

Transpiration investigation essay sample



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Introduction

In vascular plants movement of water up the xylem from the roots to the leaves is an essential process, responsible for supplying the plants tissues with water and maintaining cell turgor (which has a role in preventing the plant wilting). Aside from the weak “push” effect of the difference in water potential between the soil and the roots, the main force for transpiration is water evaporating from the spongy mesophyll tissue in plant leaves. The rate of evaporation depends on a number of factors- some directly affecting the rate at which water evaporates (such as temperature, wind speed, humidity) and others affecting the number of stomata that are open, such as light levels.

The use of a gas pressure sensor is a well-documented way to measure the rate of a plant's transpiration. The plant cutting is inserted cut-end-on to a plastic tube full of water, the other end being connected to a gas pressure sensor. As the plant takes up the water through the transpiration stream the volume within the tubing decreases, and the pressure changes with it. So if the change in pressure is recorded over a period of time the transpiration rate can be calculated from these values

Hypothesis

There are two factors that may affect the rate of transpiration relative to temperature. Firstly is the simple physical effect- light radiation will warm the leaves (and consequently the water within them), thus increasing the rate of evaporation, speeding the transpiration stream- as a result the pressure in the tubing would drop more rapidly. However, it is known that the stomata

are light sensitive, usually closing during the night (when photosynthesis is impossible) – i. e. at low light levels, and then opening during the day for gaseous exchange for photosynthesis. It may be that at very high light levels some stomata may close (or all of them may partially close) in order to mitigate water loss. However, I think that overall the direct effect of increasing light intensity will result in increasing rate of transpiration. In other words the two would be expected to have a proportional relationship.

Equipment

- * Laptop
- * Vernier go-link computer interface x 2
- * Vernier gas pressure sensor x 1
- * Philip Harris light intensity sensor
- * Clamp stand x 2
- * Clamps x 3
- * Scalpel
- * 100cm ruler (i.e. 1/20.5cm)
- * 100 Watt light source (lamp)
- * Plastic syringe
- * Clear plastic tubing approx. length 40cm, approx diameter 0.5cm

* Vaseline

* Cutting of cherry laurel, *Prunus laurocerasus* approx. 30cm

* Water

* White paper

Figure 1:

Method

Equipment setup:

1. Clamp stand, temperature sensor and gas pressure sensor positioned as shown in figure 1, in a location where humidity, temperature and light levels are most easily controlled (i. e. at a constant level)
2. Plastic tubing is prepared-
 - a. syringe connected to tubing
 - b. water drawn up into tubing using syringe
 - c. Tube is bent into U-shape. Syringe is removed
3. Plant cutting is selected, and stem is cut at 45° angle using scalpel in order to maximize surface area available. Stem directly above cut smeared with Vaseline (waterproofing agent)
4. Plant connected to tubing:
 - a. Tubing is connected at one end to the gas pressure sensor

- b. Tubing is connected at its other end to the lower clamp on the second clamp stand, which is positioned approx. 8cm below the gas pressure sensor.
 - c. Plant cutting is inserted cut-end-on into the tubing, care being taken that air bubbles are not present anywhere in the tubing
5. A double sheet of paper is secured in front of the tubing (but not obscuring the plant) as a light reflector
 6. System is allowed five minutes to adjust. Meanwhile the computer is set up. Vernier go-links are connected to the gas pressure sensor and Philip Harris light intensity sensor, and to the laptop. Laptop is prepared for data collection.

Figure 2:

Experiment:

1. Lamp is turned on, and allowed to stand for five minutes for the temperature of the bulb to stabilize
2. Lamp is positioned using ruler to a distance of 20cm from the plant cutting
3. Data collection of pressure and light levels is started, set to collection every ten seconds for 10 minutes (600 seconds)
4. Once this has been completed, the lamp is repositioned at 30cm and step 2 is repeated
5. Step 2 is repeated for lamp distance 40 and 50cm

6. Steps 2 through 5 are repeated in order to five at least three repetitions of each distance

Variables

Input:

-The distance of the lamp from the plant- the light intensity

Outcome:

-The transpiration rate of the plant cutting, measured as change in pressure per second in the plastic tubing, kPaS^{-1}

Control:

Variable/factor, and its effect on the experiment

Method of control/ monitoring the variable

Air movement- may change the rate of evaporation of the stomata in the leaves

Each trial is performed as close to the others in location/ time as possible, in an environment with as little variation as possible

Air humidity- higher humidity reduces the rate of transpiration, as water evaporates less easily

Each trial is performed as close to the others in location/ time as possible, in an environment with as little variation as possible

Air temperature- at higher temperatures water may evaporate more easily from the stomata

Each trial is performed as close to the others in location/ time as possible, in an environment with as little variation as possible. Natural light is excluded.

Radiation affecting the tubing- if the high light levels come into contact with the tubing, this could heat the water, causing thermal expansion/contraction, or even increasing the humidity (and changing the pressure) in the small air space in the gas pressure sensor

The tubing will be shielded by a reflective layer of white paper, in order to reflect the majority of light radiation and prevent heating of the tubing.

Variation due to different number of leaves, etc.

The same cutting of cherry laurel will be used each time

Variation of light levels over trial. It was found that the output of the lamp varied, particularly in the first few minutes after being turned on

The lamp is allowed five minutes to come up to temperature. After that, the light levels are measured with a Phillip Harris light intensity sensor, placed with the plant cutting