Department of biology

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((Plant Physiology))

Stage (3)

((Lecture -4-))

Imbibition

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Imbibition

Imbibition [Osmosis] is a form of diffusion that represents occurs between the imbibate (water) and the imbibant without the presence of membranes. It takes place through the force of adsorption of solvents onto the surfaces of colloidal particles, and it generates tremendous pressure when the imbibing material is placed in a confined or limited space.

For imbibition to occur, two essential conditions must be met:-

1- The existence of a water potential gradient between the imbibant and the imbibate.

2- There must be an affinity or attraction between the two systems; for instance, a piece of wood imbibes water while a piece of rubber does not, although rubber can imbibe an organic solvent such as ether.

Dry wood or seeds do not contain sugar or salt solutions, but rather materials of a colloidal nature such as cellulose and starch grains. In these cases, pressure potential is not significant because the imbibing substances are not isolated from the solvent by differentially permeable membranes.

Where do we find the phenomenon of imbibition in plants?

1- The process of seeds imbibing water is the most important and first stage of germination. It generates a pressure known as imbibition pressure, which is the highest potential pressure that can develop in an imbibing material when placed in a pure solvent (such as water). This pressure is essential for rupturing the seed coat during germination. Imbibition pressure can reach up to 30 Mega Pascals (MPa).

2-In the transport of water from the root to the leaf, a large part of the process occurs through the imbibition of cell walls as a result of the water potential gradient driven by the transpiration process.

"The factors affecting imbibition are:

1. Temperature: It has a direct effect on the rate of imbibition without affecting the total quantity imbibed.

2. Osmotic Potential of the Solution: It has an inverse effect, where imbibition decreases as the osmotic potential (or osmotic pressure) of the external solution increases.

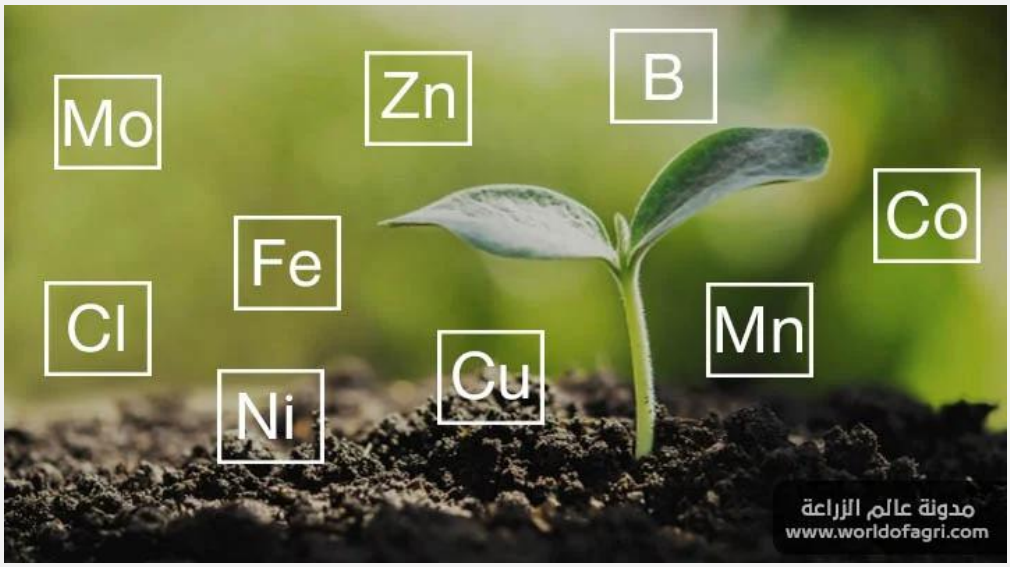
Products process of Imbibition:

1. Increase in weight and volume.
2. Rise in the system's temperature.
3. Pressure generation.

Importance of Imbibition: Seeds obtain water through the imbibition mechanism. This process is crucial for activating many enzymes within the seeds and converting starch into sugar. This provides the energy needed for the embryo to grow into a seedling and for the germination process to occur.

Elements Found in plants:-

Essential Elements



1-Macroelements: "These are the elements that the plant needs in large quantities."

(Mg,Fe,I,C,H,O,N,P,K,S,Ca)

2- Microelements: "These are the elements that the plant needs in relatively small quantities.

(Mn,ZN,B,Cu,Mo)

Conditions that must be met for an element to be considered essential:

1-It must be involved in the structure or formation of one of the important plant organs, such as **N** being involved in protein synthesis.

2-It must contribute to the completion of important biological reactions, such as **Mn**, which helps in the photosynthesis of water.

3-It must not be replaced by another element, such as **Na**, which can never replace **Ca** in its functions.

4-In the absence of the element, growth stops, becomes abnormal, or deficiency symptoms appear, such as **Mg** deficiency causing yellowing of the leaves because it is involved in the structure of chlorophyll.

The presence of the element removes the toxic effect of some toxic compounds, such as Fe, which is involved in the synthesis of the catalase enzyme that removes the toxic effect of hydrogen peroxide.

Note / that H,O is taken from the atmosphere and enters through the stomata.

Nitrogen (N)

The form that the plant absorbs and becomes available:

as nitrate NO3

ammonia NH4

Organic nitrogen

The most readily available form for the plant is **nitrate**

Physiological importance of nitrogen

1- Plant growth stops when nitrogen is absent from the plant.

2-It is involved in the structure of proteins.

3-It is involved in the structure of nitrogenous bases.

4-It is involved in the structure of coenzymes.

5-It is involved in the structure of plant hormones.

6-Vitamins contain nitrogen.

7-It is found in some enzymes that are important in metabolic processes.

Symptoms of Nitrogen Deficiency

1-Yellowing of leaves, chlorosis.

2-In some plants, a deficiency of this element leads to increased anthocyanin production, causing the petioles and veins to turn purple, as in tomato plants.

3-A deficiency of this element leads to a decrease in cell size and the rate of division.

Phosphorus (P)

Phosphorus is found in the soil in several forms, including available mineral phosphorus such as:-

1. Monophosphorus (H_2PO_4) found in acidic soil pH
2. Diphosphorus (HPO_4-2) found in neutral pH

3.Triphosphorus (PO_4-3) found in alkaline soil

Physiological Importance of Phosphorus

1-It is involved in the synthesis of nucleic acids.

2-It is involved in the synthesis of phosphorylated pesticides.

3-It is involved in the synthesis of energy compounds ATP.

4-It is involved in the synthesis of phosphorylated sugars.

Symptoms of Phosphorus Deficiency in Plants

1-Weak growth of the shoot and root systems.

2-Premature shedding of immature leaves

3-Plants appear stunted with dark-colored leaves, which appear on the lower leaves due to the ease of phosphorus movement in the plant.

4-Weakness and scarcity of lateral branches, and reduced flowering, seed production, and yield.

Calcium Ca

The form absorbed by the plant and becomes available:-

1-Monophosphate ions Ca(H2PO4)

2-Diphosphate ions CaHPO4

3-Triple phosphate ions (Ca3PO4)

4-The first is easier for the plant to absorb and precipitates in alkaline soils

Physiological Importance of Calcium

1-Major component of cell walls.

2-Essential for normal mitosis.

3-Involved in the synthesis of lipids such as lecithin.

4-Activator of some enzymes.

Symptoms of Calcium Deficiency

1-Stunted growth in plant organs.

2-Roots become thick, short, and brown.

3-Chlorophyll paleness appears on leaf margins.

4-Cell walls become brittle.

5-It is an immobile element in plants; therefore, deficiency symptoms appear on young leaves and young growth areas.