Original Research Article

Influence of Sulphur and Phosphorus Levels on Economics and Yield of Safflower (*Carthamus tinctorius* L.) Under the Eastern zone of Uttar Pradesh, India

ABSTRACT

Influence of Sulphur and Phosphorus Levels on Growth and Development: A Field Experiment yield of Safflower (*Carthamus tinctorius* L)". var. "*ISF-764*" was tested at Crop Research Farm during Rabi 2021–23. Ministry of Agriculture Sciences and technology United University, Prayagraj in the U.P. The soil of the experimental plot had a sandy loam texture, was almost pH-neutral (7.5), had low organic carbon content (0.50%), and was readily available. N (228.59 kg/ha), available P (29.80 kg/ha) and available K (125.21 kg/ha). The experiment was laid out in randomized block design with nine treatments consists three level of S 20,30,40 kg/ha and three level of P 30,40,50 kg/ha with control (Farmer practice) were replicated thrice. Results obtained that higher plant height (173.33 cm), Number of branches (19.27), dry weight (117.89 g/day), yield attributes and yield *viz.*, seed yield (2.20 t/ha), stover yield (2.98 t/ha) and Hi (42.44 %) were recorded with the application of 40 kg/ha S + 50 kg/ha P, economics *viz.* however, higher gross return (113804.07 INR/ha), net return (77799.97 INR/ha) and B:C ratio (2.16) was observed when 40 kg/ha S and 50 kg/ha P were applied. Application of 40 kg/ha S with 50 kg/ha P was therefore more productive and financially viable.

Key words: Safflower, Sulphur (S), Phosphorus (P), Growth and yield.

INTRODUCTON

Safflower (*Carthamus tinctorius* L.) is herbaceous annual broad-leaved plant belong to the family *Asteraceae*. It is native to parts of Asia, Middle East and Africa. It was grown mainly for its flowers, which were used in making dyes for clothing and food, but today, it is grown mainly

for its oil. It grows well in both dry land and irrigated areas and is a drought-tolerant plant. Safflower has become a more significant oilseed crop in recent years, particularly with the growing interest in biofuel production. Safflower's direct yield factors include the number of plants per plot, the number of heads per plant, the quantity of seeds in each head, and the weight of the seeds. Numerous variables, like as genetics, climatic circumstances, and cultural practises, influence the relative relevance of each yield component. **Nathan *et al.*, (2017).** Vegetable oil is one of the fundamental components in foods and has important functions regarding human health and its nutritional physiology. Safflower (*Carthamus tinctorius* L.) India is the fourth largest producer of oilseeds in the world in terms of output and is second in cultivated area next to food crops. India ranks first in area and production of safflower grown across the world. In India, safflower is grown in an area of 1,78,400 ha with a production of 1.453 lakh tonnes and productivity of 498 kg ha^{-1}. In India, the crop is largely grown in Maharashtra, Karnataka, Gujarat and Andhra Pradesh. In Andhra Pradesh, safflower is grown in an area of 10,000 ha with a production of about 7000 tonnes and productivity of about 600 kg ha^{-1}yield levels of safflower in India are very low compared to world productivity (878 kg ha^{-1}) **(FAO, 2021).** The cultivation of safflower crop under rainfed condition and poor crop nutrition are the major reasons for low productivity. The seeds contain 35-50% oil, 15-20% protein and 35-45% hull fraction safflower can also be grown successfully on soil with poor fertility and in areas with relatively low temperatures. **Nathan *et al.* (2017)**

Sulphur is considered as quality nutrient as its application not only influences crop yield but also improves crop quality owing to its influence on protein metabolism, oil synthesis and formation of amino acids. It is a constituent of three amino acids *viz.* Methionin (21% S), Cystine (26% S) and Cystine (27% S), which are the building blocks of protein. About 90% of plant sulphur is present in these amino acids. Sulphur is also involved in the formation of chlorophyll, glucosides and glucosinolates (mustard oils), Phosphorus retention in vertisols is difficult while in Alfisol and Oxisols, it occurs due to the presence of anhydrous sesquioxides and organic matter. Mineralization of organic matter releases the sulphur in the available form to the plant **(Murthy, 2011).** Plants absorb sulphur mostly through roots in the form of sulphate (SO_4-) and to a much lesser extent from atmosphere in gaseous form (SO_2) **(Tondon, 1995).**

Materials and Methods

A field experiment was conducted during *Ravi* 2023 at Agricultural Research Farm of United University, Rawatpur, Jhalwa, Prayagraj (U.P.), India to study the impact of Effect of Sulphur and Phosphorus Levels on Growth and Yield of Safflower (***Carthamus*** *tinctorius* L.) under integrated approaches of nutrients. The experiment as laid out in randomized block design with three replications. The experiment was comprised of ten treatment *viz*., T_{10} Control, T_1: S 20 kg/ha + P 30 kg/ha , T_2: S 20 kg/ha + P 40 kg/ha, T_3: S 20 kg/ha + P 50 kg/ha, T_4: S 30 kg/ha + P 30 kg/ha, T_5: S 30 kg/ha + P 40 kg/ha, T_6: S 30 kg/ha + P 50 kg/ha, T_7: S 40 kg/ha + P 30 kg/ha, T_8: S 40 kg/ha + P 40 kg/ha, T_9: S 40 kg/ha + P 50 kg/ha Safflower Variety *ISF-764* was sown after pre-sowing irrigation using 20 kg ha^{-1} seed rate. A basal dose of 40 kg N, 40 kg P_2O_5, 20 kg K was applied per hectare asrecommended fertilizer dosage. Before sowing, FYM was administered to the field according to the treatment instructions and blended with the soil. Accordingly, the data gathered for each character was subjected to statistical analysis using the "Analysis of Variance" technique. As recommended by the "F" test of significance at the 5% level of significance, overall differences were evaluated. **Cochran and Cox (**1957**).** Critical differences at a 5% level of probability were calculated for treatment comparison.

Results and Discussion

Grain yield (kg/ha)

Significantly higher grain yield was observed in T_9 (Sulphur 40 kg/ha + Phosphorus 50 kg/ha) (2.10 t/ha). However, (2.1 t/ha) T_8 (Sulphur 40 kg/ha + Phosphorus 40 kg/ha) and (1.93 t/ha) was recorded in T_7 (Sulphur 40 kg/ha + Phosphorus 30 kg/ha) which were statistically at par with treatment 9 (Sulphur 40 kg/ha + Phosphorus 50 kg/ha).

Stover yield (kg/ha)

Significantly higher stover yield was observed in T_9 (sulphur 40 kg/ha + phosphorus 50 kg/ha) (3.62 t/ha). however, (3.48 t/ha) T_8 (sulphur 30 kg/ha + phosphorus 50 kg/ha) and (3.47 t/ha) was recorded in T_7 (sulphur 40 kg/ha + phosphorus 30 kg/ha) which were statistically at par with sulphur 40 kg/ha + phosphorus 50 kg/ha increase in stover yield was due to increase in

plant height, branches/plant and may be to supply of essential mineral nutrients. balanced amount which resulted in better growth and development of plants by **Nathan *et al*., (2017).**

Harvest index (%)

Significantly higher harvest index was observed in T_9 (Sulphur 40 kg/ha + Phosphorus 50 kg/ha) (36.73 %). However, (36.52 %) T_8 (Sulphur 20 kg/ha + Phosphorus 40 kg/ha), (35.72 %) T_7 (Sulphur 40 kg/ha + Phosphorus 30 kg/ha). Which were statistically at par with Sulphur 40 kg/ha + Phosphorus 50 kg/ha.

Cost of cultivation (INR/ha)

The maximum cost of cultivation (INR/ha) was observed in T8 (40 kg/ha Sulphur + 40 kg/ha Phosphorus) and the significantly higher cost of cultivation (INR/ha) was observed in T9 (40 kg/ha Sulphur + 50 kg/ha Phosphorus).

Gross returns (INR/ha)

The maximum gross returns (INR/ha) were observed in T8 (40 kg/ha Sulphur + 40 kg/ha Phosphorus) and the significantly higher gross returns (INR/ha) was observed in T9 (40 kg/ha Sulphur + 50 kg/ha Phosphorus).

Net returns (INR/ha)

The maximum net returns (INR/ha) were observed in T8 (40 kg/ha Sulphur + 40 kg/ha Phosphorus) and the significantly higher net returns (INR/ha) was observed in T9 (40 kg/ha Sulphur + 50 kg/ha Phosphorus).

B: C Ratio

The maximum B:C ratio was (2.10) observed in T8 (40 kg/ha Sulphur + 40 kg/ha Phosphorus) and the significantly higher B:C Ratio was (2.16) observed in T9 40 kg/ha Sulphur + 50 kg/ha Phosphorus**.**

Conclusions

It is concluded that treatment T_9 with application of S 40 kg/ha + P 50 kg/ha was found to be the best that recorded highest plant height, number of capitulam / plant , dry weight (g), panicle length, number of panicles, number of grains per panicle, seed yield, straw yield, test weight and harvest index.

References:

Baviskar, P.K., Varsha, V.T., Jagdale, R.B., Sarika, V.S and Bhatia, N.H. 2005. Effect of levels of sulphur and its sources on S uptake, growth and yield of safflower. *Journal of Soils and Crops*. **15**(2):466-469.

Cochran, W. G. (1957). Analysis of covariance: Its nature and uses. *Biometrics,***13**(3): 261-281.

Dashora, P and Sharma, R.P. 2006. Effect of sowing date, irrigation and sulphur nutrition on yield attributes, yield and oil content of safflower. *Crop Research.* **31**(1):56-57.

Murthy, I.Y.L.N. 2011. Recent advances in secondary and micronutrient management in safflower (*Carthamus tinctorius* L.). *Journal of Oilseeds Research*.**28**(2): 94-104.

Patil, S.S., Choudhary, A.A., Goley, A.V and Rasal, S.J. 2014. Effect of phosphorus and sulphur on growth, yield and economics of linseed. *Journal of Soils and Crops.* **24**(1): 159-164.

Ravi, S., Channal, H.T and Shailendra Kumar. 2010. Response of sulphur and micronutrients (Zn and Fe) on yield and available nutrients of safflower (*Carthamus tinctorius* L.). *An Asian Journal of Soil Science*. **5**(2): 402-405.

Ravi, S., Channal, H.T and Ananda. 2008. Response of sulphur, zinc and iron nutrition on yield components and economics of safflower (*Carthamus tinctorius* L.). *An Asian Journal of Soil Science*. **3**(1): 21-23.

Santosh Kumar, Verma, S.K., Singh, T.K and Shyambeer Singh. 2011. Effect of nitrogen and sulphur on growth, yield and nutrient uptake by Indian mustard (*Brassica juncea*) under rainfed condition. *Indian Journal of Agricultural Science*. **81**(2): 145-149.

Singh, R.K and Singh, A.K. 2013. Effect of nitrogen, phosphorus and sulphur fertilization on productivity, nutrient-use efficiency and economics of safflower (*Carthamus tinctorius*) under late-sown condition. *Indian Journal of Agronomy*. **58**(4):583-587.

Tandon, H.L.S. 1995. Sulphur fertilizers for Indian agriculture. *A Guide Book*. Fertilizer development and consultation organization. New Delhi, India.

Table 1. Effect of sulphur and phosphorus levels on yield attribute and yield of safflower.

T. No.	Treatment combination	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
T_1	Sulphur 20 kg/ha + Phosphorus 30 kg/ha	1.63	2.50	39.42
T_2	Sulphur 20 kg/ha + Phosphorus 40 kg/ha	1.67	2.52	39.80
T_3	Sulphur 20 kg/ha + Phosphorus 50 kg/ha	1.70	2.57	39.88
T_4	Sulphur 30 kg/ha + Phosphorus 30 kg/ha	1.75	2.62	39.99
T_5	Sulphur 30 kg/ha + Phosphorus 40 kg/ha	1.79	2.66	40.24
T_6	Sulphur 30 kg/ha + Phosphorus 50 kg/ha	1.88	2.70	40.95
T_7	Sulphur 40 kg/ha + Phosphorus 30 kg/ha	2.08	2.83	42.22
T_8	Sulphur 40 kg/ha + Phosphorus 40 kg/ha	2.13	2.97	41.79
T_9	Sulphur 40 kg/ha + Phosphorus 50 kg/ha	2.20	2.98	42.44
T_{10}	Control	1.40	2.43	36.72
F- test		S	S	NS
SEm±		0.083	0.103	1.31
CD (p = 0.05%)		0.246	0.306	3.89

Table 2. Influence of sulphur and phosphorus levels of safflower

Treatment. No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
T_1	20 kg/ha Sulphur + 30 kg/ha Phosphorus	33533.66	84352.40	50818.74	1.52
T_2	20 kg/ha Sulphur + 40 kg/ha Phosphorus	34098.90	86462.13	52363.23	1.54
T_3	20 kg/ha Sulphur + 50 kg/ha Phosphorus	34670.90	88245.87	53574.97	1.55
T_4	30 kg/ha Sulphur + 30 kg/ha Phosphorus	34200.26	90716.27	56516.01	1.65
T_5	30 kg/ha Sulphur +40 kg/ha Phosphorus	34765.50	92822.13	58056.63	1.67
T_6	30 kg/ha Sulphur +50 kg/ha Phosphorus	35337.50	97039.70	61702.20	1.75
T_7	40 kg/ha Sulphur +30 kg/ha Phosphorus	34866.86	107380.47	72513.61	2.08
T_8	40 kg/ha Sulphur+ 40 kg/ha Phosphorus	35432.10	109916.57	74484.47	2.10
T_9	40 kg/ha Sulphur+ 50 kg/ha Phosphorus	36004.10	113804.07	77799.97	2.16
T_{10}	Control	29905.00	72716.03	42811.03	1.43