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INFLUENCE OF DIFFERENT SOURCES OF SULPHUR ON PRODUCTIVITY OF SUMMER SESAME (*SESAMUM INDICUM* L.)

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ABSTRACT

A field experiment entitled "Influence of different sources of Sulphur on productivity of summer sesame *(Sesamum indicum L.)"* was conducted during the *summer* season of 2024-25 at the College Farm, School of Agricultural Sciences, Malla Reddy University, Hyderabad. The experimental site was sandy loam soil, which was moderately alkaline in reaction, non-saline in electrical conductivity, low in organic carbon. Available nitrogen, phosphorus and potassium were at medium levels. The experiment was laid out in a randomized block design (RBD) with nine treatments replicated thrice. The crop variety used was Avani-19, sown at a spacing of 30 cm × 15 cm. The Recommended Dose of Fertilizers (RDF) applied uniformly across all treatments was 60:20:20 kg N:P_2O_5: K_2O ha^{-1}, applied as a basal dose before sowing. The treatments included different source of sulphur combinations of Zinc sulphate, Bentonite sulphur, Gypsum and Elemental sulphur (15 kg ha^{-1} and 30 kg ha^{-1} recommended dose of S), along with 100% RDF application. Sulphur sources were applied as soil amendments before sowing, mixed thoroughly into the soil to ensure even distribution and availability. Specifically, the treatments were T_1-100% RDF; T_2 - 100% RDF + 15 kg S ha^{-1} through Zinc sulphate T_3-100% RDF + 30 kg S ha^{-1} through Zinc sulphate T_4-100% RDF + 15 kg S ha^{-1} through Bentonite T_5-100% RDF + 30 kg S ha^{-1} through Bentonite T_6-100% RDF + 15 kg S ha^{-1} through Gypsum T_7-100% RDF + 30 kg S ha^{-1} through Gypsum T_8-100% RDF + 15 kg S ha^{-1} through Elemental sulphur T_9- 100% RDF + 30 kg S ha^{-1} through Elemental sulphur. The application of bentonite with 100% RDF (60:20:20) at 30,60 and at harvest days after sowing (DAS) recorded the highest plant height (100.53 cm), leaf area (2.11 cm²) and total dry matter (16.01kg^{-1}). The same treatment also produced the highest seed yield (653.26 kg ha^{-1}), stalk yield (1750.72 kg ha^{-1}) and the harvest index was highest (27.40%) under elemental sulphur 30 kg S ha^{-1} treatments. These results highlight the efficiency of bentonite sulphur in boosting reproductive growth and productivity. The control treatment (RDF) consistently recorded the lowest values across all parameters. The total NPK + S uptake under this treatment reached 1,063.3 kg ha^{-1}, markedly higher than all other treatments. Treatments with gypsum also recorded high nutrient uptake (total NPK + S: 846.4 kg ha^{-1}) but were slightly lower than Bentonite, while zinc sulphate, elemental sulphur, and the control showed comparatively reduced values ranging from (194.1 to 212.6 kg ha^{-1}). The consistent superiority of Bentonite sulphur across all nutrients highlights its role in improving nutrient availability, uptake efficiency, and overall metabolic activity, thereby supporting enhanced crop growth and productivity in summer sesame.

***Keywords* :** Growth, Sesame, Post-harvest nutrient availability and Yield.

Introduction

Oilseed crops are vital sources of edible oils and proteins, contributing nearly 90% of the global oil supply and supporting food security. Among them, sesame (*Sesamum indicum* L.) is one of the oldest domesticated oilseeds, valued for both its high-quality oil and protein-rich meal. In India, oilseeds like groundnut, soybean, sunflower, and sesame form the backbone of the edible oil sector and aid in crop diversification. Globally, sesame is cultivated across more than 75 countries, covering about 10.9 million hectares with a production of 6.5 million tonnes annually. Major producers include Sudan, Myanmar, India, and Nigeria, though productivity remains low at below 600 kg ha^{-1} due to climatic and management factors. In India, sesame covers 1.523 million ha, producing 0.802 million tonnes with an average yield of 527 kg ha^{-1}.

In Telangana, sesame occupies 57,485 ha, producing 148,310 tonnes with productivity of 645 kg ha^{-1}. Despite its economic importance, the crop faces constraints from poor soil fertility, limited irrigation, and low input use. The adoption of improved varieties and scientific practices is limited, resulting in a wide yield gap between research and field levels. Nutrient management plays a vital role in sesame productivity. While nitrogen and phosphorus are emphasized, sulphur (S) is equally important for amino acid synthesis, chlorophyll formation, and enzyme activity. Continuous use of sulphur-deficient fertilizers and declining organic manure use have led to widespread S deficiencies, particularly affecting oilseeds like sesame.

Sulphur fertilization has been shown to enhance sesame yield, oil quality, and soil health through better nutrient uptake and microbial activity. Therefore, the present study aims to assess the effects of different sulphur sources on sesame growth, yield, and quality under summer cultivation in Telangana. The outcomes are expected to guide sustainable nutrient management and support India's edible oil security.

Materials and Methods

Experimental Site and Topography

The current field experiment "Influence of different sources of Sulphur on productivity of summer sesame (*Sesamum indicum* L.)" was conducted during *summer* season, 2024-25 at D- Block, School of Agricultural Sciences, MRU, Hyderabad, Telangana. The farm is located at an elevation of 542 MSL at 17.55 North latitude and 78.46 East longitude. The soil of the experimental plot was sandy loamy soil with a pH of 8.3, E.C – 0.3 and O.C.- 0.47.

Soil of the experimental plot

In order to determine the various physico - chemical parameter of the soil, soil sample were gathered from the 10 places at a depth of 0 to 15 cm prior to the sesame crop being grown in the experimental field. The obtained materials were homogeneously mixed to generate a composite sample, which was then subjected to several physio-chemical analyses. The result shown that the soil at the experiment site was a sandy loam texture, was somewhat alkaline in response, had a low amount of organic carbon and nitrogen, and a medium amount of available potassium and phosphorus.

Experimental Details

Design and layout of the experiment

The study was carried out during the *summer* season of 2024-25 following a randomized block design (RBD) with nine treatments and three replications. Treatments were assigned to plots based on a randomization table.

Layout

The experiment was conducted following a randomized block design, with nine treatments, replicated three times. The field was prepared with ridges and furrows according to the specified dimensions. A total of 27 experimental plots were arranged, with each plot having a net size of 4.5 m × 3.9 m and a gross size of 5.1 m × 4.2 m. Treatments were assigned to the plots using a random number system. To define plot boundaries, bunds were constructed, and irrigation channels were established as per the layout design. The crop was sown, treatments were applied according to the experimental plan, and the crop was harvested upon reaching physiological maturity.

Data Collection

Table 1 : Details of Treatments:

Treatment	Treatment details
T_1	100% RDF
T_2	100% RDF + 15 kg S ha^{-1} through Zinc sulphate
T_3	100% RDF + 30 kg S ha^{-1} through Zinc sulphate
T_4	100% RDF + 15 kg S ha^{-1} through Bentonite
T_5	100% RDF + 30 kg S ha^{-1} through Bentonite
T_6	100% RDF + 15 kg S ha^{-1} through Gypsum
T_7	100% RDF + 30 kg S ha^{-1} through Gypsum
T_8	100% RDF + 15 kg S ha^{-1} through Elemental sulphur
T_9	100% RDF + 30 kg S ha^{-1} through Elemental sulphur

Growth Parameters: Plant height was recorded on 30,60 DAS at harvest by measuring from the ground level to the tip of the longest leaf the mean value was worked out and expressed in cm. The length and breadth of the 3rd leaf from the top was measured from tagged plants at 30, 60 & 90 DAS and at harvest. The leaf area index was computed as per the procedure suggested by Rajappa *et al.,* 1972. Five plants at random were uprooted from each treatment sample line at 30, 60 DAS and at harvest. Plants were partitioned into leaves, stem and reproductive parts (flowers and capsules). After this, samples were air dried first and then dried in hot air oven at 70° C till a constant dry weight was achieved. The dry weight production in plants and its accumulation in different parts were expressed as grams plant^{-1}.

Yield Parameters: Seed yield (kg ha^{-1}), stalk yield (kg ha^{-1}) and Harvest index is the ratio of economic yield to the biological yield per unit area. It was calculated by using following formula (Donald and Hamblin, 1976).

Plant Analysis: Post-harvest

The sample from different plant parts (stalk and seeds) were used for chemical estimation of total nitrogen (Parkinson and Allen, 1975), phosphorus (Vanadomolybdate method), potassium (Tandon 1998)) and sulphur Turbidometric method using spectrophotometer at 420 nm.

Statistical Analysis

The experimental data were statistically analysed using the Analysis of Variance (ANOVA) method suitable for a Randomized Block Design (RBD), as suggested by Panse and Sukhatme (1985). When the F-test indicated significant differences among treatments, comparisons were made at a 5% level of probability by calculating critical difference (CD). When the F- test was not significant, it was indicated by the term "NS" which denotes non-significant differences among treatments.

Results and Discussion

Growth Parameters

Application of various sulphur sources and levels significantly influenced the growth parameters of sesame at harvest (Table 4.1–4.3). Among the treatments, soil application of 100% RDF + 30 kg S ha^{-1} through bentonite (T_5) recorded the maximum plant height (100.5 cm), largest leaf area (2.11), and highest total dry matter accumulation (16.01 g plant^{-1}), followed closely by 100% RDF + 30 kg S ha^{-1} through gypsum (T_7). Treatments receiving lower sulphur doses, such as 100% RDF + 15 kg S ha^{-1} through bentonite or gypsum, also enhanced growth compared to the control (100% RDF only), which recorded the lowest plant height (82.2 cm), leaf area (0.56), and dry matter (8.24 g plant^{-1}). Moderate improvement was observed under zinc sulphate and elemental sulphur treatments, though they were less effective than bentonite or gypsum-based sources. The superior performance of bentonite can be attributed to its slow and continuous release of sulphur, ensuring steady nutrient availability for chlorophyll formation, enzymatic activation, and protein synthesis, thereby promoting better root growth, photosynthetic efficiency, and biomass accumulation. These findings are in close agreement with Mondal *et al.* (2023), Sujatha *et al.* (2021), and Jyothi *et al.* (2025), who also reported significant improvements in sesame growth and dry matter production with balanced sulphur fertilization, particularly from slow- release sources such as bentonite and gypsum.

Table 2 : Plant height, Leaf area index and Dry matter production (g plant^{-1}), at different growth stages of summer sesame as influenced by different sources and levels of sulphur.

Treatments	Plant height (cm)	Leaf area index	Dry matter production (g plant^{-1})
T1-100% RDF	82.2	0.56	8.24
T2-100% RDF + 15 kg S ha^{-1} through Zinc Sulphate	84.8	0.69	8.72
T3-100% RDF + 30 kg S ha^{-1} through Zinc Sulphate	85.3	0.81	9.15
T4-100% RDF + 15 kg S ha^{-1} through Bentonite	90.6	1.59	13.05
T5-100% RDF + 30 kg S ha^{-1} through Bentonite	100.5	2.11	16.01
T6-100% RDF + 15 kg S ha^{-1} through Gypsum	89.2	1.33	11.31
T7-100% RDF + 30 kg S ha^{-1} through Gypsum	90.7	1.85	14.59
T8-100% RDF + 15 kg S ha^{-1} through Elemental Sulphur	86.0	1.06	9.40
T9-100% RDF + 30 kg S ha $^{-1}$ through Elemental Sulphur	88.1	1.08	9.67
S. Em. ±	2.7	0.08	0.45
CD (p=0.05)	8.2	0.25	1.32

Yield

Application of different sulphur sources and levels significantly influenced the yield and yield components of sesame (Table 4.5 and Fig. 4.3). Among the treatments, 100% RDF + 30 kg S ha^{-1} through bentonite recorded the highest seed yield (653 kg ha^{-1}), haulm yield (1750 kg ha^{-1}), and harvest index (27.40%), followed closely by 100% RDF + 30 kg S ha^{-1} through gypsum, which produced a seed yield of

608 kg ha^{-1} and a haulm yield of 1629 kg ha^{-1}, both statistically on par with the bentonite treatment. The lowest seed yield (441 kg ha^{-1}) and haulm yield (1197 kg ha^{-1}) were observed under the control (100% RDF only), indicating the yield-limiting effect of sulphur deficiency. Intermediate yields were obtained from treatments involving zinc sulphate and elemental sulphur, showing that sulphur nutrition plays a vital role in enhancing sesame productivity. The superior performance of bentonite can be attributed to its slow and continuous release of sulphur, ensuring a consistent supply throughout the growth period, thereby improving nutrient uptake, photosynthetic efficiency, capsule formation, and assimilate partitioning towards seed yield. These findings are in close agreement with Thentu *et al.* (2014), Sujatha *et al.* (2021), Krishna *et al.* (2023), and Jat *et al.* (2017), who also reported significant improvements in sesame seed and stalk yield with balanced sulphur fertilization, particularly from slow-release sources such as bentonite and gypsum.

Table 3 : Seed Yield (kg ha^{-1}), Stalk Yield (kg ha^{-1}) and Harvest Index (%) of Summer Sesame (*Sesamum indicum* L.) as Influenced by Different Sources and Levels of Sulphur.

Treatments	Seed Yield (kg ha^{-1})	Stalk Yield (kg ha^{-1})	Harvest index (%)
T1-100% RDF	441	1197	27.00
T2-100% RDF + 15 kg S ha^{-1} through Zinc Sulphate	450	1216	27.03
T3-100% RDF + 30 kg S ha^{-1} through Zinc Sulphate	458	1233	27.06
T4-100% RDF + 15 kg S ha^{-1} through Bentonite	564	1504	27.28
T5-100% RDF + 30 kg S ha^{-1} through Bentonite	653	1750	27.17
T6-100% RDF + 15 kg S ha^{-1} through Gypsum	519	1384	27.30
T7-100% RDF + 30 kg S ha^{-1} through Gypsum	608	1629	27.23
T8-100% RDF + 15 kg S ha^{-1} through Elemental Sulphur	466	1245	27.27
T9-100% RDF + 30 kg S ha^{-1} through Elemental Sulphur	474	1259	27.40
S. Em. ±	15	40	0.94
CD (p=0.05)	45	120	NS

Post-Harvest Nutrient Uptake (kg ha^{-1})

Post-harvest plant nutrient uptake of sesame was significantly influenced by different Sulphur sources and levels (Table 4.8). Among the treatments, 100% RDF + 30 kg S ha^{-1} through bentonite (T_5) recorded the highest uptake of nitrogen (296.2 kg ha^{-1}), phosphorus (55.9 kg ha^{-1}), potassium (111.8 kg ha^{-1}), and Sulphur (31.2 kg ha^{-1}), followed by 100% RDF + 30 kg S ha^{-1} through gypsum (T_7), which recorded 270.7 kg ha^{-1} N, 50.5 kg ha^{-1} P, 106.7 kg ha^{-1} K, and 28.0 kg ha^{-1} S. Moderate nutrient uptake was observed under 100% RDF + 15 kg S ha^{-1} through bentonite (T_4), with 186.2, 33.8, 72.8, and 19.6 kg ha^{-1} of N, P, K, and S, respectively, while relatively lower uptakes were noted in gypsum at 15 kg S ha^{-1} (T_6) and elemental Sulphur treatments. The lowest nutrient uptake values were recorded in the control (T_1: 100% RDF only), with 105.0 kg ha^{-1} N, 18.2 kg ha^{-1} P, 41.0 kg ha^{-1} K, and 9.7 kg ha^{-1} S, highlighting the limiting effect of Sulphur deficiency on nutrient assimilation. The superior nutrient uptake observed under bentonite and gypsum sources may be attributed to their gradual and continuous release of Sulphur, which improves soil nutrient solubility, root growth, and overall nutrient absorption and translocation. These findings corroborate those of Jat *et al.* (2023), Dubey *et al.* (2022), Mamatha *et al.* (2015), and Lallawmzuali *et al.* (2021), who also reported that sustained Sulphur availability enhances macronutrient and Sulphur uptake in sesame through improved root activity, nutrient mobility, and metabolic efficiency.

Table 4 : Total Uptake (kg ha^{-1}) of nitrogen, phosphorus, potassium and Sulphur by summer sesame as influenced by different sources and levels of Sulphur.

Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})	S uptake (kg ha^{-1})
T1-100% RDF	105.0	18.2	41.0	9.7
T2-100% RDF + 15 kg S ha^{-1} through Zinc Sulphate	107.4	18.9	41.9	10.8
T3-100% RDF + 30 kg S ha^{-1} through Zinc Sulphate	109.4	19.4	42.6	11.2
T4-100% RDF + 15 kg S ha^{-1} through Bentonite	186.2	33.8	72.8	19.6
T5-100% RDF + 30 kg S ha^{-1} through Bentonite	296.2	55.9	11.8	31.2

T6-100% RDF + 15 kg S ha^{-1} through Gypsum	160.6	29.7	63.3	16.8
T7-100% RDF + 30 kg S ha^{-1} through Gypsum	270.7	50.5	106.7	28.0
T8-100% RDF + 15 kg S ha^{-1} through Elemental Sulphur	111.1	19.7	43.2	11.4
T9-100% RDF + 30 kg S ha $^{-1}$ through Elemental Sulphur	113.4	20.1	43.6	11.8
S. Em. ±	9.4	1.8	4.1	1.0
CD (p=0.05)	28.5	5.7	12.5	3.4

Conclusion

Application of different Sulphur sources and levels significantly improved the growth, yield, and nutrient uptake of sesame under semi-arid conditions of Telangana. The treatment with 100% RDF + 30 kg S ha^{-1} through bentonite recorded the highest plant height, leaf area, dry matter, seed and stalk yield, and nutrient uptake, followed closely by gypsum at the same level. Lower Sulphur doses and other sources such as zinc sulphate and elemental Sulphur showed moderate effects, while the control (100% RDF only) recorded the lowest values. The superior performance of bentonite was due to its slow and continuous release of Sulphur, ensuring sustained nutrient supply throughout crop growth. This enhanced chlorophyll formation, enzymatic activity, photosynthetic efficiency, and assimilate partitioning towards seed yield. Improved post-harvest nutrient uptake under bentonite and gypsum indicated efficient nutrient utilization and soil fertility maintenance. Overall, Sulphur application, particularly through bentonite, was most effective in enhancing growth, productivity, and nutrient dynamics in sesame.

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