# Chapter 12. Mineral Nutrition

**1.** Which is essential for the growth of root tip?
(a) Zn (b) Fe
(c) Ca (d) Mn
*(NEET-II 2016)*

**2.** In which of the following all three are macronutrients?
(a) Molybdenum, magnesium, manganese
(b) Nitrogen, nickel, phosphorus
(c) Boron, zinc, manganese
(d) Iron, copper, molybdenum
*(NEET-I 2016)*

**3.** The oxygen evolved during photosynthesis, comes from water molecules. Which one of the following pairs of elements is involved in this reaction?
(a) Magnesium and Molybdenum
(b) Magnesium and Chlorine
(c) Manganese and Chlorine
(d) Manganese and Potassium *(2015)*

**4.** During biological nitrogen fixation, inactivation of nitrogenase by oxygen poisoning is prevented by
(a) carotene (b) cytochrome
(c) leghaemoglobin (d) xanthophyll.
*(2015)*

**5.** Minerals known to be required in large amounts for plant growth include
(a) potassium, phosphorus, selenium, boron
(b) magnesium, sulphur, iron, zinc
(c) phosphorus, potassium, sulphur, calcium
(d) calcium, magnesium, manganese, copper.
*(2015 Cancelled)*

**6.** Deficiency symptoms of nitrogen and potassium are visible first in
(a) senescent leaves (b) young leaves
(c) roots (d) buds.
*(2014)*

**7.** The first stable product of fixation of atmospheric nitrogen in leguminous plants is
(a) $NO_3^-$ (b) glutamate
(c) $NO_2^-$ (d) ammonia.
*(NEET 2013)*

**8.** Specialized cells for fixing atmospheric nitrogen in *Nostoc* are
(a) heterocysts (b) hormogonia
(c) nodules (d) akinetes.
*(Karnataka NEET 2013)*

**9.** Which of the following elements is a constituent of biotin?
(a) Magnesium (b) Calcium
(c) Phosphorus (d) Sulphur
*(Karnataka NEET 2013)*

**10.** Which two distinct microbial processes are responsible for the release of fixed nitrogen as dinitrogen gas ($N_2$) to the atmosphere?
(a) Aerobic nitrate oxidation and nitrite reduction
(b) Decomposition of organic nitrogen and conversion of dinitrogen to ammonium compounds
(c) Enteric fermentation in cattle and nitrogen fixation by *Rhizobium* in root nodules of legumes
(d) Anaerobic ammonium oxidation and denitrification
*(Karnataka NEET 2013)*

**11.** Best defined function of manganese in green plants is
(a) photolysis of water (b) Calvin cycle
(c) nitrogen fixation (d) water absorption.
*(2012)*

**12.** Which one of the following is correctly matched?
(a) Passive transport of nutrients – ATP
(b) Apoplast – Plasmodesmata
(c) Potassium – Readily immobilisation
(d) Bakane of rice seedlings – F. Skoog
*(2012)*

**13.** For its action, nitrogenase requires
(a) high input of energy
(b) light
(c) $Mn^{2+}$
(d) super oxygen radicals. *(Mains 2012)*

**14.** Which one of the following elements in plants is not remobilised?
(a) Phosphorus (b) Calcium
(c) Potassium (d) Sulphur *(2011)*

**15.** Nitrifying bacteria
(a) oxidize ammonia to nitrates
(b) convert free nitrogen to nitrogen compounds
(c) convert proteins into ammonia
(d) reduce nitrates to free nitrogen. *(2011)*

**16.** The function of leghaemoglobin in the root nodules of legumes is
(a) inhibition of nitrogenase activity
(b) oxygen removal
(c) nodule differentiation
(d) expression of *nif* gene. *(2011)*

**17.** Which one of the following helps in absorption of phosphorus from soil by plants?
(a) *Glomus* (b) *Rhizobium*
(c) *Frankia* (d) *Anabaena*
*(2011)*

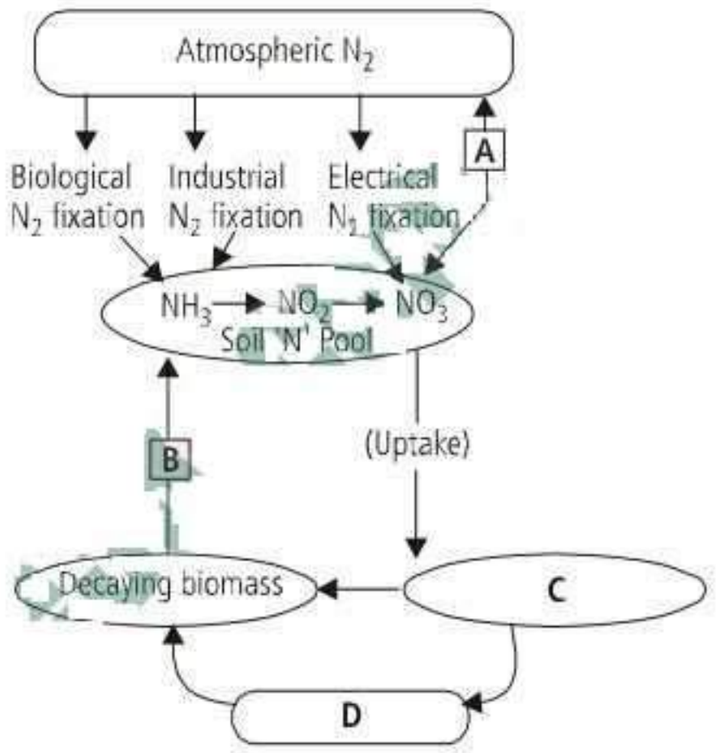
**18.** Which one of the following is not an essential mineral element for plants while the remaining three are?
(a) Iron (b) Manganese
(c) Cadmium (d) Phosphorus
*(Mains 2011)*

**19.** An element playing important role in nitrogen fixation is
(a) molybdenum (b) copper
(c) manganese (d) zinc. *(2010)*

**20.** Which one of the following is not a micronutrient?
(a) Molybdenum (b) Magnesium
(c) Zinc (d) Boron *(2010)*

**21.** Leguminous plants are able to fix atmospheric nitrogen through the process of symbiotic nitrogen fixation. Which one of the following statements is not correct during this process of nitrogen fixation?
(a) Leghaemoglobin scavenges oxygen and is pinkish in colour.
(b) Nodules act as sites for nitrogen fixation.
(c) The enzyme nitrogenase catalyses the conversion of atmospheric $N_2$ to $NH_3$.
(d) Nitrogenase is insensitive to oxygen.
*(Mains 2010)*

**22.** Study the cycle shown below and select the option which gives correct words for all the four blanks A, B, C and D.




| | A | B | C | D |
|---|---|---|---|---|
| (a) | Nitrification | Ammonification | Animals | Plants |
| (b) | Denitrification | Ammonification | Plants | Animals |
| (c) | Nitrification | Denitrification | Animals | Plants |
| (d) | Denitrification | Nitrification | Plants | Animals |

*(Mains 2010)*

**23.** Manganese is required in
(a) plant cell wall formation
(b) photolysis of water during photosynthesis
(c) chlorophyll synthesis
(d) nucleic acid synthesis. *(2009)*

**24.** Which one of the following elements is not an essential micronutrient for plant growth?
(a) Zn (b) Cu
(c) Ca (d) Mn *(2007)*

**25.** A plant requires magnesium for
(a) protein synthesis
(b) chlorophyll synthesis
(c) cell wall development
(d) holding cells together. *(2007)*

**26.** Sulphur is an important nutrient for optimum growth and productivity in
(a) oilseed crops (b) pulse crops
(c) cereals (d) fibre crops.
*(2006)*

**27.** The deficiencies of micronutrients, not only affects growth of plants but also vital functions such as photosynthetic and mitochondrial electron flow. Among the list given below, which group of three elements shall affect most, both photosynthetic and mitochondrial electron transport?
(a) Co, Ni, Mo (b) Ca, K, Na
(c) Mn, Co, Ca (d) Cu, Mn, Fe *(2005)*

**28.** If by radiation all nitrogenase enzyme are inactivated, then there will be no
(a) fixation of nitrogen in legumes
(b) fixation of atmospheric nitrogen
(c) conversion from nitrate to nitrite in legumes
(d) conversion from ammonium to nitrate in soil. *(2004)*

**29.** Gray spots of oat are caused by deficiency of
(a) Cu (b) Zn
(c) Mn (d) Fe. *(2003)*

**30.** Boron in green plants assists in
(a) activation of enzymes
(b) acting as enzyme co-factor
(c) photosynthesis
(d) sugar transport. *(2003)*

**31.** Choose the correct match.
Bladderwort, sundew, Venus flytrap
(a) *Nepenthes, Dionea, Drosera*
(b) *Nepenthes, Utricularia, Vanda*
(c) *Utricularia, Drosera, Dionea*
(d) *Dionea, Trapa, Vanda.* *(2002)*

**32.** Roots of which plant contains a red pigment which have affinity for oxygen?
(a) Carrot (b) Soybean
(c) Mustard (d) Radish *(2001)*

**33.** Which aquatic fern performs nitrogen fixation?
(a) *Azolla* (b) *Nostoc*
(c) *Salvia* (d) *Salvinia* *(2001)*

**34.** Mg is a component of
(a) chlorophyll (b) cytochrome
(c) haemoglobin (d) haemocyanin. *(2000)*

**35.** Plants take zinc in the form of
(a) $ZnSO_4$ (b) $Zn^{++}$
(c) ZnO (d) Zn. *(2000)*

**36.** When the plants are grown in magnesium deficient but urea rich soil, the symptoms expressed are
(a) yellowish leaves (b) colourless petiole
(c) dark green leaves (d) shoot apex die. *(2000)*

**37.** Which of the following is not caused by deficiency of mineral nutrition?
(a) Etiolation
(b) Shortening of internode
(c) Necrosis
(d) Chlorosis *(1997)*

**38.** Which one of the following elements is almost non-essential for plants?
(a) Zn (b) Na
(c) Ca (d) Mo *(1996)*

**39.** Which of the following elements plays an important role in biological nitrogen fixation?
(a) Copper (b) Molybdenum
(c) Zinc (d) Manganese *(1995)*

**40.** Which one is an essential mineral, not constituent of any enzyme but stimulates the activity of many enzymes?
(a) Zn (b) Mn
(c) K (d) Mg *(1989)*

**41.** Phosphorous and nitrogen ions generally get depeleted in soil because they usually occur as
(a) neutral ions
(b) negatively charged ions
(c) positively charged ions
(d) both positively and negatively charged but disproportionate mixture. *(1989)*

**Answer Key**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | (c) | **2.** | (*) | **3.** | (c) | **4.** | (c) | **5.** | (c) | **6.** | (a) | **7.** | (d) | **8.** | (a) | **9.** | (d) | **10.** | (d) |
| **11.** | (a) | **12.** | (c) | **13.** | (a) | **14.** | (b) | **15.** | (a) | **16.** | (b) | **17.** | (a) | **18.** | (c) | **19.** | (a) | **20.** | (b) |
| **21.** | (d) | **22.** | (b) | **23.** | (b) | **24.** | (c) | **25.** | (b) | **26.** | (a) | **27.** | (d) | **28.** | (a) | **29.** | (c) | **30.** | (d) |
| **31.** | (c) | **32.** | (b) | **33.** | (a) | **34.** | (a) | **35.** | (b) | **36.** | (a) | **37.** | (a) | **38.** | (b) | **39.** | (b) | **40.** | (c) |
| **41.** | (b) | | | | | | | | | | | | | | | | | | |

(*) *None of these.*

# EXPLANATIONS

**1. (c) :** Calcium (Ca) is necessary for the proper growth and functioning of root tips and meristems.

**2. None of the options is correct.**

Macronutrients are essential elements which are present in easily detectable quantities, 1-10 mg per gram of dry weight. The macronutrients include carbon, hydrogen, oxygen, nitrogen, phosphorous, sulphur, potassium, calcium and magnesium. Micronutrients or trace elements, are needed in very small amounts (equal or less than 0.1 mg/gm of dry matter). These include iron, manganese, copper, molybdenum, zinc, boron, chlorine and nickel.

**3. (c) :** Oxygen is evolved during photosynthesis by the process of photolysis of water taking place in the membranes of grana thylakoids. The phenomenon of breaking up of water into hydrogen and oxygen in the illuminated chloroplasts is called photolysis or photocatalytic splitting of water. Light energy, an oxygen evolving complex (OEC) and electron carrier $Y_z$ are required for this process. Oxygen evolving complex is attached to the inner surface of thylakoid membrane and the enzyme has four Mn ions. Light energised changes in Mn ($Mn^{2+}$, $Mn^{3+}$, $Mn^{4+}$) remove electrons from $OH^-$ component of water forming oxygen. Liberation of $O_2$ also requires two other ions, $Ca^{2+}$ and $Cl^-$

$$4H_2O \rightleftharpoons 4H^+ + 4OH^-$$

$$4OH^- \xrightarrow[Mn^{2+},Ca^{2+},Cl^-]{\text{Oxygen evolving complex}} 2H_2O + O_2 + 4e^-$$

**4. (c) :** Leghaemoglobin is a pinkish pigment present in the root nodules of leguminous plants. It acts as oxygen scavenger and prevents the inactivation of nitrogenase enzyme by oxygen poisoning.

**5. (c) :** Macroelements (macronutrients) are those essential elements which are present in easily detectable quantities, *i.e.*, 1-10 mg per gram of dry matter. Macroelements are usually involved in the synthesis of organic molecules and development of osmotic potential. They are nine in number — C, H, O, N, P, K, S, Mg and Ca.

**6. (a) :** Deficiency symptoms appear first in young leaves and young tissues in case of elements which are relatively immobile inside the plant *e.g.*, Ca, S. For mobile elements like N and K, deficiency symptoms first appear in old and senescent leaves as the elements are mobilised from senescing regions for supply to young tissues.

**7. (d) :** The enzyme nitrogenase is a Mo- Fe protein and catalyses the conversion of atmospheric nitrogen to ammonia, the first stable product of nitrogen fixation. Nitrogen fixation is the conversion of inert atmospheric nitrogen or dinitrogen ($N_2$) into utilisable compounds of nitrogen like nitrate, ammonia, amino acids etc. There are two methods of nitrogen fixation - abiological and biological. Biological nitrogen fixation is performed by both free living and symbiotic forms. Symbiotic nitrogen fixing organisms hand over a part of their nitrogen to the host in return for shelter and food. The nodule of leguminous plants contains all the necessary biochemical components, such as the enzyme nitrogenase and leghaemoglobin, for nitrogen fixation.

**8. (a) :** Certain species of cyanobacteria (*Nostoc*) possess some special cells called heterocysts which occur in terminal, basal and intercalary positions. Heterocysts are yellowish in colour and contents are homogenous. Heterocysts are now known as sites of nitrogen fixation. Atmospheric nitrogen is made available in the form of ammonia by cyanobacteria.

**9. (d) :** Sulphur is present in two vitamins of B complex, thiamine and biotin. Biotin is important to hair. It is normally found in protein foods, such as eggs, lettuce, sprouts etc.

**10. (d) :** Denitrification is a chemical process in which nitrates in the soil are reduced to molecular nitrogen ($N_2$) which is released into the atmosphere. It is done by denitrifying bacteria like *Pseudomonas denitrificans*. Anaerobic oxidation of ammonium ($NH_4$) also releases nitrogen in the atmosphere.

**11. (a) :** Manganese ($Mn^{2+}$) is used for photolysis of water to produce oxygen and electrons during light reaction of photosynthesis. It is the phenomenon of breaking up of water into hydrogen and oxygen in the illuminated chloroplast. It acts as an essential cofactor.

**12. (c) :** Immobilization or fixation of a nutrient means that the nutrient becomes unavailable for plant. The process of converting exchangeable or water soluble potassium to its non exchange or water insoluble form is known as potassium immobilisation. Potassium is present in relatively large quantities in soil (averaging about 1.9%). Depending on the circumstances, soil potassium may be not easily available, slowly available or readily available. The

first category accounts for 90 to 98% of the total soil potassium, which is only slightly soluble, the second category constitutes 2-10% of total mineral soil and third category makes up for about 1%.

**13. (a) :** Nitrogenase enzyme is present in prokaryotic nitrogen fixers. The enzyme nitrogenase requires a high input of energy to carry out biological nitrogen fixation. This can be illustrated by the following equation.

$$N_2 + 8e^- + 8H^+ + 16\,ATP \xrightarrow{\text{Nitrogenase}} 2NH_3 + H_2 + 16ADP + 16\,P_i$$

**14. (b)**

**15. (a) :** Nitrifying bacteria involves the oxidation of ammonia to nitrates through nitrites called nitrification. Nitrite bacteria (*Nitrosomonas* and *Nitrococcus*) convert ammonia to nitrites whereas, nitrate bacteria (*Nitrobacter* and *Nitrocystis*) convert nitrite to soluble nitrates.

**16. (b) :** The root nodule of legume contains enzyme nitrogenase and leghaemoglobin. Nitrogenase catalyses the conversion of atmospheric nitrogen to ammonia. It is highly sensitive to the molecular oxygen and requires anaerobic conditions. The nodules have adaptations that ensure that the enzyme is protected from oxygen. To protect these enzymes, the nodule contains an oxygen scavenger called leghaemoglobin.

**17. (a) :** Some fungi form symbiotic associations with plants (mycorrhiza). Many members of the genus *Glomus* form mycorrhiza. The fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.

**18. (c) :** C, H, O, N, P, K, S, Mg, Ca, Fe, B, Mn, Cu, Zn, Mo, Cl, Ni are essential elements, which has a specific structural or physiological role and without which plant cannot complete their life cycle.

**19. (a) :** Molybdenum is a micronutrient which is required in very minute amount by the plants. It is responsible for nodulation in legumes. It is part of nitrate reductase enzyme which helps in nitrogen fixation.

**20. (b) :** *Refer to answer 2.*

**21. (d)**

**22. (b) :** A – Denitrification
B – Ammonification
C – Plants
D – Animals

**23. (b) :** *Refer to answer 11.*

**24. (c) :** Calcium is an essential macronutrient for plant growth. Macronutrients are essential elements which are required by plants in quantity more than 1 mg/g dry matter. It is used as a calcium pectinate for the formation of middle lamella in cell wall for lipid metabolism, for cell division and cell enlargement, helps in translocation of carbohydrates and also activates enzyme activity in plants. All other like Zn, Cu and Mn are micronutrients of plants.

**25. (b) :** Magnesium is an important constituent of chlorophyll, found in all green plants and essential for photosynthesis. The chlorophyll molecule has a tetrapyrolic or porphyrin head and a phytol tail. Mg atom is present in the centre of porphyrin head. It is like tennis racket.

**26. (a) :** Sulphur is present in all the cells of the body in association with proteins made of sulphur containing amino acids, *viz.*, cystine, cysteine and methionine. Members of Cruciferae and animal proteins are rich sources of sulphur; other vegetable proteins (*e.g.*, pulses) have only little sulphur.

Plants absorb sulphur from soil in the form of sulphate ions ($SO_4^{--}$). It is a constituent of ferredoxin and some of the lipids present in chloroplasts. Pungent floroue and odour of mustard, cabbage, turnip etc. of Family Brassicaceae is due to the presence of sulphur containing oils. Application of 40 kg/ha to oilsed based cropping system is found to increase the yield, oil and protein content of the seeds.

**27. (d) :** Iron is mainly available in the ferrous form and it is absorbed in the ferric form, also. It is a part of catalases, peroxidases, cytochromes etc. and plays a role in electron transport system in photosynthesis.

Manganese is absorbed by the plants when it is in the bivalent form. Manganese participates in the photolysis of water in pigment system II during photosynthesis and thus it helps in the electron transport from water to chlorophyll.

Copper is absorbed on the clay particles as divalent cations, from where it can be absorbed by the plants by exchange mechanism. It is constituent of plastocyanin which takes part in electron transport during photosynthetic phosphorylation.

**28. (a) :** The process by which $N_2$ is reduced to $NH_4^+$ is called nitrogen fixation. Nitrogenase enzyme catalyzes this reduction. It is only carried out by prokaryotic microorganisms. Principal $N_2$-fixers include certain free living cyanobacteria in symbiotic associations with fungi in lichens or with ferns, mosses, and liverworts, and by bacteria or other microbes associated symbiotically with roots,

especially those of legumes. About 15 percent of the nearly 20,000 species in the Fabaceae (Leguminosae) family have been examined for $N_2$ fixation, and approximately 90 percent of these have root nodules in which fixation occurs. So without active nitrogenase enzyme there will be no $N_2$ fixation in legumes.

**29. (c) :** Gray spot diseases of oat is caused due to deficiency of manganese. Its symptoms include greyish - brown elongated specks and streaks, empty panicles, interveinal chlorosis on stem and leaves. The symptoms that occur only on leaves are irregular, greyish brown lesions which coalesce and bring about collapse of leaf. This is called grey speck symptom.

**30. (d) :** Boron occurs in the soil as a part of silicates, boric acid, calcium borate and magnesium borate. It is available to the plants as boric acid and borates of calcium and magnesium. It plays a role in carbohydrate metabolism and translocation of sugar is facilitated through the cell membrane through the agency of borate ion as it forms complexes with the carbohydrates.

**31. (c) :** Bladderwort or *Utricularia* is a rootless free floating insectivorous plant. Its stem is green and bears green lobed or dissected leaves. Some lobes of the leaves become modified into bladder like structures for catching insects. Sundew or *Drosera* is another insectivorous plant which has leaves that are green and bear many glandular hairs or tentacles having shining droplets to attract the insects and later trap them. Venus flytrap or *Dionea* is also an insectivorous plant in which the leaf is modified into two jaw like structures. Each jaw has long sensitive hairs on its upper surface and also has many digestive enzymes. These jaws interlock to trap the insect that enters in it. Thus *Utricularia*, *Drosera* and *Dionea* are all insectivorous plants.

**32. (b) :** Leghaemoglobin is a red respiratory pigment found in the root nodules of leguminous plant if *Rhizobium* is present. Soybean is a legume plant so it contains leghaemoglobin in its root nodules.

**33. (a) :** *Azolla* is an aquatic fern which is inoculated in the rice field to increase the yield. *Azolla* contains *Nostoc* and *Anabaena* (BGA) in its leaf cavities which perform nitrogen fixation.

**34. (a) :** *Refer to answer 25.*

**35. (b) :** Zinc is available to the plants for absorption in the divalent form. The availability of soil decreases when the pH of soil shifts towards alkaline side. Zinc may form zinc phosphate in the soil which is insoluble and in that case, it is not available to the plants. It is essential for synthesis of tryptophan amino acid, which forms IAA (Indole Acetic Acid) its deficiency causes chlorosis of older leaves.

**36. (a) :** Magnesium is important constituent of chlorophyll, thus it is found in all green plants and is essential for photosynthesis. It also helps in binding of ribosomal particles where protein synthesis occurs. It is also part of many enzymes of respiration. The deficiency symptoms of magnesium includes interveinal chlorosis in leaves and yellowing of leaves starting from basal to younger ones.

**37. (a) :** When the plants are kept in dark, they become pale yellow in colour and also become abnormally long with considerable internodal elongation, it is called etiolation. It is because 'flavonoids', which are inhibitors of GA are not formed in dark and hence in absence of flavonoids, GA show their full effect, *i.e.*, elongation (etiolation). Chlorosis involves non-development or loss of chlorophyll. It occurs due to deficiency of nitrogen and sulphur.

Necrosis involves death of tissues. It occurs due to deficiency of copper. Stunted growth occurs due to deficiency of potassium.

**38. (b) :** The 16 elements necessary for plants called essential elements, are as : C, H, O, N, P, S, K, Mg, Ca, Fe, Cu, B, Zn, Mn, Mo and Cl.

Zn is essential for the synthesis of tryptophan amino acid.

Ca is the part of middle lamella, it stabilizes the structure of chromosomes. Mo is responsible for nodulation in legumes. It is a part of nitrate reductase enzyme which helps in nitrogen fixation.

Na is a non-essential element. It seems to be involved in membrane permeability but its essentiality has not been proved.

**39. (b) :** *Refer to answer 19.*

**40. (c) :** Potassium is an essential mineral. It is not a constituent of any enzyme but accelerates the rate of activity of many enzymes. Potassuim is rich in actively dividing cells of buds, young leaves root tips. It is needed for proper growth and development. It regulates movement of stomata. A high amount of potassium is required in the process of protein synthesis.

**41. (b) :** Phosphorus and nitrogen ions generally get depleted in soil because they usually occur as negatively charged ions. Both the elements are essential for plants and acts as macromolecules which are required in large quantities.