MINERAL NUTRITION

The plants require macromolecules like carbohydrates, proteins and fats and water and minerals for their growth and development.

Methods to study the mineral requirements.

Julius van Sochs demonstrated the plants could be grown in defined nutrient solution in complete absence of soil. This technique is called *hydroponics.* This technique can be used to detect the required mineral for a plant.

ESSENTIAL MINERAL ELEMENTS.

More than 60 elements are seen in plants. But all elements are not essential for their growth. Some are non essential. Eg. Gold, strontium, selenium etc.

Criteria for essentiality

1. the element must be necessary for growth and development.
2. 2. the requirement of the element must be specific ; not substituted by another.
3. the element must be directly involve d in the metabolism of the plant.

The essential elements are further divided in to *microelements* and *macroelements.*

1. macroelements:- they require in large quantity for plant
2. microelements:- they require in small quantity.

The essential elements can also be grouped into…

1. essential elements as components of biomolecules

eg. Carbon, hydrogen, oxygen.

2. components of energy related compounds. Eg.magnesium, phosphorus
3. activate or inhibit enzymes eg. Mg., Zn., Mo

actions are:

Mg.-activate RuBP and PEPCo,
Zn- activate alcohol dehydrogenase.
Mo. Activate nitrogenase

4. can alter the osmotic potential of the cell

Eg. K,

ROLE OF MACROELEMENTS.

No.	Element	Role
1	Nitrogen	Major component of protein, nucleic acids, vitamins , hormones
2	Phosphorus	Component of cell membrane, nucleic acids, nucleotides, ATP
3	Potassium	Help in anion-cation balance, opening and closing of stomata, activation of enzymes (seen in meristematic tissues in high quantity)
4	Calcium	Component of cell wall, middle lamella, spindle fiber
5	Magnesium	Activates enzyme, involved in the synthesis of DNA and RNA, is a constituent of chlorophyll
6	Sulphur	Present in amino acids like cystein and methionine and is a main constituent of coenzymes and vitamins
7	Iron	It is present in ferredoxin and cytochromes (plants get this in ferric format)

Role of Microelements.

No.	Element	Role
1	Manganese	It activates many enzymes. Act in photolysis of water in photosynthesis
2	Zinc	Activates many enzymes, need in auxin synthesis
3	Copper	It is involved in redox reactions
4	Boron	Is required for uptake of calcium, pollen germination, cell elongation.
5	Molybdenum	Component of many enzymes
6	Chlorine	Involved in the photolysis of water, determine solute concentration

Deficiency symptems of essential elements

Main symptoms are chlorosis, necrosis, stunted growth, premature leaf and bud fall and inhibition of cell wall.

Chlorosis: is the death of chlorophyll leads to yellowing in leaves. Mainly due to the deficiency of N, K, Mg, S, Fe, Mn, Zn and Mo

Necrosis : is the death of leaf tissue is due to the deficiency of Ca, Mg, Cu, K.

KR

Toxicity of micronutrients.

Decrease of minerals causes the diseases in plants. but the increase in the consumption cause *toxicity*.

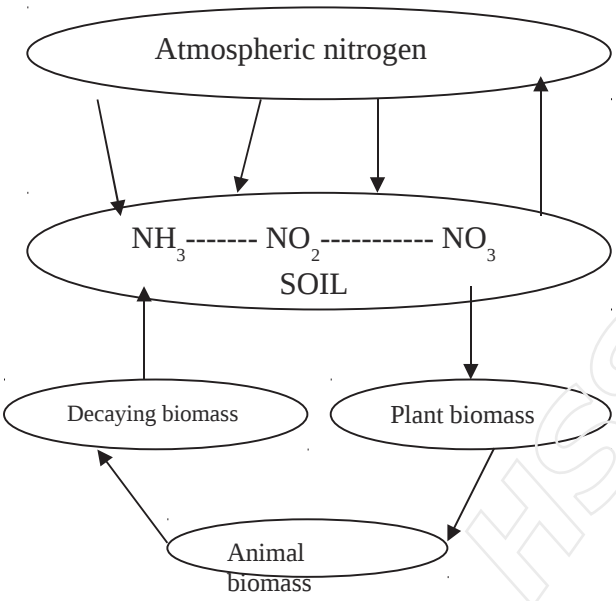
For example manganese cause toxicity, causes brown spots surrounded by chlorotic veins. We know the manganese compete with nutrients like iron ,magnesium, calcium; so the over uptake checks the uptake of such nutrients, so their deficiency symptoms seen.

Absorption of elements.

Process is an active process , that means uptake is by the ATP utilization. The movement of ions is called flux. The inward movement in to the cell is called influx. The outward movement is called efflux.

Translocation solutes occurs through xylem.

Nitrogen cycle.



Nitrogen is present in the atmosphere as molecular form. But plants do not take it as directly. Plants take it as nitrates. Atmospheric nitrogen reach at soil by *nitrogen fixation*. Here N_2 is converted into NH_3.

Nitrogen fixation is carried by different methods.like biological nitrogen fixation (by organisms), industrial nitrogen fixation (by industrial combustion), electrical nitrogen fixation (by lightning).

Ammonification:- dead organic matter is decayed and ammonia is formed . this is the ammonification.

Nitrification:- the ammonia is oxidized and form nitrite by the action of *nitrosomonas* bacteria. The nitrite is further oxidized to nitrate by the *nitrobacter* bacteria. These steps are called nitrification.

$2NH_3 + 3O_2$ ---------- $2NO_2 + 2H + 2H_2O$ (1)

$2NO_2 + O_2$ ---------- $2NO_3$ (2)

This nitrate is absorbed by plants.

The nitrate present in soil is sometime reduced to nitrogen by the action of bacterias like *pseudomonas* and *thiobacillus* . this process is called **denitrification.**

Biological nitrogen fixation

Reduction of nitrogen into ammonia by living organisms are called Biological nitrogen fixation

Nitrogenase is the enzyme which help this reduction, which is present in prokaryotes. Such organisms are called N_2 fixers.

Anaerobic freeliving N_2 fixers:- Rhodospirillum, azotobacter, bacillus

Aerobic freeliving N_2 fixers:- nostoc, anabaena

Symbiotic N_2 fixers:- they are associated with other plants eg. Rhizobium (associated with root nodules of pea)

Nodule formation Stages:-

1. rhizobia multiply and colonise the surroundins of root and get attached with the root hair
2. root hair curl and bacteria invade into it
3. an *infection thread* is formed inside the root hair ; through which bacteria reach at inner cortical cells
4. they intiate the multiplication of cortical cell and the nodule formation

the nodule contain the *nitogenase* enzyme and *leghaemoglobin*

leghaemoglobin is an oxygen scavenger which remove the oxygen inside the nodule, because nitrogenase is active in the absence of O_2.

Reaction is as follows;

$N_2 + 8e^- + 8H^+ + 16ATP$-------$2NH_3 + H_2 + 16ADP + 16Pi$

Fate of ammonia.

The ammonia inside the plants converted into ammonium ion. But it is toxic to plants. so it is converted into other forms as;

1.reductive amination:- ammonium reacts with α- keto glutaric acid and form glutamic acid.

α- keto glutaric acid + NH_4^+ ------- glutamic acid + H_2O

2.Trans amination: glutamic acid reacts with OAA and Form aspartic acid and α - keto glutaric acid . here transfer of ammonia from one compound to another occurs.

α- keto glutaric acid + OAA ------ glutamic acid + aspartic acid