similar findings were also reported by Tripathy and Bastia (2012) [13]. Among the sub treatments there was significant difference for crop growth rate of sesame. The S_3 *i.e.* application of 30 kg S ha^{-1} recorded highest crop growth rate (8.49 g m^{-2} day^{-1}) as compared to S_1 *i.e.* application of 10 kg S ha^{-1} (5.09 g m^{-2} day^{-1}) and S_2 *i.e.* application of 20 kg S ha^{-1}(6.28 g m^{-2} day^{-1}). The progressive increase in crop growth rate was due to increased S application which leads to increase in nutrient uptake which enhanced rate of photosynthesis. (Mengal and Kirkby, 2001) [5].

3.1.3 Relative growth rate
The relative growth rate of sesame crop was significantly more with application of RDF along with 25% N through FYM (0.054 g g^{-1} day^{-1}) as compared to RDF alone (0.042 g g^{-1} day^{-1}) at 30-45 DAS (Table. 3).

Among the sub treatments there was significant difference for relative growth rate of sesame. The S_3 *i.e.* application of 30 kg S ha^{-1} had recorded highest relative growth rate (0.05 g g^{-1} day^{-1}) as compared to S_1*i.e.* application of 10 kg S ha^{-1} (0.037 g g^{-1} day^{-1}) and S_2*i.e.* application of 20 kg S ha^{-1} (0.045 g g^{-1} day^{-1}). Saren *et al.* (2004) [9] also observed that application of different doses of sulphur slightly influenced the relative growth rate.

3.2 Yield
The data pertaining to seed and stover yield (Table 4) revealed that application of RDF along with 25 % N through FYM recorded significantly higher seed yield (631 kg ha^{-1}) and stover yield (1175 kg ha^{-1}) over application of RDF (seed yield 520 kg ha^{-1}, stover yield 1091 kg ha^{-1}) alone. The results are in line with Maheshbabu *et al*. (2008) [4]. Within the sub plots, the seed yield (626 kg ha^{-1}) and stover yield (1283 kg ha^{-1}) of sesame was significantly higher with S_3 (fertilized with 30 kg S ha^{-1}) followed by S_2*i.e.* 20 kg S ha^{-1} (549 kg ha^{-1} seed yield and 1152 kg ha^{-1} stover yield). The seed yield (459 kg ha^{-1}) and stover yield (1010 kg ha^{-1}) of sesame crop with S_1*i.e.* 10 kg S ha^{-1} was found to be lower. Cumulative influence of S application maintained balance source-sink relationship and ultimately resulted in increased seed yield and stover yield of sesame. The results were in close conformity with the findings of Ganesh murthy (1996) [2].

3.3 Quality
3.3.1 Oil yield (kg ha^{-1})
The oil yield of 321 kg ha^{-1} recorded in the sesame crop with application of RDF along with 25% N through FYM compared to oil yield of 263 kg ha^{-1} under application of RDF alone (Table 4). Similar results were recorded by Tahir *et al*. (2014) [12].

Among sub plots, the oil yield of 319 kg ha^{-1} of sesame was significantly higher with S_2 (fertilized with 30 kg S ha^{-1}) followed by S_2*i.e.* 20 kg S ha^{-1} (279 kg ha^{-1}). The oil yield of sesame crop with 10 kg S ha^{-1} was found to be lowest (233 kg ha^{-1}). Oil seed crops response to liberal application of sulphur because it is involved in the synthesis of fatty acids through the synthesis of certain amino acids such as cystine, cysteine and methionine. The results were in line with findings of Jadav *et al.* (2010) [3].

3.3.2 Oil content (%)
Sesame crop due to application of RDF along with 25% N through FYM had shown maximum oil content of 51.0 % over application of RDF alone (50.7 %). When sub plots were observed the oil content of 51.0 % of sesame was significantly higher with S_3 (fertilized with 30 kg S ha^{-1}) followed by S_2*i.e.* 20 kg S ha^{-1} (50.9 %). The oil content of sesame crop with S_1 10 kg S ha^{-1} was found to be on par (50.9 %) with S_2 per cent compared to rest of the treatments. Similar results were obtained by Jadav *et al.* (2010) [3].

3.3.3 Protein content (%)
The protein content of 22.2 % was found to be recorded under application of RDF along with 25% N through FYM compared to protein content of 19.7 % under application of RDF alone. Similar results were also recorded by Veeramani *et al.* (2012) [14]. Among sub plots, the protein content of sesame was significantly higher (22.2 %) with S_3 (30 kg S ha^{-1}) followed by S_2 *i.e.* 20 kg S ha^{-1} (20.5 %). The protein content of sesame crop with 10 kg S ha^{-1} was found to be lowest with 19.7 %. Interaction effect of protein content of sesame crop influenced by main and sub treatments was found to be non-significant. The treatment fertilized with 30 kg S ha^{-1} recorded maximum protein content and it might be due to the role of sulphur in enhancing synthesis of amino acids as 90 % of sulphur is used for synthesis of amino acids like cysteine, methionine etc. These findings are in conformity with the findings of Pavani *et al*. (2013) [7].

3.4 Economics
Data on the gross returns, net returns and B: C ratio (Table. 5) of sesame crop as influenced by application of different levels of sulphur presented in table 3. Gross returns, net return and B: C ratio was found to be significantly influenced by the main treatments. Application of RDF along with 25 % N through farmyard manure recorded Gross returns of 50480 ₹ ha^{-1}, net returns of 34470 ₹ ha^{-1} and B: C ratio of 3.15 was superior than gross returns (41600 ₹ ha^{-1}) net returns (27590 ₹ ha^{-1}) and B: C ratio (2.96) with application of RDF alone. Among the sub plot treatments S_3*i.e.* application of sulphur @ 30 kg ha^{-1} recorded highest gross returns (50080 ₹ ha^{-1}), net returns (35020 ₹ ha^{-1}) and B: C ratio (3.32) followed by S_2 *i.e.* application of sulphur @ 20 kg ha^{-1} (43920 ₹ gross returns ha^{-1}, 29210 net returns and 2.98 B: C ratio). The lowest gross returns (36720₹ ha^{-1}), net returns (22360 ₹ ha^{-1}) and B: C ratio (2.55) were recorded with S_1*i.e.*applicationof sulphur @ 10 kg ha^{-1}. Similar results were recorded by Pavani *et al.* (2013) [7].

Table 1: Leaf area index of sesame as influenced by application of sulphur with use of farmyard manure

Treatments	15 DAS	30 DAS	45 DAS	60 DAS	At harvest
Main treatments					
M_1- RDF	0.031	1.25	1.74	0.91	0.10
M_2- RDF + 25% N through FYM	0.036	1.33	1.86	1.12	0.10
SEm±	0.005	0.01	0.01	0.03	0.004
CD (p=0.05)	NS	0.04	0.03	0.11	NS
Sub treatments (Sulphur levels)					
S_1 - 10 kg ha^{-1}	0.02	1.12	1.71	0.77	0.09
S_2 - 20 kg ha^{-1}	0.03	1.30	1.79	0.89	0.10
S_3 - 30 kg ha^{-1}	0.04	1.44	1.89	1.17	0.11
SEm±	0.009	0.02	0.01	0.06	0.002
CD (p=0.05)	NS	0.07	0.03	0.12	NS
Interaction					
Sub treatment at same level of main treatment					
SEm±	0.001	0.03	0.01	0.09	0.003
CD (p=0.05)	NS	NS	NS	NS	NS
Main treatment at same/different level of sub treatment					
SEm±	0.001	0.02	0.01	0.09	0.003
CD (p=0.05)	NS	NS	NS	NS	NS

Table 2: Crop growth rate of sesame as influenced by application of sulphur with use of FYM

Treatments	0-15 DAS	15-30 DAS	30-45 DAS	45-60 DAS	60-Harvest
Main treatments					
M_1- RDF	4.25	5.12	5.25	5.12	1.97
M_2- RDF + 25% N through FYM	4.81	5.78	6.98	5.98	2.48
SEm±	0.07	0.07	0.16	0.18	0.12
CD (p=0.05)	NS	0.33	0.75	0.52	0.35
Sub treatments (Sulphur levels)					
S_1 - 10 kg ha^{-1}	3.37	4.60	5.09	4.49	1.50
S_2 - 20 kg ha^{-1}	3.61	5.48	6.28	5.45	1.97
S_3 - 30 kg ha^{-1}	4.02	6.67	8.49	6.70	2.90
SEm±	0.15	0.26	0.34	0.30	0.08
CD (p=0.05)	NS	0.78	1.05	0.92	0.26
Interaction					
Sub treatment at same level of main treatment					

SEm±	0.21	0.51	0.48	0.42	0.12
CD (p=0.05)	NS	NS	NS	NS	NS
Main treatment at same/different level of sub treatment					
SEm±	0.19	0.42	0.43	0.35	0.15
CD (p=0.05)	NS	NS	NS	NS	NS

Table 3: Relative growth rate of sesame as influenced by application of sulphur with use of farmyard manure

Treatments	0-15 DAS	15-30 DAS	30-45 DAS	45-60 DAS	60-Harvest
Main treatments					
M_1- RDF	0.061	0.050	0.042	0.020	0.0030
M_2- RDF + 25% N through FYM	0.062	0.054	0.054	0.021	0.0050
SEm±	0.001	0.001	0.001	0.0002	0.0001
CD (p=0.05)	NS	0.003	0.004	0.0007	0.0003
Sub treatments (Sulphur levels)					
S_1 - 10 kg ha^{-1}	0.054	0.047	0.037	0.018	0.003
S_2 - 20 kg ha^{-1}	0.059	0.052	0.045	0.021	0.004
S_3 - 30 kg ha^{-1}	0.063	0.055	0.051	0.025	0.006
SEm±	0.001	0.001	0.002	0.001	0.001
CD (p=0.05)	NS	0.003	0.005	0.003	0.0004
Interaction					
Sub treatment at same level of main treatment					
SEm±	0.003	0.007	0.003	0.001	0.002
CD (p=0.05)	NS	NS	NS	NS	NS
Main treatment at same/different level of sub treatment					
SEm±	0.003	0.0009	0.002	0.001	0.002
CD (p=0.05)	NS	NS	NS	NS	NS

Table 4: Yield and quality of sesame as influenced by application of sulphur with use of farmyard manure

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)
Main treatments					
M_1- RDF	520	1091	50.7	263	19.7
M_2- RDF + 25% N through FYM	631	1289	51.0	321	22.2
SEm±	4.0	10.9	0.12	1.9	0.44
CD (p=0.05)	12.5	49.00	NS	8.6	1.23
Sub treatments (sulphur levels)					
S_1 - 10 kg ha^{-1}	459	1010	50.9	233	19.7
S_2 - 20 kg ha^{-1}	549	1156	50.9	279	20.5
S_3 - 30 kg ha^{-1}	626	1283	51.0	319	22.2
SEm±	12.0	14.0	0.04	3.6	0.16
CD (p=0.05)	37.2	43.3	NS	11.1	0.52
Interaction					
Sub treatment at same level of main treatment					
SEm±	17.0	19.8	0.07	5.1	0.23
CD (p=0.05)	NS	NS	NS	NS	NS
Main treatment at same/different level of sub treatment					
SEm±	14.4	19.5	0.09	4.6	0.48
CD (p=0.05)	NS	NS	NS	NS	NS

Table 5: Economics of sesame as influenced by application of different levels of sulphur with FYM

Treatments	Gross returns	Net returns	B: C Ratio
Main treatments			
M_1: RDF	41600	27590	2.96
M_2: RDF + 25% N through FYM	50480	34470	3.15
Sub treatments (sulphur levels)			
S_1: 10 kg ha^{-1}	36720	22360	2.55
S_2: 20 kg ha^{-1}	43920	29210	2.98
S_3: 30 kg ha^{-1}	50080	35020	3.32

4 Conclusion
From the present investigation, it can be concluded that application of RDF (40-60-40 kg N P K ha^{-1}) along with 25 % N through FYM for sesame crop was ideal for obtaining physiological growth parameters, yield, qualityand economics. Among different levels of sulphur, application of sulphur @ 30 kg ha^{-1} was found ideal for sesame in order to obtain higher physiological growth, yield, quality parameters and economics.

5 References
1. Barik AK, Fulmali J. Effect of integrated plant nutrient supply through organic and mineral sources on productivity of summer sesame. Journal of Oilseeds Research. 2011; 28:120-122.
2. Ganeshmurthy AN. Critical plant sulphur content and effect of S application on grain and oil yield of rainfed soybean in verticustiochrepts. Journal of Indian Society of Soil Science. 1996; 44:290-294.

3. Jadav DP, Padmani DR, Polara KB, Parmar KB, Babaria NB. Effect of different levels of sulphur and potassium on growth, yield and yield attributes of sesame (Sesamumindicum L.). An Asian Journal of Soil Science. 2010; 5:106-108.
4. Maheshbabu HM, Hunje R, Biradar Patel NK, Babalad HB. Effect of organic manures on plant growth, seed yield and quality of soybean. Karnataka Journal of Agricultural Sciences. 2008; 21:219-221.
5. Mengel K, Kirkby EA. Principles of Plant Nutrition, 5th ed., Kluwer Academic Publishers, Dordrecht, 2001.
6. Nagavani AV, Sumathi V, Chandrika V, Muneendrababu A. Effect of nitrogen and sulphur on yield and oil content of sesame (Sesamumindicum L.). Journal of Oilseeds Research. 2010; 18:73-74.
7. Pavani S, Bhanurekha K, Sudhakarababu SN, Madhu M. Effect of nitrogen and sulphur on growth, yield and quality of sunflower. Crop Research. 2013; 45:152-153.
8. Radford PJ. Growth analysis formulae, their use and abuse. Crop Science. 1967; 7:171-175.
9. Saren BK, Tudu S, Nandi P. Effect of irrigation and sulphur application on growth and productivity of summer sesame. Madras Agriculture Journal. 2004; 91:56-60.
10. Scherer HW. Sulphur in crop production. European Journal of Agronomy. 2001; 14:81-111.
11. Sharma A. Study the effect of sulphur and phosphorous with and without PSB inoculation on the yield attributes, yield and nutrient uptake of soybean. Journal of Progressive Agriculture. 2011; 2:41-43.
12. Tahir M, Ibrahim MA, Tahir S, Ayub A, Tanveer A, Rehman H. Effect of sulphur levels on two sesame (Sesamumindicum L.) varieties under climatic conditions of Pakistan. International Journal of Plant and Soil Science. 2014; 3:281-288.
13. Tripathy S, Bastia DK. Irrigation and nutrient management for yield augmentation of summer sesame (Sesamumindicum L.). Journal of Crop and Weed. 2012; 8:53-57.
14. Veeramani P, Subrahmaniyan K, Ganesaraja V. Organic manure management on groundnut. Wudpecker Journal of Agricultural Research. 2012; 1:238-243.
15. Watson DJ. The physiological basis of variation in yield. Advances in Agronomy. 1952; 4:101-145.