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Chapter 19

Experimental demonstration of transpiration pulls: Mercury method for measuring xylem water transport

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1. Introduction:

Transpiration pull refers to the tension generated within the xylem elements of plants due to transpiration, facilitating the upward movement of water against gravity (Dixon, and Joly, 1894). Several theories have been proposed to elucidate this phenomenon, including Capillarity, Imbibition, Atmospheric Pressure, Root Pressure, Vital, and Cohesion theories. Among these, the Cohesion theory, proposed by H. H. Dixon and J. Jolly in 1894, is widely accepted. According to this theory, the ascent of sap relies on three fundamental elements: the driving force, adhesion or hydration, and cohesion of water. The driving force is the gradient in water potential from the soil through the plant to the atmosphere (Hopkins, and Hüner, 2008; Yadav et al 2023). Adhesion, cohesion, and high tensile strength of water, attributed to hydrogen bonding, allow it to be pulled to the top of a tree by the driving force (Scholander et al., 1965; Tripathi et al., 2018).

2. Materials Required:

1. Excised twig from plants like *Azadirachta indica* or *Polyalthia longifolia*
2. Mercury
3. Long narrow glass tube
4. Wax
5. Beaker
6. Stand,
7. Cork
8. Water

3. Procedure:

1. Cut a leafy shoot and affix it to one end of a narrow glass tube using water.
2. Seal the joint with wax.
3. Cover the other end of the glass tube with your finger and position it upright in a petri dish containing mercury.

4. Secure the setup with a clamp stand.
5. Place the apparatus in bright sunlight.
6. Monitor the rise of mercury in the glass tube.

4. Observations:

The length of the water column in the glass tube decreases while mercury rises in the tube.

5. Result:

Transpiration from the leafy shoot causes water loss to the atmosphere. The resultant suction created by transpiration leads to the rise of mercury in the narrow glass tube, demonstrating the phenomenon of transpiration pull.

6. Precautions:

1. Select a leafy sprout from a plant that is actively transpiring.
2. Place the device in direct sunshine.
3. There should be no gaps in the joint.

7. Reference:

1. Hopkins, W. G., & Hüner, N. P. A. (2008). *Introduction to plant physiology* (4th ed.). Wiley.
2. Dixon, H. H., & Joly, J. (1894). On the ascent of sap. *Philosophical Transactions of the Royal Society B: Biological Sciences, 186*, 563–576.
3. Scholander, P. F., Hammel, H. T., Bradstreet, E. D., & Hemmingsen, E. A. (1965). Sap pressure in vascular plants. *Science, 148*(3668), 339–346.
4. Tripathi, K., Kumar, N., & Abraham, G. (Eds.). (2018). *The role of photosynthetic microbes in agriculture and industry*. Nova Science Publishers.
5. Yadav, R. K., Ramteke, P. W., Tripathi, K., Varghese, E., & Abraham, G. (2023). Salinity-induced alterations in the growth and cellular ion content of *Azolla caroliniana* and *Azolla microphylla*. *Journal of Plant Growth Regulation, 42*(2), 867–876.