Lab 5: Plant Transpiration

Water is one of the basic raw materials of photosynthesis. It is the major component of plant tissues, making up 90% of the plant body. Water is the substance in which most materials enter and leave the cells of plants. It is the solvent for various biochemical reactions in living cells.

The amount of water used by plants is far greater than that used by animals of comparable weight. The reason for this is that a large amount of the water used by animals is recirculated in the form of blood plasma or tissue fluid. In plants, over 90% of the water taken in by the root system is evaporated into the air as water vapor. This process, which largely occurs through the leaves, is called transpiration. Consequently, plants not only have developed extensive and efficient transport systems but also numerous morphological adaptations to conserve water.

Transpiration is the pulling force or tension generated by the evaporation of water from leaves. Hydrogen bonding makes a continuous column of water from the molecules of water in the roots to those leaving the leaves. It is a purely physical phenomenon. A porous clay cup has a pull equal to that of a plant of the same surface area. The porous clay is similar to the spongy mesophyll layer of leaves.

In today's lab, we will examine the factors that affect transpiration in a model system of a plant cutting in a potometer. A potometer is a device for measuring the amount of water lost by a plant cutting. The pipet accurately measures the amount of water lost. A reservoir supplies water when an experiment is not running. When an experiment is running, the reservoir is clamped off so that water given off by the plant will draw the level of water in the pipet down. It is important to have the reservoir completely clamped off during an experiment so that it does not refill the pipet. If your water level does not move at all during an experiment, check the reservoir clamp. The water used in this experiment is also important. You will use only aged tap water. It is aged to allow any dissolved gas to escape. Dissolved gases (or visible air bubbles) anywhere in the potometer will break the continuous column of water required for transpiration to occur. Use only aged water and check carefully that all air bubbles have been removed from the potometer.

Wed 12-5

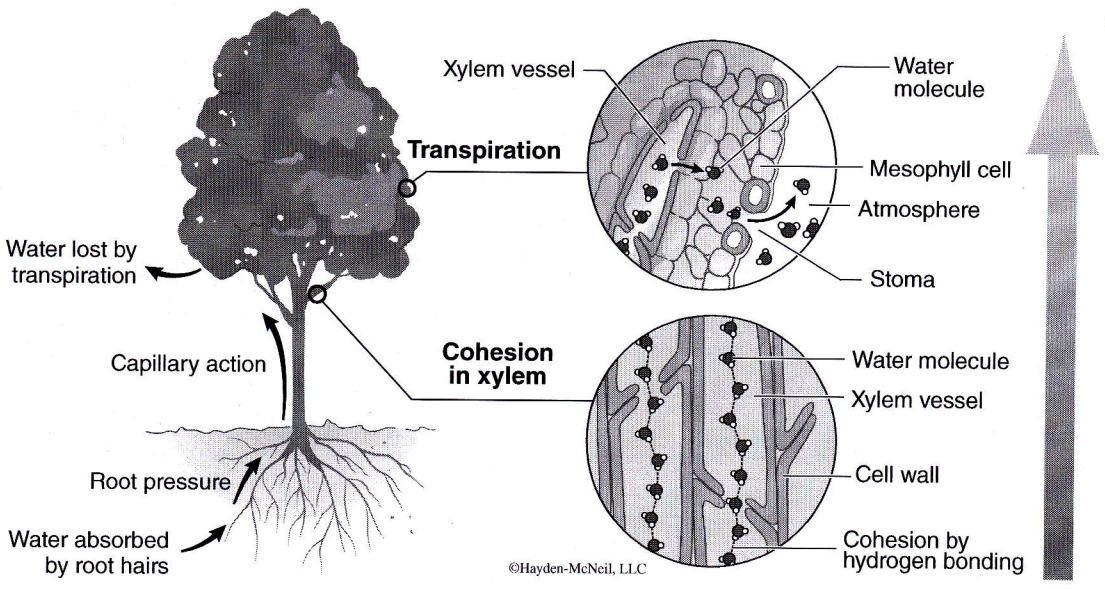


Figure 1. Transpiration

Protocol

1. Working in pairs, examine the potometer set up. It may already be set up for you. Listen to TA directions carefully BEFORE beginning.
2. Fill the funnel reservoir with aged tap water. Aging tap water allows for the release of minute air bubbles. Release both pinch clamps to fill the entire apparatus with water. When the pipet and tubing lines are full, shut the pinch clamps.
3. Make sure there are no leaks in the system. Clear all air bubbles from the system. Light the tubing from behind to help find the air bubbles. Try squeezing the tubing to force bubbles out one end. Align the top of the water level in the reservoir with the sensor. When the clamp is released, the water levels should equilibrate.
4. Obtain an evergreen cutting. The stem should fit snuggly in the tubing. Place the cutting in a finger bowl filled with aged tap water.
5. Keeping the stem underwater, slide the tubing over the stem end without introducing air bubbles. Watch the TA demo carefully. Repeat the procedure if there is an air bubble. Try to avoid wet leaves.
6. Clamp the stem to the ring stand.
7. Connect the plastic tubing to gas pressure sensor valve. CAUTION: Do NOT allow water to enter the valve.
8. Allow the system 5 minutes to adjust to the new environment. Stomata will close under new/stressful conditions. They will open again shortly. Set the computer up during this time.
9. Connect the Gas Pressure Sensor to the computer interface. Prepare the computer for data collection by opening the file "09 Transpiration" from the *Advanced Biology with Vernier* folder of Logger *Pro*.
10. After the plant has equilibrated for 5 minutes, you may begin an experiment.
11. When you are ready to run an experiment, clamp off the tubing to the reservoir. The cutting should only draw water from the gas pressure sensor. Click ▶ Collect to begin data collection. Data will be collected for 15 minutes. Write the data into the correct table for each experiment.
12. Should your cutting use all of the water from the pipet during an experiment, replace with water from the reservoir. Open the clamp to the reservoir and note how much water is added.
13. At the conclusion of each experiment, release the reservoir clamp. Refill the reservoir as needed. Avoid introducing air bubbles.
14. At the end of the lab period, do NOT remove your plant cutting. Refill the reservoir and release all clamps.

Experiments

Record water loss readings every 5 minutes for 20 minutes.

Control- Monitor water loss from your cutting under normal lab conditions. This will give you the background rate of transpiration in normal illumination and air currents.

Wind- Add a fan to gently blow your cutting. No violent wind storms please.

Light- Add an LED light source. LED lights do not generate heat.

Light & Wind- Add both the LED light and fan.

Set up for calculation of standard deviation

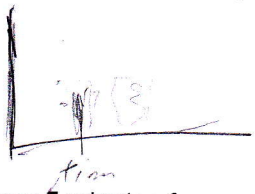
Calculation of Water Loss Rate per 5 minutes for evergreen cuttings from CONTROL.

Time	A	A- mean	(A- mean)^2
0-5	0.94	0.0875	0.00765625
5-10	0.8	-0.0525	0.00275625
10-15	0.81	-0.0425	0.001806 25
15-20	0.86	0.0075	0.00005625
	Sum= 3.41		Sum= 0.012275
	# of rows 4		# of rows-1= 3
	Mean 0.8525		Variance= 0.004091667
			SD= 0.063966139

standard deviation

Calculation of Water Loss Rate per 5 minutes for evergreen cuttings from WIND.

Time	A	A- mean	(A- mean)^2
0-5	0.81	0.11	0.0121
5-10	0.62	-0.08	0.0064
10-15	0.69	-0.01	0.0001
15-20	0.68	-0.02	0.004
	Sum= 2.8		Sum= 0.019
	# of rows 4		# of rows-1= 3
	Mean 0.7		Variance= 0.0063
			SD= 0.079580148



Calculation of Water Loss Rate per 5 minutes for evergreen cuttings from LIGHT.

Time	A	A- mean	(A- mean)^2
101.81 ← 100.87 ← 0-5	0.94	0.13	0.0169
100.08 ← 5-10	0.79	-0.02	0.0004
99.28 ← 10-15	0.8	-0.01	0.0001
98.57 ← 15-20	0.71	-0.1	0.01
	Sum= 3.24		Sum= 0.0274
	# of rows 4		# of rows-1= 3
	Mean 0.81		Variance= 0.00913
			SD= 0.0955683

Calculation of Water Loss Rate per 5 minutes for evergreen cuttings from WIND & LIGHT.

Time	A	A- mean	(A- mean)^2
102.11 ← 101.23 ← 0-5	0.88	0.0525	0.00275625
100.49 ← 5-10	0.79	-0.0375	0.00146625
99.69 ← 10-15	0.48	-0.3475	0.12075625
98.94 ← 15-20	1.16	0.3325	0.11055625
	Sum= 3.31		Sum= 0.235475
	# of rows 4		# of rows-1= 3
	Mean 0.8275		Variance= 0.078491667
			SD= 0.280163643

Lab 5 Worksheet

Name _____ Section _____

Table 1. Raw data from Transpiration lab. Water loss readings from evergreen cutting.

	Water loss readings (ml)			
Time	Control	Wind	Light	Light & Wind
0	0	0	0	0
5	0.94	0.81	0.94	0.88
10	0.8	0.62	0.79	0.79
15	0.81	0.69	0.8	0.48
20	0.86	0.68	0.71	1.16

1.3 In EXCEL calculate the