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Research Article

EFFECT OF NITROGEN AND SULPHUR LEVELS ON YIELD, NUTRIENT USE EFFICIENCY AND ECONOMICS OF SAFFLOWER (*Carthamus tinctorius* L.) CROP

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Abstract: The experiment was carried out during rabi season during years 2019-20 and 2020-21 at the Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experiment was laid out in factorial randomized block design with four nitrogen levels (N_0, N_{45}, N_{90} and N_{135} kg N ha^{-1}) and four sulphur levels (S_0, S_{15}, S_{30} and S_{45} kg S ha^{-1}) comprising sixteen treatment combinations with three replications. The soil of the experimental site found neutral to alkaline in reaction (pH 7.13), non-saline (0.21 dS m^{-1}) in nature, medium in organic carbon (5.13 g kg^{-1}), low in available nitrogen (224 kg N ha^{-1}), medium in phosphorus (13.26 kg P_2O_5 ha^{-1}), high in available potassium (345.19 kg K_2O ha^{-1}), medium available sulphur (21.35 kg S ha^{-1}) and clayey in texture. Applied treatments nitrogen and sulphur levels highest seed yield, stover yield, B:C ratio were recorded with 135 kg N ha^{-1} & 45 kg S ha^{-1}. In applied N and S levels highest NUE 45 kg N ha^{-1} & 45 kg S ha^{-1} and SUE 90 kg N ha^{-1} & 15 kg S ha^{-1} and in lowest was found under control.

Keywords: Safflower economics, Nitrogen and sulphur, Use efficiency, Safflower productivity

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Introduction

Nitrogen is an essential plant nutrient being a component of amino acids, nucleic acids, nucleotides, chlorophyll, enzymes, hormones and promotes rapid plant growth and improves yield attributes through maximum tillering, leaf area, seed formation and protein synthesis etc. and ultimately increases total biomass production, grain yield and its components. Fertilizer nitrogen (N) is believed to have contributed 40% of the growth in per capita food output over the last 50 years. Sulphur is also essential for the formation of chlorophyll and in the formation of vitamins and enzymes required for the plant to conduct its biochemical processes [1]. Sulphur plays an important role in the nutrition of oil seed crop and act as a constituent of sulphur containing amino acids cysteine, cysteine and methionine [2].

Oil seeds are of great value in nutritional demands of mankind, animal feeding, and medicine. Nitrogen and sulphur nutrition assumes exceeding importance in comparison to other nutrients as both are important components of proteins and adequate supply of both nutrients are essential for potential yield of crops. India is a major safflower growing country and contributes 60 per cent of the total world production and ranks first in area and production is grown in an area of 45.89 thousand hectare with a production of 24.64 lakh tonnes and productivity of 537 kg ha^{-1}. It is cultivated as a source of oil and protein. It contains 34% oil and 22-24% protein and its seeds are rich source of natural antioxidant (tocopherol). In Chhattisgarh, production of safflower crop was 0.11 thousand tons covering an area of 0.27 thousand hectare having average productivity of 405 kg ha^{-1} [3] and mostly grown in rice-based cropping system as broadcasting or line sown in partially irrigated situations.

Nutrient management is one of the critical inputs in achieving high yield and quality of safflower in which nitrogen and sulphur fertilizers are important inputs with suitable form and doses. N availability is an important factor in determining crop productivity, managing fertilizer rate can be a suitable strategy to improve crop growth and yield when crops need to enhance nutrient uptake. N and S nutrition interact at many levels as the uptake and assimilation of NO^{3-} and SO_4^{2-} have much in common, and there are many common products of N and S metabolism [4]. The available sulphur content of majority of soils of in the country is already low because of low organic matter build up and increase loss of sulphur through leaching and erosion. The oil seed crop requires more quantity sulphur than cereals. Therefore, nitrogen and sulphur application in suitable quantities through appropriate sources may be the important factors for maximizing safflower crop yield in the state.

Nutrient use efficiencies have been used widely as a measure of the capacity of a plant to acquire and utilize nutrients and may be broken down mechanistically in to the in general nutrients requirement and average removal by safflower crop are reported 3.96 kg N, 0.92 kg P &, 6.32 kg K q^{-1} and 20-30 kg N, 5.16-6.45 kg P, 12.45-16.60 kg K and 10-15 kg S acre-1 respectively [5,6]. The use efficiency of applied S is reported normally ranged from 8-12 percent in different crops

Materials and Methods

The experiment was carried out during Rabi season of 2019-20 & 2020-21 at Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya which is located at 21°23'N latitude, 81°70' E longitude and 296 m altitude above the mean sea level. This area is situated on NH 6Zora, Raipur, Chhattisgarh and carried out with 16 treatments and 3 replications were carried out along with four levels of Nitrogen (0,45, 90& 135) kg/ha and four levels of Sulphur (0, 15,30, 45) kg/ha with the treatment combination of sown in [Tables-1] the seeds were sown with the recommended practices. And seed rate was 20-25 kg/ha, and the basal application of fertilizers was done and seeds were sown in various plots and all the fertilizers were applied at the basal dose (0:40:30) NPK kg/ha and plot size was 3.5x5.0 m, the plants are spaced at 45x15cm followed by line sowing.

Ph determine by, Glass electrode pH meter [7], EC is Salt bridge by Black (1965) [8], OC. Is Rapid titration method [9], Available nitrogen determined by Alkaline permanganate method [10], available sulphur was determined by Turbid metric method given by Chesnin and Yien (1951) [11]. To carry out chemical analysis of plant, the randomly selected plot wises the treatment details in sown in [Table-1].

Table-1 *Treatment details*

SN	Treatment levels	Treatment combination	
	Nitrogen (kgha^{-1})		
I	N_{1-0}	N_0S_0(Control)	$N_{45}S_0$
II	N_{2-45}	N_0S_{15}	$N_{45}S_{15}$
III	N_{3-90}	N_0S_{30}	$N_{45}S_{30}$
IV	N_{4-135}	N_0S_{45}	$N_{45}S_{45}$
	Sulphur (kg ha^{-1})		
I	S_{1-0}	$N_{90}S_0$	$N_{135}S_0$
II	S_{2-15}	$N_{90}S_{15}$	$N_{135}S_{15}$
III	S_{3-30}	$N_{90}S_{30}$	$N_{135}S_{30}$
IV	S_{4-45}	$N^{90}S_{45}$	$N_{135}S_{45}$

Results and Discussion

Nitrogen use efficiency (NUE)

The data on Nitrogen use efficiency of safflower as affected by different N and S levels are presented in [Table-2]. The NUE of safflower crop influenced significantly with applied nitrogen and sulphur levels over control. The mean NUE in safflower with applied nitrogen and sulphur levels varied from 62.79 to 30.70 and 23.24 to 40.75 percentage respectively. Application of 45 kg N ha^{-1} & 45 kg S ha^{-1} recorded higher NUE as (62.79% and 40.75%) over their respective treatments. The increase in N and S levels as well as increased the crop yields resulted higher nitrogen use efficiency. Similar results of were found by Koutroubas *et al*. (2008) [12], Murtaza *et al*. (2017) [13] and Telebbeigi *et al*. (2018) [14].

Table-2 *Effect of nitrogen and sulphur levels on NUE, SUE and B:C ratio of safflower*

Nitrogen levels (kg ha^{-1})	Nitrogen use efficiency (%)	Sulphur use efficiency (%)	B:Cratio
N_0	-	7.92	1.90
N_{45}	62.79	7.13	2.18
N_{90}	42.68	9.87	2.71
N_{135}	30.70	7.42	2.74
Sulphur levels (kgha^{-1})			
S_0	23.24	-	2.22
S_{15}	33.35	13.05	2.32
S_{30}	38.84	10.59	2.50
S_{45}	40.75	8.71	2.51

Sulphur use efficiency (SUE)

The data on SUE uptake of safflower as affected by different N and S levels are presented in [Table-2]. The SUE of safflower crop influenced significantly with applied nitrogen and sulphur levels over control. The mean SUE in safflower with applied nitrogen and sulphur levels varied from 7.92 to 9.87 and 13.05 to 8.71 percentage respectively. Application of 90 kg N ha^{-1} & 15 kg S ha^{-1} recorded higher SUE as (9.87% and 13.05% kg ha^{-1}) over their respective treatments. Efficient use of applied N and S application increased the proportionate amount of N and S uptake decreased Similar results of N and S were found Shekharan *et al*. (2012) [15], Aula *et al*. (2019) [16] and Choudhary *et al*. (2020) [17]. Enhanced supply of N and S fertilizer reduced the all efficiency and the highest efficiency of these respective nutrients [18].

Economics B:C Ratio

The data on B:C Ratio of safflower as affected by different N and S levels are presented in [Table-2]. The B:C ratio of safflower crop influenced significantly with applied nitrogen and sulphur levels over control. The mean B:C ratio in safflower with applied nitrogen and sulphur levels varied from 1.90 to 2.74 and 2.22 to 2.51 respectively. Application of 135 kg N ha^{-1} & 45 kg S ha^{-1} recorded significantly higher B:C ratio as (2.74 and 2.51 kg ha^{-1}) over their respective treatments. This might be due to increase in the doses of nitrogen and sulphur that increases in the seed, stalk yield and quality of safflower. Nathan *et al*. (2018) [19] similar results were found by Bhadre *et al*. (2019).

Conclusion

The highest seed and stover yield were recorded with 135 kg N ha^{-1} & 45 kg S ha^{-1} and the nitrogen and sulphur applied 45 kg ha^{-1} and 45 kg ha^{-1} showed highest NUE and highest SUE 90 kg N ha^{-1} and 15 kg S ha^{-1}, respectively and lowest in control. The highest B:C Ratio of safflower was observed due to applied nitrogen and sulphur level @ 135 kg and 45 kg ha^{-1}, respectively and the lowest was found in control.

Seed yield (qha^{-1})

The data on Seed yield (kg ha^{-1}) of safflower as affected by different N and S levels are presented in [Table-3]. Seed yield of safflower crop influenced significantly with applied nitrogen and sulphur levels over control, shown in [Table-3]. The mean seed yield with applied nitrogen and sulphur ranged from 11.76 to 17.89 &13.42 to 16.73 qha^{-1} respectively. Application of nitrogen & sulphur @ 135 kg ha^{-1} &45 kg ha^{-1} recorded significantly higher mean seed yields as 17.89&16.73 q ha^{-1}. The lowest seed yields was observed under control On the basis of mean data, the increase in seed yield with applied @ 135,90 and 45 kg N ha^{-1} were as 52.13%, 48.21% and 16.84% and applied S @ 15, 30 and 45 kg S ha^{-1} was 8.12, 20.56 and 24.66 % compared to the control, respectively. Maximum nutrient availability due to integrated use of N and S fertilizers increased nutrient uptake by the plant which in turn lead to safflower seed yield by Patil *et al*. (2018) [20]. These findings are inconformity with the results of Singh and Singh (2013) [21], and Nathan *et al*. (2017).

Table-3 *Effect of nitrogen and sulphur levels on seed and stover yield of safflower*

Nitrogen levels (kg ha^{-1})	Seed yield (q ha-1)	Yield Increase (%) over control	Stover yield(qha-1)	Yield increase (%) over control
N_0	11.76	-	32.05	-
N_{45}	13.74	16.84	38.40	19.81
N_{90}	17.43	48.21	49.75	55.23
N_{135}	17.89	52.13	51.21	59.78
SEm ±	0.19	-	0.74	-
CD (P=0.05)	0.53	-	2.13	-
Sulphur levels (kg ha^{-1})				
S_0	13.42	-	36.74	-
S_{15}	14.51	8.12	40.95	11.46
S_{30}	16.18	20.57	46.08	25.42
S_{45}	16.73	24.66	47.66	29.72
SEm ±	0.19	-	0.74	-
CD (P=0.05)	0.53	-	2.13	-

Stover yield (kg ha^{-1})

The data on Stover yield (kg ha^{-1}) of safflower as affected by different N and S levels are presented in [Table-3]. Stover yield of safflower crop influenced significantly with applied nitrogen and sulphur levels over control, shown in [Table-3]. The mean stover yield with applied nitrogen and sulphur ranged from 32.05 to 51.21 & 36.74 to 47.66 qha^{-1} respectively. The stover yield of safflower differed significantly due to different levels of nitrogen and sulphur levels. Application of 135 kg N ha^{-1} and 45 kg S ha^{-1} was recorded significantly higher mean stover yields as 51.21&47.66 q ha^{-1}. On the basis of mean data, the increase in stover yield with 135, 90 and 45 kg N ha^{-1} was 59.78%, 55.23% and 19.81% and 15, 30 and 45 kg S ha^{-1} was 11.46%, 25.42% and 29.72 % compared to the control, respectively. These findings are in conformity with the results of Singh and Singh (2013) and Nathan *et al*. (2017).

Application of research: Study of nutrient use efficiency and economics of Safflower (*Carthamus tinctorius* L.) Crop

Research Category: Plant nutrition

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Study area / Sample Collection: Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012

Cultivar / Variety / Breed name: Safflower (*Carthamus tinctorius* L.)

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References

[1] Jat R., Naga S., Choudhary R. and Mohammad I. (2017) *Int. J. Curr. Microbiol. App. Sci.*, 6(4), 1876-1878.
[2] Parmar N.N., Patel A.P. and Choudhary M. (2018) *Int. J. Curr. Microbiol. App. Sci.*, 7(2), 2600-2605.
[3] GOI (2018) *Area, Production and productivity of Safflower in India. Ministry of agriculture & Farmers Welfare, Govt. of India*.
[4] Pilbeam D.J. and Barker A.V. (2015) *Handbook of Plant Nutrition. 2nd Ed. Boca Raton, London, New York, CRC Press Taylor and Francis Group*, 17–63.
[5] GOI (2014) *AESA based IPM package Safflower, Ministry of Agriculture, Government of India*, 14.
[6] AICRP-STCR (2019-20) *39th Annual Report of All India coordinated Research project on soil test crop response. Indira Gandhi Krishi Vishwavidyalaya, Raipur*, 13.
[7] Piper C.S. (1967) *Soil and Plant Analysis. Academic Press, New York*, 368.
[8] Black C.A. (1965) *American Soc. of Agro. Inc. Publ. Madison, Wisconsin, USA*.
[9] Walkley A. and Black I. A. (1934) *Soil Sci*., 37, 29-38.
[10] Subbiah B.V. and Asija G.L. (1956) *A Curr. Sci*.,25, 259-260.
[11] Chesnin L. and Yein (1951) *Soil. Sci. Soci. Amer. Roc*., 15, 149-151.
[12] Koutroubas D., Papakosta D.K. and Doitsinis A. (2008) *Field Crops Research*, 107, 56-61.
[13] Murtaza B., Murtaza G., Imran M., Amjad M., Naeem A., Shah G.M. and Wakeel A. (2017) *Journal of Soil Science and Plant Nutrition*, 17(3), 686-701.
[14] Talebbeigi R.M. (2018) *J. Agr. Sci. Tech*, 20, 1455-1466.
[15] Shekharan M.V. (2012) *Communication in Biometry and Crop Science*, 7(1), 35-40.
[16] Aula L., Jagmandeep S., Dhillon P.O., Gwendolyn B., Wehmeyer K., Freeman W. and William R.R. (2019) *J. of Agronomy*, 111(5), 2485-2492.
[17] Choudhury A.H., Sultana T., Rahman A., Saha B.P., Chowdhury T. and Tarafder S. (2020) *Heliyon,* 6(05726), 1-8.
[18] Rajesh K. and Amitesh K. (2013) *Ind. J. of Agronomy*, 58(4), 583-587.
[19] Nathan R.J.K., Madhavi L., Joseph B. and Madhavi A. (2017) *Int. J. Curr. Microbiol. App. Sci.*, 6(7), 600-606.
[20] Patil S.S., Ransing S.S., Hiwale S.D. and Rasal S.J. (2018) *Int. J. Curr. Microbiol. App. Sci., Special Issue*, 6, 1147-1155.
[21] Singh R.K and Singh A.K. (2013) *Indian Journal of Agronomy*, 58(4), 583-58.
[22] Divya V.U. (2019) *Int. J. Curr. Microbiol. App. Sci*., 8(7), 757-764.
[23] Fattai M. (2018) *Biologija*, 64(3), 235–248.
[24] Singh M.K., Singh T.K. and Singh U.N. (2000) *Journal of Oilseeds Research*, 17(1), 162-164.