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Effect of different sources and level of sulphur on quality studies and economics of *kharif* sesamum (*Sesamum indicum* L.)

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Abstract
The field experiment was conducted at Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS) India during the *kharif* season of 2015 to study the response of *kharif* Sesamum (*Sesamum indicum* L.) to different sources and levels of Sulphur. The experiment was laid out in Factorial Randomized Block Design with eight treatment combinations replicated thrice. The results of the study revealed that application of Bensulf as a source of sulphur recorded significantly higher gross as well as net monetory returns compared to other sources. Among the different levels of Sulfur, application of 40 kg S ha^{-1} recorded significantly higher gross monetory returns and net monetory returns over rest of the treatments except the application of 30 kg S ha^{-1} of Sesamum during season.

Keywords: sulphur sources, sulphur levels, growth, quality studies and economics

Introduction

Sesamum indicum L., is one of the most important oilseed crop grown extensively in India. Sesamum is oldest indigenous oil plant with longest history of its cultivation in India. The seed is highly rich in quality proteins and essential amino acids, especially methionine is considered rejuvenate and anti-aging for human body. Sesamum seed is rich source of linoleic acid, vitamins E, A, B_1, B_2 and niacin and minerals including calcium and phosphorus. Sesamum is the tropical and sub-tropical crop. It does well in areas having a warm humid climate with an annual rainfall of about 500 mm.

The main reasons for poor yield are lack of suitable varieties, lack of production inputs, improper management practices and inappropriate cultural operations. Oil crops are sulphur loving plants. A suitable combination of major and micro element affects growth, yield and quality of sesamum. Sulphur application has many advantages for sesamum regarding growth parameters, yield and quality. Sulphur application significantly improves the quality of sesamum oil in terms of free fatty acids, like linolic acids and oleic acids.

Sulphur (S) plays a very vital role in the nutrition of oilseed crops particularly as it is a key element of S containing amino acids. It is a building block of protein and a key ingredient in the formation of chlorophyll. Sulphur performs many important role in the synthesis of proteins, oil and vitamins. It is a constituent of three amino acids (cystine, cysteine and methionine) and thus play vital role for protein production (Takkar,1987). Without adequate S, crops cannot reach their full potential in terms of yield or protein content. Sulphur deficient plants have also less resistance under stress conditions.

Although some reports earlier elucidated the positive effects of S application in improving the productivity and oil quality of sesame but, no comprehensive study has been conducted to evaluate the role of S application in improving the yield and oil quality of sesame planted on calcareous alkaline soils under rainfed conditions. Sulphur as a plant nutrient can play a key role in augmenting the production and productivity of oilseeds in the country as it has a significant influence on quality and development of oilseeds.

Consideration the factors discussed above present investigation was undertaken with a view to study the response of *kharif* Sesamum (*Sesamum indicum* L.) to different sources and level of sulphur.

Material and Methods

The field experiment was conducted during *kharif*, 2015 at experimental farm of Agronomy department, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS). Parbhani is grouped under assured rainfall zone. The average maximum and minimum temperature recorded 31.2 ^{0}C and 22.6 ^{0}C, respectively. The soil was medium deep black and well drained.

The topography of the experimental field was fairly uniform and levelled. The experiment was comprised of a total of eight treatment combinations comprising two sources of sulphur (S_1 Gypsum and S_2 Bensulf) and four levels of sulphur (L_1 10 kg S ha^{-1}, L_2 20 kg S ha^{-1}, L_3 30 kg S ha^{-1} and L_4 40 kg S ha^{-1}) to sesamum during *kharif*, assigned in a factorial randomized block design with three replications. Sulphur application was made to the respective plots at the rate of 10 kg, 20 kg, 30 kg and 40 kg ha^{-1} according to the allocation of treatments at the time of sowing. The source of the material used was gypsum and bensulf analyzing 20% and 13% sulphur respectively. The sulphur per hectare was worked out from the percentage sulphur content of the sources gypsum and bensulf. A common dose of 50 kg N ha^{-1}, 25 kg P_2O_5 ha^{-1} and 25 kg K_2O ha^{-1} through Diammonium phosphate and Urea were applied as basal dose and FYM was also spread uniformly and mixed immediately in the soil before sowing to the all treatment plots. The sesamum crop was sown at a spacing of 45 × 15 cm on 24 June 2015 and harvested on 20 September 2016. The various biometric observations were recorded on five randomly selected sesamum plants from net plots, which were tied tags for their easy identification.

Results and Discussion

Yield Studies

The seed yield of sesamum differed significantly among the sources and levels of sulphur. Source bensulf was proved significantly superior over gypsum source and among the sulphur levels 40 kg S ha^{-1} was significantly superior over 10 and 20 kg S ha^{-1} whereas it was at par 30 kg S ha^{-1}. The sulphur fertilization played a vital role in improving the three major aspects of yield determination *i.e.* formation of vegetative structure there by photosynthesis strong sink strength through development of reproductive structure and production of assimilates to fill economically important sink. Thus cumulative influence of S application maintained balance source-sink relationship and ultimately resulted in increased seed yield. The results were in line with the findings of Ganeshmurthy (1996) and Hussain *et al.*, (2011) [3, 4].

The data on stover yield kg ha^{-1} revealed that it was influenced by different sources as well as levels of sulphur. Among sources, bensulf was significantly superior to gypsum source. In sulphur levels 40 kg S ha^{-1} significantly superior than 10 and 20 kg S ha^{-1} whereas it was at par with 30 kg S ha^{-1}. The biological yield (kg ha^{-1}) was influenced by different sources and levels of sulphur with near about similar pattern. The data on harvest index revealed that the mean harvest index influenced by various sources and levels of sulphur. Among the sources use of bensulf and in case of levels of sulphur, 40 kg S ha^{-1}recorded maximum harvest index over rest of the treatments.

Enhancement in yield attributes like number of capsules per plant, number of seeds per capsule and seed index as a result of sulphur application through gypsum might have resulted into higher seed yield of sesame. The increased stalk yield may be the result of greater accumulation of dry matter under gypsum as a source of sulphur. With regard to yield attributes, sulphur application through gypsum had significant impact on number of capsules per plant, number of seeds per capsule and seed yield over elemental sulphur source. This significant increase in dry matter accumulation and yield attributing characters under gypsum might be attributed to the higher solubility and easy availability of SO_4^{-2} sulphur present in gypsum as compared to “sulphide” form of sulphur present in elemental sulphur which essentially requires its oxidation to be converted into SO_4^{-2} form of sulphur prior to be finally absorbed by the plant. Results of Pati *et al.*, (2011) [6] also revealed that grain, stover and biological yield of sesame increased significantly with the source supplying SO_4-2 -S. Application of sulphur 40 kg ha^{-1}, owing to availability of more nutrients for plant growth, ultimately resulted in enhanced dry matter accumulation per plant and yield. These findings are coinciding with the findings of Singh (2001) [9].

Quality studies

Mean oil and protein per cent in seed (Table 2) were influenced by various sources and levels of sulphur. Use of bensulf as source produced significantly more oil per cent and oil yield over gypsum and among the different levels of sulphur, application of 40 kg S ha^{-1} was significantly superior than 10 and 20 kg S ha^{-1} whereas it was at par with 30 kg S ha^{-1}. These results are in line with those reported by Raja *et al.*, (2007) and Duhoon *et al.*, (2005) [8, 2].

Protein per cent and protein yield increased with application source bensulf over gypsum and among the levels 40 kg S ha^{-1} was significantly superior than 10 and 20 kg S ha^{-1} whereas it was at par with 30 kg S ha^{-1}. Use of 40 kg S ha^{-1} recorded maximum protein and oil content and it might be due to the role of sulphur in enhancing synthesis of amino acids. These findings are in conformity with the findings of Pavani *et al.*, (2013) [7].

Economics

The response of sulphur sources on gross and net monetary returns was found to be significant. The significantly higher gross and net monetary returns were received with the source bensulf as compared to the gypsum.

The effect of levels of sulphur on gross and net monetary returns was found to be significant. The gross and net monetary returns was obtained maximum with the application of 40 kg S ha^{-1} which was significantly superior over rest of the treatments and at par with 30 kg S ha^{-1}. The source bensulf recorded significantly higher net monetary returns as compared to the gypsum source.

Maximum net monetary returns were obtained with the application of 40 kg S ha^{-1} which was significantly superior over rest of the treatments and at par with 30 kg S ha^{-1}. This might be due to optimum seed yield, stover yield, price of produce and cost of cultivation. Similar results were obtained by Chaplot *et al.*, (1996) [1]. The highest benefit: cost ratio was recorded in the source bensulf as compared to the source gypsum, while among the levels of sulphur, application of 40 kg S ha^{-1} to sesamum crop recorded higher benefit: cost ratio and 10 kg S ha^{-1} level recorded lowest benefit: cost ratio. Similar line of results were reported by Chaplot *et al.*, (1996) [1].

Table 1: Yield and economics of sesamum as influenced by different treatments

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Gross monetary return (Rs ha^{-1})	Net monetary return (Rs ha^{-1})	Benefit cost ratio
Sources of sulphur					
S_1- Gypsum	476	1448	24503	10732	1.78
S_2- Bensulf	533	1604	27452	13028	1.90
S.E. ±	15	44	742.60	743	-
C. D. (P=0.05)	44	133	2252	2252	-
Levels of sulphur					
L_1- 10kg S ha^{-1}	421	1291	21712	7786	1.56
L_2- 20kg S ha^{-1}	490	1474	25245	11494	1.84
L_3- 30kg S ha^{-1}	539	1611	27739	13470	1.94
L_4- 40kg S ha^{-1}	567	1728	29213	14770	2.02
S.E. ±	21	62	1050	1050	-
C. D. (P=0.05)	63	188	3185	3185	-
Interaction					
S.E. ±	29	88	1485	1485	-
C. D. (P=0.05)	NS	NS	NS	NS	-
General Mean	504	1526	25977	11880	1.84

Table 2: Quality studies of sesamum as influenced by different treatments

Treatments	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
Sources of sulphur				
S_1- Gypsum	49.27	235	19.48	93
S_2- Bensulf	49.75	266	19.99	107
S.E. ±	0.15	7	0.13	3
C. D. (P=0.05)	0.46	22	0.39	9
Levels of sulphur				
L_1- 10kg S ha^{-1}	48.75	206	19.08	81
L_2- 20kg S ha^{-1}	49.45	244	19.53	96
L_3- 30kg S ha^{-1}	49.68	268	19.98	108
L_4- 40kg S ha^{-1}	50.15	284	20.33	115
S.E. ±	0.21	11	0.18	4
C. D. (P=0.05)	0.65	32	0.55	12
Interaction				
S.E. ±	0.30	15	0.26	6
C. D. (P=0.05)	NS	NS	NS	NS
General Mean	49.51	250	19.73	100

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