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Research Paper :

Effect of sulphur, zinc and iron on growth, yield and nutrient uptake by safflower

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ABSTRACT

A field experiment was carried out to study the effect of sulphur, zinc and iron nutrition on growth, yield and nutrient uptake by safflower on Vertisol at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, during *Rabi* season 2002-03. The results indicated that application of 30 kg S per ha showed superior growth parameters like plant height, number of leaves per plant, number of branches per plant and dry matter per plant, yield components like number of capsules, seed weight per head, 1000-seed weight and nutrient uptake of N, P, K, S, Zn and Fe as compared to other treatments. Combinations of sulphur along with micronutrients had significant influenced on the growth, yield and nutrient uptake by safflower. The treatment receiving 30 kg S per ha + Fe + Zn foliar recorded the highest growth, yield and nutrient uptake as compared to 30 kg S per ha, 20 kg S per ha + Fe, Zn foliar, 10 kg S per ha + Fe + Zn foliar spray and control.

Key words : Sulphur, Zinc, Iron, Safflower, *Carthamus tinctorius* L.

Safflower (*Carthamus tinctorius* L.) is an important oilseed crop of the world. In India, it is grown in winter season in the *Deccan Rabi* zone. It contains about 36 per cent of oil, which accounted for about 8 per cent of the value of total agriculture produce. It contains 72 per cent linolenic acid, the factor which reduces blood cholesterol. Moreover, due to high content of unsaturated fatty acids and it is an excellent drying oil for use in paints and varnishes. Recently, scant attention was paid to the importance of secondary and micronutrients in plant nutrition. The deficiency of secondary and micronutrients is wide spread in many parts of the country due to cultivation of high yielding varieties, intensive agriculture and increasing use of sulphur free fertilizer in large quantities with concomitant decrease in use of organic manures, which necessitate rational application of these elements as they have becoming limiting factor for obtaining higher yields of several crops.

MATERIALS AND METHODS

The field experiment was conducted on safflower var. Annigeri-I, under irrigated conditions during *Rabi* season 2002-03 in Vertisol of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka). The soil of the experimental field was neutral (soil pH 7.35) with low organic carbon (0.45%). The available N, P, K, S, Zn and Fe contents of the soil were 332, 11.90, 297.60, 10.95 kg per ha, 0.63 (ppm) and 4.45 (ppm), respectively. The treatments consisting of levels of sulphur (0, 10, 20 and 30 kg/ha) and their micronutrient combination, where sulphur applied in the form of ammonium sulphate, zinc and iron were foliar spray taken at 30 and 65 DAS in the form of zinc chloride and ferric chloride, respectively. The experiment was laid out in a randomized block design having thirteen treatments and replicated thrice. Calculated quantity of N was applied in the form of urea, P in the form of diammonium phosphate and K in the form of muriate of potash. A uniform of basal dose of N and P_2O_5 @ 75 kg per ha each and 40 kg per ha K_2O was applied. The seeds were sown at the rate of 8 kg per ha with a spacing of 60 x 30 cm.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been presented under following heads :

Growth and yield attributes:

The data presented in Table 1 showed that levels of sulphur and their micronutrient combinations had significant influence on plant height, number of leaves per plant, number of branches and dry matter production of the safflower.

Among the sulphur levels, application of 30 kg S per ha registered the highest plant height, number of leaves, dry matter production. It was significantly superior over 20 kg S per ha, 10 kg S per ha and control. The treatment receiving 30 kg S per ha might have helped in vigorous root growth, formation of chlorophyll, resulting in higher photosynthesis. The research of this investigation are in consonance with the findings of Reddappa Reddy (1981). Similar results were reported by Sreemannarayana and Raju (1993). Stimulated photosynthetic activity and synthesis of chloroplast and protein which might have

Table 1: Growth attributing characters of safflower as influenced by sulphur, zinc and iron

Treatments	Plant height	No. of leaves	Primary branches at harvest	Secondary branches at harvest	Dry matter production(kg/ha)
T_1 – Control	80.4	65.4	7.6	13.7	2029.6
T_2 – 10 kg S/ha	88.6	74.0	8.7	15.3	2274.3
T_3 – 10 kg S/ha + Fe foliar	89.0	76.2	9.2	15.7	2293.0
T_4 – 10 kg S/ha + Zn foliar	94.0	77.8	9.6	16.5	2416.6
T_5 – 10 kg S/ha + Fe + Zn foliar	97.5	81.2	10.8	17.3	2440.7
T_6 – 20 kg S/ha	96.8	80.3	10.4	17.3	2422.2
T_7 – 20 kg S/ha + Fe foliar	96.4	82.5	10.7	17.3	2483.3
T_8 – 20 kg S/ha + Zn foliar	97.3	84.7	11.4	17.4	2609.2
T_9 – 20 kg S/ha + Fe + Zn foliar	105.0	88.9	12.5	19.2	2746.2
T_{10} – 30 kg S/ha	105.0	87.5	12.1	19.2	2609.2
T_{11} – 30 kg S/ha + Fe foliar	106.4	89.5	12.1	19.3	2818.4
T_{12} – 30 kg S/ha + Zn foliar	110.9	93.0	13.5	19.9	3055.5
T_{13} – 30 kg S/ha + Fe + Zn foliar	114.7	94.5	14.3	21.2	3181.4
Mean	98.62	82.73	10.99	17.63	2567.66
S.E.±	2.74	1.61	0.34	0.48	49.6
C.D. (P=0.05)	8.00	4.70	0.99	1.40	144.9

resulted in higher dry matter production as reported in soybean (Mishra and Agarwal, 1994).

Levels of sulphur along with micronutrients had profound influence on growth parameters. The treatment receiving 30 kg S per ha + Fe + Zn foliar spray recorded the highest plant height, number of leaves, number of branches per plant and dry matter production and it was significantly superior over 30 kg S per ha, 20 kg S per ha + Fe + Zn foliar spray, 10 kg S per ha + Fe + Zn foliar spray and control. This beneficial effect might be due to interaction effect of sulphur, zinc and iron and their role in the synthesis of IAA, metabolism of auxin and formation of chlorophyll synthesis, findings of Rathore and Tomar (1990) in mustard.

The yield determining components such as number of capsules per plant, seed weight per plant, 1000-seed weight and seed yield were significantly influenced by the levels of sulphur and micronutrients (Table 2). The higher seed yield (1553 kg/ha) was obtained with the higher sulphur level (30 kg S /ha). It was significantly superior over 20 kg S per ha, 10 kg S per ha and lowest seed yield in control (1172 kg/ha). The results are in conformity with the findings of Patel *et al.* (2002) and Sharma and Bansal (1998) in safflower. The difference in the seed yield was largely because of variations in the yield components *viz.*, number of capsules per plant, seed weight per head and 1000-seed weight.

Combination of levels of sulphur and micronutrients had significant influence on seed yield. Application of 30 kg S per ha + Fe + Zn foliar spray recorded the highest seed yield (1765 kg/ha) and it was significantly superior over 30 kg S per ha (1553 kg/ha), 20 kg S per ha + Fe + Zn foliar spray (1591 kg/ha), 10 kg S per ha + Fe + Zn foliar spray (1445 kg/ha) and control (1172 kg/ha).

Similarly, the highest number of capsules per plant (32.2), seed weight per head (0.84 g) and 1000-seed weight (61.6 g) was recorded in the treatment receiving 30 kg S per ha and it was significantly superior over 20 kg S per ha, 10 kg S per ha and control. This might be due to higher yield components that are directly responsible for higher seed yield appeared to have been determined by physiological characters both during vegetative and reproductive phase of the crop, these results agree with the findings of Venkatesh *et al.* (2002). The highest number of capsules (37.1) per plant, seed weight per head (0.96g) and 1000-seed weight (68.2 g) was recorded in the treatment receiving 30 kg S per ha + Fe + Zn foliar spray and proved to be superior than 20 kg S per ha + Fe + Zn foliar spray, 10 kg S per ha + Fe Zn foliar spray and control. This might be due to various physiological characters in plant, one can exploit full genetic potential of a crop.

Nutrient uptake:

Nutrient uptake indicated that application of sulphur, zinc and iron increased the uptake of nitrogen, phosphorus, potassium, sulphur, zinc and iron significantly. Among the sulphur levels the treatment receiving 30 kg S per ha

Table 2: Effect of sulphur, zinc and iron nutrition on number of capsules, seed weight per head, thousand seed weight and seed yield of safflower

Treatments	No. of capsules/ plant	Seed weight/ head (g)	1000-seed weight (g)	Seed yield (kg/ha)
T_1 – Control	20.5	0.62	44.7	1172
T_2 – 10 kg S/ha	24.0	0.69	49.5	1298
T_3 – 10 kg S/ha + Fe foliar	25.1	0.71	51.9	1319
T_4 – 10 kg S/ha + Zn foliar	26.7	0.76	55.8	1379
T_5 – 10 kg S/ha + Fe + Zn foliar	28.8	0.78	56.8	1445
T_6 – 20 kg S/ha	27.2	0.76	56.2	1426
T_7 – 20 kg S/ha + Fe foliar	29.1	0.78	57.4	1462
T_8 – 20 kg S/ha + Zn foliar	30.6	0.82	61.7	1517
T_9 – 20 kg S/ha + Fe + Zn foliar	33.0	0.85	63.1	1591
T_{10} – 30 kg S/ha	32.2	0.84	61.6	1553
T_{11} – 30 kg S/ha + Fe foliar	33.2	0.89	63.3	1617
T_{12} – 30 kg S/ha + Zn foliar	35.3	0.92	64.9	1691
T_{13} – 30 kg S/ha + Fe + Zn foliar	37.1	0.96	68.2	1765
Mean	29.44	0.80	58.08	1479.61
S.E.±	1.02	0.02	1.49	42.63
C.D. (P=0.05)	2.96	0.06	4.35	124.44

recorded the highest uptake of nitrogen, phosphorus, potassium and sulphur and it was significantly superior over 20 kg S per ha, 10 kg S per ha and control. This may be due to the increased total dry matter production, yield and yield components *viz.*, seed weight per head, number of capsules per plant and 1000-seed weight. These results are in conformity with the findings of Abbas *et al.* (1995) and Dineshkar and Babulkar (1998) in safflower.

Application of sulphur and micronutrients together had significantly increased the nutrient uptake. The plots receiving 30 kg S per ha + Fe + Zn foliar spray recorded the highest uptake of nitrogen, phosphorus, potassium and sulphur and it was significantly superior over 30 kg S per ha, 20 kg S per ha + Fe + Zn foliar spray, 10 kg S per ha + Fe + Zn foliar spray and lowest in control. This trend may be due to increased growth and growth components,

Table 3: Effect of sulphur, zinc and iron nutrition on uptake of nutrients by safflower

Treatments	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	S uptake (kg/ha)	Zn uptake (g/ha)	Fe uptake (g/ha)
T_1 – Control	43.83	2.23	27.82	5.21	101.48	565.52
T_2 – 10 kg S/ha	49.14	3.29	36.73	6.50	125.42	675.35
T_3 – 10 kg S/ha + Fe foliar	56.08	3.38	38.91	6.58	184.56	951.58
T_4 – 10 kg S/ha + Zn foliar	58.62	4.35	41.12	7.01	234.02	985.81
T_5 – 10 kg S/ha + Fe + Zn foliar	63.51	4.89	45.00	7.32	246.60	1061.00
T_6 – 20 kg S/ha	60.65	4.72	42.99	7.51	154.22	750.81
T_7 – 20 kg S/ha + Fe foliar	67.13	5.74	47.43	8.29	251.01	1065.00
T_8 – 20 kg S/ha + Zn foliar	71.82	6.76	51.36	9.13	336.29	1082.00
T_9 – 20 kg S/ha + Fe + Zn foliar	76.47	7.78	55.51	9.88	358.75	1197.84
T_{10} – 30 kg S/ha	72.10	7.51	52.23	9.39	178.61	825.66
T_{11} – 30 kg S/ha + Fe foliar	79.12	8.21	59.40	10.99	338.97	1234.44
T_{12} – 30 kg S/ha + Zn foliar	83.68	9.19	63.71	11.92	399.85	1287.10
T_{13} – 30 kg S/ha + Fe + Zn foliar	84.38	9.49	66.35	12.41	408.59	1395.25
Mean	66.63	5.97	48.20	8.66	255.26	1009.02
S.E±	1.76	0.35	1.42	0.30	8.06	25.27
C.D. (P=0.05)	5.15	1.03	4.14	0.88	23.53	73.76

total dry matter production, yield and yield components. These findings are in general agreement with the results reported by Pasricha and Aulakh (1991) who observed synergistic relationship of S ´ Zn influencing uptake of nutrients. The increase in sulphur uptake may be due to the interaction effect of sulphur, zinc and iron are synergistic. These results are in agreement with the findings of Shukla and Prasad (1979) in groundnut.

Micronutrients (Zn and Fe):

The highest micronutrients (zinc and iron) uptake (Table 3) was recorded in the treatment receiving 30 kg S per ha and it was significantly superior over 20 kg S per ha, 10 kg S per ha, while control treatment registered for the lowest micronutrients (zinc and iron) uptake. This might be attributed to increase total dry matter production, growth components and yield components. These results are supported by the findings of Sharma *et al.* (1990) in groundnut.

Combination of sulphur and micronutrients had marked influence on micronutrients (zinc and iron) uptake. The treatment receiving 30 kg S per ha + Fe + Zn foliar spray recorded the highest micronutrients (zinc and iron) uptake as compared to other treatments. However, the lowest micronutrients (zinc and iron) uptake was recorded in control. This could be due to interaction effect of sulphur, zinc and iron. These results are supported by the findings of Patil *et al.* (1979) and Sutaria and Patel (1987) in groundnut and Sharma *et al.* (1990) in mustard.

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REFERENCES

Dineshkar and Babhulkar, P.S. (1998). Effect of sulphur and zinc on yield, quality and uptake of nutrients by safflower in Vertisols. *Indian J. Dryland agric. Res. & Develop.*, **13**(2) : 81-85.

Mishra, A.K. and Agarwal, H.P. (1994). Effect of sulphur on growth yield, protein and oil content of soybean. *J. Oilseeds Res.*, **11** : 99-102.

Mohd. Abbas, Surendra, S., Tomar and Nigam, K.B. (1995). Effect of phosphorus and sulphur fertilization in safflower (*Carthamus tinctorius* L.). *Indian J. Agron.*, **40**(2) : 243-248.

Pasricha, N.S. and Aulakh, M.S. (1991). Twenty year of sulphur research and oilseed production in Punjab. *Sulphur in agric.*, **15** : 17-22.

Patel, P.T., Patel, G.G., Patel, G. A., Sonani, V.V. and Patel, H.B. (2002), Effect of sources and levels of sulphur on seed and oil yield of safflower (*Carthamus tinctorius* L.). *J. Oilseeds Res.,* **19**(1) : 76-78.

Patil, V.C., Radder, G.D. and Kudasomannavar, B.T. (1979). Effect of zinc, iron and calcium under varying levels of phosphorus on groundnut. *Mysore J. agric. Sci.*, **13** : 395-399.

Rathore, D.S. and Tomar, S.S. (1990). Effect of sulphur and nitrogen on seed yield and nitrogen uptake by mustard. *Indian J. Agron.*, **35**(4) : 361-363.

Reddappa Reddy, M. (1981). Effect of calcium, sulphur and boron on the yield and composition of sunflower (*Helianthus annuus* L.). M. Sc. (Ag.) Thesis, University of Agricultural Sciences, Bangalore (Karnataka).

Sharma, U.C., Gangwar, M.S. and Shrivastava, P.C. (1990). Effect of zinc and sulphur on nutrient uptake and yield of mustard. *J. Indian Soc. Soil Sci.*, **38** : 696-701.

Sharma, Umeshkumar and Bansal, K.N. (1998). Influence of different levels and sources of sulphur on yield and nutrient uptake by safflower grown on alluvial soil. *Crop Res.*, **16**(3) : 306-308.

Shukla, V.C. and Prasad, K.C. (1979). Sulphur-Zinc interaction on groundnut. *J. Indian Soc. Soil Sci.*, **27** : 60-64.

Sreemannarayana, B. and Raju, S.A. (1993). Direct and residual effect of applied sulpur in sunflower based cropping systems. *Fertilizer News*, **38** : 39-42.

Sutaria, M.S. and Patel, M.S. (1987). Effect of phosphorus, sulphur, zinc and iron on yield and nutrient uptake (P, S, Zn and Fe) by groundnut grown on highly calcareous clay soils. *Indian J. agric. Chem.*, **20**(1) : 39-48.

Venkatesh, M.S., Hebsur, N.S. and Satyanarayana, T. (2002). Evaluation of sulphur carriers for safflower in Vertisols of North Karnataka. *Karnataka J. agric. Sci.*, **15**(2) : 284-287.

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