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Influence of Nitrogen and Sulphur on Growth Yield and Economics of Spineless Safflower under Irrigated Conditions

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ABSTRACT

A field experiment was conducted during Rabi, 2014 at college farm, college of agriculture, Rajendranagar, Hyderabad to realize the optimal dose of nitrogen and sulphur in safflower and to evaluate the effect of levels of nitrogen and sulphur ***on growth, yield and economics*** *of safflower. The experiment was carried out with three nitrogen levels 0, 40 and 60 kg N ha^{-1} and three sulphur levels 0, 25 and 45 kg S ha^{-1} were laid out in randomized block design with factorial concept and replicated thrice. With respect to nitrogen levels, Viz. plant height (103.0 cm), leaf area index (2.36), dry matter accumulation (8751.8 kg ha^{-1}), seed yield (1458 kg ha^{-1}), stalk yield (4133 kg ha^{-1}) were recorded highest with 60 kg N ha^{-1} and it was significantly superior than 40 kg N ha^{-1} and 0 kg N ha^{-1}. Among sulphur levels, significantly higher plant height (101.8 cm), leaf area index (2.31), dry matter accumulation(7851.4 kg ha^{-1}), seed yield (1444 kg ha^{-1}), stalk yield (4114 kg ha^{-1}) were recorded with 45 kg S ha^{-1} over 25kg S ha^{-1} and 0 kg S ha^{-1}. higher gross returns () and net returns() realized with 60 kg N ha^{-1} and 45 kg S ha^{-1} and the B:C ratio () is also highest in case of treatments received nitrogen and sulphur with 60 kg and 45 kg respectively.*

Key words: *Plant height, Leaf area index, Dry matter accumulation, Seed yield, Stalk yield, Nitrogen levels, Sulphur levels.*

INTRODUCTION

It is known that one of the essential nutrients in human consumption is oil or fat, derived from the plant or animal sources. However there is a limited increase in animal fat production. Therefore, in order to meet the increasing need in oil production is bound to the improvement and growth in oil plants. Oil is important due to the fact that not only it is an energy source in human consumption but also it is essential in the use of A, D, E, K vitamins and it contains oleic, linoleic (78%) fatty acids which reduces blood cholesterol[1]. For this reason, safflower oil is used in the diets of patients with cardiovascular disease, and bears great importance for its anti-cholesterol effect[11].

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India is a major safflower growing country and contributes 60 per cent of the total world production. 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}.

Generally, safflower is produced on marginal lands that are relatively dry and deprived of the benefits of fertilizer inputs. Attempts to improve seed yield and quality by developing agronomic practices are underway throughout the world; safflower can be a candidate crop in dry land agro-ecosystems, due to its potential for growth under water stress and the economical value in terms of both oil and seed[19]. Nitrogen compounds are important in plant chemical compounds such as protein, nucleic acid, chlorophyll and enzymes structure, and has an important role in the tissues structure of plants[5] and nitrogen deficiency reduces plant amino acid content as the basic element for the construction of amino acids and proteins[2, 5] and sulphur is one of the important nutrient 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[8]. 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. Therefore, the determination of the most suitable dose of nitrogen and sulphur fertilizer will increase the growth and seed yield of safflower.

MATERIAL AND METHODS

The field experiment was conducted at College farm, Professor Jyashankar Telangana State Agricultural University, Rajendranagar, and Hyderabad during *Rabi* season 2014-15. The experimental soil was sandy loam in texture, slightly alkaline in reaction (p^H 7.3). The fertility status of the experimental soil was low in organic carbon (0.41%) and available nitrogen (217.63 kg ha^{-1}), medium in available phosphorous (40.93 kg P_2O_5 ha^{-1}) and high in available potassium 370.7 kg K_2O ha^{-1}) and low in available sulphur (15.7 kg S ha^{-1}). The experiment was laid out in a factorial randomized block design with three replications having nine treatments combinations of three levels of nitrogen 0 kg N ha^{-1},: 40 kg N $ha^{-1}$and 60 kg N ha^{-1} and three sulphur levels 0 kg S ha^{-1}, 25 kg S ha^{-1}, 45 kg S ha^{-1}).

RESULTS AND DISCUSSION

Plant height:

Plant height differed significantly among different levels of nitrogen at all the stages. At harvest, crop fertilized with 60 kg N ha^{-1} maintained its superiority by recording significantly taller plants over corresponding lower levels of 40 kg N ha^{-1} and 0 kg N ha^{-1}. The increase in plant height with higher levels of nitrogen was probably due to its beneficial effect on cell elongation which might have resulted in internodal elongation. The nitrogen was an integral part of protein, the blocks of the plant and it also helps in maintaining higher auxin level which might have resulted in better plant height[15]. Similar findings were also reported by Singh and Singh[16] and Katara and Bansal[7].

The plant height increased with increasing sulphur level. Maximum plant height (101.8 cm) was recorded with 45 kg S ha^{-1} at harvesting stage and significantly superior to 25 kg S ha^{-1} and 0 kg S ha^{-1}. The crop receiving higher dose of sulphur might have been helped in terms of vigorous root growth, formation of chlorophyll, resulting in higher photosynthesis[10].

Leaf area index:

Maximum LAI (3.93) was recorded in 60 kg N ha^{-1} at 90 DAS significantly superior to 40 kg N ha^{-1} and 0 kg N ha^{-1}. Adequate supply of nitrogen had produced higher number of leaves $plant^{-1}$ which in turn produced more photosynthetic surface i.e. LAI. These findings are in conformity with those of Tomar *et al.*[17]; Sarkar and Mallik[14] and Vishwanath *et al*.[18].

Maximum LAI 3.56 was noticed in 45 kg S ha^{-1}at 90 DAS and significantly superior to 25 kg S ha^{-1} and control (0 kg S ha^{-1}). Application of sulphur might have influenced the overall nutrition environment of rhizosphere and that might be the reason for increase in the growth parameters of the crop[6].

Dry matter production:

Application of 60 kg N ha^{-1} recorded significantly higher dry matter accumulation (8751.8 kg ha^{-1}) over 40 kg N ha^{-1} (7489.3kg ha^{-1}) and 0 kg N ha^{-1} (5344.5kg ha^{-1}). Dry matter production related to grain productivity contributes an important factor in source-sink relationship. The increase in dry matter due to increase in N levels could be attributed to enhanced plant height, number of leaves, leaf area index and photosynthates accumulation. These findings are in conformity with those of Vishwanath *et al.*[18], Tomar *et al.*[17] and Sarkar and Mallik[14].

Seed yield:

Application of 60 kg N ha^{-1} recorded significantly higher seed yield (1458 kg ha^{-1}) over 40 and 0 kg N ha^{-1} and the lowest seed yield (1151kg ha^{-1}) was observed in control.

Seed yield is the function of several yields attributing characters *viz*., number of capitula $plant^{-1}$, number of seeds $capitulum^{-1}$ and 100 seed weight. Cumulative effect of all the yield attributing characters due to adequate nutrition of nitrogen might have resulted in the production of higher seed yield[17].

Maximum seed yield (1444 kg ha^{-1}) was recorded with 45 kg S ha^{-1}. Seed yield of safflower decreased gradually with decrease in the sulphur levels and it was significantly superior to 25 kg S ha^{-1} and control (0 kg S ha^{-1}).The favourable effect of sulphur fertilization on yield components and finally on yield might be due to balanced nutritional environment, efficient and greater partitioning of metabolites and adequate translocation of nutrients towards reproductive[3].

Stalk yield:

Application of 60 kg N ha^{-1} recorded significantly higher stalk yield (4133 kg ha^{-1}) over 40 and 0 kg N ha^{-1} while the lowest stalk yield (3650 kg ha^{-1}) was observed in control. The increase in stalk yield was due to increase in plant height, branches $plant^{-1}$, resulting from the application of higher doses of nitrogen.

Maximum stalk yield (4114 kg ha^{-1}) was recorded with 45 kg S ha^{-1} and significantly superior to 25 kg S ha^{-1} and control. Increase in vegetative growth of plants by sulphur levels was ultimately responsible for such increase in stalk yield[4] and with decrease in the sulphur levels, the stalk yield decreased.

Economics:

The highest gross returns (₹ 55408 ha^{-1}) and net returns (₹ 36777 ha^{-1}) were recorded with the application of 60 kg N ha^{-1}. The highest B: C ratio (2.97 was observed with the application of 60 kg N ha^{-1} followed by 40 kg N ha^{-1} (2.75) and control (2.68). This might be due to increase in the doses of nitrogen that increases the seed, stalk yield and quality of safflower.

The highest gross returns (₹ 54872 ha^{-1}) and net returns (₹ 34922 ha^{-1}) were recorded with the application of 45 kg S ha^{-1}. Each increasing level of sulphur increased the economic yield significantly which ultimately resulted in increased gross and net returns ha^{-1}. The highest B: C ratio (2.75) was observed with the application of 45 kg S ha^{-1} followed by 25 kg S ha^{-1} (2.70) and control (2.67). This might be due to increase in the doses of sulphur that increases the seed, stalk yield and quality of safflower. These results were in accordance with the findings of Dashora and Sharma[3], Ravi *et al.*[13], Kubsad and Mallapur[9], Patel *et al*.[10].

Table 1: Growth and yield of safflower as influenced by different nitrogen and sulphur levels

Treatments	Plant height at harvest (cm)	Leaf area index (LAI) At harvest	Dry matter production at harvest (kg ha^{-1})	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
Nitrogen levels					
N_0-0 kg ha^{-1}	95.5	1.99	5344.5	1151	3650
N_1-40 kg ha^{-1}	100.01	2.21	7489.3	1329	3900
N_2-60 kg ha^{-1}	103.0	2.36	8751.8	1458	4133
SEm ±	0.63	0.05	184.15	33.23	37.18
CD ($P \leq 0.05$)	1.88	0.11	552.03	99.63	111.47
Sulphur levels					
S_0-0 kg ha^{-1}	97.1	2.09	6465.3	1090	3799
S_1-25 kg ha^{-1}	99.6	2.19	7269.1	1309	3893
S_2-45 kg ha^{-1}	101.8	2.31	7851.4	1444	4114
SEm ±	0.63	0.05	184.15	33.23	37.18
CD ($P \leq 0.05$)	1.88	0.11	552.03	99.63	111.47
Interaction (N x S)					
SEm ±	1.09	0.08	318.96	57.55	64.40
CD ($P \leq 0.05$)	NS	NS	NS	NS	NS

Table 2: Economics of safflower as influenced by different nitrogen and sulphur levels

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C
Nitrogen levels				
N_0-0 kg ha^{-1}	16349	43734	27389	2.68
N_1-40 kg ha^{-1}	18370	50493	32122	2.75
N_2-60 kg ha^{-1}	18630	55408	36777	2.97
SEm ±	--	--	1054	--
CD ($P \leq 0.05$)	--	--	3162	--
Sulphur levels				
S_0-0 kg ha^{-1}	15450	41382	25932	2.67
S_1-25 kg ha^{-1}	17950	49723	31754	2.72
S_2-45 kg ha^{-1}	19950	54872	34922	2.75
SEm ±	--	--	1054	--
CD ($P \leq 0.05$)	--	--	3162	--

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