1. 'All elements that are present in a plant need not be essential to its survival'. Comment.
Solution: Most of the mineral elements present in the soil enter plants through roots but all of these may not be essential for their survival. Some are absorbed and accumulated by plant only because they are present in excess amount. For example plants growing near nuclear test sites take up strontium, even though it is not required by them. Thus, an essential element is that which is necessary for supporting normal growth and reproduction, its requirement must be specific i.e. its deficiency cannot be met by supplying other element and it must be directly involved in the metabolism of plant.

2. Why is purification of water and nutrient salts so important in studies involving mineral nutrition using hydroponics?
Solution: Impure water and salts contain a large number of soluble minerals and impurities. When such water and salts are used as solution culture for growing plants in hydroponics then the impurities will interfere with the experiment and will not give correct result about the essentiality of a mineral element. Therefore, purified water with defined mineral nutrients are used in hydroponics.

3.Explain with examples:macronutrients, micronutrients, beneficial nutrients, toxic elements and essential elements.
Solution:
Macronutrients: Those elements which are generally present in plant tissues in large amounts (in excess of 10 mmole Kg^{-1} of dry matter) and are involved in the synthesis of organic molecules and development of osmotic potential are called macronutrients or macroelement, e.g. carbon, hydrogen, oxygen, nitrogen, sulphur, potassium, calcium and magnesium etc.
Micronutrients: Those elements which are required by plants in'very small amounts (less than 10 mmole Kg^{-1} of dry matter) are called micronutrients, e.g. iron, zinc, manganese, boron, copper, molybdenum, chlorine and nickel. These elements are mostly involved in the functioning of enzymes as cofactor or metal activators.
Beneficial nutrients: Those elements which are required by higher plants along with the macro and micronutrients are called beneficial nutrients, e.g. cobalt, silicon, sodium and selenium.
Toxic elements: Any mineral element if supplied to plant tissue in such concentration that it reduces the dry weight of tissues by about 10 percent, is called toxic element. e.g. manganese toxicity leads to the appearance of brown spots surrounded by chlorotic veins. Excess of manganese induces deficiency of iron, magnesium and calcium.
Essential elements: Any element required by living organisms to ensure normal gfbwth, development, maintenance, metabolism and causes deficiency symptoms if not supplied to the plant from external medium is called essential element, e.g. C, H, O, N, P, K, S, Mg, Ca, Mn, Cu, Mo, Zn, B, Cl, etc. Potassium plays an important role in opening and closing of stomata, protein synthesis etc.
Magnesium is found in chlorophyll and phosphorus in ATP. Mg^{2+} is an activator for both ribulose bisphosphate carboxylase-oxygenase

and phosphsenol pyruvate carboxylase.Zn^{2+} is an activator of alcohol dehydrogenase and Mo of nitrogenase during nitrogen metabolism.

4. Name at least five different deficiency symptoms in plants. Describe them and correlate them with the concerned mineral deficiency.
Solution: Five different deficiency symptoms in plants are:

- Chlorosis - It is the loss of chlorophyll leading to yellowing of leaves. This is caused due to the deficiency of N, K, Mg, S and Fe etc.
- Necrosis - Killing or death of tissue particularly leaf is called necrosis. This is caused due to the deficiency of Ca, Mg, Cu and K etc.
- Whiptail - Degeneration of lamina but not of petiole and midrib , caused by deficiency of molybdenum.
- Die back - It is the killing of shoot apex i.e. stem tip and young leaves. This is caused due to the deficiency of K and Cu.
- Little leaf disease - Small sized leaves, caused by zinc deficiency.

5. If a plant shows a symptom which could develop due to deficiency of more than one nutrient, how would you find out experimentally, the real deficient mineral element?
Solution: Deficiency symptoms are first studied by means of pot and culture experiments. Rapidly growing plants which develop characteristic symptoms are used in culture experiments. They are called test (= indicator) plants. They are then grown in soil under test in small pots. The results are compared to know the deficiency elements. Similar tests are performed with selected crops.

6. Why is it that in certain plants deficiency symptoms appear first in younger parts of the plant while in other they do so in mature organs?
Solution: The parts of the plants that show the deficiency symptoms depend on the mobility of the element in the plant. For elements that are actively mobilised within the plants and exported to young developing tissues, the deficiency symptoms tend to appear first in the older tissues. For example, the deficiency symptoms of nitrogen, potassium and magnesium are visible first in the senescent leaves. In older leaves,biomolecules containing these elements are broken down, making these elements available for mobilising to younger leaves. The deficiency symptoms tend to appear first in the young tissues whenever the elements are relatively immobile and are not transported out of the mature organs, for example, elements like sulphur and calcium are a part of the structural component of the cell and hence are not easily released.

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