Objectives

- To demonstrate water transport in xylem tissues due to transpiration
- To describe how environmental conditions such as wind and light affect transpiration
- To measure the transpiration rate of a plant
- Determine total leaf surface area and its affect on transpiration

Introduction

In order to survive, land plants must be able to obtain enough water and then prevent that water from being lost. Plants living in various environments have structural and/or physiological adaptations to cope with water loss. This water loss from plants is called transpiration. Transpiration occurs primarily through the stomates of leaves, however, it can occur in other plant parts. In this laboratory, you will examine transpiration in several species of plants.

A. Transpiration in the xylem of celery stalks

During active photosynthesis, plants transport water in xylem elements from the roots to the leaves for photosynthesis. This is possible because stomates are open so that plants can exchange oxygen and carbon dioxide. Open stomates also allow for water loss. As a result, water is transported from the roots to the leave due to the adhesion-cohesion transpiration pull that occurs in the xylem. In this exercise, you will determine the location of the xylem vessels and the amount of dye movement in an hour.

1. Obtain a fresh piece of celery stalk with leaves.
2. Cut off and discard the bottom 5 cm of the stalk while holding the stalk under water.
3. Quickly transfer the cut stalk into a beak with 0.5% methylene blue dye.
4. Place the celery in either a sunny location or a shady location as determined by your instructor.
5. Allow the celery to remain for 30 to 60 minutes.
6. After an hour, make cross sections at 1 cm intervals up the stem to determine the distance the dye traveled.

B. The effects of varying environmental conditions on transpiration rates

There are several environmental factors that can affect transpiration. These factors include carbon dioxide levels, light, wind and humidity. In this experiment, you will examine how light and wind affect transpiration.

1. Obtain a corn (or sunflower) plant from your instructor.
2. Without getting the leaves wet, rinse off the dirt from the seedling.
3. Without getting the leaves wet, submerge the stem in water and obliquely cut the stem with a sharp razor blade or scalpel.
4. Keep the cut end of the stem submerged.
5. **Carefully** attach the cut end of the corn seedling to the potometer, a 1 mL in 1/100th pipet. Slide it in so that you will not bend the stem. Be sure that no air bubbles are in the system and no water is on the leaves. Make sure that there is a tight seal around the stem. If need be, use the dental dam, latex glove piece or rubber membrane to create a tight seal.
6. Remove the potometer setup out of the tray, making sure you do not create any air bubbles in the system as you do so.
7. Slightly elevate the pipet tip so that water does not leak out that end. The water should be at the cut end.
8. Allow about 10 minutes for the rate of water movement in the pipet to stabilize. Using the room light (control), note the position of the meniscus and allow transpiration to occur for 15 minutes.
9. Determine and record the volume of water transpired by the plant. Record the distance the meniscus moved (mL). Convert your measurements to mL/hour. This will be the control value.
10. Place the plant in complete darkness or a reduced light setting for 15 minutes and determine the rate of transpiration.
11. Place the plant in light with a mild breeze (generated by a small fan) and determine the transpiration rate after 15 minutes.
12. Place the plant in the dark with a mild breeze and determine the rate of transpiration after 15 minutes.
13. Place the leaves back in the light, this time coat the leaves with petroleum jelly. Determine the rate of transpiration after 15 minutes.
14. Remove all the leaves from your plant and determine the rate of transpiration after 15 minutes.
15. Record your data transpiration rate data on the computer before you leave.

C. **Determining leaf surface area**

In this exercise, you will determine the surface area for each of your leaves. To do this, cut out a piece of paper that is exactly 1 cm². Determine the mass of the 1 cm² paper. Determine the mass for each of the plant’s leaves. Calculate the surface area for each of your leaves. Then determine the total surface area for all leaves.

\[
\frac{A}{B} = \frac{C}{D}
\]

- Enter your data on the computer before you leave.
A. Transpiration in the xylem of celery stalks

1. Distance traveled
   Sunny location: ____________________
   Shady location: ____________________

2. Sketch the cross section of a celery stalk and indicate the location of the xylem vessels.

B. The effects of varying environmental conditions on transpiration rates

Table 1: Experiment Conditions for Measuring Transpiration

<table>
<thead>
<tr>
<th>Condition</th>
<th>Transpiration Rate (mL H₂O · h⁻¹)</th>
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</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>Dark or reduced light</td>
<td></td>
</tr>
<tr>
<td>Light; mild breeze</td>
<td></td>
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<tr>
<td>Light; leaves with petroleum jelly</td>
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<tr>
<td>Light; all leaves removed</td>
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</table>

*Do not forget to enter you data on the computer.*

C. Leaf surface area

Table 2: Mass and surface area for 1 cm² paper and plant leaves

<table>
<thead>
<tr>
<th>Mass (g)</th>
<th>Surface Area (cm²)</th>
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</thead>
<tbody>
<tr>
<td>1 cm² paper</td>
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</table>

- Using Excel, construct a graph of transpiration rate vs. total leaf surface area for the compiled data.

Assignment: write a combined abstract on sections B and C. Due one week upon completion of the laboratory.