TO TRANSPIRE OR NOT TO TRANSPIRE

November 14, 2024

Warren Road Elementary School

4th Grade

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Research Question and Purpose

How does different concentrations of sugar-water solutions affect a plant's transpiration rate?

Background Research and Bibliography

Transpiration

Transpiration is a process by which water taken in by plants is lost in the form of water vapor through evaporation from its leaves, flowers, and stem surfaces. As water enters a plant via the roots, it passes through the plant xylem (a kind of tube) into the leaves. Once water reaches the leaves, it begins to evaporate on the leaf surface (Tremble, 2021).

Much like we lose water or sweat to cool our bodies, plants sweat to cool their leaves therefore, a plant must adequately transpire water, or it will die. Any type of water stress can decrease transpiration and slow down a plants growth (Runkle, 2023).

Transpiration provides plants with the energy to transport water into the plant through a continuous upward flow of water and nutrients from its roots. As the water evaporates on the leaf's surface, it causes more water to be pulled in and up the plant's xylem. This is a continuous process. Approximately 90% of the water that enters a plant is used for transpiration (Petruzzello, 2004).

According to Water Science School (2018), plant transpiration is an invisible process and occurs in three steps. Step one, plant roots uptake water and nutrients from soil. Step 2, water moves up through the plants tissues. Step 3, plant leaves release the water vapor.

Various environmental conditions can affect a plants transpiration rate e.g., light, temperature, humidity, wind, and soil water (Kimball, n.d.). A plants' transpiration rate increases in high temperatures, light, and wind. Humidity decreases a plants transpiration rate. Transpiration is an extremely important process because it helps a plant undergo photosynthesis, thereby producing oxygen for our survival (Ha, n.d.).

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Hypothesis

I believe that different concentrations of sugar-water solutions will affect a plant's transpiration rate. I base my hypothesis on this fact:

As the concentration of a solution increases, the amount of time required to move it up the plant stem to the flower will increase. Thus, it's transpiration rate will decrease.

Variables

Independent variable: the degree of concentration of the sugar-water solution.

Dependent variable: the transpiration rate of the plant.

Materials

Clear syrup	Ruler (metric)
Distilled water	Blue food coloring
Test tube rack	Marker (fine point)
Camera	5-Applicator sticks
Faucet	Thermometer
Scissors	5-White roses

1-Graduated, disposable pipette

6-Graduated (12 ml), disposable test tubes

Procedure

1. Using a marker, label 6 graduated, disposable test tubes 1,2…6 and place the labeled tubes in test tube rack.

2. In tube #1, pour syrup up to the 10 milliliter (ml) mark, add 10 drops of blue food coloring and vigorously stir with an applicator stick to mix and discard the stick.

3. In tube #2, pour syrup up to the 5ml mark. Using the graduated pipette, add an additional 2.5 mls of syrup to the tube. The total volume is now 7.5 mls. Fill the tube with distilled water up to the 10 ml mark, add 10 drops of blue food coloring, vigorously stir with an applicator stick to mix and discard the stick. This is approximately a 75% sugar-water solution. Place the tube back into the rack.

4. In tube #3, pour syrup up to the 5 ml mark, pour in distilled water up to the 10 ml mark. . This is approximately a 50% sugar-water solution. Add 10 drops of blue food coloring to tube #3 and vigorously stir with the applicator stick to mix. Discard the stick and place tube #3 back into the rack.

5. In tube #4,pour syrup up to the 2.5 milliliter mark. Fill the tube with distilled water up to the 10 ml mark, add 10 drops of blue food coloring, vigorously stir with an applicator stick to mix and discard the stick. This is approximately a 25% sugar-water solution. Place the tube back into the rack

6. Fill tubes #5 and #6 up to the 10ml mark with distilled water, add 10 drops of blue food coloring to tube #5, stir vigorously with an applicator stick and discard the stick. This tube will act as a control to ensure transpiration is indeed taking place.

7. Lay a white rose on a flat surface. Using a ruler, make a measurement of 9 millimeters from the base of the flower down the stem. Mark the distance on the stem with a marker. Repeat this process with 4 more white rose for a total of 5 "marked" rose. Remove all the leaves from the stems.

8. Take a white rose, place the part where the stem is "marked" under running tap water and cut off the stem at the "marked' point with scissors. Remove the cut stem, with flower attached, from under the running water and place it in tube #1. Repeat this process with the other 4 roses and place one in each of the remaining tubes (2, 3, 4, and 5).

9. Place the rack, with its contents, in a place where it will not be disturbed. Place a thermometer into tube #6. Observe and record the temperature and any color changes that occur on the white roses every 2 hours over a period of 8 hours. Prepare a chart of the temperatures and observations. Take a picture of each flower at the end of the 8-hour period.

OBSERVATIONAL CHART

HOURS	100% (Tube 1) Sugar Solution	75% (Tube 2) Sugar-H_2O Solution	50% (Tube 3) Sugar-H_2O Solution	25% (Tube 4) Sugar-H_2O Solution	100% H_2O Only (Tube 5)	Temp °C
2	No Change (NC)	NC	Very faint blue hue	Faint blue color & dark edges	Light blue & dark edges	22
4	NC	Very faint blue hue	Faint blue color & dark edges	Spotted light blue & dark edges	More bluer than at 2 hours	22
6	NC	Faint blue color & dark edges	Spotted light blue & dark edges	Spotted medium blue	More bluer than at 4 hours	22
8	NC	Spotted light blue & dark edges	Spotted medium blue	Deep medium blue color	More bluer than at 6 hours	22

PHOTOGRAPHIC RESULTS

Results

The interpretation of the observed results indicated that as the concentration of the sugar-water solution increased, the transpiration rate decreased. In other words, the less concentrated the sugar-water solution was, the bluer the color was noted on the white roses as transpiration occurred. Since the control (100% distilled water), which was the least concentrated, had the most intense color, this provided experimental validation.

Conclusion

My hypothesis was proven. My experiment proved that concentration does affect a plant's transpiration rate. Visual proof, photographs, and observational charting aided in confirming proof of the hypothesis.

Extension Statement

As the temperature in this experiment remained relatively constant, future experiments could include varying the temperature to see if this too affects a plant's transpiration rate.

Abstract

The purpose of this experiment was to see if a plant's transpiration rate would be affected if it were placed in different concentrations of a sugar-water solution. I believed the transpiration rate would be affected in different sugar-water concentrations.

In this experiment, white roses, of similar size and height, were placed in different concentrations of sugar-water solutions. The concentrations prepared were 100%, 75%, 50%, and 25%. A control of 100% distilled water was also set up to ensure the experiment did indeed work. An indicator, blue food coloring, was added to each tube as well. A white rose was then added to each tube and observed for 8 hours at room temp (18-24◦C) and recorded observations at 2-hour intervals were made. At the end of the 8-hour period, a picture of each rose was taken to illustrate the rate of transpiration.

The results show that as the concentration of the sugar (syrup)-water increased, the transpiration rate of the plants decreased; therefore my hypothesis was correct. To improve the study, I would try varying the temperature of the solutions to see if any results would be the same or different.