Long Answer Type Question

Q.1. Define essential elements. Give the criteria for knowing the essentiality of an element. Give some essential elements. [KVS 2013-14]

Ans. Essential Elements: An essential element is the one which has a specific structural or physiological role and without which plants cannot complete their life cycle.

The criteria for the essentiality of an element are:

(i) It is indispensable for the growth of plant.

(ii) The element is directly involved in the nutrition of plants. It becomes a component of either a structural or functional molecule. The element may additionally have a corrective effect of mineral balance and other soil conditions.

(iii) A plant is unable to complete its vegetative or reproductive phase in the absence of the element.

(in) The element cannot be replaced by any other element.

(v) The absence or deficiency of the element produces disorders that are a direct result of the lack or deficiency of the element.
17 elements have been found to be essential. They are C, H, O, N, P, K,S, Mg, Ca, Fe, B, Mn, Cu, Zn, Mo, Cl and Ni

Q. 2. Make a list of macronutrients and mention their major functions.

Ans. Different macronutrients and their functions are :

(i) Carbon : It is the major component of carbohydrates and other cellular constituents.

(ii) Oxygen : It is an important component of carbohydrates and other structural constituents of the cells.

(iii) Magnesium: It is an essential component of chlorophyll and is involved in binding of ribosome components. It acts as enzyme activator in those cases which are concerned with phosphate metabolism.

(iv) Calcium :

(a) Synthesizes calcium pectinate, the constituents of middle lamella in the cell wall.

(b) It helps in translocation of carbohydrates.

(c) It regulates cell permeability.

(d) It helps in lipid metabolism.

(v) Nitrogen:

(a) It is an important constituent of protoplasm and protein.

(b) It is found in amino acids, NAD, NADP, purines, pyrimidines, chlorophyll enzyme etc.

(vi) Phosphorus:

(a) An important constituent of cell membrane, certain proteins, all nucleic acid and nucleotides.

(b) It is present in AMP, ADP ATP GDP and GTP and plays an important role in the energy transfer of photosynthesis and respiration.

(c) Essential for all phosphorylation reactions.

Q. 3. Briefly mention the functions of mineral elements in plants.

Ans. The mineral elements are required by higher plants. General functions of mineral elements are given below:

(i) Constituents of plant body : Various mineral elements become permanent constituents of molecules found in the protoplasm and cell wall. Elements like carbon, hydrogen and oxygen are used in the formation of carbohydrates. Nitrogen is an essential component of all amino acids, protein, nucleic acids, chlorophyll, auxins, cytokinins and vitamins. Calcium is a constituent of calcium pectate of middle lamella. Magnesium is an essential part of the chlorophyll molecule and also activates certain enzymes.

(ii) Osmotic potential of cells: The osmotic potential of a cell is maintained by the inorganic salts present in the cell sap. Osmotic potential is required for water absorption and maintenance of cell's turgidity.

(iii) Permeability of cytoplasmic membranes: The permeability of cytoplasmic membranes is affected by the presence of various cations and anions in the external medium. Monovalent cations commonly increase the membrane permeability, while divalent cations decrease the same.

(iv) Toxic effects: Many minerals elements in their ionic form produce a toxic effect on the protoplasm Important among them are arsenic, copper, mercury etc.

(v) Catalytic effects: Several mineral elements participate in catalytic systems of plants. For example, calcium, magnesium, manganese, sodium, potassium and chlorine serve as cofactors at enzymes.

Q. 4. Make a list of micronutrients and mention their principal function in plants.
[V. Imp.]

Ans. Following micronutrients are involved in many metabolic activities of the plants:

(i) Boron (B) is involved in the formation of pectin in the cell wall, in the translocation of carbohydrates absorption of water and calcium.

(ii) Copper (Cu), being an essential component of plastocyanin, is involved in the electron transport and plays a role in photosynthesis.

(iii) Manganese (Mn) and molybdenum plays an important role in nitrogen metabolism.

(iv) Zinc (Zn) helps in the synthesis of Indole Acetic Acid (IAA).

As catalysts in the enzymatic reactions : Zinc, copper and manganese act as enzyme activators for various enzymatic reactions in plant cells. As for example:

(i) Zinc activates many enzymes such as lactic dehydrogenase, carboxy peptidases, glutamic acid dehydrogenase and alcohol dehydrogenase.

(ii) Manganese acts as an activator for the enzymes which are involved in decarboxylation reaction and dehydrogenation during respiration.

Q. 5. What are the reasons for minerals depletion in soil and how it is restored ?

Ans. Minerals get depleted in the soil due to several reasons :

(i) Overcropping which withdraws minerals from the top layers of the soil.

(ii) Use of high yielding varieties which require higher quantity of mineral nutrients.

(iii) Non-rotation of crops causing deficiency of minerals at a particular level in the soil.

(iv) Leaching or washing down of minerals along with gravitational water.

(v) Precipitation of minerals due to change in soil pH.

Restoration of Mineral Fertility : It is done through two methods, natural and artificial.

(i) Natural replenishment : In soil under natural vegetation, mineral fertility is restored naturally through :

(a) Recovery of minerals from decomposition of fallen leaves, twigs, dead roots, dead animals and animal excreta.

(b) Slow process of weathering of bed rocks.

(c) Burrowing habit of some animals like earthworms which bring sub-soil over the surface of top soil.

(d) Biological nitrogen fixation.

(ii) Artificial replenishment: It is carried out by human efforts :

(a) Addition of farmyard manure. Manure contains humus. Humus form colloidal particles in soil for increased hydration, crumb structure, aeration, loosening the soil, slow release of minerals and organic substances that stimulate plant growth.

(b) Green manuring.

(c) Crop rotation or sowing of alternate crops successively in the same field. It helps in maintaining nitrogen fertility of the soil.

(d) Addition of fertilizers.

Q. 6. Explain the process of nitrogen fixation in leguminous plant. Where does this process occur in plant ?

Ans. (i) *Rhizobium* is nitrogen fixing bacterial symbiont of legumes, Rhizobia increase in number and attach with epidermis of roots. Root hairs curls and bacteria invade it. An infection thread is formed carrying the bacteria into the cortex of root.

(i) Nodule formation starts in cortex of root. Bacteria is released from the thread into the cells which leads to formation of specialized nitrogen fixing cells.

(ii) Nodules establish direct vascular connection with host for exchange of nutrients.

(iii) Nodule contain all necessary biochemical components like enzyme nitrogenase and leghaemoglobin.

(iv) Enzyme nitrogenase is a Mo-Fe protein and catalyses the conversion of atmospheric nitrogen into ammonia.

(v) The reaction is as follows :

$N2 + 8e^- + 8H^+ + 16ATP \rightarrow 2NH3 + H2 + 16ADP + 16Pi$

Q. 7. Explain nitrogen cycle.

Ans. There are four steps in the nitrogen cycle namely, nitrogen fixation, ammonification, nitrification and denitrification.

(i) Nitrogen fixation

(a) During this step, the atmospheric free nitrogen is converted into those nitrogen compounds which can be absorbed by plants.

(b) The fixation may be biological and carried out by free living bacteria, (e.g., *Azotobacter*, *Clostridium*) or cyanobacteria or bacterium in symbiotic association (e.g., *Rhizobiun*).

(c) The fixation can also occur by physical processes in the atmosphere.

(d) Ammonium compounds are formed as a result of this process.

(ii) Ammonification

(a) When the dead/waste parts of plants and animals are decomposed, ammonia is formed.

(b) It is carried out by certain fungi and certain bacteria.

(c) The process of formation of ammonia from organic nitrogenous wastes, is called ammonification.

(iii) Nitrification

(a) The process of conversion of ammonia into nitrites and then into nitrates is called nitrification.

(b) The first step, i.e., conversion of ammonia to nitrite is carried out by bacteria like *Nitrosomonas* and *Nitrococcus*.

(c) The second step, i.e., conversion of nitrites to nitrates is done by *Nitrobacter*.

$2NH_3 + 3O_2 \rightarrow 2NO_2^- + 2H^+ + 2H_2O$

$2NO_2^- + O_2 \rightarrow 2NO_3^-$

(d) The nitrates are absorbed and metabolised by plants.

(iv) Denitrification

(a) The process by which the fixed forms of nitrogen, i.e., nitrites and nitrates, are converted back into free nitrogen, is called denitrification.

(b) It is carried out by *Peudomonas* like bacterium.

(c) This nitrogen again enters the nitrogen cycle.

Q. 8. Briefly describe the mechanism of biological nitrogen fixation.

OR

What is meant by biological nitrogen fixation ? Elaborate your answer with the example

OR

Explain symbiotic nitrogen fixation in leguminous plants.

Ans. Biological nitrogen fixation is the process in which certain living organisms convert the free nitrogen into those compounds which can be used by plants.

(i) The organisms may be free-living bacteria (e.g., *Azotobacter*), symbiotic bacteria like *Rhizobium* or Cyanobacteria.

(ii) The enzyme involved in the process is nitrogenase, which is a Mo-Fe protein.

(iii) During this process, the atmospheric nitrogen is reduced by the addition of hydrogen.

(iv) The three bonds between the two nitrogen atoms (N ≡ N) are broken and hydrogen is progressively added to form ammonia.

(v) This fixation requires three components:

(a) ATP, to supply energy.

(b) A strong reducing agent, to transfer hydrogen atoms.

(c) The enzyme system (nitrogenase)

(vi) The overall reaction is as follows :

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

Q. 9. Distinguish between the following: Micronutrients and Macronutrients.

Ans

S. No.	Micronutrients	Macronutrients
(i)	Micronutrients form minor portion of dry weight of a plant.	Macronutrients form major portion of dry weight of a plant.
(ii)	They are required in minute quantities i.e., less than 10 m mole/kg of dry matter	They are required in relatively large quantities i.e., in excess of 10 mmole kg^{-1} of dry matter
(iii)	Most of them act as activators for enzymes, e.g., Manganese, Zinc, Boron etc.	They enter into the structure of macromolecules of the cell, e.g., Carbon, Hydrogen and Nitrogen etc.
(iv)	These are called trace elements.	These are called major elements.

(Any three)