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Why are micronutrients required in plants?

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Introduction

Mineral nutrients are required by plants in the right proportion to perform different functions for their existence and survival. Micronutrients have been found to have significant impact on various plant activities like chlorophyll synthesis, reproductive growth, plant metabolism etc. these nutrients may be present in soil in large quantities but are acquired by plants in relatively trace amounts. Micronutrients

help plants to mitigate biotic and abiotic effects. Deficiency of micronutrients may lead to several disease in plants that can result in reduction of quality and quantity of food. Keeping all these points in consideration, the following article outlines the role of micronutrients and effect of their deficiency on plant growth and various functions.

There are 7 micronutrients that are required by plants in small quantities and include boron (B), chlorine (Cl), copper (Cu), iron (Fe) manganese (Mn), molybdenum (Mo) and zinc (Zn). The term micronutrient is used to indicate the relative quantity of the nutrients required by the plants. But it does not imply that these nutrients can be avoided. If these nutrients are not available adequately to the plants then the growth of the plants will be retarded leading to compromise in the quality and quantity of the produce.

Source of Micronutrients and Factors Affecting Their Availability in Soil

The parent material from which the soil develops and different soil forming processes at that place determine the amount of the inorganic micronutrient present in that soil. Breakdown of the mineral during the soil formation leads to gradual release of the micronutrient in the plant available form.

Soil organic matter serves as secondary source of micronutrients. When the organic matter decomposes, it slowly releases micronutrients in the forms readily available to the plants which are otherwise held tightly with the complex organic compounds.

The availability and uptake of these micronutrients is affected by the following factors:

- The availability of micronutrients is low in soils that have either low organic matter content (less than 2 per cent) or very high level of organic matter (> 30 per cent)
- As compared to soils with higher clay content, sandy soils are likely to have low amount of plant available micronutrients.
- Temperature and moisture of soil also affect micronutrient availability. e.g., the amount of micronutrient uptake by plants is reduced in cool and wet soils.
- Except molybdenum, micronutrients' availability reduces as the soil pH increases.

Micronutrients Functions and Deficiency Symptoms

To evaluate the nutritional health of different crops, the visual symptoms serve as an important diagnostic tool for knowing plant nutritional deficiencies in the field. Nutrient deficiency symptoms have few characteristic features for the particular nutrient but can generally be grouped into the following categories: i) stunted growth, ii) chlorosis, iii) interveinal chlorosis, iv) purplish-red colouring and v) necrosis. Micronutrient's deficiency symptoms may lead to stunted growth of plants or may induce deficiency or excess of any other nutrient in them. So, it becomes necessary to know about the functions and symptoms of micronutrients. Following is a partial list of deficiency symptoms for the micronutrients.

Micronutrient	Ionic form available to plants	Characteristic/Function	Deficiency Symptom	Excess
Boron (B)	BO_3^{2-}, $B_4O_7^{2-}$	It is required to enhance the yield and quality of fruits and vegetables. Boron is also associated with calcium utilization and cation absorption. It is extremely immobile in plants that is not translocated to new growth, but moves readily in soil	Abnormal development of the growing points (meristematic tissue). Apical growth becomes stunted. Rowers and fruits get aborted abort. In few grain and fruit crops, yield and quantity is significantly reduced	Leaf tips and margins turn brown and ultimately die
Manganese (Mn)	Mn^{2+}	It intensifies availability of Ca, Mg, and P and is required for chlorophyll synthesis and photosynthesis. Manganese is an important component of many enzyme systems. It is immobile in plants and in soil its mobility decreases as the pH increases.	Plants and leaves remain green in colour but interveinal chlorosis of younger leaves occurs.	Brown spots are shown by older leaves that are surrounded by a chlorotic zone and circle.
Zinc (Zn)	Zn^{2+}	Zinc is required for plant enzyme system function, seed production, starch production and auxin synthesis. It is mobile in plants but as the pH increases mobility in soil decreases. Availability of zinc is reduced by high pH, low levels of organic matter in mineral soils, soil compaction, excessive rates of P, and low temperature and wet soil	Interveinal chlorosis is shown by upper leaves with whitening of the affected leaves eventually. Leaves may be small and dis-torted with a rosette form.	Iron deficiency may occur
Molybdenum (Mo)	MoO_4^{2-}	It is important component in nitrogen metabolism. Molybdenum is mobile in plants and in soil but is less available at a lower pH. And	Symptoms appear similar to N deficiency. Older and middle leaves become chlorotic.	Not common

		generally, there is no deficiency over pH 6.0.	In few cases, leaf margins are rolled leading to restricted growth and flower formation	
Iron (Fe)	Fe^{2+}, Fe^{3+}	Iron is necessary for chlorophyll maintenance but is immobile in plants and its mobility in soil decreases with an increase in pH. Even if enough Fe is in the soil, its deficiency can occur under the following conditions: poorly drained soil, high Ca, high Mn, high pH, high P, high heavy metals, oxygen deficiency.	Interveinal chlorosis on young and emerging leaves occurs which further leads to bleaching of the new growth. Under severe conditions, the whole plant becomes light green	Bronzing of the leaves occurs with tiny brown spots.
Copper (Cu)	Cu^{2+}	Copper is an important constituent of different enzyme systems. It is involved in photosynthesis, respiration and the formation of lignin. Copper is relatively immobile in soil and plants. It may be deficient more often in organic than mineral soils, and in sandy than heavy soils.	Witch's broom. Stunted growth of plants with distorted young leaves and lead to death of growing points	Root growth is stunted. Iron deficiency is induced with slow growth
Chlorine (Cl)	Cl^-	Chloride is required by the plant for leaf turgor and photosynthesis. It is also associated with osmo-regulation of plants grown in saline soils.	The younger leaves become chlorotic and plants start wilting easily.	Lower leaves become yellow prematurely and burning of leaf tips and margins occurs. Leaf abscission occurs and plant wilt easily

Steps to Diagnose Micronutrient Deficiency

The interrelationship between a nutrient's availability, soil pH, air and soil temperature, available moisture, excesses of other nutrients, soil organic matter and soil mineral content are complex. Though visual symptoms can be used to identify possible problems but ideally, deficiencies are determined by soil testing and/or plant tissue analysis. Following steps can help to identify a micronutrient deficiency:

- Firstly, it should be ensured that poor crop growth is not the result of a macronutrient deficiency, drought, salinity, disease or insect problem, herbicide injury or some physiological problem.
- It should also be confirmed if a micronutrient deficiency has been identified earlier in a particular crop or soil type in the area under consideration.
- The affected crop should be examined carefully for the specific micronutrient deficiency symptoms.
- For complete analysis, take separate soil samples from both the affected and unaffected areas including micronutrients.
- If all indications point to a micronutrient deficiency, apply the micronutrient to a specific, clearly marked out affected area of land to observe results in subsequent seasons as suggested by the expert.

Points to Remember

- Visual nutritional deficiency symptoms are seldom seen in woody landscape plants, with few exceptions
- Low nutrient levels are better indicated by subnormal shoot growth and leaf size
- Nutrients having more mobility will show deficiency symptoms first on the older foliage and less mobile nutrients will show deficiency symptoms first on the younger foliage.
- As rapid growth is expected from newly planted and young plants, so nutrient deficiencies need to be addressed for their development
- Soil tests are also an important tool for deficiency diagnosis. In addition, nutrient symptoms are very difficult to distinguish from other symptoms associated with insects or disease, other adverse soil conditions such as compaction or discontinuous texture layers, and improper irrigation practices