Transpiration

Transpiration is a process during which water is lost in the form of water vapour through the aerial parts of the plant.

Demonstration of Transpiration

Experiment 1

- Drops of water appear on the inner side of the polythene bag.
- No such drops appear in the empty polythene bag.
- The plant gives off water vapour which saturates and condenses on the inner surface of the polythene bag.



Experiment 2

- Setup A: Water vapour condenses on the inner wall of the bell jar.
- Setup B: The bell jar also shows similar condensation of water vapour, and at the same time, the cobalt chloride paper which is initially blue turns pink.
- Setup C: In this bell jar, neither water droplets are found nor does the cobalt chloride paper turn pink.
- Condensation of water vapour occurs on the inner walls of the bell jar in setups A and B.
- Change in the colour of cobalt chloride paper proves that plants give off water vapour during transpiration.





Kinds of Transpiration



| Stomatal Transpiration | Cuticular Transpiration | Lenticular Transpiration |
|---|---|--|
| Water vapour escapes through the stomata of the leaf. | Transpiration occurs directly from the surface of the leaves and stems. | Transpiration occurs through lenticels present on old stems. |

Stoma

A stoma is surrounded by two bean-shaped guard cells. The number of stomata may range from 1,000 to 10,000 per cm².



Mechanism of Stomatal Transpiration

- The surfaces of spongy mesophyll cells in a leaf are exposed to intercellular spaces.
- Water vapour formed saturates the air in the intercellular spaces, diffuses into connecting intercellular spaces and reaches the sub-stomatal space. Finally, it escapes in the atmosphere through air.
- The turgor pressure in cells forces some water out of the cell wall into the intercellular space.
- Here, the water evaporates, and the water vapour from the intercellular spaces diffuses into the sub-stomatal space from where it finally diffuses through stomata.
- The opening and closing of stomata is regulated by the guard cells.

Experiment

- The cobalt paper on the lower side turns pink in much lesser time than the one on the upper surface.
- This shows that more transpiration occurs from the lower surface of the leaf which is due to more number of stomata on the lower surface.



Rate of Transpiration

Experiment: Potometer Method

A potometer is a device which measures the rate of water intake by a plant which is almost equal to the water lost through transpiration.

Air bubbles move through the horizontal arm.

Water loss during transpiration sets up a suction force which pulls the water from the beaker, and bubbles move along in the capillary.



Factors Affecting the Rate of Transpiration

| Intensity of sunlight | With increase in the intensity of sunlight, the rate of transpiration increases. |
|---|--|
| Temperature | Increase in the temperature of the air increases the rate of transpiration. |
| Velocity of wind | Transpiration increases with rapid or active air movement. |
| Humidity | If the air is humid, then the rate of transpiration is reduced. |
| Carbon dioxide | Increase in the CO_2 level in the atmosphere over normal 0.03% causes stomatal closure. Hence, it decreases the rate of transpiration. |
| Atmospheric pressure | With decrease in atmospheric pressure, the rate of transpiration increases. |

Adaptation in Plants to Control Excessive Transpiration

Plants which grow in dry climate have evolved a variety of adaptations to curtail transpiration.

- Leaves may be modified into spines as in cactus or into needles as in pines.
- Leaves may be folded or rolled up.
- The number of stomata is reduced, and they may be sunken in pits.
- A thick waxy cuticle develops on the leaves. Examples: Banyan tree, evergreen trees

Significance of Transpiration

- Evaporation reduces the temperature of leaf surfaces.
- It draws more water up through the stem which causes roots to absorb more water from the soil.
- Higher the rate of transpiration, greater the rate of absorption of water and solutes from the soil.

Differences between Transpiration and Evaporation

| Transpiration | Evaporation |
|---|---|
| Loss of water in the form of water vapour | Loss of water from the surface of water |
| from aerial parts of the plant. | bodies. |
| It is a slow process. | It is a fast process. |

Guttation and Bleeding

Guttation

The water appears as tiny drops along the margins or tips of leaves. This loss of excessive water is called **guttation**.

Guttation occurs through hydathodes.

Bleeding

Loss of water, i.e. cell sap, through a cut stem is called **bleeding**.

Differences between Transpiration and Guttation

| Transpiration | Guttation |
|--|--|
| Water is lost in the form of vapour. | Water is lost in the form of water droplets. |
| Water vapour is lost through stomata, lenticels and cuticle. | Water is lost through hydathodes. |