Interactions

Big Idea 4

Baker's Dozen Lab 11: Transpiration

Objectives

Before doing this lab you should understand how water moves from roots to leaves in terms of the physical/chemical properties of water and the forces provided by differences in water potential; the role of transpiration in the transport of water within a plant; and the structures used by plants to transport water and regulate water movement.
After doing this lab you should be able to test the effects of environmental variables on rates of transpiration using a controlled experiment.

Introduction

The amount of water needed daily by plants for growth and maintenance is small in comparison to the amount that is lost through the process of **transpiration** (the evaporation of water from the plant surface) and **guttation** (the loss of liquids from the ends of vascular tissues at the margins of leaves). If this water is not replaced, the plant will wilt and die.

The transport of water up from the roots in the xylem is governed by differences in **water potential** (the potential energy of water molecules). These differences account for water movement from cell to cell and over long distances in the plant. Gravity, pressure, and solute concentration all contribute to water potential, and water always moves from an area of high water potential to an area of low water potential. The movement itself is facilitated by osmosis, root pressure, and adhesion and cohesion of water molecules.

The Overall Process: Minerals actively transported into the root accumulate in the xylem, increasing solute concentration and decreasing water potential. Water moves in by **osmosis**. As water enters the xylem, it forces fluid up the xylem due to hydrostatic **root pressure**. But this pressure can only move fluid a short distance. The most significant force moving the water and dissolved minerals in the xylem is the upward pull as a result of transpiration, which creates tension. The "pull" on the water from transpiration results from the **cohesion** and **adhesion** of water molecules.

Evaporation through open stomates is a major route of water loss in plants. However, the stomates must open to allow the entry of CO_2 used in photosynthesis. Therefore, a balance must be maintained between the gain of CO_2 and the loss of water by regulating the opening and closing of stomates on the leaf surface. Many environmental conditions influence the opening and closing of stomates and also the rate of transpiration including temperature, light intensity, air currents, and humidity. Different plants also vary in the rate of transpiration and in the regulation of stomatal opening.

Materials

plants	aquarium	fan	balance
light	spray bottle	plastic bag	graduated cylinder

Hypothesis: Write a hypothesis and a null hypothesis stating what you expect to occur based on what you know about transpiration and stomata regulation.

H1: _____

_____

H0: _____

_____

<u>Procedure:</u> Procedure: Each lab group (of three students) will expose one plant to one treatment.

1. Select a plant that you will expose to your assigned environmental condition.
2. Remove any blooms that are on the plant so they don't fall off during the experiment.
3. Pull the entire plant out of its container, and wrap the root ball in a plastic bag.
4. Add 10 mL of water to the bag.
5. Tie the bag shut around the base of the stem with yarn so that only the leaves are exposed.
6. Mass the plant in the bag. Record the initial mass on the bag and on your data table.
7. Place the plant back in its container and place container under the appropriate environmental conditions.
    - Humidity: Plants should be placed on tray under aquarium.
    - Breeze: Plants should be placed one meter in front of the fan on low setting.
    - Light: Plants should be placed one meter from the heat lamp.
    - Normal: Plants should be placed along the windowsills in the back of the room.
8. Mass the plant in the bag each day for the duration of the experiment. Record the mass in your data table. REMINDER: If any blooms or leaves fall off the plant during the experiment, they should be placed on the center of the plant so the mass of the plant is not adversely affected.
9. Calculate the percent change of the mass of the plant for each day of the experiment. Record in your data table.
10. Obtain the class average for each group of plants under the four different environmental conditions.
11. Graph the class average for percent change of mass.

Data Table 11.1: Individual Water Loss Under Environmental Condition: _____

Day	Mass (in grams)	Percent Change of Mass
Initial mass		
1		
2		
3		

Data Table 11.2: Class Average Percent Change of Mass

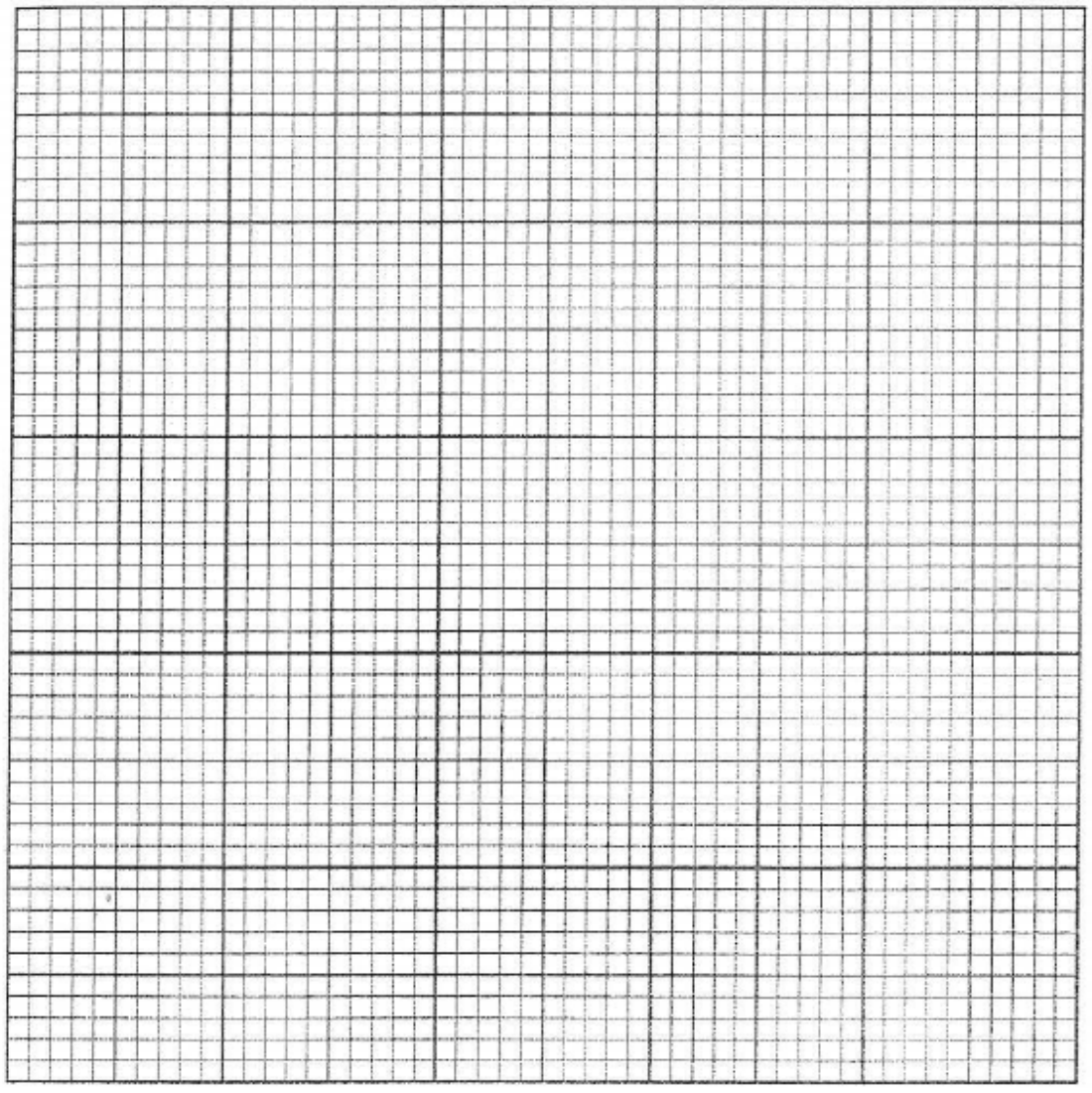
Treatment	Initial	Day 1	Day 2	Day 3
Room	**0**			
Light	**0**			
Breeze	**0**			
Humidity	**0**			

For each treatment, graph the class average data for each day. For this graph you will need to determine the following:

a. The *independent* variable: _____

b. The *dependent* variable: _____

Graph 11.1 Title: _____



Analysis

1. Which environmental condition resulted in the highest rate of transpiration? Which environmental condition resulted in the lowest rate of transpiration?

_____

_____

2. Explain why each of these conditions causes an increase or decrease in transpiration compared with the control.

Condition	Effect	Explanation of Effect
Light		
Breeze		
Humidity		

3. Explain the role of water potential in the movement of water from the soil through the plant and into the air.

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4. What is the advantage of closed stomata to a plant when water is in short supply? What are the disadvantages?

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5. Describe several adaptations that enable plants to reduce water loss from their leaves. Include both structural and physiological adaptations.

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