14. TRANSPIRATION

How does a fan affect the rate of transpiration in plants?

Objectives

- Compare the transpiration rate in a plant under different atmospheric conditions.

Materials and Equipment

- Data collection system
- Pressure sensor with tubing and sensor connector
- Syringe with tubing connector
- Ring stand or base and support rod
- Utility clamps or three-finger clamps (2)
- Test tube clamp or thermometer clamp
- Large tub or bucket
- Fan
- Scissors
- Metric ruler
- Round toothpick
- Modeling clay (if using test tube clamp)
- Petroleum jelly, 3 g
- Glycerin, 1 mL
- Plant sample containing numerous leaves

Safety

Follow regular lab safety procedures.

Procedure

1. Select Sensor Data in SPARKvue.

2. Connect the pressure sensor to your device.

3. Make sure only the pressure measurement is checked and choose the Graph template. When the graph appears, select the Pressure measurement on the y-axis. Use the menu that opens to change the units from kPa to hPa (kilopascal to hectopascal).

4. Put a drop of glycerin on the outside of the barbed end of the sensor connector. Fully insert the barb into one end of the plastic tubing.

5. Perform steps a through d to set up a potometer, which detects transpiration in a plant sample. You must keep the plastic tubing fully submerged under water until you are instructed to remove the tubing from the water in a later step.

    a. Fill the tub or bucket with water. Submerge the entire length of tubing in the tub of water including the clay if present. Avoid moving or re-shaping the clay.

    b. Attach a tubing connector to the end of the syringe. Fill the syringe with water and loosely insert it into the open end of the tubing. Push the syringe plunger to fill the tubing with water. The tubing is filled with water when air bubbles no longer exit from the opposite end.

    c. Hold the plant stem under water. Cut the plant stem at a 45° angle. Immediately insert the cut stem into the open section of the tubing.

d. The plant stem must fit tightly in the tubing. Use petroleum jelly to create an airtight seal where the plant stem emerges from the tubing as shown in Figure 1 (left). Gently wrap a piece of clay slightly below the plant stem as shown.

Note: Use petroleum jelly carefully; it is difficult to remove from the tubing.

6. Position the empty test tube or thermometer clamp below a utility or three-finger clamp as shown in Figure 1. Use the utility or three-finger clamp to attach the pressure sensor to the ring stand as shown.

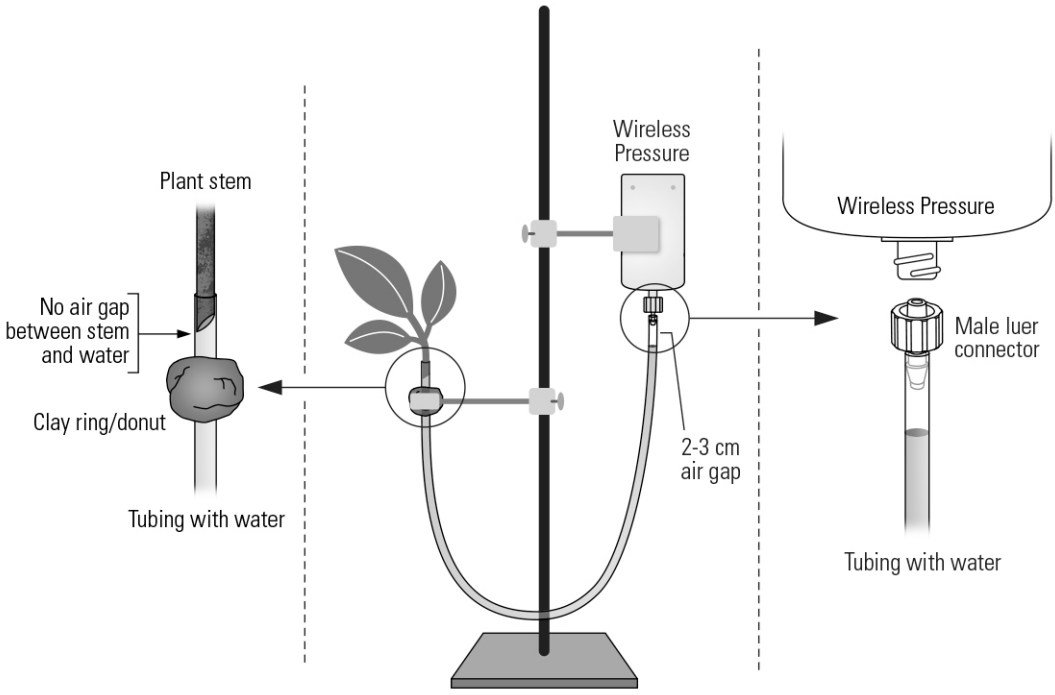


Figure 1: Transpiration setup with clay and thermometer clamp

7. Prepare to remove the tubing from the water. To prevent water from spilling out of the tubing when you remove it from the water, hold the tubing in a "U" shape with the sensor connector held higher than the plant side as shown in Figure 1 (center). You should have a continuous column of water inside the tube with no breaks or bubbles. Repeat Steps 5 and 7 if necessary.

8. Tighten the test tube clamp around the piece of clay to secure the tubing without squeezing it. Be sure the plant remains upright. If using a thermometer clamp, insert the tubing in the clamp just beneath the plant stem and gently tighten the clamp to secure the tubing without squeezing.

9. Create a 2–3 cm air gap at the connector end of the tubing as shown in Figure 1 (right). Insert two-thirds of the toothpick into the tubing through the connector opening and quickly remove it. Repeat until a 2–3 cm air gap appears. Make sure there is no water blocking the air gap.

10. Remove the pressure sensor from the clamp and attach it to the connector. Make sure water does not back up into the sensor and do not allow the sensor to get wet. Return the pressure sensor to the clamp. The sensor connector and air gap should be slightly higher than the plant sample as shown in Figure 1.

11. Leave the potometer undisturbed for at least one minute before beginning data collection, then select Start to begin collecting data. Record the initial pressure in Table 1.

12. Stop collecting data after 10 minutes. Record the final pressure and time elapsed in Table 1.

13. Without changing the tubing height, carefully detach the tubing from the sensor to re-set the pressure. Re-attach the sensor and leave the potometer undisturbed for at least one minute.

14. Place a fan at about 1 meter from the plant. Turn on the fan to a low setting so it blows lightly over the plant.

15. Start collecting data. Record the initial pressure in Table 1.

16. Stop collecting data after 10 minutes. Record the final pressure and time elapsed in Table 1.

17. Show both runs in SPARKvue and scale the display. Sketch your results in Graph 1. Include numbers, labels, and units on the x- and y-axes. Add a key to identify each run.

18. Calculate the pressure change for each run according to the following equation and record the result in Table 1.

    Change in Pressure = Final Pressure – Initial Pressure

19. Calculate the rate of pressure change for each run according to the following equation and record the result in Table 1.

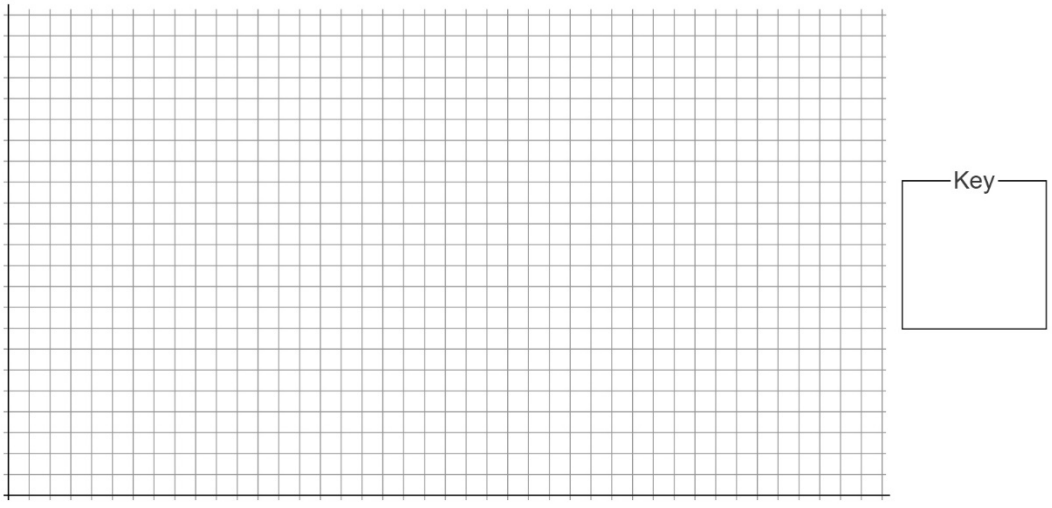
    Rate of Pressure Change = Change in Pressure ÷ Time

Data Collection

Table 1: Transpiration rate with and without fan

Condition	Initial Pressure (hPa)	Final Pressure (hPa)	Time Elapsed (s)	Change in Pressure (hPa)	Rate of Pressure Change (hPa/s)
Without fan					
With fan					

Graph 1: Pressure change with and without fan



Questions and Analysis

1. Identify the controlled, independent, and dependent variables in this investigation. The independent variable is changed by you, and the dependent variable responds to a change in the independent variable.

2. Plants lose water through their stomata during transpiration. Does a pressure decrease in the tubing indicate an increase in water loss, or does it indicate decrease in water loss? Support your answer with data.

3. Describe the effect of the fan on the rate of pressure change. What natural phenomena does the fan mimic?

4. Describe some adaptations that enable plants to minimize water loss from their leaves.

5. Identify a type of plant different from the one used in this investigation. Predict the results for that plant if you performed the same investigation.