**MINERAL NUTRIENTS AND MINERAL NUTRITION:**

**Mineral Nutrients:**

These are the inorganic elements which are primarily acquired in the form of ions from soil are called **mineral nutrients**. The study of how plants obtain and use mineral nutrients is called **mineral nutrition**.

Carbon (C), Hydrogen (H), and Oxygen (O) are not mineral nutrients. Carbon (C) comes from CO2, hydrogen (H) comes from water, and Oxygen (O) comes from air and hydrolysis of water.

**Essential nutrients Vs Beneficial nutrients:**

|  |  |
| --- | --- |
| **Essential nutrients** | **Beneficial nutrients** |
| They must be present everywhere. | They are often limited only to a few species, e.g. sodium is essential for C4 plants, cobalt is essential for nitrogen fixing nodules |
| There absence prevent the completion of normal life cycle | Plant can complete life cycle without them |
| Some are required throughout and some at specific stages during growth period of plant | Their presence in some plants stimulates the growth and development. |
| Absence lead to deficiency | Their absence do not show deficiency symptoms |
| They have clear physiological role i.e. required for specific function may be a reaction or a part of body structure. |  |
| N, K, P, Mg, Ca, S, Zn, Mn, Cl, Fe, Cu, Ni, B, Mo | Si, Se, Al, Co |

* Carbon enter through stomata from the air
* Hydrogen enter in the form of water
* Oxygen present in air.

These nutrients require in bulk quantity.

**CLASSIFICATION OF ESSENTIAL NUTRIENTS:**

There are three bases of classifying mineral nutrients:

1. Amount required and present in plant tissues
2. Biochemical or physiological functions
3. Mobility in the plants

**1(a): Classification based on amount required**

**I. Macro Nutrients**

These are required by plants in high amounts. Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulphur (S) are major nutrients.

1. **Primary Nutrients**

Primary nutrients are required in high quantity to plants. And they must be supplemented in the form of fertilizer to the crops as these are deficient in the plant environment e.g. N, P, K

1. **Secondary Nutrients**

They are also required in high quantity to the plants but they seldom be supplemented in the form of fertilizer to crop. These are abundant in the plant environment or automatically applied with synthetic fertilizers along with primary nutrients e.g. Ca, Mg, S

**II. Micro Nutrients**

These are required in low quantity but are as essential as macro nutrients e.g. iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), chlorine (Cl) and nickel (Ni).

**1(b): Classification on the basis of amount present in plant tissue**

**i. Macro essential mineral nutrients:**

Their amount present in plant dry matter is ≥ 1000 µg g-1 of plant dry weight.

Plant highest concentrations are hydrogen then carbon and then oxygen. Macro nutrients are divided into primary and secondary nutrients. According to the requirement of the plant nitrogen (N) is the first in number, then potassium (K), then calcium (Ca) (present in cell wall and cell membrane), then magnesium (Mg) (it is the component of chlorophyll), then phosphorus (P) (component of phospholipids, ATPs, nucleic acid, and then sulphur (S) and silicon (Si).

**ii. Micro essential mineral nutrients:**

Their amount present in plant dry matter is ≤ 100 µg g-1 of plant dry weight.

In micro nutrients, the nutrient present in higher amount is chlorine (Cl), then iron (Fe) & boron (B) then Mn, then Na, then Zn, then Cu, then Ni, and then Mo.

**2. Classification based on biochemical or physiological functions**

**i. Nutrients that are the part of Carbon (C) compounds**

**Nitrogen (N):** Nitrogen is the part of nucleic acid, amino acid, nucleotides, proteins, co-enzyme, and hexo-enzymes.

**Sulphur (S):** Sulphur is the part of sulphur containing amino acids e.g. cystein, cystine, and methionine.

**ii. Nutrients that are important in energy storage/ structural integrity**

The number one nutrient present in excess amount is phosphorus, then silicon and the third one is boron in energy storage and structural integrity.

**Phosphorus (P):** P is the part of sugar phosphate, nucleic acid, ATPs, nucleotide and phospholipids.

**Silicon (Si):** Silicon (Si) is deposited as amorphous silica in cell wall causing rigidity and elasticity of cell wall.

**Boron (B):** It is required for cell elongation and nucleic acid metabolism. It forms complexes with important constituents of the cell wall.

**iii. Nutrients that are remain in plant in ionic form**

Potassium, calcium, magnesium, chlorine, Mn, and sodium are present in ionic form in the plant. Potassium never becomes part of any chemical reaction or enzyme even than a macro nutrient.

**iv. Nutrients that are involved in Redox reaction**

Electron transport chain is redox reaction.

Iron, Zinc, Copper, Mo, Ni are nutrients that involved in redox reaction.

**Iron (Fe):** It is the constituent of cytochromes and non-hemi iron proteins involved in photosynthesis, respiration, and in biological nitrogen fixation.

**Zinc (Zn):** It is the part of carbonic anhydrase and alcohol dehydrogenase required for photosynthesis.

**Nickle (Ni):** It is the part of urease and in nitrogen fixing bacteria part of hydrogenase.

**Mo:** It is the part of nitrogenase and nitrate reductase (when N enters into the plant in the form of nitrate, it is readily converted into ammonia through this enzyme).

Only borate is mineral nutrient which is adsorbed by plants a neutral form whereas all other nutrients are in ionic form.

**3. Classification based on nutrient mobility in the plants**

1. **Mobile nutrients:**

N, P, K, Mn, Zn, Cl, Ni, Mg are mobile nutrients.

1. **Immobile nutrients:**

Ca, S, Fe, Cu, B are immobile nutrients.

1. **Partially mobile nutrients:** Their Deficiency symptoms appear both on older and younger leaves e.g. Mn

**Nutrition Uptake:**

* Major uptake of the nutrients occurs through roots from soil.
* Soil less culture (Hydroponics, Aeroponics, Foliar application of nutrients)
* Mycorrhiza helps the roots to absorb nutrients
* Phosphate solubilizing bacteria (produce certain acids and these acids convert phosphate into uptake form)
* siderphors (helps the uptake of iron from soil)