

## Plant Physiology

### Topic 3: Mineral Nutrition

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# Topic outline

- Mineral Nutrition
- Criteria for an Essential Element
- Mobile and Immobile Essential Elements
- Function and Deficiency Symptoms of Essential Elements



# Mineral Nutrition

- Carbon dioxide and water supply plants with carbon, hydrogen and oxygen
- Plants, animals and other organisms also need;
  - nitrogen, potassium, phosphorus, calcium, magnesium and sulphur
- Plants absorb these elements from the soil
  - present as inorganic compounds and dissolved ions



## Mineral Nutrition cont.

- Plants use these elements and the glyceraldehydes-3-phosphate from chloroplasts to build all their chemical components
- Most of the elements essential for plant growth and development
  - present in the crystal matrix of minerals
  - become available to roots of a plant as weathered rock and break down to form the soil
- The roles of these elements in plant nutrition are called **mineral nutrition**



## Essential element:

required for normal growth and reproduction of the plant

### Macro or major essential elements

- needed in a relatively large concentration
- for examples: carbon, oxygen, hydrogen, nitrogen, potassium, calcium, phosphorus, magnesium and sulfur

### Micro or minor essential elements

- needed only in a very low concentration
- for examples: boron, chlorine, copper, iron, manganese, molybdenum and zinc

# Criteria for an Essential Element

- Three basic criteria to be considered as essential to the growth and reproduction of a plant
- For a normal plant development and growth through a full life cycle, the element must be:
  1. Necessary
  2. No substitute can be effective to replace it
  3. Acting and functioning within the plant



# Mobile and Immobile Essential Elements

- **Mobile Essential Element:**
  - Removable from mature tissues and transported to young or newly formed tissues
  - i.e. chlorine, magnesium, nitrogen, phosphorus, potassium, and sulphur;
- Even after they have been incorporated into a tissue,
  - these essential elements can still be translocated to younger tissues



## Mobile and Immobile Essential Elements cont.

- If the soil becomes exhausted of one of these elements:
  - plant will scarify the older leaves
  - essential element is salvaged and moved to the growing regions





## Mobile and Immobile Essential Elements cont.

- **Immobile Essential Element:**
  - cannot be removed from mature tissues
  - i.e. boron, calcium, and iron
- If a plant becomes deficient in an immobile essential element;
  - young tissues show symptoms even though older tissues may have extra of this essential element



# Function and Deficiency Symptoms of Essential Elements

## Nitrogen

### Function:

Synthesis of protein molecules.

- Present in purines, pyrimidines and porphyrins molecules

### Deficiency symptoms:

- Chlorosis or yellowing of leaves due to a loss in chlorophyll

## Phosphorus

### Function:

- A constituent of nucleic acids, phospholipids, coenzymes (NAD and NADP)

### Deficiency symptoms:

- Purple or red anthocyanin colour of the midrib of leaves

# Function and Deficiency Symptoms of Essential Elements cont.

## Potassium

### Function:

- Important for photosynthesis especially chlorophyll development and respiration

### Deficiency symptoms:

- Mottled chlorosis first occurs, followed by the development of necrotic areas at the tip and margin of the leaf

## Magnesium

### Function:

- Important for photosynthesis and carbohydrate metabolism

### Deficiency symptoms:

- Extensive interveinal chlorosis of the leaves due to lack of chlorophyll pigments

# Function and Deficiency Symptoms of Essential Elements cont.

## Calcium

### Function:

- A constituent of cell wall, in the form of calcium pectate for formation of cell membranes and lipid structures

### Deficiency symptoms:

- Chlorosis occurs along the margins of young leaves and the affected areas become necrotic

## Sulphur

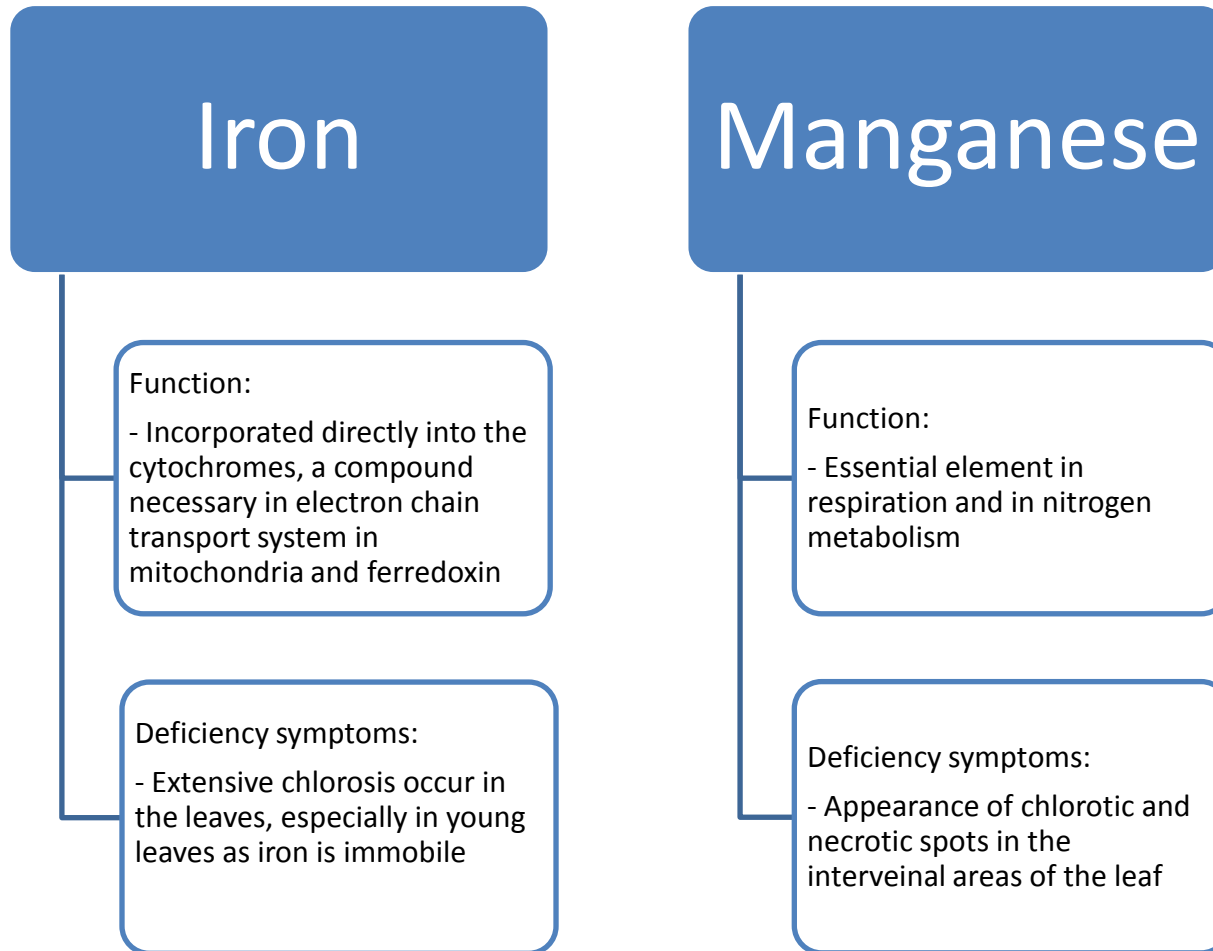
### Function:

- Participates in the formation of protein structure in the form of sulphur bearing amino acids such as cystine, cysteine and methionine

### Deficiency symptoms:

- Similar to chlorosis symptoms with N deficiency, except that chlorosis occur first in young leaves and later in old leaves

# Function and Deficiency Symptoms of Essential Elements cont.



## Function and Deficiency Symptoms of Essential Elements cont.

### Copper

Function:

- Acts as a component of enzymes especially in phenolase, lactase and ascorbic acid oxidase for normal metabolism of the plant

Deficiency symptoms:

- Necrosis of tip of young leaves, begin along the margin of leaf

### Zinc

Function:

- Biosynthesis of the plant auxin, indole-3-acetic acid

Deficiency symptoms:

- Chlorosis of older leaves, starting at the tips and margins

# Function and Deficiency Symptoms of Essential Elements cont.

## Boron

### Function:

- Involved in the transport of the carbohydrate and synthesis of DNA within the plant

### Deficiency symptoms:

- Quick death of the shoot tip or shoot meristem due to the withdrawal of DNA synthesis and sugar deficiency for source of energy

## Molybdenum

### Function:

- Necessary for gaseous nitrogen fixation and nitrate assimilation

### Deficiency symptoms:

- Begin with chlorotic interveinal mottling of the lower leaves, followed by marginal necrosis and infolding of the leaves

# Thought question

How do you make sure plants receive enough mineral nutrition for its normal growth and development?





# Further reading

- Taiz, L. and Zeiger, E. (2010) Plant physiology 5th ed. Sunderland, MA : Sinauer Associates.



# End of Topic 3

Thank you

