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Transpiration and Its Significance

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The loss of water in the form of vapor from the living tissues of aerial parts of the plant is termed transpiration. Most of the water absorbed by the plants is lost in the atmosphere. Less than 5% of water is utilized by the plants for their growth and development. Transpiration is also basically an evaporation phenomenon. But it differs from the general Process of evaporation. Evaporation means loss of water vapor from the free surface, but in transpiration, water passes through the epidermis through the stomata.

Types of Transpiration

Transpiration can take place through three main organs of plants, so transpiration is of three types:

I. **Stomatal Transpiration**:- It is the loss of water vapour through stomata. It accounts for 80−90% of the total water loss from the plants.

II. **Cuticular Transpiration:**– Cuticle is the outer waxy covering of the leaves. If it is thin, then cuticular transpiration takes place. But if it is thick, then water vapour loss is significantly reduced. Up to 20% of total transpiration takes place through this process.

II. **Lenticular Transpiration:**– Loss of water through lenticels (present in woody stems) is called lenticular transpiration.

Factors Affecting Rates of Transpiration

PLANT PARAMETERS: These plant parameters help plants control rates of transpiration by serving as forms of resistance to water movement out of the plant.

Stomata:- Stomata are pores in the leaf that allow gas exchange where water vapor leaves the plant and carbon dioxide enters. Special cells called guard cells control each pore's opening or closing. When stomata are open, transpiration rate increase when they are closed, transpiration rates decrease.

Boundary layer:- The boundary layer is a thin layer of still air hugging the surface of the leaf. This layer of air is not moving. For transpiration to occur, water vapor leaving the stomata must diffuse through this motionless layer to reach the atmosphere where the water vapor will be removed by moving air. The larger the boundary layer, the slower the rates of transpiration. Plants can alter the size of their boundary layers around leaves through a variety of structural features. Leaves that possess many hairs or pubescence will have larger boundary layers; the hairs serve as mini-wind breaks by increasing the layer of still air around the leaf surface and slowing transpiration rates. Some plants possess stomata that are sunken into the leaf surface, dramatically increasing the boundary layer and slowing transpiration. Boundary layers increase as leaf size increases, reducing rates of transpiration as well. For

example, plants from desert climates often have small leaves so that their small boundary layers will help cool the leaf with higher rates of transpiration.

Cuticle:- The cuticle is the waxy layer present on all above-ground tissue of a plant and serves as a barrier to water movement out of a leaf. Because the cuticle is made of wax, it is very hydrophobic or 'water-repelling'; therefore, water does not move through it very easily. The thicker the cuticle layer on a leaf surface, the slower the transpiration rate. Cuticle thickness varies widely among plant species. In general, plants from hot, dry climates have thicker cuticles than plants from cool, moist climates. In addition, leaves that develop under direct sunlight will have much thicker cuticles than leaves that develop under shade conditions.

ENVIRONMENTAL CONDITIONS: Some environmental conditions create the driving force for movement of water out of the plant. Others alter the plant's ability to control water loss.

Relative humidity:– Relative humidity (RH) is the amount of water vapor in the air compared to the amount of water vapor that air could hold at a given temperature. A hydrated leaf would have a RH near 100%, just as the atmosphere on a rainy day would have. Any reduction in water in the atmosphere creates a gradient for water to move from the leaf to the atmosphere. The lower the RH, the less moist the atmosphere and thus, the greater the driving force for transpiration. When RH is high, the atmosphere contains more moisture, reducing the driving force for transpiration.

Temperature:– Temperature greatly influences the magnitude of the driving force for water movement out of a plant rather than having a direct effect on stomata. As temperature increases, the water holding capacity of that air increases sharply. The amount of water does not change, just the ability of that air to hold water. Because warmer air can hold more water, its relative humidity is less than the same air sample at a lower temperature, or it is 'drier air'. Because cooler air holds less water, its relative humidity increases or it is 'moister air'. Therefore, warmer air will increase the driving force for transpiration and cooler air will decrease the driving force for transpiration.

Soil water:– The source of water for transpiration out of the plant comes from the soil. Plants with adequate soil moisture will normally transpire at high rates because the soil provides the water to move through the plant. Plants cannot continue to transpire without wilting if the soil is very dry because the water in the xylem that moves out through the leaves is not being replaced by the soil water. This condition causes the leaf to lose turgid or firmness, and the stomata to close. If this loss of turgor continues throughout the plant, the plant will wilt.

Light:– Stomata are triggered to open in the light so that carbon dioxide is available for the light-dependent process of Photosynthesis Stomata are closed in the dark in most plants. Very low levels of light at dawn can cause stomata to open so they can access carbon dioxide for photosynthesis as soon as the sun hits their leaves. Stomata are most sensitive to blue light, the light predominating at sunrise.

Wind:– Wind can alter rates of transpiration by removing the boundary layer, that still layer of water vapor hugging the surface of leaves. Wind increases the movement of water from the leaf surface when it reduces the boundary layer, because the path for water to reach the atmosphere is shorter.

Significances of Transpiration

Following are the significance of transpiration:-

I. **Cooling Effect**:- Transpiration involves the evaporation of water, and we know that evaporation results in the cooling of the surface. So, transpiration leads to the cooling of the plant organs. High temperatures can denature the enzymes of the plant.

II. **Bringing water to the top of the plant**:- Transpiration helps in the ascent of sap. When transpiration takes place, water evaporates from the intercellular spaces of the leaves into the outer atmosphere through the stomata. Due to water loss, a negative hydrostatic pressure is created to draw water from the roots to the veins of the leaves. The negative tension is then gradually transmitted downwards. As a result, there is a continuous upward movement of the water column in the plant and lumen of tracheids and vessels of a xylem link to form a narrow tube and water rises in the narrow tube due to the force of surface tension through capillary action. This biological process is responsible for moving water to the top of tall trees; as water evaporates from the leaves, it creates a suction force at the top.

III. **Absorption and upward translocation of mineral salts:-** Mineral salts are absorbed from the soil through roots and reach the xylem vessel. In the vessel, these minerals get mixed with water and are transported upward with the water to all parts of the plant. This translocation is also dependent on transpiration. More is the rate of transpiration; more is the absorption and upward translocation of minerals.

IV. **Removal of excess water absorbed by plants**:- Excess water in the cells may clog the intercellular spaces of the leaves, so transpiration helps in the removal of excess water that is absorbed from the soil.

V. **Distribution of water**:- Transpiration helps in the distribution of water all over the plant body.

VI. **Optimum turgidity:-** This process maintains the cell turgidity of the plant, i.e., neither too turgidity is beneficial for the plant growth nor too shrank or flaccid cells, which results when water potential gets decreased or highly negative.

VII. **Affects climate**:- Transpiration increases the moisture in the atmosphere and brings rain. Thus, forests contribute to bringing rain. Transpiration is one of the important steps in maintaining a water cycle.

Conclusion

Transpiration is the evaporation of water from the of water from the surface of leaf cells in actively growing plants. The process of transpiration provides the plant with evaporative cooling, nutrients, carbon dioxide entry and water to provide plant structure. Rates of transpiration depend on the water potential gradient from the soil to the atmosphere and the resistances to its movement through the plant.

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