Does Leaf Surface Area Affect the Rate of Transpiration in a Plant?

Aim:

The aim of my investigation is to find out if the leaf surface area affects the rate of transpiration in a plant.

Variables:

The variables of this experiment are;-

- ☑ The leaf surface area
- ☑ Temperature of the surrounding air
- ☑ The speed and amount of wind
- ☑ The amount of light

Environmental Factors:

Temperature of air

The temperature of the air affects the rate of transpiration. If it is a hot day then the heat will evaporate some of the water and then the leaf will have less water and so it will increase the rate at which the leaf can transpire.

Wind

The wind also affects the rate at which a leaf can transpire. When the wind blows it carries hot air under the leaves which carries some of the water vapour, thus increasing the rate of transpiration in the leaf.

Light

When there is a lot of light, a leaf will photosynthesis at a faster rate and so the water is used more and therefore with less water the leaf can also increase the rate at which it transpires.

Humidity

The rate of transpiration increases as the difference in concentration between a substance in the plant and in the air around it increases. When the surrounding air is dry, then more water will leave the leaf faster because the concentration differences are greater.

Soil Water

A plant cannot continue to transpire quickly if its water loss is not made up by a replacement from the soil. When absorption of water by the roots fails to keep up with the rate of transpiration, loss of turgid occurs and the stomata close. This immediately reduces the rate of transpiration (as well as photosynthesis). If the loss of turgid extends to the rest of the leaf and stem and the plant begins to wilt.

Prediction:

I think that the rate of transpiration will increase in proportion to the surface area of the leaf.

Hypothesis:

I think that the rate of transpiration will increase in proportion to the surface area of the leaf because the more surface area a leaf has the more stomata it will have. The more stomata there are then the more opportunity for the loss of water making the rate of transpiration faster.

Transpiration is the process of water loss from plants through the stomata. Stomata are small opening found on the underside of the leaves. All plants have the ability to open and close their stomata. Transpiration is a passive process mainly controlled by the humidity of the atmosphere and the moisture content of the soil. Of the transpired water passing through a plant only 1% is used in the growth process. Transpiration also carries nutrients from the soil into the roots and carries them to various cells in the plant.

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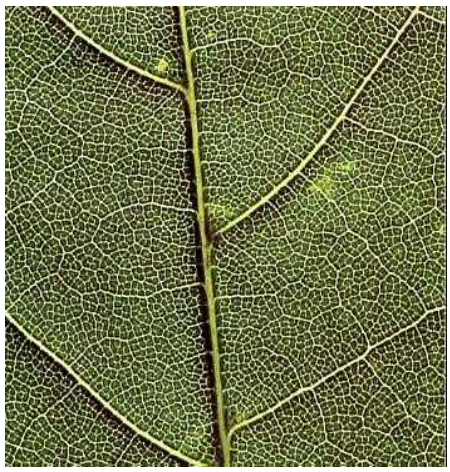

Photosynthesis also affects the rate of transpiration because during the day photosynthesis takes place much faster and it requires more water and more gases. This means that the demands for gases mean that transpiration must work faster to keep up with the amount required, hence making the rate of transpiration faster during the day.

Apparatus:

The apparatus I will use in my experiment is;

- ☑ Six test tubes
- ☑ Sycamore leaves (three large, three small)
- ☑ Water
- ☑ Ruler
- ☑ Oil
- ☑ Test tube rack
- ☑ Measuring cylinder

Diagram:

This is how I intend to set up my apparatus;

Method:

1. Select three large sycamore leave and make sure they are all a similar size.
2. Using graph paper, calculate the area of each of the leaves. (To do this trace the perimeter of the leaf onto the graph paper then count the amount of whole squares that it covers to estimate the amount of cm2 it covers). Record all of the areas in a table labelling each one from A – C and noting which is which.
3. Select three small sycamore leaves and measure their area too. Record theses measurements as well.
4. Label the smaller leaves D – F and make a note of which is which again.
5. Fill six test tubes with 40ml of cold water, which will be measured out accurately using the measuring cylinder.

6. Place one leaf's stalk into each of the test tubes.
7. Add a drop of oil to the top of each tube; this will prevent evaporation of the water.
8. Mark the start level of water in each tube using an OHP pen.
9. Measure using a ruler in millimetres and mark the level on the side for five consecutive days.
10. Measure the depth of each line and record the data into the table.
11. Take an average level for each day for the larger leaves (A/B/C) and the smaller leaves (D/E/F).

NOTE: Because of how the method works in this experiment, you are repeating the experiment three times whilst only running through it one time. Therefore an average can be taken from the results and the experiment does not need repeating anymore.

Fair test:

In order to make this experiment a fair test the following must be checked;-

- ☑ Make sure the amount of water in each test tube is of equal amounts.
- ☑ Make sure that each tube has the required even amount of oil, to help stop evaporation and keep the test fair.
- ☑ Make sure that each of the tubes have the same amount of light and heat as this will affect the amount of water lost through evaporation and would affect the rate of transpiration.

Safety precautions:

To make sure that the experiment is carried out safely;-

- ☑ Wear safety goggles wherever required.
- ☑ Make sure you handle test tubes correctly and if you break one report it to a member of staff immediately.
- ☑ Do not run in the lab.
- ☑ Do not shout or create excessive/unnecessary noise.
- ☑ Wear any other protective clothing wherever required.

Results:

The table shows the level of water from the top of the test tube for each day for the five consecutive days. It was measured using a ruler in millimetres. A total was taken and an average was made from this.

		Amount of water lost (mm)				
Leaf	***Size***	***Day 1***	***Day 2***	***Day 3***	***Total***	***Average***
A	16mm	5	5.5	6.5	17	5.67
B	19mm	4	5	5.5	14.5	4.83
C	23mm	5.5	6	7	18.5	6.17
D	28mm	8	9	9.5	26.5	8.83
E	31mm	10	10.5	11	31.5	10.50
F	34mm	9.5	10	11	30.5	10.17

Conclusion:

From the above results which I obtained from the further above experiment, I can draw the conclusion that my prediction was correct and that the rate of transpiration changes in proportion to the surface area of a leaf. I can say this because the larger leaves, with bigger surface area lost more water than those with a smaller surface area therefore the larger surface area had a higher rate of transpiration. This is because with more surface area there is more room for stomata which mans that the rate of water loss is increases through the stomata making the rate of transpiration faster.

I took an average loss per day for each of the leaves and I then used those averages to make an estimate loss of water over five days for a small leaf and for a larger leaf.

The average loss of water for a small leaf is approximately 5.56mm/day. This estimate has been made by using the averages per day for each of the three smaller leaves. The average loss of water for a larger leaf is approximately 9.83mm/day. This estimate has been made by using the averages per day for each of the three larger leaves. This clearly shows that more water was lost from the larger leaves per day on average than of what was from the smaller leaves. Therefore this proves that the larger the surface area on a leaf the higer the amount of water loss through the more stomata, thus the faster rate of transpiration.

Evaluation:

My experiment was good because the average was taken through doing the experiment once and my prediction was accurate and proved by the experiment.

My experiment was bad because not all the water was to an exact even level to begin with and the oil was applied evenly to each test tube. This may have changed the rate of evaporation on each test tube therefore making the test unfair.

My experiment can be improved testing the leaves for more days, i.e. five instead of three, and measuring the oil and water more accurately and carefully to make sure that each leaf has the same amount of water to lose and the same amount of oil which may slow down the loss of water as it has water proof characteristics.