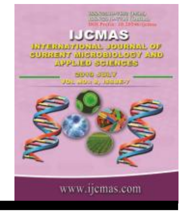
Int.J.Curr.Microbiol.App.Sci (2019) *8*(7): 757-764

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 07 (2019)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2019.807.091

Effect of Different Sources and Levels of Sulphur on Safflower (*Carthamus tinctorius* L.)

V.U. Divya*

Department of Agronomy, Palli Siksha Bhavana, Visva-Bharati University, West Bengal, India

**Corresponding author*

A B S T R A C T

Keywords

Sulphur, Safflower, Zinc sulphate, Elemental sulphur, Single super phosphate

Article Info

Accepted:
07 June 2019
Available Online:
10 July 2019

A field experiment was carried out during *rabi*seas on of 2016-17 at the Agricultural College Farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati University, Sriniketan, Birbhum, West Bengal, India to study the effect of different sources and levels of sulphur on safflower. Experimental findings revealed that the use of different sources and levels of sulphur had significant effect in influencing the growth parameters, yield attributes. Among the levels and sources of Sulphur, $ZnSO_4$ @ 40 kg S ha^{-1} resulted maximum growth parameters, yield attributes and yield of safflower. Application of zinc sulphate recorded 33.2 % and 14.4 % more seed yield over single super phosphate and elemental sulphur respectively.

Introduction

Safflower (*Carthamus tinctorius* L.) is an important rabi oilseed crop, grown in India since time immemorial predominantly in peninsular regions of the country. There are approximately 25 valid species in the genus, of which only *C. tinctorius* is the cultivated type, having 2n = 24 chromosomes. Though India has achieved a breakthrough in production of food grains mainly through wheat and rice, it is yet to achieve self-sufficiency in the yield and production of oil seeds and pulses. Safflower has a deep root system allowing the plant to utilize efficiently the nutrients that may not be available to small-grain crops (Tanaka and Merrill, 1998). Safflower plants are hardy in nature and have a capacity to withstand drought conditions hence it is grown successfully in rainfed condition (Knowles and Miller, 1965). It is becoming popular among the farmers because of its drought tolerance, short duration, deep tap root system, cultivable on all types of soil, well adaptation to dry and saline land conditions and commercial value. Dense root structure can improve soil tilth and porosity. Roots also add to organic matter, improving soil water holding capacity. The deficiency of secondary and micronutrients is wide spread in many parts of the country due to cultivation of high-yielding varieties, intensive agriculture and increasing use of sulphur-free fertilizers in large quantities with concomitant decrease in use of organic manures. In recent years, nutrient management is one of the critical inputs in achieving high productivity of safflower (Mundel *et al.,* 2004). Sulphur is accumulated in plants in low concentrations compared to N, but is an essential element as a constituent of proteins, cysteine-containing peptides such as glutathione, or numerous secondary metabolites (Scherer *et al.,* 2008). For oilseed crop producers, sulphur containing fertilizer is important because oilseed crops require more sulphur than cereals. Sulphur is very crucial for the formation of sulphur containing amino acids and oil synthesis (Gangadhara *et al.,* 1990). The biochemical oxidation of sulphur produces H_2SO_4 which decreases soil pH and solubilizes $CaCO_3$ in alkaline calcareous soils to make more favorable soil conditions for plants growth including the availability of plant nutrients (Abdou, 2006). Erdal *et al.,* (2006) reported that soil pH decreased with the application of S, resulting in increases in nutrient concentration, plant nutrient uptake, chlorophyll concentration, root nodules and dry matter production

Hence, an attempt was made to study the effect of sulphur levels and sources on growth, yield and nutrient uptake parameters of safflower (*Carthamus tinctorius* L.) under irrigated condition at the agriculture farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal during the winter (November-December) season of 2016-2017.

Materials and Methods

This experiment has been conducted in the semi-arid, sub-humid, sub-tropical lateritic belt of West Bengal. Maximum and minimum temperature of the growing season varied from 27 to 41.8, 6.4 to 23.64 respectively and maximum and minimum RH of the growing season varied from 76 to 96.00, 18 to 72 respectively. Mean sunshine hours during growing season was 6.24 hrs day^{-1}. Rainfall received during the entire growing season was 9.24 mm. The experiment was laid out in a randomized block design. The treatments consisted of three sources and three levels of sulphur along with control plot. There were 10 treatments and each treatment was replicated thrice giving a total of 30 unit plots each measuring 3 m x 2 m. The treatments consisted of three different sources of sulphur (viz.; Single super phosphate, elemental Sulphur and zinc sulphate) and three levels of sulphur (20, 40 and 60 kg S ha^{-1}) and one control. Lime application was done to correct pH since the soil is acidic soil. The full dose of sulphur was applied from different sources of sulphur *i.e.* single super phosphate, zinc sulphate and elemental sulphur at 20, 40 and 60 kg S ha^{-1} at the time of sowing as per treatment combinations. The recommended dose of nitrogen, phosphorus and potassium were applied at the rate of 40:20:20 kg N, P_2O_5 and K_2O per hectare in the form of urea, di ammonium phosphate and muriate of potash after taking into consideration of the contribution of P_2O_5 from single super phosphate. Urea was given in two split doses. First dose was given at the time of sowing and second dose was given one month after sowing. For recording various biometric observations, a sample size consisting of five plants from each treatment was selected randomly. From the samples, observations on various growth, morphological, yield and yield components were recorded at different stages of plant growth (30 DAS, 60 DAS, 90 DAS and at harvest).

Results and Discussion

At 30 DAS, on an average zinc sulphate recorded maximum (9.3 cm) plant height, maximum (3.08 g m^{-2}) dry matter accumulation followed by elemental sulphur and SSP. Application of zinc sulphate, 40 kg S ha^{-1} resulted highest (10.4 cm) plant height, highest dry matter accumulation (3.54 g m^{-2}) followed by 60 kg S ha^{-1} and 20 kg S ha^{-1}. At 60 DAS, on an average, zinc sulphate resulted highest (24.3 cm) plant height, highest number of branches (14.19), highest dry matter accumulation (15.3 g m^{-2}) followed by elemental sulphur and SSP. Application of zinc sulphate, 40 kg S ha^{-1} recorded highest (35.5 cm) plant height, highest (15.83) number of branches, highest (17.68 g cm^{-2}) dry matter accumulation followed by 60 kg S ha^{-1} and 20 kg S ha^{-1}. At 90 DAS, on an average, zinc sulphate resulted highest (65.1 cm) plant height, highest number of branches (14.3), highest dry matter accumulation (115.21 g m^{-2}) followed by elemental sulphur and SSP. Application of zinc sulphate, 40 kg S ha^{-1} recorded highest (73.5 cm) plant height, highest (15.9) number of branches, highest (133.2 g cm^{-2}) dry matter accumulation followed by 60 kg S ha^{-1} and 20 kg S ha^{-1}. From 30–60 DAS, on an average, maximum (0.41 g m^{-2} day^{-1}) CGR observed with zinc sulphate followed by elemental sulphur and SSP. Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (0.47 g m^{-2} day^{-1}) CGR followed by 60 and 20 kg S ha^{-1}.From 60–90 DAS, on an average, maximum (0.77 g m^{-2} day^{-1}) CGR observed with zinc sulphate followed by elemental sulphur and SSP. Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (0.89 g m^{-2} day^{-1}) CGR followed by 60 and 20 kg S ha^{-1}. Increase in growth might be ascribed to better root formation due to sulphur, which in turn activated highest absorption of N, P, K and sulphur from soil and improved metabolic activity inside the plant (Kalaiyarasan *et al.*, 2003). The fact was also supported by (Rao, 2009), (Debnath and Basu, 2013), (Singh and Thenua, 2016). Among levels of sulphur, 40 kg S ha^{-1} was giving higher number of branches compared to other levels of sulphur. Nathan, (2015), Singh and Thenua, (2016), Shekhargouda *et al.*, (1997) also reported similarly regarding levels of sulphur application.

In respect to, number of capitula per plant, on an average, maximum (17.03) number of capitula $plant^{-1}$ observed with zinc sulphate followed by elemental sulphur and SSP. Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (21.9) capitula $plant^{-1}$ followed by 60 and 20 kg S ha^{-1}.This result is in accordance with Rao, (1991), Singh and Thenua, 2016 and Nathan, (2015).

The data in relation to number of seeds $capitulum^{-1}$ showed that, on an average, maximum (17.03) number of capitula $plant^{-1}$ observed with zinc sulphate followed by elemental sulphur and SSP. Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (23.43) seeds $capitulum^{-1}$ followed by 60 and 20 kg S ha^{-1}. Application of sulphur increased the plant growth by increasing the assimilating surface area. The highest photosynthates assimilation helped in net export of carbon to sink and thus increased the number of seeds $capitulum^{-1}$ (Shekhawat and Shivay, 2008).

In respect to test weight, proved that, on an average, maximum (30.67g) test weight observed with zinc sulphate followed by elemental sulphur and SSP. Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (31.7 g) test weight followed by 60 and 20 kg S ha^{-1}. This fact was also supported by Nathan (2015) regarding levels of sulphur.

In respect to, seed yield (kg ha^{-1}), on an average, maximum (730 kg ha^{-1}) seed yield observed with zinc sulphate followed by elemental sulphur and SSP (Table 1–6).

Table.1 Effect of different sources and levels of sulphur on plant height of safflower

Treatments	Plant height (cm)		
	30DAS	60DAS	90DAS
Control (no sulphur)	6.5	11.3	44.6
SSP @20 kg S ha^{-1}	7.1	14.8	54.5
SSP@ 40 kg S ha^{-1}	7.5	16.6	57.9
SSP @ 60 kg S ha^{-1}	7.3	15.6	55.4
Zinc sulphate @ 20 kg S ha^{-1}	7.7	16.8	57.8
Zinc sulphate @ 40 Kg S ha^{-1}	10.4	35.5	73.5
Zinc sulphate @ 60 kg S ha^{-1}	9.9	20.7	64.0
Elemental sulphur @ 20 kg S ha^{-1}	7.5	16.7	56.3
Elemental sulphur @ 40 kg S ha^{-1}	9.0	20.3	62.0
Elemental sulphur @ 60 kg S ha^{-1}	8.1	18.9	60.7
S Em (±)	0.8	2.1	4.7
CD (*p*=0.05)	2.3	6.3	14.0

Table.2 Effect of different sources and levels of sulphur on number of branches of safflower at different days after sowing (DAS)

Treatments	Number of branches per plant		
	60DAS	90DAS	At harvest
Control (no sulphur)	7.33	7.5	7.20
SSP @20 kg S ha^{-1}	7.73	7.9	11.6
SSP@ 40 kg S ha^{-1}	11.1	11.2	12.9
SSP @ 60 kg S ha^{-1}	7.9	8.1	12.1
Zinc sulphate @ 20 kg S ha^{-1}	11.7	11.7	13.8
Zinc sulphate @ 40 Kg S ha^{-1}	15.8	15.9	21.9
Zinc sulphate @ 60 kg S ha^{-1}	15.1	15.3	15.4
Elemental sulphur @ 20 kg S ha^{-1}	9.6	9.9	12.5
Elemental sulphur @ 40 kg S ha^{-1}	14.8	14.9	14.13
Elemental sulphur @ 60 kg S ha^{-1}	12.7	12.7	13.67
S Em (±)	1.27	1.3	1.52
CD (*p*=0.05)	3.78	3.7	4.52

Table.3 Effect of different sources and levels of sulphur on dry matter accumulation of safflower at different days after sowing (DAS)

Treatments	Dry matter accumulation (gm^{-2})		
	30DAS	60DAS	90 DAS
Control (no sulphur)	1.83	9.16	49.1
SSP @20 kg S ha^{-1}	2.21	11.06	80.8
SSP@ 40 kg S ha^{-1}	2.46	12.32	95.0
SSP @ 60 kg S ha^{-1}	2.27	11.34	92.2
Zinc sulphate @ 20 kg S ha^{-1}	2.73	13.66	104.5
Zinc sulphate @ 40 Kg S ha^{-1}	3.54	17.68	133.2
Zinc sulphate @ 60 kg S ha^{-1}	2.98	14.55	109.7
Elemental sulphur @ 20 kg S ha^{-1}	2.39	11.97	93.9
Elemental sulphur @ 40 kg S ha^{-1}	2.87	14.37	108.1
Elemental sulphur @ 60 kg S ha^{-1}	2.82	14.09	107.0
S Em (±)	0.21	0.997	7.4
CD (*p*=0.05)	0.62	2.962	21.9

Table.4 Effect of different sources and levels of sulphur on crop growth rate (CGR) of safflower

Treatments	CGR(30DAS-60DAS) (g m $^{-2}$day^{-1})	CGR (60 DAS-90DAS) (g m $^{-2}$day^{-1})
Control (no sulphur)	0.24	0.31
SSP @20 kg S ha^{-1}	0.29	0.54
SSP@ 40 kg S ha^{-1}	0.33	0.64
SSP @ 60 kg S ha^{-1}	0.30	0.62
Zinc sulphate @ 20 kg S ha^{-1}	0.36	0.70
Zinc sulphate @ 40 Kg S ha^{-1}	0.47	0.89
Zinc sulphate @ 60 kg S ha^{-1}	0.40	0.73
Elemental sulphur @ 20 kg S ha^{-1}	0.32	0.63
Elemental sulphur @ 40 kg S ha^{-1}	0.38	0.72
Elemental sulphur @ 60 kg S ha^{-1}	0.38	0.71
S Em (±)	0.03	0.057
CD (*p*=0.05)	0.08	0.17

Table.5 Effect of different sources and levels of sulphur on yield attributes of safflower

Treatments	Number of capitula plant^{-1}	Number of seeds capitulum^{-1}	Test weight (g)
Control (no sulphur)	7.1	15.37	23.6
SSP @20 kg S ha^{-1}	11.6	15.47	26.4
SSP@ 40 kg S ha^{-1}	12.9	16.63	29.2
SSP @ 60 kg S ha^{-1}	12.1	16.60	27.9
Zinc sulphate @ 20 kg S ha^{-1}	13.8	18.60	29.5
Zinc sulphate @ 40 Kg S ha^{-1}	21.9	23.43	31.7
Zinc sulphate @ 60 kg S ha^{-1}	15.4	23.40	30.8
Elemental sulphur @ 20 kg S ha^{-1}	12.5	16.63	28.8
Elemental sulphur @ 40 kg S ha^{-1}	14.3	21.53	30.7
Elemental sulphur @ 60 kg S ha^{-1}	14.1	20.57	30.4
S Em (±)	1.6	1.994	2.3
CD (*p*=0.05)	4.6	5.924	6.8

Table.6 Effect of different sources and levels of sulphur on seed yield, stalk yield and harvest index of safflower

Treatments	Seed yield (Kg ha^{-1})	Stover yield (Kg ha^{-1})	Harvest index (%)
Control (no sulphur)	433.3	1590.0	20.7
SSP @20 kg S ha^{-1}	523.3	1940.0	21.5
SSP@ 40 kg S ha^{-1}	583.3	2150.0	21.4
SSP @ 60 kg S ha^{-1}	536.7	2190.0	20.0
Zinc sulphate @ 20 kg S ha^{-1}	646.7	2410.0	21.5
Zinc sulphate @ 40 Kg S ha^{-1}	836.7	2746.67	24.4
Zinc sulphate @ 60 kg S ha^{-1}	706.7	2320.0	23.3
Elemental sulphur @ 20 kg S ha^{-1}	566.7	2280.0	19.9
Elemental sulphur @ 40 kg S ha^{-1}	680.0	2500.0	21.4
Elemental sulphur @ 60 kg S ha^{-1}	666.7	2603.0	20.4
S Em (±)	49.2	210.13	1.8
CD (*p*=0.05)	146.2	624.27	NS

Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (836.7 kg ha^{-1}) seed yield followed by 60 and 20 kg S ha^{-1}. This result is in accordance with Rao, (1991), Kumar *et al.*, 2009 and Singh and Singh, 2014, regarding the result of levels of sulphur used.

Data in relation to stover yield proved that, on an average, maximum (3328 kg ha^{-1}) stover yield observed with elemental sulphur followed by zinc sulphate and SSP. Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (2746 kg ha^{-1}) stover yield followed by 60 and 20 kg S ha^{-1}

Maximum (23.06 %) harvest index (%) recorded with zinc sulphate followed by SSP and elemental sulphur. Among different sulphur levels, application of zinc sulphate, 40 kg S ha^{-1} recorded maximum (24.4 %) harvest index followed by 60 and 20 kg S ha^{-1}. Gokhle, (2004) recorded that both 20 and 40 kg S ha^{-1} produced the same effect. Similar result was obtained by Rao, (1991), Nathan, (2015), Singh and Thenua (2016).This might be due to adequate supply of sulphur helps in preventing floral abortion for potential establishments of larger number of filled seeds (Hocking *et al.,* 1987).

It may be concluded that among the levels and sources of Sulphur, $ZnSO_4$ @ 40 kg S ha^{-1} resulted maximum growth parameters, yield attributes and yield of safflower while in case of sulphur levels, zinc sulphate fertilizer, 40 kg S ha^{-1} was reported superior over 60 kg S ha^{-1} and 20 kg S ha^{-1}, respectively

Acknowledgements

I am glad to convey my deep sense of gratitude and respect to Dr. N. C. Sarkar, Assistant Professor of Agronomy, Palli Siksha Bhavana, Visva-Bharati and Chairman of my advisory committee for his proper and effective guidance.

I express my deep sense to the members of the Advisory Committee Dr. B. Duary Associate Professor of the Department of Agronomy, Dr. P. Ghosh Assistant Professor of Department of a Department of Agronomy, Prof. G. K. Ghosh, Professor of the Department of Soil Science and Agricultural Chemistry, Dr. Kadar Ali Sarkar, Department of EES, Palli Siksha Bhavana for their kind help and valuable suggestions throughout the course of investigation.

I bestow my sincere gratitude to Prof. Ashish Chatterjee, Principal, Palli Siksha Bhavana and Prof. A. K. Barik, Head, Department of Agronomy (in the year 2016-18) for their cordial support and facilities provided for the successful completion of the experiment. I acknowledge my indebtedness to Prof. B. K. Saren, Dr. S.K. Maity, Dr. G. C. Malik, Dr. K. Paramanik, Dr. M. Banerjee, of the Department of Agronomy for their co-operation at various stages of the study. I also record my thanks to the staff members of the Agronomy Department, Agronomy and Soil Science Laboratory, Principal office of Palli Siksha Bhavana.

I must acknowledge Dr. Anup Kumar Das, Farm Manager and other staff members of PSB Agricultural Farm for their generous help and assistance during the entire period of field experiment.

References

Abdou, A.S. (2006). Effect of applied elemental sulfur and sulfur-oxidizing bacteria (*Parococcus versutus*) into calcareous sandy soils on the availability of native and applied phosphorus and some micronutrients. In: 18th World Congress of Soil Science, July 9-15, 2006, Philadelphia, Pennsylvania, USA.

Debnath, S. and Basu, A.K. (2013). Effect of sulphur on seed yield and oil content in safflower. *Journal ofCrop and Weed*, 9(2): 113-114.

Erdal, I., Kepenek, K., and Kizilgoz, I. (2006). Effect of elemental sulphur and sulphur containing waste on the iron nutrition of strawberry plants grown in a calcareous soil. *Biological Agriculture and Horticulture*, 23: 263-272.

Gangadhara, G.A., Manjunathaiah, H.M. and Satyanarayana, T. (1990). Effect of sulphur on yield, oil content of sunflower and uptake of micronutrients by plants. *Journal of the Indian Society of Soil Science,* 38: 692-695.

Gokhle, K. (2004). Phosphorus and Sulphur management in Safflower *(Carthamus tinctorius L.)* (Master's thesis). Department Of Agronomy, Agricultural College, Bapatla, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad – 500 030, India.

Hocking, P., Randall, P.J. and Pinkerton, A. (1987). Sulphur nutrition of sunflower (*Helianthus annuus* L.) as effected by N supply: Effects on vegetative growth, the development of yield components and seed yield and quality. *Field CropsResearch*, 16: 157-175.

Kalaiyarasan, C., Vaiyapuri, V. and Sriramachandrasekharan, M. V. (2007). Effect of sulphur sources and levels on the nutrient uptake, crop quality and SUE in groundnut. *Journal of Interacademicia*, 11(1): 55-58.

Knowles, P.K. and Miller, M.D. (1965). Safflower circular 632 California Agricultural Experimental station. California University, Davis, California, USA.

Kumar, R. (2009). Influence of sulphur and boron on growth and yield of sunflower (*Helianthus annuus* L.) (Master's thesis) Department of Agronomy, College of Agriculture, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030, India.

Mundel, H.H., Morrison, R.J., Blackshaw, R.E. and Roth, B. (2004). Safflower Production on the Canadian Prairies: Revisited in 2004. Agriculture Canadian Research Station. Lethbridge, Alberta T1J 4B1, 11, 19, 23. Available from http://res2.agr.ca/lethbridge/safflo/part1_e.htm.2004.

Nathan, R. (2015). Nitrogen and sulphur studies in spineless safflower variety under irrigated condition (master's thesis) Department of Agronomy, College of Agriculture, Telangana State Agricultural University, Rajendranagar, Hyderabad - 500 030, India.

Rao, D.V. (1991). Effect of phosphorus and Sulphur on nutrient uptake, yield and oil content of Safflower (*Carthamus tinctorius* Var. Manjira) (Master's thesis). Department of Soil Science and Agricultural Chemistry, College of Agriculture, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad-500 030, India.

Scherer, H.W., Pacyna, S., Spoth, K.R. and Schulz, M. (2008). Low levels of ferredoxin, ATP, and leghemoglobin contribute to limited N2 -fixation of peas (*Pisum sativum* L.) and alfalfa (*Medicago sativa* L.) under S deficiency conditions. *Biology and Fertility of Soils*, 44: 909-916.

Shekhargouda, Ravi Hunje, Biradar Patil, N.K. and Manjappa, K. (1997). Effect of sulphur and zinc on the growth and yield of safflower (*Carthamus tinctorius* L.). *Karnataka Journal of Agricultural Science*, 10(3): 766-771.

Shekhawat, K. and Shivay, Y.S. (2008). Effect of nitrogen sources, sulphur and boron levels on productivity, nutrient uptake and quality of sunflower (*Helianthus annuus*). *Indian Journal of Agronomy*, 53(2): 129-134.

Singh, R.K. and Singh, A.K. (2014).Effect of nitrogen, phosphorus and sulphur fertilization on productivity, nutrient-use efficiency and economics. *Indian Journal of Agronomy*, 58(4): 583-587.

Singh, S. B., and Thenua, O.V. (2016). Effects of Phosphorus and Sulphur Fertilization on yield And NPS uptake by mustard (*Brassica juncea* L.). *An International Journal Society for Scientific Development*, 11(1): 80-83.

Tanaka, D.L. and Merrill, S.D. (1998). Deep-rooted safflower cuts fertilizers losses. *Agriculture Research Management* (April). p. 17.

How to cite this article:

Divya, V.U. 2019. Effect of Different Sources and Levels of Sulphur on Safflower (*Carthamus tinctorius* L.). *Int.J.Curr.Microbiol.App.Sci*. 8(07): 757-764.
doi: https://doi.org/10.20546/ijcmas.2019.807.091