



Influence of Phosphorus and Sulphur Levels on Economics and Yield of Safflower (*Carthamus tinctorius* L.) under the Eastern Zone of UP, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study highlights the influence of Phosphorus and Sulphur Levels on Economics and Yield of Safflower (*Carthamus tinctorius* L.): 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. Safflower (*Carthamus*

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tinctorius L.) India ranks second in terms of planted area after food crops and is the world's fourth-largest producer of oilseeds in terms of output. 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. It is concluded that treatment T9 with application of S 40 kg/ha + P 50 kg/ha was found to be the best that recorded highest plant height, number of capitulum / plant, dry weight (g), panicle length, number of panicles, number of grains per panicle, seed yield, straw yield, test weight and harvest index.

Keywords: Safflower; sulphur (S); phosphorus (P); growth; yield.

1. 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” [1-3]. “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” [4-7]. “Numerous variables, like as genetics, climatic circumstances, and cultural practises, influence the relative relevance of each yield component” (Nathan et al.. 2017). “One of the essential ingredients in diet, vegetable oil serves vital purposes for human health and nutritional physiology. Safflower (*Carthamus tinctorius* L.) India ranks second in terms of planted area after food crops and is the world's fourth-largest producer of oilseeds in terms of output. In terms of both acreage and global safflower production, India leads the pack. In India, 1.453 lakh tonnes of safflower are produced annually on an area of 1,78,400 hectares, with a productivity of 498 kg ha⁻¹. The crop is primarily farmed in Gujarat, Andhra Pradesh, Maharashtra, and Karnataka in India. Safflower is produced on 10,000 hectares in Andhra Pradesh, with an estimated 7000 tonnes of production and 600 kg ha⁻¹ of productivity; yield levels of safflower in India are extremely low when compared to global 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).

“Because it affects protein metabolism, oil production, and the synthesis of amino acids, sulphur is regarded as a high-quality nutrient whose application not only affects crop productivity but also enhances crop quality. It is a component of the three amino acids that make up protein: methionin (21% S), cysteine (26% S), and cysteine (27% S). These amino acids include about 90 percent of the sulphur found in plants. Moreover, sulphur contributes to the synthesis of glucosides, glucosinolates, and chlorophyll. (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” [8] “Plants absorb sulphur mostly through roots in the form of sulphate (SO₄⁻) and to a much lesser extent from atmosphere in gaseous form (SO₂)” [9].

2. 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 Influence of Phosphorus and Sulphur Levels on Economics 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., T₁₀ Control, T₁: S 20 kg/ha + P 30 kg/ha, T₂: S 20 kg/ha + P 40 kg/ha, T₃: S 20 kg/ha + P 50 kg/ha, T₄: S 30 kg/ha + P 30 kg/ha, T₅: S 30 kg/ha + P 40 kg/ha, T₆: S 30 kg/ha + P 50 kg/ha, T₇: S 40 kg/ha + P 30 kg/ha, T₈: S 40 kg/ha + P 40 kg/ha, T₉: 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 P₂O₅, 20 kg K was applied per hectare as recommended 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 [10] Critical differences at a 5% level of probability were calculated for treatment comparison.

3. RESULTS AND DISCUSSION

3.1 Grain Yield (kg/ha)

Significantly higher grain yield was observed in T₉ (Sulphur 40 kg/ha + Phosphorus 50kg/ha) (2.10 t/ha). However, (2.1 t/ha) T₈ (Sulphur 40 kg/ha + Phosphorus 40 kg/ha) and (1.93 t/ha) was recorded in T₇ (Sulphur 40 kg/ha + Phosphorus 30 kg/ha) which were statistically atpar with

treatment 9 (Sulphur 40 kg/ha + Phosphorus 50 kg/ha).

3.2 Stover Yield (kg/ha)

"Significantly higher stover yield was observed in T₉ (sulphur 40 kg/ha + phosphorus 50kg/ha) (3.62 t/ha). however, (3.48 t/ha) T₈ (sulphur 30 kg/ha + phosphorus 50 kg/ha) and (3.47 t/ha) was recorded in T₇ (sulphur 40 kg/ha + phosphorus 30 kg/ha) which were statistically atpar 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 provide vital nutrients and minerals. Balanced quantity, which improved plant growth and development". By Nathan et al., (2017).

3.3 Harvest Index (%)

"Significantly higher harvest index was observed in T₉ (Sulphur 40 kg/ha + Phosphorus 50 kg/ha) (36.73%). However, (36.52%) T₈ (Sulphur 20 kg/ha + Phosphorus 40 kg/ha), (35.72%) T₇ (Sulphur 40 kg/ha + Phosphorus 30 kg/ha). Which were statistically at par with Sulphur 40 kg/ha + Phosphorus 50kg/ha" [11].

3.4 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).

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	S 20 kg/ha + P 30 kg/ha	1.63	2.50	39.42
T ₂	S 20 kg/ha + P 40 kg/ha	1.67	2.52	39.80
T ₃	S 20 kg/ha + P 50 kg/ha	1.70	2.57	39.88
T ₄	S 30 kg/ha + P 30 kg/ha	1.75	2.62	39.99
T ₅	S 30 kg/ha + P 40 kg/ha	1.79	2.66	40.24
T ₆	S 30 kg/ha + P 50 kg/ha	1.88	2.70	40.95
T ₇	S 40 kg/ha + P 30 kg/ha	2.08	2.83	42.22
T ₈	S 40 kg/ha + P 40 kg/ha	2.13	2.97	41.79
T ₉	S 40 kg/ha + P 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.N.	Treatment combinations	Cost ofcultivation (INR/h)	Grossreturns (INR/ha)	Net returns (INR/ha)	B:Cratio
T ₁	S 20 kg/ha + P 30 kg/ha	33533.66	84352.40	50818.74	1.52
T ₂	S 20 kg/ha + P 40 kg/ha	34098.90	86462.13	52363.23	1.54
T ₃	S 20 kg/ha + P 50 kg/ha	34670.90	88245.87	53574.97	1.55
T ₄	S 30 kg/ha + P 30 kg/ha	34200.26	90716.27	56516.01	1.65
T ₅	S 30 kg/ha + P 40 kg/ha	34765.50	92822.13	58056.63	1.67
T ₆	S 30 kg/ha + P 50 kg/ha	35337.50	97039.70	61702.20	1.75
T ₇	S 40 kg/ha + P 30 kg/ha	34866.86	107380.47	72513.61	2.08
T ₈	S 40 kg/ha + P 40 kg/ha	35432.10	109916.57	74484.47	2.10
T ₉	S 40 kg/ha + P 50 kg/ha	36004.10	113804.07	77799.97	2.16
T ₁₀	Control	29905.00	72716.03	42811.03	1.43

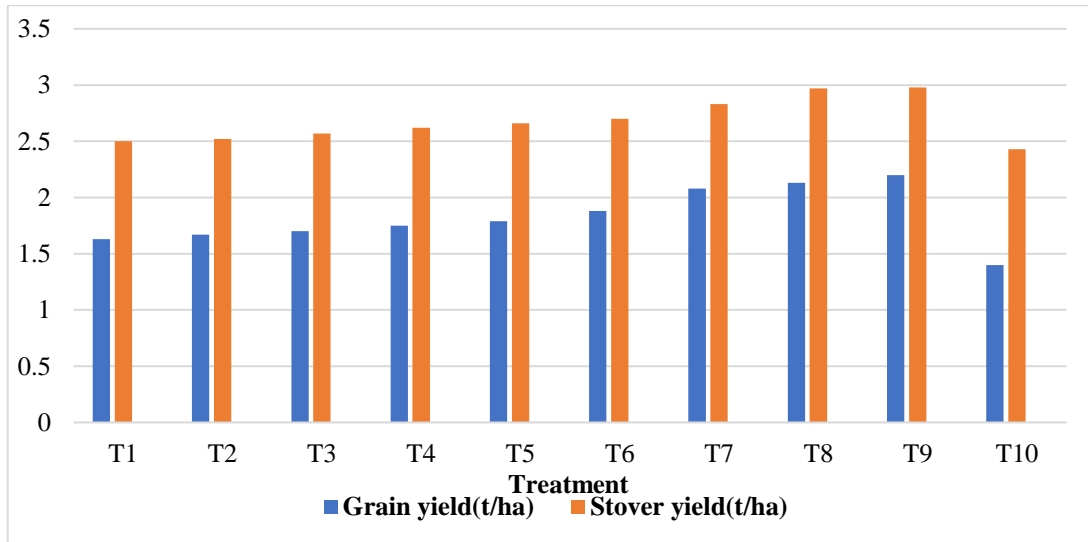


Fig. 1. Influence of phosphorus and Sulphur levels Grain yield and Stover yield of safflower

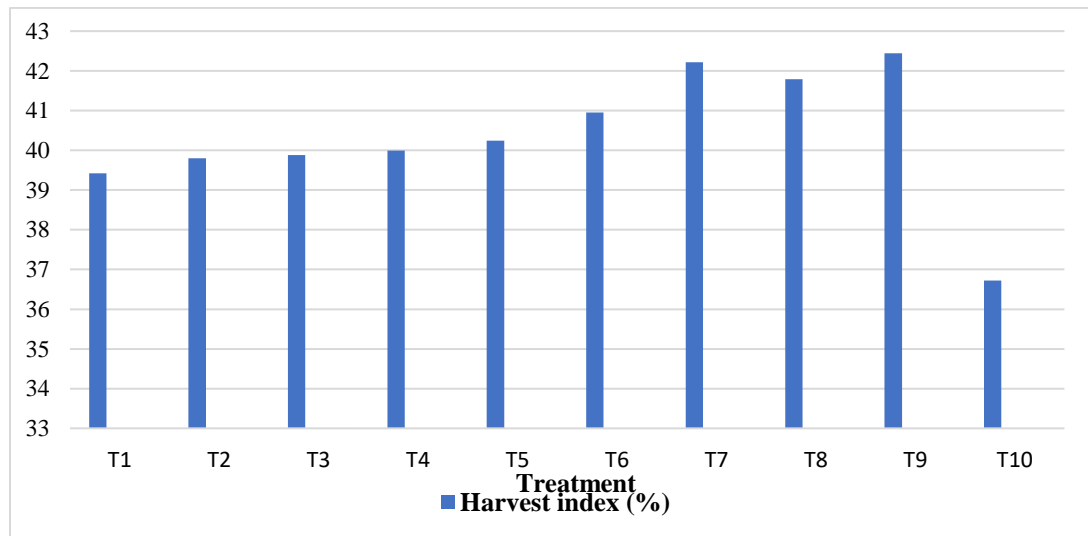


Fig. 2. Influence of phosphorus and Sulphur levels on Harvest index of safflower



Fig. 3. Initial stage



Fig. 4. Starting observation



Fig. 5. Mid observation



Fig. 6. With observation board



Fig. 7. Final observation

3.5 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).

3.6 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).

3.7 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.

4. CONCLUSIONS

It is concluded that treatment T₉ with application of S 40 kg/ha + P 50 kg/ha was found to be the best that recorded highest plant height, number of capitulum / plant, dry weight (g), panicle length, number of panicles, number of grains per panicle, seed yield, straw yield, test weight and harvest index.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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