International J. Seed Spices 4(2), July 2014:32-35

Influence of sulphur and zinc on growth and yield of coriander (*Coriandrum sativum* L.)

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Abstract

A field experiment was conducted during the *Rabi* season of 2012-13 at NRCSS, Ajmer, Rajasthan, to study growth and yield of coriander as influenced by varying levels of sulphur and zinc. Treatments comprising of three sulphur levels (soil application of 20, 30 and 40 kg sulphur ha^{-1}) and three zinc levels (foliar application of 0.4, 0.5 and 0.6 % zinc) were studied in factorial randomized block design with four replications. Reduction in days to germination initiation and enhanced days of flowering were observed due to higher dosage of sulphur. Plant height was not significantly influenced with varying sulphur levels except at 60 days after sowing. Higher number of primary (8.03) and secondary branches $plant^{-1}$ (25.08), number of umbellates $umbel^{-1}$ (5.61) and seed yield (1990.69 kg ha^{-1}) was obtained with soil application of 40 kg sulphur $hectare^{-1}$. Varying levels of foliar application of zinc did not significantly influence plant height except at 60 DAS. The highest number of primary branches $plant^{-1}$ (7.66), number of umblets $umbel^{-1}$ (5.61) and seed yield (2027 kg ha^{-1}) were obtained with foliar application of 0.6% zinc. Basal application of sulphur @ 40 kg ha^{-1} along with foliar application of 0.6 percent zinc is better for realizing higher yield of coriander.

Key words : Coriander, growth, nutrient, sulphur, yield, zinc

Introduction

Coriander (*Coriandrum sativum* L.) is an aromatic annual herb, having diploid chromosome 2n=22 and belongs to the family *Apiaceae* (Umbelliferae). Whole or ground seeds are used as condiment to flavour foods like pickles and confectionery. Young leaves are used for preparing chutney, seasoning of curry soups etc. Rajasthan occupies the premiere position in production and acreage with the production of 2.18 lakh tons of coriander from 1.97 lakh ha land. The average productivity of coriander in Rajasthan is 1100 kg per ha (Anonymous, 2), which is higher than the national average (857 kg ha^{-1}) but still seems to be very low and can be increased. Poor soil fertility is one of the important factors contributing to low yields, which is reflected by the low carbon sequestration coupled with alarmingly higher nutrient mining of these soils. Poor nutrient management by the growers has resulted in depletion of carbon reserves, reduced nutrient levels and decreased nutrient cycling processes due to the decreased biological activity (Dixit and Shukla, 5). Abnormal pH and lower levels of organic carbon, S, Ca, Mg, Mn, Fe, Cu, Zn etc, are the limitting factors in spice growing fields contributing to the lower productivity and quality. Micronutrient deficiencies are widespread, 50 percent of world soils are deficient in zinc (Korayem, 7) which is essential for the transformation of carbohydrates & synthesis of tryptophan, which act as precursor of vitamin A, regulating consumption of sugars. It is also the part of the enzyme systems which regulate plant growth. Its deficiency causes interveinal necrosis where the main veins remain green. In the early stages of zinc deficiency the younger leaves become yellow and pitting develops in the interveinal upper surfaces of the mature leaves and may exhibit delayed maturity.

Sulphur is essential for production of protein, fats and oils, promotes enzyme activity and helps in chlorophyll formation, improves root growth and grain filling resulting in vigorous plant growth and resistance to cold. Its deficiency causes interveinal chlorosis with a very distinct reddish color of the veins and petioles (Shanyn and Lucy, 13).

In general, farmers only apply nutrients when crops show deficiency symptoms, while nutrient deficiencies decrease yields before symptoms appear. Applications of balanced nutrition will not only enhance productivity but will also increase the total production and the efficiency of fertilizer use in spice crops (Bochalia, 4). Thus looking to the situation, there is an urgent need to augment supplies of customised fertilisers supplying secondary and micronutrients to sufficiently support, the integrated need of nutrient in coriander production. Considering the above facts, the studies on influence of sulphur and zinc on growth, and yield of coriander was undertaken.

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Materials and methods

The present investigation was carried out at the National Research Center on Seed Spices, Tabiji, Ajmer (Rajasthan) during *Rabi* 2012-13, to find out the influence of sulphur and zinc on growth and yield of coriander. The soil of the experimental field was sandy loam having 78.58 kg ha^{-1} available nitrogen, 8.06 kg ha^{-1} available phosphorous and 223.28 kg ha^{-1} available potassium, 10.23 kg ha^{-1} available sulphur and 0.37 mg kg^{-1} DTPA extractable zinc. The study was carried out with soil application of sulphur (20, 30, 40 kg ha^{-1}) through sulphur dust (85% S) and foliar spray of zinc (0.4 percent, 0.5 percent, 0.6 percent) through $ZnSO_4$ (34% Zn) on ACr-1 variety. The recommended dose of major nutrients (NPK) for the crop was applied (60:30:20 kg ha^{-1}). Experiment was performed in Factorial RBD and the plot size was 4m x 2m (8 m^2) with three replications. Coriander was sown at 30 cm row to row spacing using 16 kg seed per hectare. Plant to plant spacing was maintained at 10 cm. Healthy crop of coriander was raised following standard agronomic practices. The observations on vegetative growth, yield parameters and yield of coriander were recorded periodically with respect to influence of sulphur, zinc and their interaction effects. The data were statistically analyzed as per the method suggested by Panse and Sukhatme (9).To ascertain the economic feasibility of different treatments, economics of treatments was worked out in terms of net profit per hectare so that most remunerative treatment could be recommended.

Results and discussion

Growth parameters

Influencing growth parameters such as days of germination of coriander was not significantly influenced by the treatments with sulphur and zinc. However data showed early germination with higher levels of sulphur (S_3) and zinc (Z_3) as compared to (S_1 and Z_1) lower level as the germination is not influenced much by the nutritional level of the soil in most of the crops and is mainly affected by the temperature and moisture level of soil. It is only at the later stages, at the active growth phase, where the nutrients have significant role to play for growth and development of plant as can be seen in the plant height parameters which is significantly affected by both the nutrients at 60 DAS where as the influence was non significant at 30, 90 DAS and at harvest. In the coriander crop 45-60 DAS is the active growth period, (sigmoid growth curve) where most of the vegetative growth occurs, as the reproductive stage starts. The primary and secondary branching also occurs during the log phase only, which is significantly affected by the levels of the treatment (higher at higher doses) of sulphur (S_3) but non- significant with the foliar spray of zinc. Foliar spray of zinc also exhibited non- significant influence on secondary branching pattern.

Reproductive and yield parameters

Reproductive characters such as days to initiation of flowering, number of umbels per plant, number of seeds per umbellet, seed yield per plot and seed yield per ha are given in Table 1 and 2. Initiation and 50 per cent of flowering was significantly influenced by different sulphur levels. Higher level (S_3) took maximum days to initiation of flowering (67and 80) over minimum level i.e. S_1 (65 and 75), respectively. Maximum days to initiation of flowering and 50 per cent flowering were 66.89 and 78.67 days recorded in Zn_3 level, while minimum at 65.33, 77.22 days in Zn_1 level respectively, the intermediate levels of sulphur and zinc (S_2 and Zn_2) were at par with the S_1 and Zn_1 treatments for both the parameters.

Basal application of varying levels of sulphur significantly influenced the number of umbellats per umbel and seed yield per hectare but number of umbels per plant was at par. Soil application of sulphur (40 kg ha^{-1}) produced higher umbels $plant^{-1}$ (5.61) and seed yield (1990.69 kg ha^{-1}). Number of umbellats per umbel and seed yield of coriander was significantly influenced with varying levels of foliar application of zinc (Table -2). Foliar application of 0.6 percent zinc resulted in the highest number of umbellats per umbel (5.61) and seed yield (2027 kg ha^{-1}).

Though the flower initiation was delayed with the application of nutrients such as sulphur and zinc, still the other yield attributing traits were better in the later stages, this could easily be explained as the availability of balanced nutrition (RDF plus other essential nutrients) helped to flourish the plants to its complete efficiency in both the stages (Vegetative and reproductive) and elongates the life span of the plants. Bhagvatagoudra and Rokhade (3) in cabbage and Bochalia (4) also reported higher yield in fenugreek with higher level of sulphur.

Sulphur is a secondary plant nutrient essential for synthesis of several vitamins and amino acids viz., cystine, cysteine and methionine and it helps in photosynthesis and nitrogen fixation. Uptake of nitrogen, phosphorous and sulphur by plants were also increased with the application of sulphur (Sivkumaran *et al.*, 14) in coriander. It is further inferred that increased content of sulphur in plant helped in better development and thickening of xylem, collenchymas tissue, such favourable effects might have resulted in stronger stem and increasing photosynthetic as well as meristematic activities which might have promoted vegetative growth and consequently yield attributes and yield. Application of sulphur might be attributed to increased availability of nutrients owing to

favourable environment created by sulphur and also it plays a significant role in overall biosynthesis process. These results of the investigation are in line of work reported by Sivkumaran *et al*. (14) and Rampratap *et al*. (11).The positive effect of zinc with respect to plant vegetative growth and yield with its attributes is due to the fact that zinc favors the enzyme system, auxin and protein synthesis and seed production directly or indirectly (Sharma *et al*., 12). Khattab and Umer (6) in fennel and Pariari *et al*. (10) in fenugreek also recorded and increased plant growth and yield with zinc application.

Interaction studies

Combined effect of varying levels of sulphur and zinc was significant with respect to seed yield (Table 3). The highest seed yield (2081.25 kg ha^{-1}) of coriander was obtained with soil application of 30 kg ha^{-1} sulphur along with 0.6 % foliar application of zinc. The improvement in the coriander yield with interactive effects might be due to additive influence of improvement in growth, yield attributes and yield due the application of sulphur and zinc. The application of sulphur as secondary nutrient and zinc as micro nutrient in an integrated manner might have exhibited the positive effects in plant growth, development and yield. Manure *et al*. (8) also reported that yield attributes, seed and oil yield and oil content were all enhanced by the application of N, S and Zn fertilizers. Aishwath *et al.* (1) also advocated that micro nutrients play a significant role towards improving growth, yield and quality of seed spices.

Net returns

The economic evaluation shows that in the coriander crop, the application of sulphur at the rate of 40 kg ha^{-1} (S_3 treatment) exhibited maximum net returns (Rs. 49288.07 ha^{-1}) with B: C ratio of 2.62 as compared to minimum net returns (Rs. 44523.60 ha^{-1}) with B: C ratio 2.55 in S_1 treatment (20 kg ha^{-1}). Similarly the highest net returns (Rs. 51281.27 ha^{-1}) with B: C ratio 2.72 was obtained with the application of 0.6% zinc (Z_3 treatment) as compared to least net returns (Rs. 43784.33 ha^{-1}) with B: C of 2.50 under Z_1 treatment (0.4% zinc). Thus on the basis of the above findings it is concluded that basal application of sulphur at the rate of 40 kg ha^{-1} along with foliar application of 0.6% zinc is better for realizing higher growth and yield of coriander with maximum net returns.

Table 1. Effect of soil application of sulphur and foliar spray of zinc on growth parameters in coriander.

Treatment	Days to germination initiation	Days to final germination	Days to flowering initiation	Days to 50% flowering	Plant height			
					30DAS	60DAS	90DAS	At harvest
Soil application of sulphur (S)								
S_1 : 20 kg ha^{-1}	7.56	12.00	65.22	75.89	7.99	15.19	108.49	135.06
S_2 : 30 kg ha^{-1}	7.44	12.00	65.67	77.22	7.92	16.78	108.47	139.28
S_3 : 40 kg ha^{-1}	7.44	11.56	67.11	80.00	8.33	15.31	107.93	140.69
S Em±	0.17	0.30	0.34	0.26	0.15	0.30	1.83	2.89
CD(P =0.05)	NS	NS	1.03	0.79	NS	0.89	NS	NS
Foliar application of Zinc (Zn)								
Zn_1 : 0.4%	7.78	12.11	65.33	77.22	7.83	15.10	106.36	137.90
Zn_2 : 0.5%	7.44	12.11	65.78	77.22	8.07	15.82	108.00	138.50
Zn_3 : 0.6%	7.22	11.33	66.89	78.67	8.34	16.36	110.53	138.62
S Em±	0.17	0.30	0.34	0.26	0.15	0.30	1.83	2.89
CD(P=0.05)	NS	NS	1.03	0.79	NS	0.89	NS	NS
CV %	6.99	7.62	1.57	1.01	5.57	5.65	5.08	6.27

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Table 2. Effect of soil application of sulphur and foliar spray of zinc on yield and its attributing parameters in coriander.

Treatment	No. of primary branches Plant^{-1}	No of secondary branches plant^{-1}	No of umbel plant^{-1}	No of umbellate umbel^{-1}	Seed yield plot^{-1} (g)	Seed yield (kg ha^{-1})
Soil application of sulphur (S)						
S_1 : 20 kg ha^{-1}	6.33	21.24	41.18	4.86	1464.44	1830.56
S_2 : 30 kg ha^{-1}	7.44	22.94	44.43	5.22	1536.11	1920.14
S_3 :40 kg ha^{-1}	8.03	25.08	43.87	5.61	1592.56	1990.69
S Em±	0.11	0.43	1.14	0.13	26.85	33.57
CD(P =0.05)	0.33	1.30	NS	0.40	80.50	100.62
Foliar application of Zinc (Zn)						
Zn_1 : 0.4%	6.88	22.44	42.04	4.97	1460.00	1825.00
Zn_2 : 0.5%	7.28	23.08	42.61	5.11	1511.00	1888.75
Zn_3 : 0.6%	7.66	23.74	44.83	5.61	1622.11	2027.64
S Em±	0.11	0.43	1.14	0.13	26.85	33.57
CD(P=0.05)	NS	NS	NS	0.40	0.80	100.62
CV %	4.53	5.65	7.94	7.61	5.26	5.26

Tabel 3. Interaction effect of soil application of sulphur and foliar spray of zinc on yield of coriander.

Soil application of sulphur/ foliar application of Zinc	Seed yield (kg ha^{-1})		
	Zn_1 : 0.4% W/V	Zn_2 : 0.5% W/V	Zn_3 : 0.6% W/V
S_1 : 20 kg ha^{-1}	1716.67	1828.75	1946.25
S_2 : 30 kg ha^{-1}	1812.50	1866.67	2081.25
S_3 : 40 kg ha^{-1}	1945.83	1970.83	2055.42
S Em±		58.14	
CD(P=0.05)		174.28	

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Received : April 2014; Revised : June 2014; Accepted : July 2014.