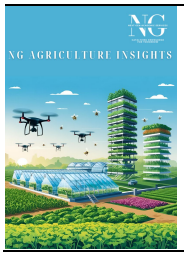

NG Agriculture Insights

A Popular Magazine (ISSN: 3107-5703)
Volume 2, Issue 4, July-August, 2026, 44-46

Role of Soil Micronutrients in Crop Productivity and Nutritional Security

Anusha Pabbu[1*] and Vengaldas Chaitanya[2]

[1] Department of Soil Science and Agricultural Chemistry, Professor Jayashankar Telangana Agricultural University, Hyderabad, Telangana- 500030, India
[2]Department of Agronomy, Professor Jayashankar Telangana Agricultural University, Hyderabad, Telangana-500030, India

*Corresponding author email ID: pabbuanusha1111@gmail.com

A B S T R A C T

Micronutrients are generally required in small amounts that are essential for plant development, crop quality and productivity. This article reviews the major micronutrients, factors influencing their availability and challenges of micronutrient deficiency under intensive agriculture. Various approaches such as soil testing, fertilization in a balanced proportion, organic inputs, foliar application and site-specific management are vital to improve availability of micronutrients. Management can enhance soil health, crop productivity and nutritional quality which leads to sustainable agriculture.

Keywords: Nutritional Security, Soil Fertility, Crop Productivity, Micronutrients

Submitted: 14-08-2026 Accepted: 21-08-2026 Online: 25-08-2026

1. INTRODUCTION

Micronutrients are elements that plants require in minute quantities but are vital for growth, development and metabolism (Jena and Pramanik, 2020). They perform various functions such as enzyme activity, photosynthesis, protein synthesis respiration and reproductive development. There are eight micronutrients. They are boron (B), chlorine (Cl), molybdenum (Mo), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), and zinc (Zn). Each performs a specific physiological function. Iron and manganese are involves in photosynthesis, zinc and copper are needed for enzyme activity and metabolism. While, boron is important for reproduction development and cell wall formation. Molybdenum and nickel are associated with nitrogen metabolism and chlorine takes part in osmotic balance and photosynthesis. These nutrients are required in small amounts but their insufficient availability can interfere with plant growth, reduce yield and affect crop quality.

2. ROLE OF SOIL MICRO NUTRIENTS

Zinc is a vital element for enzyme activity, protein synthesis and normal plant growth. Its deficiency will reduce yield and growth of the plant. The management of zinc can increase zinc concentration of the grain thus improving the nutritional quality of the crop (Kihara et al., 2024). Manganese helps in photosynthesis and enzyme activity. Copper is involved in respiration and electron

https://doi.org/ 10.5281/zenodo.22098264

transport. Iron is important for the formation of chlorophyll, photosynthesis and various metabolic reactions. It may be of limited availability on calcareous and high pH soils. Good Fe management can enhance crop micronutrient concentration and yield. Boron plays a role in cell-wall formation, pollen development and reproductive growth. Deficiency of it will retard flowering, seed formation and plant growth.

3. FACTORS INFLUENCING THE AVAILABILITY OF MICRONUTRIENTS

The availability of micronutrients depends not only on total nutrient content but also on various soil properties such as pH, soil texture, mineral composition, soil organic matter (SOM), moisture content and soil microbial activity. These factors influence the solubility, retention and uptake of nutrients by plants. The higher soil pH generally reduces the availability of Zinc, Iron, Manganese and Copper, soil organic matter and soil microbial activity that facilitate nutrient cycling. Therefore, micronutrient application should be based on soil-specific conditions and crop requirements rather than blanket recommendations.

4. MANAGEMENT OF SOIL MICRONUTRIENTS

Effective micronutrient management should be based on soil testing and crop requirements and it includes the following:

1. Soil Testing helps in identifying deficiencies and supports appropriate fertilizer recommendations
2. Balanced fertilization of macro and micronutrients improves nutrient use efficiency.
3. Foliar application will provide rapid nutrient supply when soil availability is limited, particularly during critical growth stages.
4. Organic matter can be improved by the application of Farmyard manure, vermicompost etc.,
5. Spatial assessment of nutrients can help in identifying management zones (Shukla *et al.,* 2024).

Thus, overall integration of these kind of approaches and nutrient management can improve micronutrient availability and reduce unnecessary usage of fertilizers.

5. CASE STUDIES SUPPORTING THE REQUIREMENT OF PROPER MANAGEMENT OF MICRONUTRIENTS

Intensive cultivation, continuous removal of nutrients, imbalanced fertilization and declining organic matter can cause depletion of micronutrients. Shukla et al. (2021) revealed in a study that there is a widespread micronutrient deficiencies in Indian agricultural soils. In a study, it was noted that the improvement in the concentration of Zn and Fe in maize grain with proper nutrient management (Kihara *et al.,* 2024). Rajput *et al.* (2024) studied boron and iron application benefits in enhancing the micronutrient content and quality of basmati rice. Therefore, proper application of these nutrients is necessary for maintaining the soil fertility and improving productivity.

6. ROLE OF MICRONUTRIENTS IN SUSTAINABLE AGRICULTURE

A balanced crop nutrition is key to sustainable agriculture which aims to reduce the use of unnecessary inputs and nutrient losses (Jena *et al*., 2024). Proper micronutrient management will rectify deficiencies and maintains soil fertility. Yet, excessive application will cause toxicity and nutrient imbalance. Therefore, micronutrients should be applied in right amount, place and time period as per the crop requirements. Micronutrient availability and sustainable crop production can be improved using organic manures, fertilizers and soil conservation practices etc.

7. FUTURE PERSPECTIVES

Various technologies such as GIS, digital soil mapping and spatial analysis can enhance nutrient and fertilizer recommendation assessments. Sahay et al. (2024) demonstrated in his work regarding the ability of spatial nutrient mapping to develop management zones. Nutritional levels of staple crops can be improved by the method of bio-fortification (Kihara *et al.,* 2024; Rajput *et al.,* 2024). Thus, the integration of soil science, plant nutrition, precision agriculture and microbiology will be imperative for sustainable and site-specific micronutrient management.

8. CONCLUSION

Micronutrients are required in small quantities but are essential for healthy growth of the crop, productivity and quality. Under intensive cultivation deficiencies are likely to increase, which highlights the need for soil testing, balanced fertilization, organic matter management and site-specific nutrient application. Effective management of micronutrients improves soil health and crop performance. It also improves food quality which is an important component of sustainable agriculture and nutritional security.

REFERENCES

Jena, C., & Pramanik, K. (2020). Micronutrients: A way to quality fruit production. *Food and Scientific Reports*, *1*(9), 58-9.

Jena, C., Panda, P. K., Sethi, K., Nayak, R. K., & Panda, R. K. (2024). Nutrient responsiveness and correlation analysis of cashew (Anacardium occidentale L.) cv. Balabhadra for vegetative, reproductive traits and nut yield under coastal Odisha condition. *Journal of Environmental Biology*, *45*(5), 635-644.

Kihara, J., Sileshi, G. W., Bolo, P., Mutambu, D., Senthilkumar, K., Sila, A. & Saito, K. (2024). Maize-grain zinc and iron concentrations as influenced by agronomic management and biophysical factors: a meta-analysis: Addressing maize grain zinc and iron deficiencies. *Food Security*, 16(5): 1147-1173.

Rajput, P., Singh, A., Rajput, R. K., Bhatt, R., Alamri, S., Kanaujiya, P. K., & Gautam, S. K. (2024). Agronomic biofortification of basmati rice (Oryza sativa L.) through iron and boron under varying seedling densities. *Frontiers in Sustainable Food Systems*, 8: 1388807.

Sahay, R., Maurya, R. C., Singh, C., Singh, S. K., Mishra, R. K., Srivastava, P., & Yadav, J. K. (2024). Assessment of Micronutrient Deficiencies in Agricultural Soils of Hasanganj and Auras Blocks, Unnao District, Uttar Pradesh, India: Implications for Sustainable Farming. *Journal of Experimental Agriculture International*, 46(12): 793-800.

Shukla, A. K., Behera, S. K., Basumatary, A., Sarangthem, I., Mishra, R., Dutta, S., ... & Datta, S. P. (2024). PCA and fuzzy clustering-based delineation of soil nutrient (S, B, Zn, Mn, Fe, and Cu) management zones of sub-tropical Northeastern India for precision nutrient management. *Journal of Environmental Management,* 365: 121511.

Shukla, A. K., Behera, S. K., Prakash, C., Patra, A. K., Rao, C. S., Chaudhari, S. K., & Green, A. (2021). Assessing multi-micronutrients deficiency in agricultural soils of India. *Sustainability*, 13(16): 9136.