Transpiration

The loss of water in the form of water vapour from the aerial parts such as the leaves and the green shoots of the plant is called **transpiration**.

Types of Transpiration

Depending upon the parts of the plant involved, there are three types of transpiration.

1. Stomatal transpiration

- This kind of transpiration occurs through stomata. Each stomata (singular) is surrounded by two guard cell. These guard cell regulate the opening and closing of stomata.
- When stoma is opened, transpiration take place and when it is closed, transpiration stops.

2. Cuticular transpiration

The loss of water vapour from the cuticle is called cuticular transpiration. The lesser the thickness of the cuticle, the greater the transpiration. Cuticle transpiration accounts for about 10% of the total amount of water transpired from the leaves.

3. Lenticular transpiration.

- In woody plants and in many fruits, transpiration also take place through lenticels, which remain open all the time because they do not have guard cells.
- Lenticels are small openings in the bark of the woody stem, underground stems, twigs and fruits. It also helps in diffusion of respiratory gases.

Mechanism of stomatal transpiration

- Water absorbed by the roots is conducted to the mesophyll cell of leaves through the xylem elements.
- These cells have large intercellular spaces. Water evaporates from the surface of the mesophyll cells, accumulates in the intercellular space and then escapes to the outer atmosphere

through stomata.

- Most of the water gets transpired by stomata found on the leaves of plants. The stomata open for a certain period in the daytime for intake of carbon dioxide for photosynthesis and during the dark they remain partly closed.

The guard cells at stomatal openings regulate the transpiration.

Measurement of Transpiration.

Transpiration can be measured by the following methods.

1. Weighing method

- The relation between transpiration and absorption can be worked out for the various hours of the day and under diverse external conditions by a weighing method.
- It should be noted that the experiment also shows separately the rate of absorption and the rate of transpiration which are almost equal.
- In this experiment, a leafy shoot is inserted in a test tube filled with water and some oil is poured on the surface of water to prevent loss of water by evaporation.

The test tube is weighed by keeping it in a beaker. The test tube is again weighed after a few hours. The difference in the weight shows the loss of water by the shoot.

2. Potometer method

- A glass device which is used to measure and compare the rate of transpiration in different conditions is known as potometer.

There are different types of potometer: Ganong's potometer, simple potometer, farmer's potometer, Bose's potometer etc.

Precautions to be taken during setting up of a photometer.

- The twig should be cut obliquely while dipped inside the water.
- The apparatus should be watertight.
- The air bubbles should be set on zero-point by opening

the stopper of the reservoir carefully.

- The capillary tube should be properly dipped in the water.
- Once the coloured water starts moving into the capillary tube, introduce the air bubbles.
- The potometer is best for recording effects of different environmental factors on transpiration, such as air, light, temperature etc.

Limitation of potometer

- In a potometer, a cut shoot of a plant is used which gets shriveled up after few readings.
- Also, the rate of transpiration may differ from that of the shoot attached to an intact plant due to the absence of the root system.

cobalt chloride paper method

In this method, transpiration is indicated by change in colour of the cobalt chloride paper.

The cobalt chloride paper is blue when dry and pink when moist.

The method is suitable for comparing the rate of transpiration in case of dorsiventral or dicot leaf.

factors affecting the rate of transpiration

1. Temperature: The rate of transpiration increases as the temp-erature increases. This is because at higher temperature, there is more evaporation of water from mesophyll cells.
2. Humidity: The higher the humidity of the air, the less is the rate of transpiration.

3. Velocity of wind: On a windy day, water evaporates more quickly than on a fine day. This is because strong wind takes away the moisture laden air from the trees, then leaves transpire more water because air can hold more moisture.

4. Light: High intensity and long duration of light increases the rate of transpiration. This is because stomata usually open in the light as a result of photosynthesis and close at night when there is no photosynthesis.

5. Available soil water: If there is less uptake of water by roots, the guard cells become flaccid, closing the stomata, and the rate of transpiration is decreased

6. Percentage of carbon dioxide: An increase in the percentage of carbon dioxide i.e more than 0.03% results in decrease of rate of transpiration because it combines with moisture and forms carbonic acid which clogs the stomatal pore.

7. Atmospheric Pressure: The lesser the atmospheric pressure, the more is the rate of transpiration.

Adaptations to reduce excessive transpiration

The important structural modifications are as follows:

- The presence of thick cuticle on the upper side than on the lower side and multiple epidermis in certain leaves to check excessive loss of water eg. banana, rubber plant, nerium and banyan leaves.
- The presence of sunken stomata eg. prickly pear and nerium
- The number of stomata gets reduced eg upper surface of dicot leaf.
- Rolling, folding and drooping of leaves eg Pteris (fern) and desert grass.
- Reduction in leaf area by their modification into spines or scales eg. prickly poppy or cactus (xerophytes)
- The presence of hairs, scales, etc. on the surface of the leaf minimizes transpiration to a great extent e.g petunia and hollyhock.

Importance of Transpiration.

The excess water is eliminated from the plant body by transpiration.

- Transpiration also helps in the distribution of minerals and water throughout the plant body.

Transpiration secures concentration of the cell sap and thereby helps in the process of osmosis.

- As a result of transpiration, in summers, plants body become cool since a considerable amount of latent heat is lost in converting water from liquid to a gaseous state.
- As a result of transpiration from the leaf surface, a suction force is generated by decreasing water content of leaf cells, which draws water from the cell below it in the form of a pull which helps in the ascent of water to the tip of the trees.
- As the water evaporates, hygroscopic salts are left on the surface of the leaf. These salts absorb moisture from the atmosphere and do not allow the leaf or the plant as a whole to dry up.

Guttation or Exudation

- The excess of water is also eliminated by many herbaceous plants by a process, commonly called exudation or guttation.
- Thus, in balsam, rose, water lettuce, grapevine, many aroids, garden nasturtium, sunflower, chrysanthemum, canna, many grasses etc. It is seen that the drops of water accumulate at the apex or the margin of the leaves in the early morning.
- The water escapes through the hydathodes.
- Exudation, normally, take place during warm and damp night.
- In some plants, a considerable quantity of water exudes every night. Exudation does not take place at very low temperatures.
- Oozing out of the cell sap due to root pressure is called bleeding. e.g. latex of rubber tree is collected by making a deep cut in the main stem.