MBOTCC-7, Unit-1

Mechanism of water absorption

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Water is essential for various physiological functions of the plant cell. In higher plants water is absorbed through **root hairs** which form a **root hair zone** (Fig.4.1) present little behind the root tip. Root hairs are tubular hair like prolongations of the cell of the epidermal layer of the roots. The wall of root hair is permeable and consists of **pectic substances** and **cellulose** which are **hydrophilic** in nature.

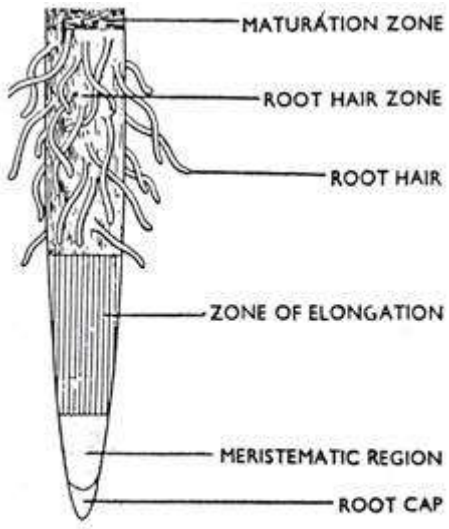

Fig. 4.1. Diagrammatic representation of a root tip showing root hair zone.

Mechanism of water absorption is of two types:

1. **Active absorption of water** – In this process the root cells play an active role in the absorption of water and metabolic energy is consumed in this process. There are two major theories to explain the active absorption

   a. **Osmotic theory of active absorption**
   b. **Non- osmotic theory of active absorption**

a. **Osmotic theory of active absorption** – This theory was postulated by **Atkins (1916)** and supported by **Priestley (1920**). According to this theory, water moves by diffusion along a gradient of decreasing free energy.

b. **Non-osmotic theory of active absorption** – Investigators like **Beenet Clark et al (1936**) and **Prell (1953**) believe that there is a **non-osmotic active water uptake** in plants. According to them water is absorbed against the **concentration gradient** and requires the expenditure of **metabolic energy.**

2. **Passive absorption of water –** According to this theory, rapid **transpiration** of water from leaves create a **diffusion pressure deficit (DPD)** in the leaf cells. Therefore water from the leaf **xylem cells** diffuses out to **mesophyll** cells of a leaf that create tension in the water of the **xylem cell** of the leaves. This tension is transmitted from **mesophyll cells** of leaves to the **xylem cells** of the root end through the **water column** of the **xylem cells** of stem and the water rises upward to reach the transpiring surfaces. So a **diffusion pressure deficit** is created in peripheral root hair cells, as a result, **soil water** enters into the **cortical cells** through root hairs to reach the **xylem vessels** of root to maintain the supply of water. In the process of **passive absorption**, the absorption of water takes place due to **active transpiration** by leaves, and the cells of root play only a passive role. In passive absorption large quantity of water is absorbed in a rapid rate and to a higher extent.

   Pathway of water across root cells:
   Due to the increasing **gradient of diffusion pressure deficit** in the root hair cells soil water moves into the cell (Fig. 3.1). As the water moves into the cell its DPD falls. The adjacent cortical cell which has much higher DPD absorbs water from root hair cell this way water moves from cell to cell and through **passage cells of endodermis** enters into the **pericycle cells** by **osmotic diffusion**. In the last step, water is drowned **by xylem vessels** from **turgid pericycle cells**. The force with which water will is drown by the xylem ducts from the soil will depend on the difference between the diffusion pressure deficit (DPD) of the soil water.

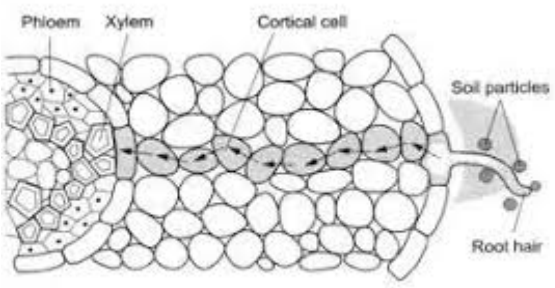

Fig. 3.1 Absorption of water through root hair

Factors Affecting Water Absorption

The following soil factors have a considerable effect on the rate of water absorption:

1. **Available soil water** – Decrease in soil water below the permanent wilting percentage causes a decrease in water absorption.

2. **The Concentration of soil solution** – If the concentration of soil solution is greater than the concentration of the cell solution it will inhibit water absorption.

3. **Soil aeration** – Absorption of water by the root is rapid in well-aerated soil.

4. **Soil temperature** – The optimum temperature for good water absorption is between 20 to 30-degree centigrade.

LEARNING OUTCOME

1. What is absoption of water
2. What is the mechanism of absorption of water
3. Different theories regarding absorption of water
4. What are the factors affecting the water intake