

NUTRIOPHYSIOLOGY

19.1 FUNCTIONS OF PLANT MICRO NUTRIENTS

A. IRON

1. Iron is a constituent of cytochromes, ferredoxin, catalase and peroxidase. The cytochromes(cyt b₆ and cyt-f) play an important role in electron transport process of oxidative phosphorylation (respiration) and photo phosphorylation (photosynthesis). The iron containing protein ferredoxin plays an important role in the reduction of **CO₂**, atmospheric nitrogen and of sulphate.
2. The leghaemoglobin present in the root nodules of leguminous crops contains iron as an essential constituent.
3. Although iron is not a component of the chlorophyll molecule, it is essential for its synthesis. It has some role in the synthesis of the chlorophyll precursor protoporphyrin –IX. Most of the iron (60-80% of the iron content of the leaves) is found in the chloroplasts.
4. The important iron containing enzymes of higher plants is succinic dehydrogenase, cytochrome oxidase, catalase, peroxidase and aconitase.

B. MANGANESE

1. Manganese is believed to be specific activator of some enzyme like oxidases, peroxidases, dehydrogenases and kinases.
2. Manganese is known to be a constituent of nitrite reductase and hydroxylamine reductase, both of which are concerned in nitrogen assimilation. In the absence of manganese, nitrite accumulates and leaves show symptoms of nitrogen deficiency. Manganese regulates the reduction of nitrite into hydroxylamine and subsequently into ammonia by influencing hydroxylamine reductase.
3. Manganese plays a key role in carbohydrate metabolism and also affects the absorption of calcium and potassium ions.
4. Manganese is involved in the oxygen evolving step in photosynthesis –of **PSII (water oxidizing enzyme complex)**

C. COPPER

1. The copper containing compounds plastoquinones and plastocyanins are involved in the electron transport from chlorophyll to NADP during the primary reactions in photosynthesis. Thus copper stress in plants has been shown to result in a decreased rate of photosynthesis.
2. Copper is a constituent part of several enzymes like nitrite reductase, cytochrome oxidase and ascorbic oxidase.

3. Relatively, high concentrations of Cu occur in chloroplasts. About 70 percent of the total Cu in the leaf is found in these organelles.

D) BORON

1. Boron is associated with the reproductive phase in plants and its deficiency is often found to associate with **sterility and malformation** of reproductive organs. Boron is thus required for the germination of pollen and growth of pollen tube.
2. Boron plays an important role in carbohydrate metabolism, particularly in the **translocation of photosynthates**. Boron was considered to be involved in the translocation of sugars in the form of **sugar borate complexes**. These complexes pass more rapidly through cell membranes than the free sugars.
3. Boron is required for the proper development and differentiation of vascular elements.

E) ZINC

1. Zinc is a metal component of a number of metallo enzymes like **alcohol dehydrogenase** and **lactic dehydrogenase**.
2. Zinc is essential for the synthesis of the amino acid **tryptophan**, a precursor of an important plant growth hormone indole acetic acid (IAA).
3. Zinc is closely involved in N-metabolism of the plant.
4. Zinc plays a role in plant metabolism involved in starch formation. **Zinc** along with **Cu** has been shown to be a constituent of the enzyme **super oxide dismutase**.

F) MOLYBDENUM

1. Mo is an essential component of two major enzymes in plants viz., nitrate reductase and nitrogenase. Nitrate reductase concerned with the reduction of nitrate to nitrite in both microorganism and higher plants.
Nitrogenase consists of two enzyme protein complexes, the bigger of which contains Fe and Mo in a ration of about 9:1
2. By virtue of being a constituent of nitrate reductase, Mo plays direct role in nitrogen metabolism of plants.
3. Mo is known to be a specific inhibitor of acid phosphatase.

G) CHLORINE

1. Chlorine has been shown to be involved in the oxygen evolution in photo system II in photosynthesis (Cl and Mn are important for this reaction)
2. It raises the cell osmotic pressure.
3. Chlorine accelerates the activation of amylase which converts starch into soluble sugars.

19.2 FUNCTIONS OF BENEFICIAL NUTRIENTS

a) COBALT

1. Cobalt is required by rhizobia for the fixation of elemental nitrogen both by leguminous and non-leguminous symbionts.
2. It is a structural component of **vitamin B₁₂ (cyanocobalamine)**.
3. B₁₂ is essential for the formation of hemoglobin concerned in nitrogen fixation.

b) SODIUM

1. In higher plants, sodium has so far been shown to be essential only for two halophytic species *Atriplex vasicaria* and *Halogeton glomeratus*.
2. The best known role of sodium is in the maintenance of osmotic relations of the cell.
3. Sodium has beneficial effect on growth and water relations of sugar beet.

c) SILICON

1. The effect of Si is especially important in the yield and quantity of the **rice** crop.
2. Recent studies have shown that, Silicon imparts disease resistance and lodging resistance in paddy
3. The grain yield of the plants with Si is twice more than the plants without Si.
4. The concentration of Si in rice will be around 100 mg g⁻¹.

19.3 MOBILITY (PHLOEM TRANSPORT) OF INORGANIC SOLUTES

The mineral nutrients initially acquired by the roots move up ward in xylem. Many of them are then subjected to redistribution via the phloem but a few are not. Immobility in the phloem presumably is caused by failure of these elements to enter the sieve tube.

Bukovac and Wittwer (1957) studied the mobility of many radio actively labeled mineral elements applied to leaves of bean plants and classified them into three groups based on the mobility in phloem.

Mobile	Intermediate	Immobile
Nitrogen	Iron	Calcium
Phosphorus	Manganese	Boron
Potassium	Zinc	
Magnesium	Copper	
Chlorine	Molybdenum	
Rubidium		
Sodium		
Sulphur		
