Ecofarming (e-Magazine)

Agriculture

Ecofarming
e-Magazine for Agriculture and Allied Sciences
http://www.ecofarming.rdagriculture.in
e-ISSN: 2583-0791

The Importance of Micronutrients in Citrus Crops

1. **Tripti Pal**
ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh 462038, India
2. **S G Sarowar**
Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi 110012, India
3. **Soumya Roy Chowdhury**
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar 848125, India
4. **VK Sharma**
Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi 110012, India
5. **Indu Chopra**
Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi 110012, India
6. **Soumodip Sarkar**
ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh 462038, India

Received: August, 2025; Accepted: September, 2025; Published: October, 2025

Introduction

Citrus fruits (oranges, mandarins, limes, lemons etc.) belonging to the family Rutaceae, are considered as one of the world's most important fruit crops, extensively cultivated in many tropical and subtropical regions between 40°N and 40°S. Citrus is highly valued for its delicious juice and pulp content, as well as its role as a major dietary source of vitamin C. In addition to its economic significance, citrus fruits provide a variety of bioactive compounds such as citric acid, flavonoids, phenolics, pectin, limonoids, and ascorbic acid, which make them valuable for nutritional, medicinal, industrial, and cosmetic uses. The growth and development of citrus crops heavily rely on the nutrients provided at various stages of growth for both young and mature plants. Micronutrients are crucial for plant metabolism, supporting various enzymatic activities and synthesis processes. While micronutrients like zinc, iron, boron and copper etc. are required in minute quantities, but they hold equal importance to macronutrients. Citrus is also a micronutrient loving crop, so more precise management of nutrients is required to fulfill the nutrient demand for economically profitable citrus fruit production and to ensure its quality.

Role of micronutrients in citrus

Iron (Fe) is crucial for chlorophyll synthesis, respiratory and photosynthetic enzyme activity, and the reduction of nitrates and sulfates. Zinc (Zn) regulates carbon metabolism, enzyme systems, protein metabolism, chlorophyll formation, photosynthesis, auxin synthesis, and improves water uptake. Manganese (Mn) functions as an enzyme activator, supports amino acids and protein synthesis, nitrogen metabolism, nitrate reduction, chlorophyll formation and photosynthesis. Boron (B) is vital for carbohydrate metabolism, sugar translocation, active cell division, reproductive processes, nitrogen metabolism, hormone activity and calcium utilization. Copper (Cu) participates in photosynthesis, chlorophyll formation, protein utilization, uptake and utilization of iron, enzyme regulation, cell wall lignification and redox reactions. Molybdenum (Mo) aids in protein synthesis, starch and vitamin formation, nitrate reduction, and nitrogen fixation. Chlorine (Cl) contributes to guard cell turgor regulation, oxygen evolution in photosynthesis, and chlorophyll stability.

Micronutrient deficiencies and disorders in citrus

Citrus frequently experiences lime-induced iron chlorosis on alkaline calcareous soils. This issue starts with a yellowing between the veins on young leaves, which can eventually lead to the leaves turning completely yellow, becoming bleached, and developing into thin, fragile "paper leaves." In more severe situations, the trees may drop their leaves early, experience dieback at the edges of the canopy, show stunted growth, produce lower yields, and the fruits can turn hard.

Green veins and mottled chlorosis on young leaves are the first signs of manganese deficiency in citrus, which subsequently spreads to older leaves. When leaves get older, they first have a light green background with green vein networks, then whitish interveinal spots that give them a greyish look. The leaves become dull green to yellowish-green with pale interveinal areas in extreme cases.

Copper deficiency in citrus, often referred to as exanthema or die-back, is characterized by dark green leaves on 'S'-shaped twigs, yellow spots beneath nodes, gum oozing from stems and formation of numerous buds that result in witch's broom or bushy growth effect. The fruits may develop brown, gum-soaked spots, experience rind splitting, and have gum pockets around the central pith. In severe cases, twigs may die back, leaves can twist, growth may be stunted, and the overall fruit yield decreases.

The symptoms of zinc deficiency in citrus include severe twig dieback, small and narrow pointed leaves, shortened internodes that form rosette appearance, and irregular chlorotic leaf spots. On young leaves, chlorosis begins between veins and develops into whitish streaks, yellowing, and green bands around the midribs. In severe cases, the leaves become tiny, upright, and yellow, and the twigs can thin out and die back quickly. Fruits are woody, smaller and have less vitamin C and acid.

Boron deficiency in citrus, known as hard or stony fruit, is marked by distorted, twisted leaves with thick, corky veins and eventual death of the apical meristems (rosette form). Excessive fruits shedding occurs early. Fruits are hard, misshapen and low in juice content. The rind is thickened and cracked, and the white rind contains diagnostic brown gum pockets.

In citrus, a lack of molybdenum is characterized by limited leaf growth followed by light yellow chlorosis. When leaves get older, the lower surface develops yellow spots and brown gum deposits that eventually turn black.

Factors affecting micronutrients availability

Agronomic practices such as uneven application of nitrogen, phosphorus, and potassium, along with intensified farming methods and cultivating crops in saline or alkaline soils, can really exacerbate micronutrient deficiencies. This, in turn, leads to issues like fruit drop, flower drop, and even fruit cracking in citrus plants. B deficiency can get worse due to extreme drought, excessive lime use or irrigation with alkaline water. Compared to fine-textured clayey soils, coarse-textured, well-drained sandy soils have a higher leaching potential and are therefore more likely to be boron deficient. The severity of Cu deficiency tends to increase with heavy N fertilization. Zn deficiency is common in alkaline soils because of poor zinc solubility and in acid-leached sandy soils because of low zinc content. Application of alkaline-forming nitrogen fertilizers and high phosphorus fertilizers frequently make it worse. Acid soils (pH < 5) cause high Fe and Mn saturation and low availability of Mo and B. When temperatures and moisture levels drop, the availability of most micronutrients tends to decline because of lower rates of nutrient dissolution and diffusion.

Impact on yield and quality of fruits

Micronutrients play a crucial role in boosting both the yield and quality of citrus fruits. Iron improves fruit volume and ascorbic acid content. Iron and zinc are essential for promoting cell division and enlargement, which leads to larger and heavier fruits. Boron helps with fruit set, sugar metabolism by hydrolysing complex saccharides into simple sugars, and higher total soluble solids (TSS) content in fruit juice. Boron also prevents excessive peel cell division, which results in a thinner peel and a better pulp-to-peel ratio. Additionally, copper also contribute to the accumulation of TSS, while zinc helps minimize the dropping of flowers and fruits by preventing abscission layer formation. These micronutrients can significantly enhance juice content by improving assimilate production.

Micronutrient management strategies

Balanced plant nutrition is crucial for successful citrus cultivation. Relying too heavily on chemical fertilizers has adversely affected soil health, therefore incorporating biofertilizers is essential to counteract these negative effects and enhance soil quality. When roots struggle to absorb nutrients due to challenging soil conditions—like extended wet or dry periods, calcareous soils, or chilly temperatures—using foliar application can be a quick fix to address nutrient shortages. This method boosts the efficiency of micronutrients uptake, cuts down on fertilizer use and the risk of groundwater contamination, and delivers a rapid response, especially for nutrients like Zn, Mn, Cu, and B, although its benefits are temporary compared to soil application. On the other hand, applying Fe chelates to the soil remains the best way to tackle iron deficiency. In citrus orchards, various diagnostic methods are employed to assess nutrient limitations. These include leaf analysis, soil analysis, juice analysis, sap analysis, biochemical analysis, and identifying deficiency symptoms linked to morphological changes. Morphological symptoms act as a useful field guide for citrus growers, helping them identify nutrient deficiencies in leaves, fruits, and roots, allowing for quick corrective actions accordingly. Leaf nutrient concentrations stand out as the most reliable indicator of a fruit crop's nutritional status, as they effectively reflect how nutrients are accumulated and redistributed throughout the plant. On the other hand, soil analysis proves to be a more valuable tool when conducted over several consecutive years, allowing for the observation of trends over time. Fertigation, process of applying fertilizers through irrigation water, ensures better synchronization with crop demand by delivering micronutrients to the root zone at low rates and high frequency in citrus production. The Integrated Plant Nutrient System (IPNS) presents a sustainable method by combining inorganic fertilizers with organic and biological nutrient sources to uphold soil fertility and achieve balanced nutrition. This approach enhances nutrient availability, boosts flowering and fruiting, improves both fruit yield and quality, supports the long-term productivity and profitability of citrus cultivation.

Table: Correction measures for micronutrient deficiencies in citrus

Micronutrients	Method	Dose	Variety/Crop
Iron	Foliar spray	0.50-0.75% $FeSO_4$	'Mosambi' sweet orange, 'Kinnow' mandarin, Acid lime
	Soil application	250–300 g $FeSO_4$ $tree^{-1}$ $year^{-1}$	'Kinnow' mandarin
Manganese	Foliar spray	0.25% $MnSO_4$	'Kinnow' mandarin
	Soil application	300 g $MnSO_4$ $tree^{-1}$ $year^{-1}$	'Nagpur' mandarin
Copper	Foliar spray	0.25–0.50% $CuSO_4$	'Coorg' mandarin, 'Mosambi' sweet orange
	Soil application	100 g $CuSO_4$ $tree^{-1}$ $year^{-1}$	'Sathgudi' sweet orange
Zinc	Foliar spray	0.50% $ZnSO_4$	'Nagpur' mandarin, 'Sathgudi' sweet orange
	Soil application	300 g $ZnSO_4$ $tree^{-1}$ $year^{-1}$	'Nagpur' mandarin
Boron	Foliar spray	0.30% borax	'Kagzi' lime
	Soil application	50 g borax $tree^{-1}$ $year^{-1}$	'Coorg' mandarin
Molybdenum	Foliar spray	0.08–1.0% ammonium molybdate	'Sathgudi' sweet orange, 'Kinnow' mandarin
	Soil application	25 g ammonium molybdate $tree^{-1}$ $year^{-1}$	'Sathgudi' sweet orange

Conclusion

Micronutrients, although needed in trace quantities, play a crucial function in maintaining citrus production, fruit quality, and tree health. Fe, Zn, B, Mn, Cu, and Mo deficiencies lead to lower productivity and induce severe physiological disorders, demonstrating their function in metabolism, reproduction, and fruit development. As supply of micronutrients is influenced by soil, climate, and management practices, balanced and site-specific application using foliar sprays, fertigation, or chelates is necessary. Innovative solutions like nano-fertilizers and nutrient-efficient rootstocks further improve nutrient-use efficiency. In the face of climate change and resource limitation, accurate micronutrient management is critical for the profitability and long-term survival of citrus production.