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Effect of foliar spray and soil application of micronutrients on yield and quality of coriander in lateritic soils of Konkan region

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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 yield and quality of coriander the present investigation was undertaken. The highest yield of 11.18 t ha^{-1} of coriander was obtained with the application of 0.5 per cent $ZnSO_4$ through foliar spray along with 100 per cent RDF (**T_5**) with highest chlorophyll content of 2.54 mg g^{-1} and ascorbic acid content of 524.79 mg 100 g^{-1} of coriander. However, the yield of coriander (10.56 t ha^{-1}) with the soil application of $ZnSO_4$ @ 20 kg ha^{-1} along with 100 per cent RDF (**T_6**) which is at par with the treatment **T_5** had significantly superior β-carotene content of 2502.12 µg 100 g^{-1} in coriander. Thus, the application of $ZnSO_4$ @ 0.5 per cent foliar spray along with 100 per cent RDF or the soil application of $ZnSO_4$ @ 20 kg ha^{-1} along with 100 per cent RDF to coriander crop significantly increase the yield, influence the nutrient content and nutrient uptake by the plant, the soil properties and available nutrient status of the soil and improve the quality of coriander in terms of chlorophyll, ascorbic acid and β-carotene content

Keywords: Micronutrients, coriander, yield, quality, 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) [3].

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) [1]. 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) [13] 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) [16].

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli has released a new variety of coriander 'Konkan Kasturi' in 2013 (Anonymous, 2013) [2] which is quite suitable for commercial cultivation in Rice based cropping system under Konkan agro-climatic conditions. 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 at Vegetable Improvement Scheme, Pangari Block, Central Experimental Station, Wakavali, *Tahsil* Dapoli and Dist. Ratanagiri during *Rabi* season of the year 2016-2017, from the month of December to January.

The soil of the experimental plot at the initial stage *i.e.* before the commencement of the experiment, 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.

Ascorbic acid in green coriander leaves was determined by 2, 6, dichlorophenol indophenol dye method while, Beta carotene was estimated colorimetrically and chlorophyll content was estimated volumetrically as described by Ranganna (1986) [17].

3. Results and discussions

3.1 Yield of Coriander

The highest yield of coriander (11.18 t ha^{-1}) was recorded for the treatment T_5 in which 100 per cent RDF was applied along with 0.5 per cent $ZnSO_4$ through foliar spray and this finding is at par with the yield of coriander (10.56 t ha^{-1}) of treatment T_6 (100 per cent RDF + $ZnSO_4$ @ 20 kg ha^{-1} through soil application). The lowest yield (5.32 t ha^{-1}) was obtained for treatment T_1 (control). Similar are the findings of Diana and Nehru (2014) [7] and Lal *et al.* (2014) [15].

The increase in the yield might be due to zinc application as zinc is involved in many enzymatic activities. Zinc is also important in the synthesis of tryptophan, an amino acid required for the synthesis of some proteins and a compound needed for the production of growth hormones (auxins) such as indole acetic acid which promote the stem and cell elongation in plants (Tisdale *et al*., 1995) [20].

Table 1: Effect of foliar spray and soil application of micronutrients on yield of coriander

Treatments	Yield (kg $plot^{-1}$)	Yield (t ha^{-1})
T_1-Absolute control	4.79	5.32
T_2-100 % RDF (60:60:30 N: P_2O_5: K_2O kg ha^{-1})	8.71	9.68
T_3-100 % RDF + $ZnSO_4$ @ 0.25 % Foliar spray	9.15	10.17
T_4-100 % RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil	9.04	10.04
T_5-100 % RDF + $ZnSO_4$ @ 0.5 % Foliar spray	10.06	11.18
T_6-100 % RDF + $ZnSO_4$ @ 20 kg ha^{-1} through soil	9.50	10.56
T_7-100 % RDF + $CuSO_4$ @ 0.25 % Foliar spray	8.92	9.91
T_8-100 % RDF + $CuSO_4$ @ 15 kg ha^{-1} through soil	8.82	9.80
T_9-100 % RDF + $CuSO_4$ @ 0.5 % Foliar spray	9.13	10.14
T_{10}-100 % RDF + $CuSO_4$ @ 20 kg ha^{-1} through soil	8.99	9.98
Mean	8.71	9.68
SE (m) ±	0.23	0.25
CD at 5 %	0.68	0.75

3.2 Quality of Coriander

The data related to quality parameters *viz.,* Chlorophyll, β-carotene and Ascorbic acid as influenced by the application of micronutrients is presented here:

3.2.1 Chlorophyll content of coriander

The chlorophyll content 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 chlorophyll content (2.54 mg g^{-1}) of coriander and the finding is at par with the chlorophyll content (2.48 mg g^{-1}) of the treatment T_6 (100 per cent RDF + $ZnSO_4$ @ 20 kg ha^{-1} through soil). However, the lowest chlorophyll content of coriander (1.48 mg g^{-1}) was found in the treatment T_1 (control). The findings of the study agree with the results of Sharma (2012) [18] and Kazami (2013) [11].

This might be due to the beneficial effect of zinc on photosynthetic pigments and it's role in increasing the rate of photochemical reduction (Kumar *et. al.,* 1988) [14]. Hisamitsu *et al*. (2001) [10] from their investigation have reported that zinc deficiency disrupts the chlorophyll synthesis. Increased chlorophyll contents are due to zinc which acts as a structural and catalytic component of proteins, enzymes and as a co-factor for normal development of pigment biosynthesis (Balashouri, 1995) [5].

Table 2: Effect of foliar spray and soil application of micronutrients on quality of coriander

Treatment	Chlorophyll Content (mg g^{-1})	β-Carotene (µg 100 g^{-1})	Ascorbic acid (mg 100 g^{-1})
T_1-Absolute control	1.48	1221.28	187.43
T_2-100 % RDF (60:60:30 N: P_2O_5: K_2O kg ha^{-1})	1.76	1512.53	308.21
T_3-100 % RDF + $ZnSO_4$ @ 0.25 % Foliar spray	2.38	2147.99	420.67
T_4-100 % RDF + $ZnSO_4$ @ 15 kg ha^{-1} through soil	2.33	2273.76	404.01
T_5-100 % RDF + $ZnSO_4$ @ 0.5 % Foliar spray	2.54	2502.12	524.79
T_6-100 % RDF + $ZnSO_4$ @ 20 kg ha^{-1} through soil	2.48	2392.91	495.64
T_7-100 % RDF + $CuSO_4$ @ 0.25 % Foliar spray	2.28	1969.26	395.68
T_8-100 % RDF + $CuSO_4$ @ 15 kg ha^{-1} through soil	2.23	1883.21	374.85
T_9-100 % RDF + $CuSO_4$ @ 0.5 % Foliar spray	2.35	2055.32	458.15
T_{10}-100 % RDF + $CuSO_4$ @ 20 kg ha^{-1} through soil	2.30	2131.44	404.01
Mean	2.21	2008.98	397.34
SE (m) ±	0.022	28.199	16.500
CD at 5 %	0.067	83.783	5.553

4.4.2 β-carotene content of coriander

The β-carotene content of 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 β-carotene content (2502.12 µg 100 g^{-1}) in coriander. However, the lowest β-carotene content (1221.28 µg 100 g^{-1}) at harvest was found in the treatment T_1 (control). The findings are similar to those reported by Dube *et al*. (2003) [8].

4.4.3 Ascorbic acid content of coriander

The ascorbic acid content 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 ascorbic acid content (524.79 mg 100 g^{-1}) of coriander. However, the lowest ascorbic acid content of coriander (187.43 mg 100 g^{-1}) was found in the treatment **T_1** (control). The findings of the study agree with the results of Babu *et al*. (2007) [4], Khan *et al*. (2010) [12], Sharma (2012) [18] and Bhatt *et al*. (2004) [6].

This might be due to the role of zinc as an activator of many enzymes particularly carbonic anhydrase and carboxylase that lead to enhanced ascorbic acid content (Suchitra, 2013) [19].

4. Conclusion

The application of $ZnSO_4$ @ 0.5 per cent foliar spray along with 100 per cent RDF or the soil application of $ZnSO_4$ @ 20 kg ha^{-1} along with 100 per cent RDF to coriander crop significantly increases the yield and improves the quality of coriander in terms of chlorophyll, ascorbic acid and β-carotene content.

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