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Response of *Cuminum cyminum* for various modes of micronutrients application including uptake and their availability in soil

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Abstract

Cumin is one of the major seed spice crop of arid region of India mainly Rajasthan and Gujarat. Cumin is low biomass yielding crop and able to remove lesser amount of nutrients from soil. With this view a field experiment was conducted to study the effect of micronutrient application by different methods on micronutrients dynamics in cumin (*Cuminum cyminum* L.). Results revealed that uptake of iron was highest in T_2 (697.5 g ha^{-1}) manganese in T_3 (288.7 g ha^{-1}) Cu in T_4 (144.9 g ha^{-1}) where each of Fe and Mn applied @ 10 kg ha^{-1} and Cu 5 kg ha^{-1} respectively. In case of zinc, cumin removed highest zinc from T_{11} (29.4 g ha^{-1}) and T_5 (28.3 g ha^{-1}) where crop was fertilized by 0.5% $ZnSO_4$ as a foliar spray and soil application @ 10 kg ha^{-1} respectively. However, boron uptake did not show any clear trend for uptake among treatments. Average uptake of Fe, Mn, Cu, Zn and B by cumin was 439.8 g ha^{-1}, 201.8 g ha^{-1}, 107.6 g ha^{-1}, 22.2 g ha^{-1} and 37.4 g ha^{-1}, respectively. It clearly showed that all applied micronutrients by all the three methods are utilized by crop in higher quantity as compared to control.

Key words : cumin, micronutrients uptake, zinc, Iron, soil available nutrients.

Introduction

Cumin is important major seed spice crop of India particularly arid and semi-arid region of Rajasthan and Gujarat. Biomass accumulation in cumin least than the other seed spices. More over cumin is a short duration crop and matures in 110-125 days. Short duration nature of crop and locality of its cultivation that is arid regions of Rajasthan and Gujarat implies very poor nature of soil and having fewer nutrients. Crop performs well in this soil types as it needs less water and nutrients. For the optimal growth and development of any plants, balanced application of nutrients is highly essential. If any element is lacking in the soil or not adequately balanced with other nutrients, growth suppression or even complete inhibition may result (Mengel *et al.*, 2001). In recent days excessive use of high analysis fertilizers (N, P & K) and less or no use of organic manures lead to micronutrients disorder in crop plants particularly in arid and semi arid regions of India where soils are coarse textured and low in native nutrient. Application of nutrients untimely, following inappropriate method of application leads to severe loss of nutrients by leaching and fixation. But in reality uptake is influenced by many factors such as agro climatic conditions, soil type, method of application, nutrients mobility and its accumulation sites (Arunachalam *et al.*, 2013). With this context an experiment was conducted on cumin, an important seed spice crop of arid and semi-arid region of India to study the effect of various micronutrients on micronutrient uptake, and soil fertility status after harvest.

Materials and methods

The present study was carried out at the ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer (Rajasthan) during *Rabi* season of 2014-15, to find out the impact of micronutrients such as iron, manganese, zinc, copper and boron on growth and yield of cumin. The soil of the experimental field was sandy loam in nature having 4.32 mg kg^{-1} of DTPA extractable iron, 8.77 mg kg^{-1} of DTPA extractable manganese, 0.78 mg kg^{-1} of DTPA extractable copper, 0.96 mg kg^{-1} of DTPA extractable zinc and 0.43 mg kg^{-1} of hot water extractable boron. Micronutrients were applied by three methods such as soil application, foliar spray and seed priming. The soil application treatments includes T_1- control, T_2-Fe 10 kg ha^{-1}, T_3-Mn 10kg ha^{-1}, T_4-Cu 5 kg ha^{-1}, T_5-Zn 5 kg ha^{-1} and T_6 -boron 2.5 kg ha^{-1} through Ferrous Sulphate ($FeSo_4.7H_2O$), Manganese Sulphate ($MgSO_4.H_2O$), Copper sulphate ($CuSO_4$ $.5H_2O$), Zinc Sulphate ($ZnSO_4.7H_2O$) and Borax Powder (Di-Sodium tetra borate) ($Na_2B_4O_7.10H_2O$), respectively. All the micronutrient fertilizers were applied to soil by incorporating in soil just before sowing. In foliar spray treatments the micronutrients

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such as T_7 - water spray, T_8 - $FeSO_4$ 0.5 %, T_9 -$MnSO_4$ 0.5 %, T_{10} -$CuSO_4$ 0.5 %, T_{11} - $ZnSO_4$ 0.5 % and T_{12} -Borax 0.25 % are sprayed at 45 and 90 DAS by mixing with sticker at the rate of one ml per litre of spray solution. Spraying was carried out using 5.0 litre capacity hand sprayer. In seed treatments T_{13}- Water soaking, T_{14}- Iron 500ppm, T_{15}- Manganese 500ppm, T_{16}- Copper 500ppm, T_{17}- Zinc 500ppm and T_{18}- Boron 250ppm solutions were prepared and seeds were soaked for 12 hours, surface washed by water to remove surface nutrients and shade dried for 24 hours to bring the seed moisture to its original status. Experiment was laid out in RBD and the plot size was 3.5 m x 3m (10.5 m^2) with three replications. The soil samples were collected before and after the cropping season to assess the nutrient uptake by the crop and soil available nutrients. The plant samples were collected at physiological maturity to analyse plant nutrient status of cumin. Samples were air dried and powdered with wooden mortar and passed through a 2 mm stainless steel sieve. Soil samples were extracted for micronutrients using 0.005M DTPA and analyzed using atomic absorption spectrophotometer. The plant samples were collected at the time of physiological maturity. Plant samples were successively washed with tape water, 0.1 M HCl and distilled water and dried at 70°C. After proper drying samples were powdered in wily mill and passed through the 20 mesh steal sieve. The samples were digested in nitric acid and perchloric acid mixture (8:4) and digested samples were analyzed using atomic absorption spectrophotometer.

Results and discussion

Results obtained on soil available nutrient status after harvest of cumin crop, nutrient content of plant tissue, nutrient uptake by cumin (table 1) are discussed in detail here under. The results show remarked influence on soil nutrients status after harvest of the cumin crop.

Plant nutrient status and Nutrient uptake

No significant differences in plant micronutrient content were observed in cumin crop by micro nutrient fertilization. It is found that micronutrient need of the cumin crop is less and it was not affected by fertilization. The result pertaining to nutrient removal by cumin crop is presented in table 1. Cumin crop did not influenced by application of micronutrients and it is found that nutrient uptake was non significant by micronutrient application. Crop removed very less amount of nutrients and its uptake of iron is highest in T_2 (697.5 g ha^{-1}) followed by T_{14} (615.7 g ha^{-1}) and T_{11} (550.9 g ha^{-1}). In case of manganese its uptake was highest in T_3 (288.7 g ha^{-1}) followed by T_{15} (257.2 g ha^{-1}) and T_{11} (247.3 g ha^{-1}). Cu uptake was highest in T_4 (144.9 g ha^{-1}) followed by T_{10} (127.8 g ha^{-1}) and T_{14} (133.3 g ha^{-1}). Zinc uptake by cumin was not observed any clear trend even though Zn applied in soil, foliar spray and seed treatment. The same was reported by Mortvedt (1992) in corn that broadcast and incorporation of fine powder or liquid micronutrients resulting in uptake efficiencies of 0.8 to 8.5% of applied Zn. Similarly boron uptake was varied with treatments. It clearly showed that all applied micronutrients by all the three methods were utilized by crop in very lower quantity. In case of iron soil was deficit in initial status and when supplied as soil application crop removed higher amount as compared to foliar and seed treatment. Harisha *et al.*, (2017) reported in fennel crop that crop response to micronutrients when there is deficiency in soil or crop demands more nutrients.

Soil fertility after the harvest

It is obvious that after harvest of the crop the expected balance of micronutrients will not be same as actual balance of micronutrients in the soil. It is mainly due to the losses by fixation, leaching and crop uptake. In cumin crop it was found that residual soil DTPA extractable iron content was not influenced significantly. Even then highest Fe content was observed in T_2 (6.29 mg kg^{-1}) which is higher than initial fertility status of soil (4.32 mg kg^{-1}). But DTPA extractable manganese, Copper and zinc were influenced significantly by micronutrient fertilization. Highest residual Mn content was observed in T_3 (6.74 mg kg^{-1}) where soil was fertilized with Mn 10 kg ha^{-1}. Copper content of soil was highest in T_4 (1.99) and zinc content was highest in T_5 (0.88 mg kg^{-1}). Where ever soil was fertilized by micronutrients the fertility was improved. Here DTPA extractable Fe content was increased in all the treatments as compared to initial status and Mn content decreased. This may be due to interaction of iron with other elements such as manganese, copper and zinc. In case of DTPA extractable manganese in the soil after harvest of crop was noticed that all the treatments were less in residual manganese as compared to expected balance. This may be due to availability of sufficient manganese in soil and process of ion exchange mechanism might have responsible for lower amount of DTPA extractable Mn in the soil. In the same way copper content was found higher actual balance than the initial balance in the soil except soil application of copper 5 kg ha^{-1}. Zinc status was found negative trend after the harvest of cumin crop. It was lesser than the initial status of zinc in the soil and this may be due to fixation of zinc in clay complex of soil. Same were reported by Bolland and Brennan (2006) that the residual effect of copper, zinc are strongly affected by cultivation practices, which

Table 1. Plant micronutrient status, micronutrient uptake, residue of micronutrients after the harvest of cumin crop

T. no	Soil micronutrient status (mg kg^{-1})					Plant micronutrient content (mg kg^{-1})					Nutrient uptake (g ha^{-1})				
	Fe	Mn	Cu	Zn	B	Fe	Mn	Cu	Zn	B	Fe	Mn	Cu	Zn	B
T1	3.18	4.54	1.07	0.62	0.40	301.9	152.9	84.8	17.1	28.7	353.2	181.3	101.3	20.3	33.9
T2	6.29	4.35	1.12	0.65	0.45	490.6	163.5	67.8	18.0	29.2	697.5	232.0	96.1	25.9	41.5
T3	4.15	6.74	1.03	0.67	0.43	347.2	217.1	87.6	16.6	30.1	449.0	288.7	101.9	21.0	38.0
T4	3.85	4.81	1.99	0.73	0.42	339.6	189.8	116.4	19.0	28.4	426.9	236.7	144.9	23.6	35.4
T5	3.85	4.97	1.10	0.88	0.45	362.3	184.6	69.3	20.5	29.5	498.1	254.1	97.7	28.3	41.0
T6	4.44	4.42	1.37	0.79	0.62	297.0	131.8	91.2	16.6	34.8	356.3	153.0	110.8	20.4	42.7
T7	3.26	4.06	0.98	0.61	0.44	301.9	141.0	84.8	15.6	29.9	375.6	175.6	105.5	19.3	37.8
T8	3.85	4.71	1.22	0.73	0.46	400.0	137.7	87.6	18.0	28.5	468.1	159.2	94.8	20.7	33.3
T9	4.15	3.83	1.10	0.69	0.38	301.9	163.5	85.0	16.1	29.5	364.8	194.1	107.6	20.0	36.2
T10	4.93	4.02	1.20	0.70	0.41	324.5	110.7	103.8	19.0	32.5	396.0	129.8	127.8	23.1	40.3
T11	4.33	4.91	1.22	0.70	0.43	400.0	168.7	87.6	21.0	30.5	550.9	247.3	123.4	29.4	42.8
T12	4.30	4.66	1.09	0.69	0.43	339.6	163.5	97.0	19.0	32.1	335.4	166.6	96.2	18.9	32.2
T13	3.56	3.76	1.15	0.64	0.41	254.2	158.2	90.5	15.1	29.7	281.7	176.9	99.4	16.9	32.8
T14	3.26	4.61	1.17	0.63	0.41	430.2	168.7	96.1	18.0	30.1	615.7	229.6	133.3	25.0	41.7
T15	4.74	4.54	1.12	0.71	0.38	286.8	189.8	82.0	17.1	29.9	383.1	257.2	117.2	23.4	41.4
T16	4.60	4.47	1.35	0.71	0.38	369.8	163.5	63.7	17.1	29.6	453.0	201.9	79.6	21.0	36.4
T17	4.70	4.54	0.94	0.67	0.36	415.1	147.7	96.1	19.5	28.8	478.2	173.3	109.7	22.6	33.4
T18	3.56	4.22	1.07	0.77	0.43	369.8	152.9	79.1	19.0	29.6	433.4	175.4	90.5	21.4	33.7
F test	NS	*	*	*	*	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
SEm ±	0.85	0.46	0.16	0.046	0.02	71.1	23.5	17.2	1.83	1.14	97.9	32.2	18.7	2.6	3.6
CD @ 5%	..	0.13	0.47	0.132	0.075	..	..	..	..	3.28	..	..	..	..	..

breaks up and mixes the residual copper and zinc throughout the soil increasing its uptake by the subsequent crops.

Conclusion

From study it can be concluded that cumin is one of the low nutrient required crop and foliar or seed treatment methods for supply of nutrients is ideal rather than soil application which leads to more loss by fixation in the soil. Average uptake of micronutrients by cumin is Fe-439.8 g ha^{-1}, Mn-201.8 g ha^{-1}, Cu-107.6 g ha^{-1}, Zn-22.2 g ha^{-1} and B-37.4 g ha^{-1}. In this study micronutrient metals such as Mn and Zn loss was greater than other elements. In case of all micronutrient elements external application by soil leads to net loss of nutrients.

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