

STRONG TOWER ACADEMY

SS 2 AGRIC SCIENCE

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PLANT NUTRIENTS

A soil is said to be fertile if it contains or can supply adequate nutrients to plants when needed. These conditions however, do not make the soil productive. A productive soil is one that contains those essential nutrients in available form and meets other conditions such as availability of soil moisture, air and support.

Essential nutrients are defined as those elements that are required by plants to perform their physiological functions. These nutrients are present in the soil in solution and the plants absorb them as ions. These nutrients are grouped into two namely:

1. **Macro nutrients:** required by plants in relatively large quantities e.g. nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, oxygen, carbon and hydrogen.
2. **Micro nutrients:** required by plants in relatively small quantities. They are also known as trace Elements e.g. manganese, iron, boron, zinc, copper, molybdenum.

MACRO NUTRIENTS

NITROGEN is absorbed in the form of NO_3^- (nitrate anions) and NH_4^+ (ammonium cations).

Functions

1. It is essential for plant growth and reproduction.
2. It is important in protein and carbohydrate synthesis.
3. It is essential for the synthesis of plant hormones and enzymes.
4. It enhances the uptake of phosphorus and potassium.
5. It promotes chlorophyll formation leading to the deep green colour of leaves.
6. It promotes vegetative growth.

Deficiency Symptoms

1. Stunted growth.
2. Chlorosis or yellowing of leaves.
3. Premature dropping of leaves.
4. Weak, slender stems.
5. Poor fruit and flower formation.

Effects of Excess Nitrogen

1. Delayed crop maturation.
2. Reduced resistance of crops to diseases.
3. Delayed fruiting and ripening of fruits.
4. Lodging in plants especially cereals.
5. Excessive vegetative growth.

Sources of Nitrogen

1. Inorganic manures/fertilizers like ammonium sulphate, Calcium Ammonium Nitrate (CAN), urea etc.
2. Organic manures e.g. compost, green manures, farm yard manure (FYM) etc.
3. Through the action of thunder and lightning.

PHOSPHORUS is absorbed by plants in the form of H_2PO_4^- , HPO_4^{2-} and $(\text{PO}_4)^{3-}$.

Functions

1. It is essential in cell division.
2. It increases disease resistance.
3. It is essential for seed and fruit formation.
4. It is essential for flowering and root development.
5. It helps in strengthening the plants' skeletal structure.
6. It enhances enzymatic reaction.
7. It improves palatability of forages and vegetables.
8. It hastens fruit ripening and maturity.
9. It is necessary for crop maturity.

Deficiency Symptoms

1. Leaves become purple or dull green.
2. Stunted growth.
3. Flowering, seed and fruit formation are delayed.
4. Lodging of plants due to poor root development.

Effects of Excess Phosphorus

1. It leads to iron deficiency.

Sources of Phosphorus in the Soil

1. Fertilizers like NPK, Single Super Phosphate (SSP).
2. Wood ash.
3. Organic manures.

POTASSIUM is absorbed in the form of K^+ .

Functions

1. It aids carbohydrate formation.
2. It activates enzymatic reactions.
3. It is necessary for starch translocation.
4. It is essential in the neutralization of organic acid.
5. It is necessary for the development of young plants.
6. It aids nitrate uptake.
7. It is essential for flower and fruit formation.

Deficiency Symptoms

1. Weak slender stems.
2. Delayed plant growth.
3. Margin of leaves turn brown.
4. Premature death of leaves.
5. Delayed maturity and reduced photosynthetic ability.

Effects of Excess Potassium

1. Reduction in the amount of other cations which the crop can take up.

Sources

1. Wood ash.
2. Potassium fertilizers like muriate of potash.
3. Rock minerals like mica, feldspar, albite etc.

CALCIUM is absorbed in the form of Ca^{2+}

Functions

1. It strengthens plant cell walls.
2. It helps in the translocation and storage of carbohydrate and proteins into tubers and seeds.
3. It controls the toxicity of aluminium, manganese and Na^+ .
4. It helps in high flocculation i.e. good water infiltration and retention.
5. It improves the pH of the soil for nitrogen fixation to be carried out.
6. It is necessary for normal root tip growth.

Deficiency Symptoms

1. Weak slender stems.
2. Stunted roots.
3. Pale yellow colour of leaves.
4. Soil acidity.

Effects of Excess Calcium

1. Soil alkalinity.
2. Reduction in boron utilization by plants.
3. Phosphorus may not be available to plants.

Sources

1. Rock minerals e.g. feldspar, hornblends, calcite, dolomite etc.
2. Calcium salts/lime materials, e.g. CaO (quicklime), limestone, slaked lime, gypsum etc.
3. Wood ash.
4. Basic slag.

MAGNESIUM is absorbed in the form of Magnesium cations (Mg^{2+}).

Functions

1. It is a constituent of chlorophyll, therefore, it is important in the synthesis of carbohydrate.
2. It helps in phosphate transport and fruit formation in plants.
3. It enhances plant growth.
4. It is important in cell division.
5. It helps in the synthesis of oils in plants.

Deficiency Symptoms

1. Chlorosis or yellowing of leaves along the veins.
2. Stunted growth.
3. Poor rate of photosynthesis.
4. Premature leaf fall.

Sources

1. Rock minerals e.g. mica, hornblende, dolomite and aluminium silicates.
2. Magnesium salts like sulphates, chlorides and trioxocarbonates.

SULPHUR is absorbed as sulphite anion (SO_3^{2-}) and sulphate anion (SO_4^-). Some plants absorb SO_2 (sulphur dioxide) through their leaves.

Functions

1. Important in the function of plant hormone and protein.
2. Essential in chlorophyll formation.
3. Required carbohydrate metabolism and nitrogen fixation by legumes.
4. It is a constituent of plant protein since it occurs in some amino acids such as cysteine and methionine.

Deficiency Symptoms

1. Yellowing of leaves or chlorosis.
2. Stunted growth.
3. Disturbed photosynthesis.
4. Reduced nodulation in legumes.

Sources

1. Fertilizers like superphosphates, ammonium sulphates.
2. Atmospheric sulphur dioxide.
3. Organic matter.

CARBON is absorbed as CO_2 .

Functions

1. Essential for photosynthesis i.e. carbohydrate synthesis.
2. It is an essential component of plant tissue.

Deficiency Symptoms

1. Disruption of photosynthesis.
2. Low yield.

N.B: Carbon dioxide is hardly deficient in the atmosphere.

Sources

1. Through the respiratory action of animals.
2. Decomposition of plants and animals.
3. Volcanic eruptions.

MICRO NUTRIENTS

IRON is absorbed as Fe^{2+} and Fe^{3+} .

Functions

1. It helps in chlorophyll formation.
2. It helps in protein synthesis.
3. It promotes enzymatic oxidation and reduction reactions.

Deficiency Symptoms

1. Chlorotic condition in leaves which makes them turn pale green.

Sources

Sources of iron in the soil are iron-bearing minerals which include pyrites and oxides.

MANGANESE is absorbed as Mn^{2+}

Functions

1. It helps in enzymatic synthesis of proteins.
2. It is important in nitrogen transformations.

Deficiency Symptom

Pale-greenish yellow of young leaves with discolouration of the veins.

Sources

Mineral oxides of manganese and rock minerals containing manganese.

COPPER is absorbed as Cu^{2+} .

Functions

1. Necessary for photosynthesis.

2. It is important in respiration and utilization of iron.
3. It is a constituent of some enzymes.

Deficiency Symptoms

1. Die back of young leaf tips.
2. Tips of older leaves dry and die off.
3. Leaves turn pale green.

Sources

Fertilizers and manures.

ZINC is absorbed in the form of Zn^{2+} .

Functions

1. It is essential in the formation of some growth hormone.
2. It is required in the production and maturation of seeds.
3. It activates enzymes in the synthesis of carbohydrates and proteins.

Deficiency Symptoms

1. Stunted shoots.
2. Production of mottled leaves.
3. Small leaves are also produced.

BORON is absorbed by plants as Br_4O_7^- .

Functions

1. It is necessary for protein synthesis.
2. It is involved in the formation of roots, fruits and shoots.
3. It is essential in water absorption.
4. It is essential in the translocation of sugar.
5. It encourages the division of cells in the growing regions of plants.

Deficiency Symptoms

1. Poor plant growth.
2. Failure of flower buds to develop.
3. Water absorption by plants and translocation of sugar become difficult.

4. It causes lodging.
5. Death of terminal buds.
6. Death of root tips and shoots.

MOLYBDENUM is absorbed by plants as MoO_4^{2+} .

Functions

1. It helps in nitrogen fixation in legumes.
2. It is an essential part of enzymatic system involved in nitrogen exchange.
3. It is essential in protein synthesis.

Deficiency Symptoms

1. Chlorosis in young leaves.
2. Premature flower-drops.
3. Pale yellow leaves in legumes.
4. Stunted shoots.

FACTORS AFFECTING NUTRIENT AVAILABILITY IN THE SOIL

1. **Soil pH:** This refers to the level of the acidity or alkalinity of the soil. If the soil is acidic (i.e. low pH), micronutrients except boron, dissolve in large quantities and become toxic to plants. If the soil is alkaline (high pH), the availability of most micro nutrients is reduced. Therefore, moderate pH of 5.5-7.5 is optimal for most crops.
2. **Excess of other nutrients:** The concentration of a nutrient in the soil, in relation to others affects the release of such a nutrient. For example, excess of Calcium may affect the availability of phosphorus.
3. **Leaching:** This refers to the washing of nutrients down the soil beyond the reach of plant roots by the action of percolating water.
4. **Erosion:** This washes away soil nutrients from the surface of the soil (i.e. top soil) under the influence of heavy rain or windstorm.
5. **Crop removal:** When crops are harvested, the nutrients they have absorbed from the soil in the course of their growth and development are lost.
6. **Oxidation and reduction:** Oxidation of ammonium radicals leads to loss of nitrogen in the ammonium gas while reduction of nitrates to molecular and gaseous nitrogen during denitrification process also leads to loss of nitrogen.
7. **Burning:** This is disadvantageous to the soil because some nutrients e.g. carbon, sulphur, phosphorus, nitrogen are lost to the atmosphere in their gaseous forms. Burning also depletes the organic matter of the soil which is a source of nutrient.

Other factors include organic matter content, soil type/texture and soil structure.

ASSIGNMENT

With the aid of well – labelled diagrams, describe:

1. The Nitrogen cycle
2. The Carbon cycle