MINERAL NUTRITION

CHAPTER VIII

MINERAL NUTRITION

- Mineral nutrition is a part of the complex interaction between the plants, soil and atmosphere.
- It refers to the uptake of inorganic ions from the soil, for the growth and development of plants. The nutrients required for growth of plants can be obtained from the soil, water or atmosphere.
- The elements that are obtained from water or the atmosphere include carbon, oxygen and water, whereas soil provides other elements in the form of cations or anions.

MINERAL NUTRITION

- The availability of these minerals limits the plant growth and in turns affects the productivity of plants. It is therefore, imperative to study the minerals acquired and their effective use by plants.

ESSENTIAL ELEMENTS

- About seventeen elements are termed essential elements.
- **ESSENTIAL ELEMENTS-** termed as deficiency of these elements renders the plant incapable of completing its life cycle.
- These may play a nutritive/structural role, catalytic role or may have a balancing role (maintaining electro neutrality in plants).

ESSENTIAL ELEMENTS

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- These essential elements are divided into main groups: **NON-MINERAL AND MINERAL.**

NON-MINERAL NUTRIENTS

- The non-mineral nutrients are hydrogen (H), oxygen (O) and carbon (C).
- These nutrients are found in the air and water.
- In a process called photosynthesis, plants use energy form the sun to change carbon dioxide and water into starches and sugars. These starches and sugars are the plant's food.

MINERAL NUTRIENTS

- The mineral nutrients, which come from the soil, are dissolved in water and absorbed through a plant's root.
- The mineral nutrients are divided into two groups: macronutrients and micronutrients.

NITROGEN

- Nitrogen (N2) is an inert, odorless, tasteless, colorless gas that makes up 77.5% of the air by weight and 78% by volume.
- Atmospheric nitrogen cannot be used by plants, it must be “fixed” in a soluble inorganic form it can be absorbed and assimilited by plant tissues.

NITROGEN

FUNCTIONS IN PLANTS

- Amino acids and many other plant substances, including purines, vitamins, and alkaloids, are composed in part of nitrogen.
- Nitrogen accounts for only 1-2% of the dry weight but nitrogen containing compounds makes up 25% of the dry weight.
- Nitrogen excesses delay maturity and fruiting of some crops by promoting vegetative growth, Severe N deficiency can also delay crop maturity and reduce yields.
- Nitrogen causes plants to grow rapidly, resulting in a high proportion of succulent, fleshy plant tissue.

NITROGEN

DEFICIENCY SYMPTOMS

- Leaves of nitrogen-deficient plants are usually very light green.
- Leaves of such plants are small.
- The lower leaves are usually the first to show discoloration, and they may turn yellow before the topmost leaves have lost their intense green color.
- Individual branches may die, and the entire plant is stunted.

NITROGEN

❑ FERTILIZATION

- ❖ Nitrogen fertilizers maybe organic or chemical.
- ❖ ORGANIC FERTILIZER- organic matter has been used for fertilizer for thousand of years (legumes)
- ❖ INORGANIC FERTILIZER
  - ○ Ammonium sulfate (20.5 %N)
  - ○ Ammonium (NH_4^+) nitrate (NO_3^-)- 33.5% N
  - ○ Ammonium phosphate
  - ○ UREA (45% N)

PHOSPHORUS

❑ FUNCTIONS IN PLANTS

- ❖ P can be found in plants in many forms:
  - ○ Phytins- stored in seeds
  - ○ Nucleoproteins- DNA and RNA
  - ○ ATP- involve in metabolic transfer process.
- ❖ It accounts 0.2 percent of the total dry weight of plant.

PHOSPHORUS

❑ DEFICIENCY SYMPTOMS

- ❖ Have purplish leaves, stems and branches.
- ❖ Retarded maturity and slow growth.
- ❖ Yields of fruits and seeds are usually poor; fruit often drops prematurely e.g.
  - ○ P deficiency results to rosetting in tobacco
  - ○ High requirement of P among legumes
  - ○ P deficiency results to coarse skin, sour juice, and poor shape in oranges.

PHOSPHORUS

- **FERTILIZATION**
  - Superphosphate- 8.6% available P
  - Triple Superphosphate- 20% P
  - Ammonium phosphates
  - Calcium metaphosphates
  - Ground phosphate rock

POTASSIUM

❑ FUNCTIONS IN PLANTS

❖ 1866- K was first discovered to be essential for plant growth

- It was found that oats would not produce flowers unless K were present.

❖ K is necessary for the formation of sugars and starches, for the synthesis of protein, and for cell division.

❖ It neutralizes organic acids and regulates the activity of other mineral nutrients in plants.

POTASSIUM

❑ FUNCTIONS IN PLANTS

- ❖ It activates certain enzymes, helps to adjust water relations,and promotes the growth of young plants.
- ❖ Improves the rigidity of straw which helps to prevent lodging.
- ❖ Increases the oil content of fruits (fruits grown for oil) contributes to cold hardiness.
- ❖ Associated with enhanced flavor and color of some fruit and vegetable crops.
- ❖ It is never found as part of organic compounds.
- ❖ About 1% of the DW of plants.

POTASSIUM

❑ DEFICIENCY IN PLANTS

- ❖ Low yields
- ❖ Leaves are usually mottled, spotted or curled first seen among older leaves.
- ❖ Leaves may appear “scorched” or “burned” along the margins and on the tips.
- ❖ In corn, usually streaked with yellow and yellowish green .
- ❖ Poorly developed root system.

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POTASSIUM

- **FERTILIZATION**
  - Potassium chloride
  - Potassium sulfate
  - Potash magnesia

CALCIUM

FUNCTION IN PLANTS

- Ca is fixed in cell walls as a calcium salt of the pectic compounds of the middle lamella.
- It is necessary for cell growth and division in apical meristem.
- Calcium has complex relations with other elements e.g. Ca deficiency tends to some species not be able to assimilate N.
- Plants contain 0.2 to 0.3% Ca by dry weight.

CALCIUM

DEFICIENCY

- Deformed terminal leaves and branches
- Roots of many species turn black and die.
- Internal browning of brussel sprouts
- Blossom end rot of tomato

MAGNESIUM

❑ FUNCTION IN PLANTS

- ❖ Mg is an essential part of chlorophyll molecule and is also necessary for the formation of amino acids and vitamins.
- ❖ Necessary for the formation of fats, germination of seeds and synthesis of sugar (functions as coenzyme).
- ❖ Average plant contain about 0.2% magnesium by dry weight.

MAGNESIUM

- Plants deficient in magnesium are usually chlorotic which frequently most evident between the veins of older leaves, starting at the tips moving inward.
- Leaves may also droop.

MAGNESIUM

❑ FERTILIZATION

- ❖ Magnesium is generally added to soils when lime is added. Finely ground dolomitic limestone is frequently used to correct deficiencies.
- ❖ When severe: foliar sprays of epsom salts ($MgSO_4$), magnesium nitrate, and magnesium chloride.

SULFUR

- Sulfur was used medicinally as early as 1000 B.C.E. It is found in regions where volcanoes have been active and in association with salt domes along the gulf coast of North America.
- FUNCTION IN PLANTS:

- Sulfur is an important component of several amino acids such as methionine and cysteine.
- Thiamin and Biotin also contain sulfur.
- S compounds impart flavor to cruciferous plants and pungency to the onion.
- In general, plants contain perhaps 0.2% S by dry weight.

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SULFUR

❑ DEFICIENCY SYMPTOMS

- The symptoms of sulfur deficiency are somewhat similar to those of N deficiency- LIGHT GREEN (S is essential part of chlorophyll molecule needed for the synthesis.

❑ FERTILIZATION

- Ammonium sulfate, calcium sulfate, superphosphate.

❑ BORON

- Helps in the use of nutrients and regulates other nutrients
- Aids production of sugar and carbohydrates
- Essential for sugar and fruit development
- Sources of boron are organic matter and borax

❑ COPPER

- Important for reproductive growth
- Aids in root metabolism and helps in the utilization of proteins.

❑ CHLORIDE

- Aids in plant metabolism
- Chloride is found in soil

❑ IRON

- Essential for formation of chlorophyll
- Sources of iron are the soil, iron sulfate, iron chelate

❑ MANGANESE

- Functions with enzyme systems involved in breakdown of carbohydrates, nitrogen metabolism
- Soil is a source of manganese.

❑ MOLYBDENUM

- Helps in the use of nitrogen
- Soil is a source of molybdenum.

❑ ZINC

- Essential for the transformation of carbohydrates
- Regulates consumption of sugars
- Part of the enzyme systems which regulate plant growth.
- Sources of zinc are soil, zinc oxide, zinc sulfate, zinc chelate.

❑ NICKEL

- Component of enzymes urease and hydrogenase
- Involved in the mobilization of organic compounds.