Micronutrient management in spices

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MICRO NUTRIENT MANAGEMENT IN SPICE CROPS

Micronutrients are the elements required by plants in very small quantities but it is essential for proper growth and development of the plants. Micronutrients also called as 'trace elements', are: iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), nickel (Ni) and chlorine (Cl), and are essential for plant growth. Micronutrients play an important role in the growth, development, and quality enhancement of spice crops, which are integral to culinary, medicinal, and industrial applications worldwide. Micronutrient deficiency has emerged as one of the major constraints to crop productivity in India. About 48.1% of Indian soils are deficient in zinc, 11.2% in iron, 7% in available copper and 5.1% in manganese. In India, the major spices are cultivated in the highly weathered laterite and red soils of low nutrient status. Excess application of macro nutrients like N, P and K with less attention to the application of organic manures aggravate the deficiency of micronutrients in soil. Despite being required in trace amounts, deficiencies of micronutrients like zinc, boron, molybdenum, iron, and manganese can significantly impair plant health, reduce yields, and compromise the spice quality characteristics such as flavor, aroma, and essential oil content. Effective micronutrient management involves precise assessment of soil and plant needs, tailored fertilization strategies, and innovative approaches such as application of adequate organic manures, soil application of recommended dose of micronutrients, addition of appropriate soil amendments to correct acidity and alkalinity of soil, foliar sprays of micronutrients, designer micronutrient mixtures and nano-formulations to ensure optimal nutrient availability.

Micronutrient deficiency assessment

The deficiency of micronutrients in soil and plants can be assessed by soil testing, deficiency symptoms on plants and leaf analysis.

1. Soil testing: Representative soil samples are drawn from the field and tested for micronutrient contents in laboratory and the same is compared with the general values prescribed to assess the deficiency / sufficiency of micronutrients.

Element	Critical level	
	Extractant used	Value (mg kg-1)
Zinc	DTPA	0.6 (0.4 to 1.2)
Iron	DTPA	2.5 - 4.5
Manganese	DTPA	2.0
Copper	DTPA	0.2
Boron	Hot water	0.5
Molybdenum	Ammonium Oxalate	0.2

2. Tissue testing: Leaf analysis is the quickest way to assess the nutrient supplying power of the soil. However, the usefulness of leaf analysis depends upon the correctness of leaf sampling. So utmost care should be exercised while collecting leaves for analysis. The general optimum range in concentration of micronutrients in plants are given below

Nutrient	Deficient (mg/kg)	Optimum (mg/kg)
Zinc	10 – 20	20 – 100
Iron	< 50	50 – 250
Manganese	15 – 25	20 – 300
Copper	2 – 5	5 – 20
Boron	5 – 30	20 – 100
Molybdenum	0.03 – 0.15	0.1 – 0.5

3. Deficiency symptoms: When the plants are unable to take up nutrients from soil due to its deficiency in soil or other reasons, the plant develop symptoms which are more or less characteristics to the element and these deficiency symptoms can serve as quick guide to assess the nutrient status in soil.

The deficiency symptoms of micronutrient in spices

Element	Deficiency symptoms
Fe	Interveinal yellowing of younger leaves with distinct green veins. Entire leaves become dark yellow or white with severe deficiency, and leaf borders turn brown and die.
Mn	Interveinal tissue becomes light green with veins and surrounding tissue remaining green on dicots (Christmas tree design) and long interveinal leaf streaks on cereals. Develop necrosis in advanced stages.
Zn	Deep yellowing of whorl leaves (cereals). Dwarfing (rosette) and yellowing of growing points of leaves and roots (dicots). Rusting in strip on older leaves with yellowing in mature leaves. Leaf size reduced. Main vein of leaf or vascular bundle tissue becomes silver-white, and marked stripes appear in middle of leaf.
Cu	Yellowing of young leaves. Rolling and dieback of leaf tips. Leaves are small. Tillering is retarded. Growth is stunted.
B	Death of growing points of shoot and root. Failure of flower buds to develop. Blackening and death of tissues, especially inner tissue of brassica plants.
Mo	Mottled pale appearance in young leaves. Bleaching and withering of leaves and sometimes tip death. Legumes suffering Mo deficiency have pale green to yellowish leaves. Growth stunted. Seed production is poor.
Cl	Reduced leaf size, yellowing, bronzing and necrosis on leaves. Roots reduced in growth and without hairs.

The deficiency symptoms in some of the spice crops are given below.

Iron deficiency

Zinc deficiency

Black pepper

Zinc deficiency

Iron deficiency

Copper deficiency

Ginger

Iron deficiency

Turmeric

Magnesium deficiency

Iron deficiency

Boron deficiency

Nutmeg

Micronutrient management

Micronutrient deficiencies in soil can significantly impact the growth and development of plants, making effective management of nutrient stress crucial for ensuring food and nutritional security. Since each crop has specific micronutrient requirements and these nutrients are interdependent in their functions, it is challenging to establish universal soil management practices for maintaining optimal micronutrient levels. Tailored, location-specific approaches are essential, as the margin between deficiency and toxicity levels of micronutrients in soil is often narrow. Various management options are listed below.

1. Application of soil amendments, organic manures and fertilisers: The availability of micronutrients in soil is dependent on soil pH, organic matter content and concentration of salts in soil. Amelioration of soil therefore can aid in making available the micronutrients to the plants. The soil which is deficient in major nutrients cannot supply the nutrients to the crop. Adequate fertilizer also needs to be applied based on the recommendation for the crops. The general recommendation for spice crops in red and laterite soils is given below.

Sl. No.	Crop	Organic manure	N-P2O5-K2O recommendation*	Lime
1	Black pepper	10.0 kg / vine; or castor and cotton cakes at 1-2 kg per plant or poultry manure at 1-2 kg or cattle manure at 3-5 kg and Neem cake @ 1 kg/vine	50:50:150 or 140:55:250 g/vine/ year (for 3 years and above and reduced dosage for young vines), in 2 splits	0.5-1.0 kg per standard
2	Small cardamom	neem cake at 1-2 kg plant-1& poultry manure/ FYM/ compost/ vermicompost at 2 kg plant-1 or 3-4 t FYM / ha	75:75:150 kg/ha for rainfed, in 2 splits 125:125:250 kg/ha for irrigated, in 3 splits	2 kg per Plant
3	Ginger	20-30 t/ha (10 kg/bed) Neem cake 2 t/ha (1 kg/bed)	70:50:50 kg/ha (Full dose P as basal; 50% N&K each at 45 DAP and 90 DAP) in Kerala	1 to 2 t/ha (500-1000 g / 3 m2 bed)

	Turmeric	FYM 20-30 t/ha (10 kg/bed) Neem cake 2 t/ha (1 kg/bed)	60:50:120 kg/ha in Kerala (Full dose P as basal; N&K in 2-3 split doses at 45, 90 and 120 DAP)	1 to 2 t/ha (500-1000 g / 3 m2 bed)
	Nutmeg	15 to 50 kg FYM per tree	First year: 20:20:50 g/ tree10-15 years: 500: 250:1000 g/tree in 2 splits	0.5 to 1.0 kg per tree
	Cinnamon	25 to 50 kg FYM per tree	First year: 20-25-25 g / seedlingAfter 10 years: 200-180-250 g/tree in 2 splits	0.5 to 1.0 kg per tree
	Clove	25 to 50 kg FYM per tree	First year: 20-18-50 g per seedlingAfter 10 years: 200-180-200 g/ treeAfter 15 years: 300-250-750 g/tree in 2 splits	0.5 to 1.0 kg per tree

*The general recommendation needs to be adjusted based on soil test report.

2. Application of micronutrient fertilizers: In soils deficient in micronutrients, the external application of the micronutrient fertilizers either as soil application or as foliar spray can be adopted. Generally, soil application is adopted in field crops in alternate years. Based on research at ICAR-Indian Institute of Spices Research, soil application of zinc sulphate @ 25.0-30.0 kg/ ha is optimum for spices like black pepper, Cardamom, ginger and turmeric in zinc deficient soil. Similarly, 10.0-20.0 kg borax/ ha is optimum for spices in boron deficient soil.

Crop specific micronutrient mixtures for spices

The occurrence and availability of micronutrients in soil is dependent on the characteristics of soil such as pH. Similarly, the requirement also varies with the crops. ICAR-IISR, Kozhikode has developed crop specific and soil pH-based mixtures of micronutrients for black pepper, cardamom, ginger, turmeric. The important features of these micronutrient mixtures are given below.

- Apart from the much-needed micronutrients, these mixtures supply essential nutrients such as potassium also.
- The mixtures are water soluble and compatible with simple and complex standard fertilizers.
- The mixtures are easy to transport and has a long storage life of up to one year.
- Use of the micronutrient mixtures as foliar spray provide a rapid and efficient method for micronutrients to be absorbed directly through the leaves. This is particularly useful when the soil nutrients are deficient or when there is a slow uptake of nutrients from the soil due to poor root health or environmental conditions.
- Micronutrients such as zinc, iron, copper, manganese, and boron are often present in soil in forms that are not easily accessible to plants. Foliar application ensures that these essential nutrients are available in a more readily usable form, thereby overcoming soil limitations.
- Micronutrients play a vital role in many physiological processes such as photosynthesis, enzyme activity, and chlorophyll production.
- The foliar application of micronutrient mixtures improves the health, quality and yield of spice crops. An increase of 15-25% in yield of spices is observed by the use of designer micronutrient formulations. For one hectare approximately 6.0-8.0 kg mixture costing Rs 1200-1600 may be needed as foliar spray depending upon the crop canopy.
- Unlike soil applications, which can lead to over-fertilization and nutrient imbalances in the soil, foliar spraying ensures that the plant gets the exact amount of nutrients it needs, thus preventing nutrient leaching and environmental pollution.
- The micronutrient mixtures can also be used under organic agriculture and are environment friendly.
- These mixtures should never be mixed with any other chemical pesticides during application

Application schedule of micronutrient mixtures of IISR

The mixtures are to be applied as foliar spray at the rate of 5 g per litre water. The method of application is provided in the table below.

Sl. No.	Crop	Method of application
	Black pepper	2-3 Foliar sprays@ 5 g per L of water once during flowering (May-June) and another after one month preferably (Aug-September) during berry development stages
	Cardamom	2-3 Foliar sprays@ 5 g per litre of water during specific stages preferably flowering (April-May) and capsule formation & developmental stages (June –Aug) for best results.
	Ginger	2 Foliar sprays @ 5 g per litre once during 60 days after planting and another 90 days after planting
	Turmeric	2 Foliar sprays @ 5 g per litre once during 60 days after planting and another 90 days after planting

Adequate attention must be given to the identification and management of micronutrient deficiencies in soil to ensure the health and productivity of spice crops. Timely and targeted corrective measures, such as soil testing, foliar applications, or soil amendments, should be implemented to address deficiencies in essential micronutrients like zinc, boron, iron, and manganese. Failure to correct these imbalances can lead to suboptimal crop growth, reduced yield, and compromised quality of the spices, affecting both their market value and nutritional content. Regular monitoring and early intervention can help maintain soil fertility and ensure that spice crops reach their full potential in terms of both quantity and quality.

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