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Economics, quality and nutrient uptake of sesame [*Sesamum indicum* L.] as response of varieties to varying levels of sulphur fertilization

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Abstract

A field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif*¸ 2015 on loamy sand soil. The experiment comprising of four levels of sulphur (0, 20, 40 and 60 kg/ha) and four sesame varieties (RT-125, RT-127, RT-346 and RT-351) thereby making 16 treatment combinations was laid out in randomized block design and replicated thrice.

Results revealed that N, P and S concentration in seed and stalk, their uptake, protein and oil content in seed and oil yield were improved significantly upto 40 kg S/ha. Being at par with 60 kg/ha, sulphur fertilization at 40 kg/ha also fetched 12.7 and 64.2% more net returns over 20 kg/ha and control, respectively. The maximum sulphur use efficiency was recorded when its level was raised from 0 to 20 kg/ha.

It is further apparent from the data that N and P concentration in seed and stalk of sesame was not influenced significantly due to different varieties while S concentration in seed is significantly higher in RT-351 than the other varieties. It also represented significant improvement is nutrient uptake, oil content in seed and oil yield and fetched the maximum net returns of ₹52073/ha with the highest B: C ratio (2.74) among all the varieties. Application of sulphur at 49.19 kg/ha was found as the optimum dose for sesame as derived from response function.

Keywords: Sesame, net return, B: C ratio, Nutrient uptake, protein content, oil content

1. Introduction

Oilseeds are the main source of fat and protein, particularly for vegetarians. Sesame or gingelly (*Sesamum indicum* L.) commonly known as til also called as "queen of oilseeds" has been known to be one of the earliest domesticated edible oilseeds used by the mankind. The crop is grown in wide range of environments extending from semi-arid tropics and sub-tropics to temperate regions.

Sesame is an important edible oilseed crop next to groundnut and rapeseed-mustard. Its oil content generally varies from 46 to 52% and protein from 18 to 20%. Nearly 73% of the oil is used for edible purposes, 14.5% for domestic uses including preparation of sweet candies as condiments, culinary and confectionary purposes, whereas 8.3% for hydrogenization and 4.2% for industrial purposes in the manufacture of paints, perfumed oils, pharmaceuticals and insecticides. Sesame oil is also used in soap, cosmetic and skin care industries. It has anti-bacterial, anti-viral, anti-fungal and anti-oxidant properties. Since, sesame oil is cholesterol free, it is also used in food industries and recommended for heart patients.

The oil is highly resistant to oxidative rancidity and is characterized for its stability and quality. Because of excellent quality characters, it is also sometimes referred to as "poor mans substitute for ghee''. Sesame cake or meal obtained as a by-product of oil milling industry is rich source of protein, carbohydrates, vitamin niacin and mineral nutrients such as Ca and P. The oil cake is an edible cake, rich in methionine, cystein, arginine and tryptophan. It is used as cattle feed especially for milch animals. It is being used as a valuable ingredient upto 5% in well formulated poultry feed. Cake contains 6.0-6.2% N, 2.0-2.2% P_2O_5 and 1.0-1.2% of K_2O and can be used as manure. Despite of being such an important sesame growing state, the average productivity is very low in comparison to global as well as national level. Sulphur plays an important role in many physiological processes of plant like synthesis of sulphur containing amino acids (cystine, cystein and methionine), vitamins (biotin and thiamine), co-enzyme-A and chlorophyll and metabolism of carbohydrates, protein and fats. It also helps in synthesis of glucosides in sesame oil and increasing the oil quality of oilseed crops. Sulphur also has an essential role in development of root system and increases drought and cold tolerance in oilseeds due to disulphide linkage. It helps in control of diseases and pests and hastens the decomposition of crop residues.

Available sulphur in soil usually does not exceed 10-15 ppm and is frequently lower than 5-10 ppm in light textured soil of Rajasthan. Response of sulphur through gypsum is most readily achieved since, its sulphur content is already in available SO_4^{2-} form. Slow oxidation of elemental sulphur assumes considerable importance especially in light textured soil where both the sources are compared. The direct source of sulphur is elemental sulphur which is not only costly but unavailable also. The locally available material is gypsum and is being abundantly excavated in the state of Rajasthan. It is wise to select either of the two which is relatively inexpensive and more effective.

Materials and methods

A field experiment was conducted during *kharif* season of the year 2015 at Agronomy farm, S.K.N. College of Agriculture, Jobner to find out the economics, quality and nutrient uptake of sesame [*Sesamum indicum* L.] as response of varieties to varying levels of sulphur fertilization. The average rainfall of this tract varies from 350 mm to 400 mm most of which is received during the period of July to September. The soil of experimental field was loamy sand in texture, alkaline in reaction (pH 8.2), low in organic carbon (0.18%), available nitrogen (132.4 kg/ha), available sulphur (8.5 mg/kg) available phosphorus (18.25 kg P_2O_5/ha) and medium in available potassium (144.26 kg K_2O/ha) content. The experiment comprised four levels of sulphur (0, 20, 40 and 60 kg/ha) and four sesame varieties (RT-125, RT-127, RT-346 and RT-351) thereby making sixteen treatment combinations that were laid down in randomized block design and replicated thrice. The Sesame varieties were sown on 2 July, 2015 using a seed rate of 4 kg/ha in the rows spaced at 30 cm apart. Two irrigation was given to protect the crop from moisture stress. The crop was harvested on 26 September, 2015. The economics of the crop was calculated on the basis of prevailing market price at the time of selling of the produce. For quality and nutrient uptake the samples were collected at the time of threshing and analysed in the laboratory by using standard procedures. Statistical analysis of the data was carried out using standard analysis of variance technique (Fisher, 1950) [1].

Result and Discussion

Based on the results it may be concluded that Soil application of sulphur at 40 kg/ha was found the most suitable dose for obtaining higher net returns (₹50938/ha) and B: C ratio (2.67) in sesame. Similarly, RT-351 was found the most superior variety of sesame wherein, the maximum seed yield (789 kg/ha), net returns (₹52073/ha) and B: C ratio (2.74) were recorded. Variety RT-351 recorded the significantly higher oil content in seed as compared to RT-127 and RT-125. Data indicated that increasing levels of sulphur fertilization in sesame significantly enhanced the N,P and S concentration in seed upto 40 kg/ha and stalk upto 20 kg/ha However, the highest concentration in seed and stalk was obtained at 60 kg/ha. Further examination of the data indicated that different varieties did not differ significantly with respect to nitrogen and Phosphorus concentration in seed and stalk of sesame crop at harvest stages. All the varieties of sesame differed significantly with respect to sulphur concentration in sesame seed. Remaining at par with each other, sesame varieties RT-346 and RT-127 were noted to attain significantly higher S concentrations in seed. The highest concentration was recorded under the variety RT-351 that was significantly higher as compared to RT-127 and RT-125, respectively. Sulphur concentration in stalk was not influenced significantly due to different varieties. Total uptake of nitrogen by crop exhibited profound increase due to sulphur fertilization. Application of sulphur at 40 kg/ha resulted in the total uptake of 57.93 kg N/ha and thus increased it to the extent of 39.8 and 63.6% over 20 kg/ha and control, respectively. Application of 60 kg S/ha also recorded 22.2 and 70.7% more uptake of total N as compared to 20 kg/ha and control, respectively and thus proved equally effective to 40 kg/ha. Table 4.9 and fig.4.7 sesame varieties differed significantly with respect to total N uptake. The highest uptake of 57.3 kg N/ha was recorded under the variety RT-351 indicating a significant increase of 6.7, 12.8 and 28.8% over RT-346, RT-127 and RT-125 varieties, respectively. Being at par with each other, RT-346 and RT-127 also registered a quantum increase of 6.72 and 6.29 kg N/ha over RT-125, respectively and thus observed as the next better varieties in enhancing N uptake by crop. It is clear from the data presented in table 4.10 and fig. 4.7 that every addition in graded level of sulphur upto 40 kg/ha resulted in significantly higher uptake of phosphorus over lower levels. All the varieties of sesame recorded significantly higher uptake of phosphorus than RT-125 (Table 4.10 and fig. 4.7). Remaining at par with each other, RT-346 and RT-127 improved the total uptake of P by 16.7 and 13.5% over RT-125, respectively. The maximum uptake of 10.9 kg P/ha was obtained under RT-351 that was higher by 1.07, 1.3 and 2.46 kg/ha over RT-351, RT-127 and RT-125, respectively. It was observed that total uptake of sulphur by crop was improved considerably with every increase in level of sulphur upto 40 kg/ha (Table 4.11 and Fig. 4.7). Further increase in level of sulphur to 60 kg/ha also recorded significantly higher uptake of total sulphur. However, it was found statistically at par with 40 kg S/ha. Significant difference in total uptake of S was noted under different varieties of sesame (Table 4.11 and Fig. 4.7). Variety RT-346 and RT-127 recorded the total uptake of 5.13 and 4.94 kg S/ha. Remaining at par with each other, these varieties improved the uptake by margin of 31.4 and 18.5% over RT-125. The maximum uptake of 5.69 kg S/ha was obtained under RT-351 thereby increasing it to the extent of 15.2 and 31.4% over RT-127 and RT-125, respectively. It is clear from the data that application of sulphur at 40 kg/ha significantly improved the crude protein, Oil content and oil yield in sesame seed as compared to 20 kg/ha and control, respectively. Further increase in level of sulphur to 60 kg/ha was found to exhibit the highest protein content, oil content and oil yield but the difference between these two levels was not upto the level of significance. Results showed that none of the sesame variety could bring variation in crude protein content of sesame seed upto the levels of significance further study of data showed that varieties of sesame differed significantly with respect to oil content and oil yield in their seed. The maximum oil content and oil yield was observed under the variety RT-351 which represented a significant increase of% over RT-127 and RT-125, respectively. However, it showed statistical similarity with RT-346 which also recorded higher oil content and oil yield than RT-125. The variety RT-125 was also found at par with RT-346 in this quality attribute of sesame. A comparison of data presented in revealed that agronomic efficiency, apparent recovery and physiological efficiency of applied sulphur in sesame showed negative response with increasing levels of sulphur. Raising the level of sulphur from control to 20 kg/ha recorded the highest agronomic efficiency, apparent recovery and physiological efficiency in sesame. Afterwards, it showed significant decline upto 60 kg/ha, wherein, the lowest agronomic efficiency, apparent recovery and physiological efficiency was recorded. It is also apparent from the data that sesame varieties differed significantly with respect to agronomic efficiency and apparent recovery of sulphur wherein the highest efficiency was obtained under the variety RT-351 which was significantly higher than rest of the varieties. Remaining at par with each other, RT-346 and RT-127 also resulted significant improvement of in agronomic efficiency and apparent recovery of sulphur as compared to RT-125, respectively. Further study of data (Table 4.13) revealed that the physiological efficiency of sulphur in sesame did not differ significantly among different varieties. The lesser oil content and oil yield obtained with other varieties was the result of lower percentage of oil along with the lesser seed yield. Results obtained by Kewat *et al.* (2009) [2] in sesame clearly showed that sesame varieties varied significantly in their oil content. Sulphur synthesized some sulphur containing amino acids like cystine, cystein and methionine and resulted in higher protein content which is in accordance with the findings of Saren *et al.* (2004) [6]. These results are also in agreement with the findings of Vaiyapuri *et al.* (2003) [7] and Maragatham et *al.* (2006) [5]. Higher uptake of N, P and S is directly associated with the higher nutrient concentration and increased seed and stalk yields due to application of sulphur. Several workers have also reported higher N, P and S concentrations and uptake due to S application (Kumar and Trivedi 2008 and Mona, 2013) [3, 4].

Table 1: Effect of sulphur fertilization and varieties on N concentration in seed and stalk of sesame and its uptake

Treatments	N concentration (%)		Total N uptake (kg/ha)
	Seed	Stalk	
Sulphur levels (kg/ha)			
Control	2.64	1.05	35.6
20	3.05	1.20	49.7
40	3.35	1.27	57.9
60	3.44	1.31	60.7
SEm ±	0.06	0.03	1.33
CD (P=0.05)	0.19	0.08	3.83
Varieties			
RT-125	3.07	1.18	44.5
RT-127	3.16	1.21	50.8
RT-346	3.07	1.20	51.2
RT-351	3.18	1.24	57.3
SEm ±	0.06	0.03	1.33
CD (P=0.05)	NS	NS	3.83
CV (%)	7.17	7.89	9.01

NS: Non significant

Table 2: Effect of sulphur fertilization and varieties on P concentration in seed and stalk of sesame and its uptake

Treatments	P concentration (%)		Total P uptake (kg/ha)
	Seed	Stalk	
Sulphur levels(kg/ha)			
Control	0.605	0.176	6.86
20	0.711	0.199	9.72
40	0.735	0.205	10.86
60	0.752	0.213	11.37
SEm ±	0.014	0.004	0.24
CD (P=0.05)	0.041	0.011	0.70
Varieties			
RT-125	0.683	0.195	8.44
RT-127	0.705	0.197	9.62
RT-346	0.698	0.199	9.85
RT-351	0.715	0.202	10.92
SEm ±	0.014	0.004	0.24
CD (P=0.05)	NS	NS	0.70
CV (%)	7.09	6.45	8.62

NS: Non significant

Table 3: Effect of sulphur fertilization and varieties on S concentration in seed and stalk of sesame and its uptake

Treatments	S concentration (%)		Total S uptake (kg/ha)
	Seed	Stalk	
Sulphur levels (kg/ha)			
Control	0.162	0.135	3.64
20	0.188	0.152	4.94
40	0.197	0.160	5.60
60	0.210	0.166	5.91
SEm ±	0.004	0.004	0.14

CD (P=0.05)	0.012	0.010	0.40
Varieties			
RT-125	0.182	0.148	4.33
RT-127	0.186	0.153	4.94
RT-346	0.191	0.155	5.13
RT-351	0.198	0.158	5.69
SEm ±	0.004	0.004	0.14
CD (P=0.05)	0.012	NS	0.40
CV (%)	7.50	8.06	9.63

NS: Non significant

Table 4: Effect of sulphur fertilization and varieties on protein and oil content in sesame seed and oil yield

Treatments	Protein content (%)	Oil content (%)	Oil yield (kg/ha)
Sulphur levels (kg/ha)			
Control	16.50	44.03	245.6
20	19.06	47.51	342.3
40	20.94	50.75	395.9
60	21.50	51.11	403.9
SEm ±	0.53	1.08	9.36
CD (P=0.05)	1.53	3.12	27.02
Varieties			
RT-125	19.19	46.44	289.0
RT-127	19.75	47.89	337.2
RT-346	19.19	49.79	358.6
RT-351	19.88	51.18	402.9
SEm ±	0.53	1.08	9.36
CD (P=0.05)	NS	3.12	27.02
CV (%)	9.43	7.73	9.24

NS: Non significant

Table 5: Effect of sulphur fertilization and varieties on sulphur use efficiency in sesame

Treatments	AEs (kg seed/kg S)	Res (%)	PEs (kg/kg S)
Sulphur levels(kg/ha)			
Control	-	-	-
20	8.11	6.43	126.28
40	5.54	4.91	112.89
60	3.86	3.88	99.57
SEm ±	0.15	0.14	2.97
CD (P=0.05)	0.43	0.39	8.56
Varieties			
RT-125	3.84	3.27	86.54
RT-127	4.35	3.73	85.67
RT-346	4.45	3.90	83.83
RT-351	4.86	4.33	82.71
SEm ±	0.17	0.16	3.42
CD (P=0.05)	0.50	0.45	NS
CV (%)	8.91	9.21	9.10

AEs = Agronomic efficiency of sulphur (kg seed/kg S)
REs = Apparent recovery of sulphur (%)
PEs = Physiological efficiency of sulphur (kg seed /kg uptake of S)

Table 6: Effect of sulphur fertilization and varieties on net returns and B: C ratio in sesame

Treatments	Net returns (`/ha)	B:C ratio
Sulphur levels(kg/ha)		
Control	31440	1.69
20	45818	2.43
40	50938	2.67
60	51630	2.68
SEm ±	1071.67	0.05
CD (P=0.05)	3094.80	0.15
Varieties		
RT-125	37174	1.96
RT-127	44561	2.35
RT-346	46017	2.42

RT-351	52073	2.74
SEm ±	1071.67	0.05
CD (P=0.05)	3094.80	0.15
CV (%)	8.26	7.59

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