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

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ABSTRACT

Influence of Sulphur and Phosphorus Levels on Growth and Development: A Field Experiment yield of Safflower (*Carthamus tinctorius* L)". var. "*ISF-764*" was conducted at Crop Research Farm during *Rabi* season 2021-23. Department of Agriculture Sciences and technology United University, Prayagraj (U.P.). The soil of the experimental plot had a sandy loam texture, was almost pH-neutral (7.5), had a 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.*

Introduction

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. 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

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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).

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), Cysteine (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 replication. The experiment was comprised of ten treatment *viz*., T_{10}Control, T_1S 20 kg/ha + P 30 kg/ha, T_2S 20 kg/ha + P 40 kg/ha, T_3S 20 kg/ha + P 50 kg/ha, T_4S 30 kg/ha + P 30 kg/ha, T_5S 30 kg/ha + P 40 kg/ha, T_6S 30 kg/ha + P 50 kg/ha, T_7S 40 kg/ha + P 30 kg/ha, T_8S 40 kg/ha + P 40 kg/ha, T_9S 40 kg/ha + P 50 kg/ha Safflower Variety *I*SF-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 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 (1957). Critical differences at a 5% level of probability were calculated for treatment comparison.

Results and Discussion

Effect of growth parameter

At harvest, significantly highest plant height (173.33 cm), dry weight (117.89), was recorded in the treatment with T_9 (S 40 kg/ha + P 50 kg/ha) over all the other treatments. However, the treatments T_8(S 40 kg/ha + P 40 kg/ha) and T_7(S 40 kg/ha + P 30 kg/ha) was found to be statistically at par with T_9(Sulphur 40 kg/ha + phosphorus 50 kg/ha).

Higher levels of sulphur may have increased plant height because of the many roles that sulphur plays in plants' glucose metabolism by activating several enzymes involved in the dark reaction of photosynthesis, which results in increased plant height. Ravi *et al.,* (2008). Impact of In a same manner, phosphorus is essential for photosynthesis, res-

Table 1. Quantity and used formula in fertilizer.

Treatment	Source	Fertilizer formula	Quantity of fertilizer
Sulphur 20 kg/ha	Arjun Sulphur 90	Nutrient (kg/ha) nutrient in fertilizer(%)*100	22.22kg/ha
Sulphur 30 kg/ha	Arjun Sulphur 90	Nutrient (kg/ha) nutrient in fertilizer(%)*100	33.33kg/ha
Sulphur 40 kg/ha	Arjun Sulphur 90	Nutrient (kg/ha) nutrient in fertilizer (%)*100	44.44kg/ha
Phosphorus 30 kg/ha	DAP	Nutrient (kg/ha) nutrient in fertilizer (%)*100	65.21 kg/ha
Phosphorus 40 kg/ha	DAP	Nutrient (kg/ha) nutrient in fertilizer (%)*100	86.95 kg/ha
Phosphorus 50 kg/ha	DAP	Nutrient (kg/ha) nutrient in fertilizer (%)*100	108.69kg/ha

piration, energy storage and transfer, cell division, cell enlargement, and the development of meristematic structures, all of which contribute to the heightening of plants.

Influence on yield characteristics and yield

Significantly highest capitulum/plant (24.50), seeds/capitulum (24.90), test weight (35.45 g), grain yield (2.20 t/ha), stover yield (2.98 t/ha), and harvest index (42.44%) was observed in T_9 (S 40 kg/ha + P 50 kg/ha). However, T_8 (S 40 kg/ha + P 40 kg/ha), T_7 (S 40 kg/ha + P 30 kg/ha) and T_7 (S 30 kg/ha + P 50 kg/ha), which were statistically at par with T_9 (S 40 kg/ha + P 50 kg/ha).

The higher grain yield/plant under variety might be due to the optimum utilization of nutrient. The safflower of short duration high have the potential to give the maximum grain yield then rest of the varieties. The other reason of the high yield of variety could be due to the better growth attribute resulting to produce higher grain yield.

Table 1. Influence of sulphur and phosphorus levels of safflower

Treatment		At harvest	
		Plant height (cm)	Dry matter (g)
T_1	S 20 kg/ha + P 30 kg/ha	126.67	91.18
T_2	S 20 kg/ha + P 40 kg/ha	129.33	99.76
T_3	S 20 kg/ha + P 50 kg/ha	133.67	99.51
T_4	S 30 kg/ha + P 30 kg/ha	134.33	102.17
T_5	S 30 kg/ha + P 40 kg/ha	134.93	108.30
T_6	S 30 kg/ha + P 50 kg/ha	139.33	113.55
T_7	S 40 kg/ha + P 30 kg/ha	143.33	111.69
T_8	S 40 kg/ha + P 40 kg/ha	146.33	114.84
T_9	S 40 kg/ha + P 50 kg/ha	173.33	117.89
T_{10}	Control	122.00	81.03
	S.Em(±)	7.91	4.96
	CD (p=0.05%)	23.5	14.7

Conclusion

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.

Conflict of Interest

None

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Table 2. Influence of Sulphur and Phosphorus levels on yield attribute and yield of Safflower.

T. No.	Treatments details	Capitulum/ plant	Seeds/ capitulum	Test weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
T_1	S 20 kg/ha + P 30 kg/ha	19.27	21.07	32.00	1.63	2.50	39.42
T_2	S 20 kg/ha + P 40 kg/ha	21.00	21.33	32.5	1.67	2.52	39.80
T_3	S 20 kg/ha + P 50 kg/ha	21.80	22.07	32.65	1.70	2.57	39.88
T_4	S 30 kg/ha + P 30 kg/ha	22.07	22.54	34.05	1.75	2.62	39.99
T_5	S 30 kg/ha + P 40 kg/ha	22.80	22.73	34.38	1.79	2.66	40.24
T_6	S 30 kg/ha + P 50 kg/ha	22.24	23.40	35.12	1.88	2.70	40.95
T_7	S 40 kg/ha + P 30 kg/ha	23.53	24.40	35.15	2.08	2.83	42.22
T_8	S 40 kg/ha + P 40 kg/ha	24.00	24.50	35.32	2.13	2.97	41.79
T_9	S 40 kg/ha + P 50 kg/ha	24.50	24.90	35.45	2.20	2.98	42.44
T_{10}	Control	15.88	15.98	26.91	1.40	2.43	36.72
	S.Em(±)	0.63	0.78	0.43	0.083	0.103	1.31
	CD (p = 0.05%)	1.90	2.35	1.28	0.246	0.306	3.89

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