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RESEARCH PAPER

Effect of sulphur on growth, yield and economics of sesame (*Sesamum indicum*)

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Abstract : The productivity of sesame is mainly dependant on proper agronomic management practices including nutrient management. In oilseeds, sulphur plays a prominent role in the synthesis of essential oils, chlorophyll formation and gives pungency in oil. It is also increasing drought and cold resistance of oilseed crops. Hence, field studies were conducted for two consecutive years to study the effect of various sources of sulphur (Gypsum and Sulphur Bentonite) and their different levels (15, 30 and 45 kg S ha^{-1}) on growth, yield and economics of sesame. Studies revealed that, irrespective of sources of sulphur seed yield increased progressively with increase in sulphur dose from 15 to 45 kg ha^{-1} and the increase was significant at 45 kg ha^{-1} over 15 kg ha^{-1}and control. Application of sulphur at 45 kg/ha through gypsum produced significantly higher plant height (97.1 cm), branches/plant (4.98), capsules/ plant (95.9) and seed yield (586.5 kg/ha) than at 15 kg S/ha through gypsum, Sulphur bentonite and recommended NPK and remaining at par with application of Sulphur at 30 kg/ha. Sulphur application at 45 and 30 kg ha^{-1} through gypsum recorded significantly higher net returns (Rs. 33365 and 31963 ha^{-1} respectively) and B: C ratio (2.47 and 2.38 respectively) than Sulphur Bentonite and recommended NPK during both the years.

Key Words : Sesame, Sulphur, Seed yield, Economics, Sulphur bentonite, Gypsum

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INTRODUCTION

Sesame (*Sesamum indicum* L.) is the oldest edible oilseed crop cultivated in India. Sesame seeds contain 45- 55% oil and 25 % protein. Sesame is popularly called as "Queen of oilseeds" because of its excellent oil quality characters. India ranks first in the world with 1.75 m ha area and 0.77 million tonnes production with average productivity of 410 kg ha^{-1}. (Ministry of Agriculture and Farmers welfare, G.O.I, 2018). In Andhra Pradesh, it is cultivated in an area of 0.64 lakh ha with a production of 0.17 lakh tonnes and productivity of 257 kg ha^{-1} (Agricultural Statistics at a glance, 2016-17). It clearly shows that the productivity of sesame in Andhra Pradesh is less than the national average yield. It is mainly due to its cultivation in poor fertile soils without proper management practices especially fertiliser management. Being an oilseed the application of NPK alone would not suffice to achieve the full yield potential cannot be achieved due to inadequate supply of secondary and micronutrients. Sulphur is the fourth major plant nutrient

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after N, P and K. In oilseeds, sulphur plays a prominent role in the synthesis of essential oils, chlorophyll formation and gives pungency in oil. It is also increasing drought and cold resistance of oilseed crops (Patel and Shelke, 1995). Sulphur is an important constituent of three amino acids *viz*., cystine, cysteine and methionine which are essential components of proteins. The addition of sulphur increases the seed yield and oil content of sesame was reported by Tiwari and Gupta, 2006 and Kundu *et al.* (2010). Among the sulphur supplying fertilizers, gypsum and sulphur bentonite are easily available in the market. Hence, a field study was conducted to suggest optimum level of sulphur and cheaper source for sesame.

Material and Methods

Field experiments were carried out during *rabi* season of 2015-16 and 2016-17 at Agricultural Research Station, Yellamanchili, Visakhapatnam, Andhra Pradesh. The experiment was carried out in randomized block design with three replications. The soil of the experimental site was sandy loam in texture, slightly alkaline in reaction (pH 7.5), with 0.22 % organic carbon and 178, 16 and 103 kg ha^{-1} of N, P and K, respectively. The experiment consisted of seven treatments as given under.

Treatments	Details of the treatment
T_1	Control (40-20-20 kg NPK ha^{-1} without sulphur)
T_2	T_1+ 15kg S ha^{-1} through Sulphur Bentonite
T_3	T_1+ 30kg S ha^{-1} through Sulphur Bentonite
T_4	T_1+ 45kg S ha^{-1} through Sulphur Bentonite
T_5	T_1+ 15kg S ha^{-1} through Gypsum
T_6	T_1+ 30 kg S ha^{-1} through Gypsum
T_7	T_1+ 45kg S ha^{-1} through Gypsum

Sesame cv. YLM-66 was sown @ 5 Kg seeds/ha with spacing of 30 cm between the rows and 10 cm between the plants. Thinning of and gap filling was done 7 days after sowing. Recommended doses of 40 kg N + 20 kg P_20_5 + 20 kg K_2O/ha was given through urea (46% N), single super phosphate (16% P_20_5) and murate of potash (60% K_20) to the sesame crop. Half of the total nitrogen was applied at the time of sowing and rest of nitrogen was top dressed at 30 days after sowing. Full dose of P_2O_5 and K_2O was given at the time of sowing. Different sulphur fertilisers *viz*., Gypsum and sulphur bentonite were applied at the time of sowing as per treatments. Recommended agronomic practices and plant protection measures were followed to maintain a good crop. Observations on growth, yield attributes and seed yield were recorded at the time of harvesting. The economics of the treatments was worked out on the basis of pooled mean seed yield. The data was subjected to statistical analysis as by using standard statistical procedures suggested by Rangaswamy (1995).

Results and Discussion

The results with regard to effect of different doses and sources of sulphur on growth, seed yield and economics of sesame are presented in Table 2.

Growth:

The growth of sesame measured in terms of plant height, number of branches plant^{-1} and number of

Table 1 : Growth, yield and economics of sesame as influenced by the sulphur

Treatments	Plant height (cm)	No. of branches / Plant	No. of capsules / Plant	Seed yield (Kg ha^{-1})	Gross returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net returns (Rs ha^{-1})	BC Ratio
T_1 - Control (40-20-20 kg NPK without sulphur)	63.5	3.76	68.4	405.4	32432	13180	19252	1.47
T_2 - T_1 + 15 kg S ha^{-1} through Sulphur Bentonite	75.7	4.29	78.9	481.3	38504	14151	24353	1.72
T_3 - T_1 + 30 kg S ha^{-1} through Sulphur Bentonite	89.4	4.91	89.2	560.7	44856	15128	29728	1.97
T_4 - T_1 + 45 kg S ha^{-1} through Sulphur Bentonite	93.6	4.95	93.1	577.9	46232	16105	30127	1.87
T_5 - T_1 + 15 kg S ha^{-1} through Gypsum	77.3	4.37	80.0	484.6	38768	13305	25463	1.92
T_6 - T_1 + 30 kg S ha^{-1} through Gypsum	91.2	4.93	90.3	567.4	45392	13429	31963	2.38
T_7 - T_1 + 45 kg S ha^{-1} through Gypsum	97.1	4.98	95.9	586.5	46920	13555	33365	2.47
Sem ±	3.12	0.16	2.95	24.3				
CD (P = 0.05)	10.11	0.51	9.09	74.9				
CV (%)	7.5	6.30	6.2	8.2				

Pooled mean data for two consecutive seasons (2016-17 and 2017-18) capsules $plant^{-1}$ as influenced by different treatments are presented hereunder. Pooled data of two years indicated that significantly highest plant height (97.1 cm) was recorded with application of 45 kg/ha through Gypsum (T_7) than at 15 kg S/ha through Gypsum (77.3 cm), Sulphur Bentonite (75.7 cm) and recommended NPK (63.5 cm). The higher plant height might be due to more synthesis of amino acids, increase in chlorophyll content in growing region and improving the photosynthetic activity, ultimately enhancing cell division and thereby increased the plant height. These results are in agreement with the findings of Lali Jat *et al*. (2017) and Sindhu Murmu *et al*. (2015).

Significantly maximum number of branches $plant^{-1}$ (4.98) was observed with the application of 45 kg/ha through Gypsum (T_7) than at 15 kg S/ha through Gypsum (4.37), Sulphur Bentonite (4.29) and recommended NPK (3.76). This might be due to the beneficial effect of sulphur on various metabolic activities in plants which seem to have promoted a greater number of branches $plant^{-1}$. The results are in conformity with the findings of Vaiyapuri *et al*. (2004) and Nagavani *et al*. (2001)

Significantly highest number of capsules per plant (95.9) was observed with the application of 45 kg/ha through Gypsum (T_7) than at 15 kg S/ha through Gypsum (80.0), Sulphur Bentonite (78.9) and recommended NPK (68.4). The supply and bioactivity of sulphur might have helped in floral primordial initiation that evidently resulted in greater number of capsules $plant^{-1}$. Similar results were also obtained by Mamatha *et al*. (2017) and Saren *et al*. (2004).

Seed yield :

Irrespective of sources of Sulphur seed yield increased progressively with increase in Sulphur dose from 15 to 45 kg/ha and the increase was significant at 45 kg/ha over 15 kg/ha. Seed yield (587 kg/ha) was significantly higher at 45 kg/ha through Gypsum (T_7) than at 15 kg S/ha through Gypsum (485 kg/ha), Sulphur Bentonite (481 kg/ha) and recommended NPK (405 kg/ha). Application of sulphur resulted in improved growth and yield parameters and therefore, finally increased the seed yield. These findings are in accordance with the earlier reports of Swapan kumar paul *et al*. (2008), Raja *et al*. (2007) and Jadav *et al*. (2010). The lower sesame seed yield recorded under control treatment might be due to the limited availability of sulphur nutrient in soil. The results are in line with Longkumer and Gohain (2012).

Economics:

The data regarding economics and B:C ratio of sesame are presented in Table 1. Economics of different treatments were calculated on the basis of market prices of inputs used during those particular years. Results indicated that, application of 45 kg S ha^{-1} through Gypsum (T_7) recorded higher gross returns (Rs.46920 ha^{-1}) closely followed by T_4 *i.e.*, T_1 + 45kg S ha^{-1} through Sulphur Bentonite (Rs.46232 ha^{-1}). This might be due to higher seed yield. Sulphur application at 45 and 30 kg ha^{-1} through gypsum recorded significantly higher net returns (Rs. 33365 and 31963 ha^{-1}, respectively) and B: C ratio (2.47 and 2.38, respectively) than Sulphur Bentonite and recommended NPK (1.47). This might be due to its higher seed yield and lower cost of cultivation of sesame. Lower net returns and B:C ratio of elemental sulphur was due to higher cost of cultivation. These results are in accordance with the findings of Deshmukh *et al*. (2010), Parmar *et al*. (2018) and Verma *et al*. (2014).

Conclusion:

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. Present study indicated that sulphur has a synergistic effect on the yield and yield attributes of sesame. Based on these results it was concluded that application of 30 kg sulphur ha^{-1} through gypsum in addition to recommended dose of NPK was found to be most economical for improving the productivity and profitability of sesame.

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