RAMA UNIVERSITY

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FACULTY OF ENGINEERING & TECHNOLOGY

Topic -4th

IMBIBITION

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Introduction

- Imbibition is a special type of diffusion when water is absorbed by the solid particles called colloids, causing an enormous increase in volume. The solution is not formed in the process.

- the solid substances are referred to as Imbibants and the imbibed liquid is referred to as imbibate. E.g. the absorption of water by seed or dry wood.

- The capacity of imbibing will differ in different imbibants. For instance consider proteins, since it is a hydrophilic collides it will have maximum imbibing capacity. Compared to this, starch has less capacity and cellulose with least capacity.

- Imbibition is the first step of water absorption. It facilitates water absorption by roots and helps in the seed germination.

- Imbibition is the process of water adsorption by solid substances without forming a solution. For eg., swelling of seeds immersed in water.

- Imbibition occurs when water goes to inside the seeds.

- Imbibition is necessary for the germination.

(A. Hadas et al., 2005)

Cont...

- The imbibition phase starts with the entry of water into the seed. This water is distributed in crevices, cracks, and flaws in the seed cover, and is absorbed by the seed tissues.

- Water uptake is depend on; temperature and accompanied by increases in respiration rate and in light sensitivity in some seed species.

- The imbibition of water by seeds before germination can be divided into three phases:

- ❑ phase I- Rapid uptake of water,
- ❑ phase II- Phase of enhanced water uptake and,
- ❑ phase III-Uptake of water along with the initiation of growth.

(Akhila Sen, et., al 2020)

Water

- As germination begins with imbibition, water is clearly required. A seed must be exposed to moist soil so that it can take up sufficient water into its tissues to allow germination. The availability of water to a seed is generally observed in terms of the water potential (Ψ, measured in MPa) of the soil or other surrounding medium.

- Imbibition of dry seeds under optimal conditions, including appropriate temperatures,oxygen and light, i.e. generally leads to germination and postgerminative events.

- spontaneous physical imbibition of a liquid by a contacting solid, which can occur by either of two processes.

- In the first process or mode the pores of the solid, the openings through which the liquid enters, are of molecular dimensions and the liquid enters by diffusion.

- In the second mode of absorption the solid is either continuous and macroscopically porous or discontinuous but composed of closely adjacent particles.

Cell Elongation

The process of germination starts with seed imbibition/uptake of water by the dry seed and terminates with radicle penetration through the seed covering layers

The first phase involves rapid water intake along with an increase in seed volume and some physiological and metabolic activities including respiration and protein synthesis. This phase is primarily a physical process, which depends on the permeability of the testa. Although most absorption occurs through the micropylar region of the testa, involvement of water channel proteins and membrane aquaporin has been demonstrated

After imbibition, the active embryo initiates a stage of high metabolic activity that generates high energetic demands and leads to increased cell elongation and cell divisions, with cell wall loosening continuously occurring in this context – a process in which auxins (particularly indole-3-acetic acid [IAA]) are involved.

Auxin-induced cell elongation is a consequence of cell wall loosening mediated by hydroxyl radicals ($^{\bullet}OH$). In a reaction catalyzed by cell wall-associated peroxidase (POX), auxin reacts with dioxygen (O_2) producing $O_2^{\bullet -}$, which is, in turn, readily converted to H_2O_2 (mainly through superoxide dismutase – SOD activity) (Kawano, 2003). $^{\bullet}OH$ can then easily be produced from H_2O_2 by Fenton reactions, which are catalyzed by metal ions. $^{\bullet}OH$ can also be produced by NADPH oxidase (NOX) in the plasma membrane.

(Mojović et al., 2004)

Imbibition In Plants

- Imbibition causes swelling of seeds and results in the breaking of testa.
- Imbibition is the initial step in seed germination.
- The water moves into ovules which are ripening into seeds by imbibition.
- Imbibition is dominant in the initial stage of water absorption by roots.

Imbibition Pressure

- This pressure can be of tremendous magnitude and can be shown by a technique that is used by early Egyptians.

- It was used to break stone blocks. Split rock and insert a wooden stalk that is completely dry in the crevices of the rocks and soak them in water.

- Proteins have a very high imbibing capacity compared to starch and cellulose has the least. That is why proteinaceous pea seeds swell more on imbibition than starchy wheat seeds.

Features of Imbibition

- **Water Potential-** The water potential or matric potential of imbibants is negative. Water has maximum water potential, i.e. 0.

- **Increase in Volume-** During imbibition, the volume of an imbibant increases. E.g. swelling of the soaked seeds, swelling of wooden frames during rains.

- **Water Potential Gradient-** A steep water potential gradient is created, when a dry imbibant comes in contact with water. Water diffuses from the higher potential into the imbibant.

- **Heat of Wetting-** The heat released during imbibition is known as the heat of wetting.

- **Adsorption-** The imbibant holds the imbibate by adsorption. It is an attractive force between two substances.

Condition Necessary for Imbibition:

- Water potential gradient between imbibate and imbibant.
- Force of attraction between imbibant and imbibate.
- IImbibation increases with an increase in temperature.

Factors Affecting Imbibition

Different biotic and abiotic factors affect the process of seed germination.

- Pressure
- Texture of the imbibant
- pH of the medium
- Affinity of the imbibant for the imbibate
- During seed germination (imbibition) rapid seed rehydration results in cellular damage and priming eliminates this situation.
- oxidative damage of lipids, proteins, and nucleic acids and leads to cell death
- For the preservation of seeds vigor, DNA repair mechanisms is active at the embryonic stage.

(Stress Tolerance in Crop Plants, 2020)

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Significance of Imbibition

1) It facilitates water absorption.
2) It helps in seed germination.
3) It keeps the cells moist.

THANK YOU