

Chapter 4: Transpiration

1. Introduction:

Transpiration is the process through which plants lose water in the form of water vapor from their aerial parts, primarily through the stomata on leaves.

2. Process of Transpiration:

- Water absorbed by roots is transported to leaves via the xylem.
 - Water evaporates from the leaf surface, mainly through stomata.
 - This evaporation creates a negative pressure, pulling more water upward (transpirational pull).
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3. Significance of Transpiration:

- Helps in the ascent of sap (water and minerals).
 - Maintains the plant's temperature through cooling.
 - Facilitates the distribution of minerals within the plant.
 - Creates a suction force that aids in water uptake.
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4. Mechanism of Stomatal Transpiration:

- **Potassium Ion Exchange Theory:**
 - During the day, guard cells absorb potassium ions (K^+), lowering the water potential, causing water to enter and making the stomata open.
 - At night, potassium ions move out, water follows, and the stomata close.
 - Stomatal opening and closing depend on light, water availability, and internal CO_2 concentration.
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5. Experiments Related to Transpiration:

a) Ganong's Potometer:

- Measures the rate of water uptake, indirectly indicating the transpiration rate.
- **Limitations:**
 - Air bubbles may block water movement.
 - Does not directly measure water loss, as some water is used in photosynthesis.

b) Experiment: Loss in Weight of a Potted Plant:

- A potted plant is weighed before and after a specific period.
- The decrease in weight is attributed to water loss due to transpiration.

c) Experiment: Cobalt Chloride Paper Test:

- Cobalt chloride paper changes color from blue to pink in the presence of water vapor.
 - Demonstrates that transpiration is higher from the lower surface (abaxial) of a dorsiventral leaf.
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6. Factors Affecting Transpiration:

1. Environmental Factors:

- Light: Increases transpiration by opening stomata.
- Temperature: Higher temperature increases evaporation.
- Humidity: Low humidity increases the rate.
- Wind: Removes moisture, increasing the rate.

2. Plant Factors:

- Leaf Structure: Thin, broad leaves increase the surface area.
 - Number and Distribution of Stomata: More stomata increase transpiration.
 - Water Availability: Low water reduces transpiration as stomata close.
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7. Adaptations to Reduce Transpiration:

- Thick, waxy cuticle on leaves.
 - Reduced leaf surface area.
 - Sunken stomata to reduce water loss.
 - Hairy leaves to trap moisture.
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8. Guttation and Bleeding:

- **Guttation:**
 - Exudation of water droplets from hydathodes at leaf margins, typically at night or in high humidity.
 - Caused by root pressure when transpiration is low.
 - **Bleeding:**
 - The oozing of sap from injured parts of a plant.
 - Occurs due to root pressure forcing liquid out of the damaged area.
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9. Key Points:

- Transpiration mainly occurs through stomata and helps in water movement and cooling.
 - Various experiments demonstrate the process and rate of transpiration.
 - Plants have structural adaptations to minimize water loss.
 - Guttation and bleeding are processes related to water exudation but differ from transpiration.
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