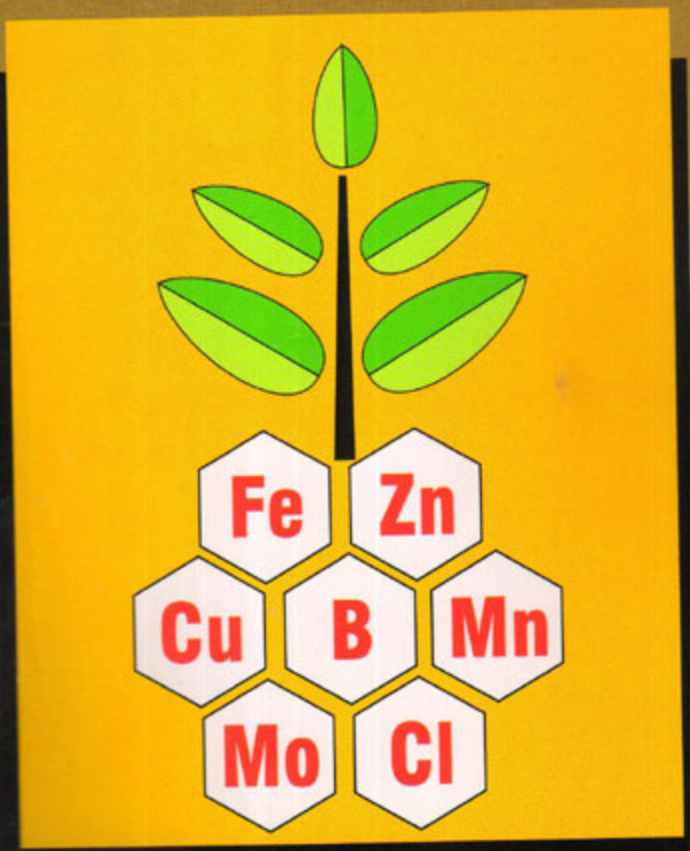
MICRONUTRIENTS FOR Soil AND PLANT HEALTH



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Preface

The incidence of micronutrient deficiencies in crop has increased markedly in recent years due to intensive cropping, loss of top soil by erosion, losses of micronutrients through leaching, liming of acid soils, decreased proportion of FYM to chemical fertilizers, increased purity of high analysis fertilizers and use of marginal lands for crop production.

Micronutrients in general are either metallic constituents, prosthetic groups, co–enzymes or simply activators of various enzyme systems in the plants. As a result, their inadequacies affect adversely their specific metabolic pathways or the products, leading to decreased rates of growth and development before some visible symptoms in the form of chlorosis or necrosis appear on the leaves/shoot. But by the time the visible deficiency symptoms appear, a lot of irrepairable damage is already done that is reflects in terms of yield and quality of produce. Thus the nutrient inadequacies need to be evaluated at much earlier growth stages, preferably through functional forms of micronutrient, *viz.*, determination of activities of metalloenzymes, related biochemical functions/or metabolic products in addition to soil test crop response studies.

It is becoming evident that without the use of some of the micronutrients like Zn, Fe, Mn, B, it is not possible to get the maximum benefit of NPK fertilizers and high yielding varieties. It is also clear that micronutrient use requires a very thorough knowledge about the soil and plant and no *ad hoc* recommendation on use of any micronutrient mixture can be made because of the antagonism between the different nutrients and the polluting effect that might ensue. There is a great need for specific information on

micronutrient deficiency for different areas so as to make use of missing or deficient nutrients.

Everything concerning a particular micronutrient relating to soil or plant aspects has been discussed by an expert scholar in the field.

Though efforts have been made to collect all the available information on the subject, the author/editor do not claim this to be an exhaustive treatise on the subject. It is hoped that it will serve a useful purpose for researchers and the practical agriculturists.

L. L. SOMANI
EDITOR

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PREAMBLE

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Chemical analysis of plants reveals the presence of over sixty elements in plant body. But only sixteen of these are essential for plant growth and development. Nine of these (C, H, O, N, P, K, Ca, Mg, S) are needed in relatively higher amounts and are called as macronutrients. Macronutrients are again sub–divided into primary (C, H, O, N, P, K) and secondary (Ca, Mg, S) nutrients. The remaining seven (Zn, Fe, Mn, Cu, B, Mo, Cl) are needed in small amounts. These are called micronutrients. Each of these nutrients plays a specific role in the plant growth and development. Their presence in optimum concentrations is essential for plant to complete its life cycle. These roles range from very simple to highly complex and very specific for a given micronutrient. Therefore, one essential plant nutrient cannot perform the role of another. The deficiency of say boron (B) can only be rectified by applying B containing fertiliser only. Biological nitrogen fixation by *Rhizobium* can only proceed smoothly when Mo is sufficiently available in soil. Strong cell wall can be built when boron availability is optimum and photosynthesis is only possible with manganese and so on.

Over the years, with intensive cultivation, Indian agriculture has moved from an era of scattered single element deficiencies to more complex multiple nutrient deficiencies. At least five essential nutrients are already of widespread practical importance in terms of application. These are nitrogen, phosphorus, potassium, sulphur and zinc. The deficiency of magnesium, iron, and boron is also increasing. Thus, balanced crop nutrition must include the

application and management of all those nutrients which are deficient in soil and not available to the crop in adequate quantity irrespective of the fact whether these are be termed primary (NPK), secondary (Ca, Mg, S) and micro–nutrients (Zn, Fe, Mn, Cu, B, Mo, Cl).

All soils contain all nutrients, but their reserves are limited. Soils are, therefore, depleted due to continuous cropping, erosion and leaching. No soil can sustain high crop yield from its own nutrient reserves for long. Soils become deficient in plant nutrient after nutrient mining through some years of cropping.

A deficient soil is poor. Nutrient deficiency, however, can be corrected through application of fertilisers and manures and also creating conducive conditions which enhance nutrient availability.

Nutrient deficiencies in soils and crops are being increasingly reported. In India, the deficiency of micronutrients has been observed in the light–textured and calcareous soils. The problem has been aggravated due to intensive cropping after introduction of high yielding fertiliser responsive crop varieties. As the demand of nutrients for higher yield increases and plant needs for macro–nutrients are met with more efficiently, micro–nutrient deficiencies are likely to become more acute. With increased awareness of crop quality and maximum production, a renewed interest in the role of micronutrients in plant, animal and human nutrition is very much expected.

As the limit of deficiency and toxicity is very narrow, the investment on a non–limiting plant nutrient is a waste and has also a deleterious effect on crops when its availability is increased to the excessive range by additional application. The effect of micronutrient on pollution cannot also be ignored. This is why delineation of micronutrient deficiencies is a must before their application. Delineation of micronutrient deficient areas helps in the production, promotion and marketing of micronutrient fertilisers.

Use of soil analysis is most common for predicting the availability of micronutrients. Under some situations, nutrient content of plant tissue provides better indication about the nutrient stress. The

threshold value of micronutrients vary with crops and the varieties of the same crop as well

The plants cannot communicate through our language, but they have their own way of expression indicating therein that they are suffering from the deficiency of a particulars nutrient. If the nutrient is marginally deficient, the plant suffers silently and does not produce any visible sign of hunger but its productivity goes down This is known as hidden hunger which can be determined by plant analysis. However, in case of acute deficiency of particular nutrient, specific deficiency symptoms appear on the leaves. For example, in case of iron deficiency in rice, yellowing of younger leaves starts initially and thereafter, the whole plant may become yellow.

Critical concentration of a nutrient is different for different crops. A knowledge of the relative tolerance of particular crop to a nutrient deficiency can be of practical use. For example in a deficient soil, a susceptible variety should receive the nutrient application on a priority basis compared to tolerant crop. Likewise, if the needed micronutrient is not available, a farmer should plant a tolerant variety and not one which is sensitive to that particular deficiency. If a particular area is known to be deficient in a particular nutrient, making available seed which are relatively tolerant to that deficiency in that area can increase agricultural production. For practical implication of this information, effective coordination among various agencies like research, the seed and extension agencies is needed.

Micronutrients differ in their mobility within the plant. Relative mobility of a nutrient influences the site of appearance of its deficiency systems In a relatively mobile element, deficiency symptoms appear on the older (lower) leaves because the plant is able to move that nutrient from older to younger leaves. It thus nourishes younger leaves at the cost of older leaves to the extent possible. In contrast, deficiency symptoms of an immobile nutrient usually appear on the younger leaves because the plant is not able to move that nutrient from older to the younger leaves after absorption.

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