Nutritional Imbalance of Micronutrients in Calcareous Soil of Bihar

Kshirod Chandra Sahoo[1]*, Jyotirmayee Sahoo[2], Akhila Nand Dubey[3] and Vipin Kumar[4]

[1]PhD Scholar, 4Associate Professor-cum-Senior Scientist,
Department of Soil Science, Post Graduate College of Agriculture,
Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar, 848125
[2]PhD Scholar, Department of Food and Nutrition, College of Community Science,
Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar, 848125
[3]Assistant Professor-cum-Junior Scientist, Rabindra Nath Tagore Agriculture College,
Birsa Agricultural University, Deoghar, Jharkhand-814157

Corresponding Author
Kshirod Chandra Sahoo
Email: sahookshirodchandra123@gmail.com

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ABSTRACT

Micronutrients plays an important role in increasing quality of crops. In crop production, application of macronutrients without giving much priority on micronutrients imbalance the soil ecosystem as well as the plant sustenance. Calcareous soils of Bihar found in districts like Champaran, Saran, Kaimur, Kishanganj, Muzaffarpur, Darbhanga, Saharsa and Samastipur. Calcareous soils are characterised by presence of high calcium carbonate (>15 %) with increasing pH (alkaline upto 9.0). Hence, micronutrients (Fe & Zn) are fixed in insoluble form which is not available for plant growth. So, due consideration should be given to apply judicious mixture of both macro and micro nutrients as required by the crop.

INTRODUCTION

The growth of plant depends on nutrients, water and carbon dioxide which is required for photosynthesis process. Among the nutrients, macronutrients required in more amounts for the growth of plant

particularly nitrogen, phosphorus and potassium. Secondary macronutrients (Ca, Mg & S) required in comparatively less amounts. Micronutrients play key roles in improving quality of the crops by influencing the enzymatic reactions, metabolic processes and stress resistance that is contribute to the overall productivity. Calcareous soils are characterised by high calcium carbonate content (>15% $CaCO_3$), which leads to a high alkaline pH (upto 9.0). Micronutrients are not available to plant due to their adsorption in clay colloids such as Iron, manganese and zinc become fixed as insoluble forms. There is transformation of iron from its available ferrous form (Fe^{2+}) to the unavailable ferric form (Fe^{3+}) by the presence of calcium carbonate. **Zinc and manganese availability is severely limited in calcareous soils** due to their precipitation as hydroxides and carbonates. In calcareous soils, **zinc uptake by plants decreases with increased clay content and phosphorus levels**. Each unit increase in pH decreases 100 times the availability of micronutrients (Zn & Mn). There is growing problem of the availability of cationic micronutrients to plant.

A lack of essential micronutrients can cause physiological imbalances, weaken plant resistance to diseases, and ultimately result in reduced yields and inferior crop quality (Jatav *et al*., 2020). With soil degradation and nutrient depletion intensifying under continuous farming practices, effective micronutrient management has become increasing task for growers. Recognizing the significance of these nutrients and their functions in crop plant which enables farmers to implement improved fertilization strategies, fostering healthier plants and ensuring sustainable agricultural productivity (Imtiaz *et al*., 2010). Micronutrient deficiency as a primary issue for quality of crops from 1965 onwards due to green revolution when Zn and Fe deficiency occurs in soil (Fig.1).

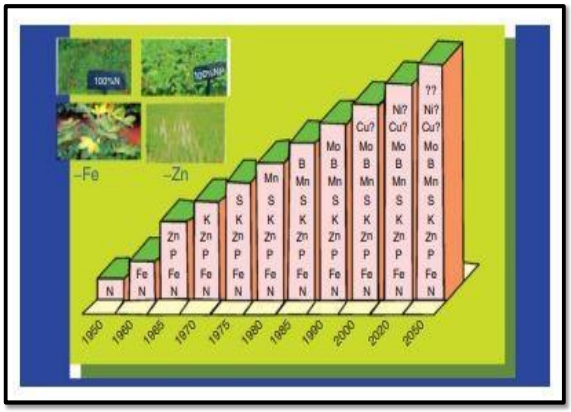

Fig.1: Emergence of Micronutrient Deficiency in Soil

Role of micronutrients:

Micronutrients are essential minerals that required by plants in less amounts (<1 ppm) to complete their life cycle. Despite their minimal requirements, they are having vital effects on plant growth and development (Fig. 2)

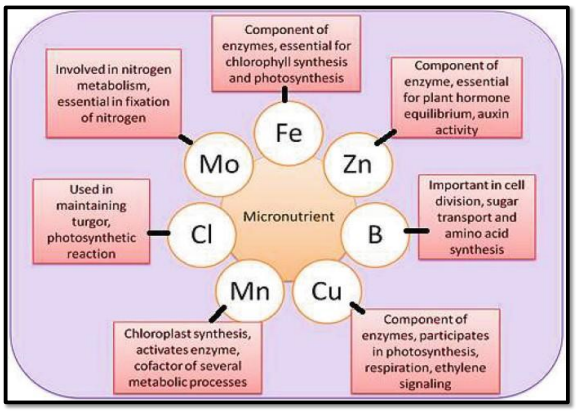

Fig. 2: Role of Micronutrients (Source: Tripathi *et al*., 2015)

There are eight micronutrients which are essential for plant growth. Out of which, five are cationic micronutrients (Zn, Fe, Cu, Mn & Ni) and three are anionic micronutrients (B, Mo & Cl).

The role of micronutrients are:

i. **Zinc (Zn):** It influence the formation of auxin. Zinc helps in formation of various enzymes that regulate plant growth, root development and resistance to environmental stress, role in photosynthesis and involved in formation of chlorophyll & protein.

ii. **Iron (Fe):** This is very important for chlorophyll synthesis, iron enables efficient photosynthesis and energy production, directly influencing plant vigour. Oxidation-reduction reactions in plant can be carried out in presence of iron.

iii. **Manganese (Mn):** It involved in oxidation-reduction reactions and electron transport in photosystem II, plays an important role in chloroplast formation, acts as a co-factor of number of enzymes.

iv. **Copper (Cu):** Cu influences on pollen formation & fertilization enhances reproductive growth and also contributing to enzyme activation.

v. **Boron (B):** The main role of boron in pollen formation, pollen tube growth, proper pollination, fruit or seed set and translocation of sugars through cellular membranes and essential for cell division in the meristematic tissues.

vi. **Molybdenum (Mo):** It is having essential role in protein synthesis and nitrogen fixation. helpful for reduction of NO_3^- to NH_4^+.

vii. **Chlorine (Cl):** It is having influential role in water splitting in Photo system II, helps in evolution of oxygen by chloroplasts in Photo system II and opening & closing of stomata.

viii. **Nickel (Ni):** Nickel is a crucial element for urease activity. It acts as a catalyst in fixation of nitrogen in legume.

Table 1: Micronutrients their available forms and deficiency symptom:

Micronutrients	Available form	Deficiency Symptom
Zinc	Zn^{2+}	Little leaf, Chlorotic and Brown rusty spots on leaves, Rosetting & stunted growth
Iron	Fe^{2+}	Interveinal chlorosis of younger leaves with veins remaining green, Leaf margins become reddish brown necrotic spots
Copper	Cu^{2+}	Die back, downward cuppling of leaves, induces pollen sterility
Manganese	Mn^{2+}	Interveinal chlorosis on old leaves, stunted leaf and root development
Nickel	Ni^{2+}	Necrotic legions on leaf tips and Cause urea toxicity
Boron	H_3BO_3	Cork formation and later cracking in stems, stalks and fruits. Premature seed or fruit drop and prevents sugar and starch accumulation in the leaves.

Molybdenum	MoO_4^{2-}	Leaves wither, curl & margins collapse, sometimes bright yellow mottling between veins seen
Chlorine	Cl^-	Chlorosis and burning of tips and margin of leaves, over wilting effect and leaf fall.

CONCLUSION:

Micronutrient deficiencies in agricultural soils represent a critical global challenge that directly impacts crop productivity, food quality and human nutrition. These deficiencies occur when essential trace elements required by plants in small quantities become unavailable for plant uptake, leading to reduced yields and compromised nutritional content in food crops. Increasing use of macronutrients without taking into consideration the importance of micronutrients also causes severe deficiency in soil. These are useful for increasing quality of crops. In calcareous soil, it is not available due to fixation in insoluble form has negative impact on crop growth. Zinc and iron mostly form their unavailable form and cause deficiency symptom on crop grown in calcareous soil of Bihar. So, judicious application of micronutrient along with macronutrient helpful for increasing crop production and productivity.

So finally, we can say that, in Calcareous soil of Bihar, micronutrient deficiency particularly Fe & Zn is growing issue which create great hinderance for crop growth. Organic matter application should be given on priority basis which can diminish the negative impact of fixation of nutrients in insoluble form. So, due consideration should be given for integrated application of both macro and micro nutrients for efficient crop growth.

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