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SC Jadhav
Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

Pooja S Sawant
Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

JP Devmore
Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

SS Prabhudesai
Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

AG Mahale
Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

Snehal V Raut
Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

Correspondence
SC Jadhav
Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

Effect of foliar spray and soil application of micronutrients on major nutrient content and uptake of coriander in lateritic soils of Konkan region

SC Jadhav, Pooja S Sawant, JP Devmore, SS Prabhudesai, AG Mahale and Snehal V Raut

Abstract
Coriander (*Coriandrum sativum* L.) belongs to family Apiaceae is a native of Mediterranean region and is extensively grown in India. In order to study the effect of foliar spray and soil application of micronutrients on major nutrient content and uptake of coriander, the present investigation was undertaken. The highest nutrient content (1.64, 0.27, 1.69 and 0.26 % N, P, K and S respectively) of coriander was obtained with the application of $ZnSO_4$ @ 20 kg ha^{-1} along with 100 per cent RDF (T_6). However, the highest N uptake (27.57 kg ha^{-1}) of coriander was obtained with the application of $ZnSO_4$ @ 0.5 per cent foliar spray along with 100 per cent RDF (T_5) and P, K and S uptake (4.43, 28.01 and 4.24 kg ha^{-1} respectively) of coriander was obtained with the application of $ZnSO_4$ @ 20 kg ha^{-1} along with 100 per cent RDF (T_6).

Keywords: Micronutrients, coriander, nutrient content, uptake, Konkan

1. Introduction
Coriander (*Coriandrum sativum* L.) belongs to family Apiaceae is an annual herb mainly cultivated for its tender green leaves and seeds. Coriander is cultivated over an area of 447 thousand hectares with an annual production of 314 thousand tonne in the country (Anonymous, 2015) [4].

The micronutrients *viz.* Fe, Cu, Mn, Zn, B, Mo, Cl and Ni plays an important role in the production of good quality and high yield of crops (Amjad *et al*., 2014) [2]. However, their deficiencies are widespread and may cause a great disturbance in the physiological and metabolic processes in the plants. Fifty per cent of world soils are deficient in zinc (Korayem, 1993) [12] which is essential for the transformation of carbohydrates and synthesis of tryptophan. Copper is an essential micronutrient for all living organisms including plant (Goyer, 1991) [9] playing an irreplaceable role in a large number of metalloenzymes, photosynthesis related plastocyanin and membrane structure and vital to cell metabolism (Marschner, 1995) [14].

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli has released a new variety of coriander 'Konkan Kasturi' in 2013 which is quite suitable for commercial cultivation in Rice based cropping system under Konkan agro-climatic conditions (Anonymous, 2013) [3]. The response of farmers for cultivation of the new variety is on the increase. However, no systematic research work has been conducted so far to study the effect of micronutrients on this crop. Hence, the present investigation was undertaken.

2. Material and methods
A field trial was laid out in randomized block design with 3 replicates and 10 treatments at Vegetable Improvement Scheme, Pangari Block, Central Experimental Station, Wakavali, during *Rabi* 2016-2017.

The soil of the experimental plot was acidic in reaction and showed low electrical conductivity. While, it was found to be high in organic carbon and K_2O, medium in available N and S and low in available P_2O_5.

Total nitrogen content in coriander plant was determined as per the procedure given by Tandon, 1993 [22] while, phosphorus was determined colorimetrically (Chopra and Kanwar, 1978) [8], total potassium was estimated by flame photometery (Piper, 1966) [18] and Total sulphur was estimated by turbidity method (Chesnin and Yien, 1950) [7].

3. Results and discussions

3.1 Effect of micronutrients on nutrient content of coriander

The plant samples were collected periodically and analyzed for various major nutrients viz. N, P, K and S. The data was statistically analyzed and is presented and interpreted here (Panse and Sukhatme, 1967) [16].

3.1.1 Nitrogen content

The nitrogen content in the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 20 kg ha^{-1} through soil along with 100 per cent RDF (T_6) resulted in the highest nitrogen content (1.64 per cent) in coriander and the treatment T_5 (100 per cent RDF + $ZnSO_4$ @ 0.5 per cent foliar spray) was at par (1.56 per cent) with treatment T_6. The findings of the study agree with results of Suchitra (2013) [20].

The higher nitrogen content in coriander could be due to the application of Zn which exerts a synergistic relationship with N. Further, zinc has a role in the protein metabolism in plants and nitrogen is an essential constituent of proteins.

3.1.2 Phosphorus content

The phosphorus content in the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 20 kg ha^{-1} through soil along with 100 per cent RDF (T_6) resulted in the highest phosphorus content (0.27 per cent) in coriander and this finding was at par with the phosphorus content in coriander (0.26 per cent) of treatment T_4 (100 per cent RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil) and also with the phosphorus content in coriander (0.25 per cent) of treatment T_{10} (100 per cent RDF + $CuSO_4$ @ 20 kg ha^{-1} through soil). The findings of the study are in line with the findings of Bairwa *et al.* (2012) [5] in their field experiment on the effect of zinc on nutrient content of bottle gourd.

Table 1: Effect of Micronutrients on Nitrogen, Phosphorous, Potassium and Sulphur Content of Coriander

Treatment	N (%)	P (%)	K (%)	S (%)
T_1-Absolute control	1.23	0.20	1.30	0.16
T_2-100 % RDF (60:60:30 N: P_2O_5: K_2O kg ha^{-1})	1.37	0.23	1.34	0.19
T_3-100 % RDF + $ZnSO_4$ @ 0.25 % Foliar spray	1.45	0.22	1.41	0.21
T_4-100 % RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil	1.42	0.26	1.44	0.24
T_5-100 % RDF + $ZnSO_4$ @ 0.5 % Foliar spray	1.56	0.20	1.47	0.22
T_6-100 % RDF + $ZnSO_4$ @ 20 kg ha^{-1} through soil	1.64	0.27	1.69	0.26
T_7-100 % RDF + $CuSO_4$ @ 0.25 % Foliar spray	1.35	0.21	1.43	0.21
T_8-100 % RDF + $CuSO_4$ @ 15 kg ha^{-1} through soil	1.39	0.24	1.39	0.20
T_9-100 % RDF + $CuSO_4$ @ 0.5 % Foliar spray	1.33	0.21	1.50	0.23
T_{10}-100 % RDF + $CuSO_4$ @ 20 kg ha^{-1} through soil	1.42	0.25	1.53	0.22
Mean	1.41	0.23	1.45	0.21
SE (m) ±	0.03	0.008	0.043	0.008
CD at 5 %	0.10	0.023	0.127	0.024

3.1.3 Potassium content

The potassium content in the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 20 kg ha^{-1} through soil along with 100 per cent RDF (T_6) resulted in significantly superior potassium content (1.69 per cent) in coriander. The findings of the study are in accordance with the findings of Naga (2005) [15], Jakhar (2006) [10] and Kumwat (2008) [13].

This might be due to the beneficial role of zinc in increasing the cation exchange capacity of roots which thereby helps in increased absorption of nutrients from the soil (Tisdale *et al.*, 1995) [23].

3.1.4 Sulphur content

The sulphur content in the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 20 kg ha^{-1} through soil along with 100 per cent RDF (T_6) resulted in the highest sulphur content (0.26 per cent) in coriander and the finding was at par with the sulphur content (0.24 per cent) in coriander of the treatment T_4 (100 per cent RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil). Similar are the findings of Suchitra (2013) [20].

The slight increase in sulphur content in the coriander might be due to the application of copper sulphate or zinc sulphate in addition to RDF. Even though the sulphate content in copper sulphate is 12 per cent while in zinc sulphate is 11 per cent, the treatments that have received zinc sulphate either through soil application or foliar spray have recorded higher sulphur content than the treatments that have received copper sulphate. This could be due to the synergistic relationship between sulphur and zinc causing increased sulphur content (Suchitra, 2013) [20].

3.2 Effect of micronutrients on the nutrient uptake by coriander

The plant samples were collected periodically and uptake of different major nutrients viz. N, P, K and S was calculated.

3.2.1 Nitrogen uptake

The nitrogen uptake in the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 0.5 per cent foliar spray along with 100 per cent RDF (T_5) resulted in the highest nitrogen uptake (27.57 kg ha^{-1}) in coriander and the finding is at par with the nitrogen uptake (27.17 kg ha^{-1}) in coriander of the treatment T_6 (100 per cent RDF + $ZnSO_4$ @ 20 kg ha^{-1} through soil). The findings of the study agree with results of Agarwal *et al*. (2004).

3.2.2 Phosphorus uptake

The phosphorus uptake by the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 20 kg ha^{-1} through soil along with 100 per cent RDF (T_6) resulted in the highest phosphorus uptake (4.43 kg ha^{-1}) by coriander and this finding was at par with the phosphorus uptake by coriander (4.01 kg ha^{-1}) of treatment T_4 (100 per cent RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil) and also with the phosphorus uptake by coriander (3.93 kg ha^{-1}) of treatment T_{10} (100 per cent RDF + $CuSO_4$ @ 20 kg ha^{-1} through soil). The findings of the study agree well with results of the trials conducted by Patil *et al*. (2011) [17] and Chavan *et al.* (2012) [6].

Table 2: Effect of Micronutrients on Nitrogen, Phosphorous, Potassium and Sulphur Uptake by Coriander

Treatment	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})
T_1-Absolute control	12.85	2.10	13.66	1.64
T_2-100 % RDF (60:60:30 N: P_2O_5: K_2O kg ha^{-1})	20.88	3.46	20.54	2.93
T_3-100 % RDF + $ZnSO_4$ @ 0.25 % Foliar spray	24.60	3.72	23.95	3.63
T_4-100 % RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil	22.27	4.01	22.63	3.78
T_5-100 % RDF + $ZnSO_4$ @ 0.5 % Foliar spray	27.57	3.57	26.03	3.84
T_6-100 % RDF + $ZnSO_4$ @ 20 kg ha^{-1} through soil	27.17	4.43	28.01	4.24
T_7-100 % RDF + $CuSO_4$ @ 0.25 % Foliar spray	20.93	3.35	22.18	3.24
T_8-100 % RDF + $CuSO_4$ @ 15 kg ha^{-1} through soil	21.48	3.79	21.45	3.11
T_9-100 % RDF + $CuSO_4$ @ 0.5 % Foliar spray	21.14	3.28	23.91	3.70
T_{10}-100 % RDF + $CuSO_4$ @ 20 kg ha^{-1} through soil	22.28	3.93	24.14	3.53
Mean	22.12	3.56	22.65	3.36
SE (m) ±	0.712	0.169	0.765	0.156
CD at 5 %	2.115	0.502	2.273	0.464

3.2.3 Potassium uptake

The potassium uptake by the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 20 kg ha^{-1} through soil along with 100 per cent RDF (T_6) resulted in highest potassium uptake (28.01 kg ha^{-1}) by coriander and the finding is at par with the potassium uptake (26.03 kg ha^{-1}) by coriander of the treatment T_5 (100 per cent RDF + $ZnSO_4$ @ 0.5 % foliar spray). Similar are the findings of Prasad and Ram (1991) [19] and Chavan (2012) [6].

The high potassium uptake may be due to high vegetative growth with zinc application. Zinc has a beneficial role in chlorophyll formation and it regulates the auxin concentration. Its stimulatory effect on most of the physiological and metabolic processes of the plants might have helped in absorption of higher amount of nutrients from the soil (Jat *et al*., 2012) [11].

3.2.4 Sulphur uptake

The sulphur uptake by the coriander at harvest was found to be significantly influenced by the application of micronutrients. Application of $ZnSO_4$ @ 20 kg ha^{-1} through soil along with 100 per cent RDF (T_6) resulted in the highest sulphur uptake (4.24 kg ha^{-1}) by coriander and this finding is at par with the sulphur uptake by coriander (3.78 kg ha^{-1}) of treatment T_4 (100 per cent RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil) and also with the sulphur uptake by coriander (3.84 kg ha^{-1}) of the treatment T_5 (100 per cent RDF + $ZnSO_4$ @ 0.5 per cent foliar spray). Similar are the findings of Salve (2008) [21] and Suchitra (2013) [20].

4. Conclusion

The application of $ZnSO_4$ @ 20 kg ha^{-1} along with 100 per cent RDF (T_6) to coriander significantly increases the nutrient content (1.64, 0.27, 1.69 and 0.26 % N, P, K and S respectively). However, the highest N uptake of coriander was obtained with the application of $ZnSO_4$ @ 0.5 per cent foliar spray along with 100 per cent RDF (T_5) and P, K and S uptake of coriander was obtained with the application of $ZnSO_4$ @ 20 kg ha^{-1} along with 100 per cent RDF (T_6).

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