Investigating rate of transpiration essay

AIMS The aim of this experiment was to investigate the effect of temperature rise on the rate of transpiration of a plant (hibiscus) by measuring the plant's water uptake in a period of time. HYPOTHESIS Transpiration is the process by which plants loses water to the atmosphere from their leaves. Water in the plant is lost to the atmosphere by evaporation. Evaporation of water can occur at any temperature. In the presence of sunlight, water in the plants evaporates into the intercellular air spaces and diffuses out through the stomata into the atmosphere.

The diffusion of water from the plant into the air lowered the water potential in the outermost cell (mesophyll). The differences of water potential with the adjacent cell will cause water to move from the adjacent cell into the mesophyll cell which then established a water potential gradient in the plant. The water potential gradient will cause water to flow from the xylem along a chain of cells to the outermost mesophyll cell. Since, the experiment was dealing with rising the temperature of the plant's surrounding air, water in the plant will have a greater tendency to evaporate and diffuses out into the atmosphere. Transpiration rate of the plant therefore should be increasing with temperature (to a certain extent).

INTRODUCTION There are several factors which can affect the rate at which plants loses water from the leaves (transpiration). These factors can either be internal (e. g. no. of stomata, distribution of stomata, etc) or external factors (e. g.

temperature, humidity, etc). For this particular experiment, the temperature surrounding the hibiscus plant was raise by placing a table lamp near it. A

simple potometer (figure 1) where the distance travelled by an air bubble was used to measure the rate of water uptake from the plant. Figure 1 The distance (in cm) travelled by the air bubble at a period of time (in h) was taken to be the transpiration rate for the plant. This rate can be calculated by the following formula; Transpiration rate= Final distance – initial distance Time taken APPARATUS USED 1.

Hibiscus shoot 2. Potometer 3. Stopwatch 4. Retort stand 5.

Table lamp 6. Thermometer PROCEDURE A leafy hibiscus shoot was carefully cut from its stem. This leafy shoot was then immersed in water where the last one centimetre of the stalk was cut off under water. Next, the potometer was set up to receive the leafy shoot. Its capillary tube was filled with water via its reservoir and the water was left to drain into the sink for a while to ensure that there was no air bubbles along the tube. As the potometer was then filled with water it was ready to receive the leafy shoot.

The leafy shoot was carefully inserted into the rubber end of the potometer. A retort stand was used to ensure the leafy shoot stood upright throughout the experiment. When there were no air bubbles in the tube, the reservoir was shut down by clamping its rubber tube tightly. One air bubble was introduced at the starting end of the potometer to be use later as an indicator for water uptake measurement.

Three trial runs with the plant at room temperature which was 21. 5oC were done to settle down the plant to a steady rate of transpiration before the real experiment began. These measurements were recorded in table 1. The experiment began when a heat source (table lamp) was switch on to

generate heat, raising the temperature of the plant’s immediate surroundings. The plant was allowed 5 minutes time lapse to enable it to adapt to the change in temperature.

When the time was up, the stop watch was started. Initial distance of the air bubble, the temperature of the plant’s immediate surroundings was read and recorded. Distance and temperature were recorded at 1 minute interval for 5 minutes in table 2. At the end of the experiment, all the leaves were carefully remove from the shoot. These leaves were then assembled according to their sizes. From the smallest to the broadest, one sample of the leaves from each sizes were accounted for its surface area.

This procedure was done by tracing the outline of the leaves onto graph paper. The number of 1 cm2 grid that the leaves took up was determined as its surface area. RESULT Table 1 shows the distance moved by air bubble in the trial run at room temperature 21. 5oC.

Trial 1Time in minuteDistance in cmTemperature in oC 0 0. 5 21. 5 1 0. 7 21. 5 2 0. 8 21.

5 3 1. 1 21. 5 4 1. 21.

5 5 1. 4 21. 5 Trial 2Time in minuteDistance in cmTemperature in oC 0 0. 1 21.

5 1 0. 3 21. 5 2 0. 5 21. 5 3 0.

6 21. 5 4 0. 8 21. 5 5 1.

21. 5 Trial 3Time in minuteDistance in cmTemperature in oC 0 0. 2 21. 5 1 0. 3 21. 5 2 0.

5 21. 5 3 0. 7 21. 5 4 0. 8 21.

5 5 1. 0 21. 5 Table 1 The rate of transpiration from trial 1 was; Final distance – initial distance= 1. 4 cm – 0. 5 cm Time taken 5 min = 0. 18 cm/min = 10.

8 cm/hr The rate of transpiration from trial 2 was; Final distance – initial distance= 1. 0 cm – 0. 1 cm Time taken 5 min = 0. 18 cm/min = 10.

8 cm/hr The rate of transpiration from trial 3 was; Final distance – initial distance= 0. 9 cm – 0. 2 cm Time taken 5 min = 0. 14 cm/min = 8. 4 cm/hrTherefore the steady rate of transpiration for this plant was derived by taking the average from the 3 transpiration rates above.

Steady rate of transpiration = 10. 8 cm/hr + 10. 8 cm/hr + 8. 4 cm/hr 3 = 10 cm/hr Table 2 show the distance moved by air bubble with corresponded to the surrounding temperature. Experiment 1Time in minuteDistance in cmTemperature in oC 00. 223.

0 10. 423. 0 20. 523. 0 30. 623.

0 40. 823. 0 50. 923. 5 Experiment 2Time in minuteDistance in cmTemperature in oC 00. 223.

5 10. 423. 5 0. 523. 5 30. 623.

5 40. 823. 5 51. 023.

5 Experiment 3Time in minuteDistance in cmTemperature in oC 00. 224. 5 10. 424. 5 20.

524. 5 30. 724. 5 40.

924. 5 51. 024. 5 The rate of transpiration from experiment 1; Final distance – initial distance= 0. 9 cm – 0. 2 cm Time taken 5 min = 0.

14 cm/min = 8. 4 cm/h The rate of transpiration from experiment 2 was; Final distance – initial distance= 1. 0 cm – 0. 2 cm Time taken 5 min = 0. 16 cm/min 9.

6 cm/h The rate of transpiration from experiment 3 was; Final distance – initial distance= 1. 0 cm – 0. 2 cm Time taken 5 min = 0. 16 cm/min = 9. 6 cm/h Therefore average transpiration rate for the plant was; = 8.

4 cm/h + 9. 6 cm/h + 9. 6 cm/h 3 = 9. 2 cm/h Total surface area of the leaves. The total surface area of the leaves was determined by adding up the surface area of all leaves from the leafy shoot used. Leaf sampleNo.

of leavesArea in cm2Total area in cm2Leaf 1 4 4 16 Leaf 2 2 4 8 Leaf 3 6 11 66 Leaf 4 3 20 60 Leaf 5 8 37 296 Leaf 6 17 83 1411 Leaf 7 10 31 310 Total surface area of all leaves= (16 + 8 + 66 + 60 + 296 + 1411 + 310) cm2 = 2167 cm2 = (2167/ 10000) m2 = 0. 2167 m2 Water uptake in distance per unit time per leaf area. Water uptake express as in distance per unit time per leaf area can be determined as follow; Average water uptake at 21. 5 oC = Transpiration rate= 10. cm/h Total Area 0. 2167 m2 = 46.

1 cm/h/m2 Average water uptake at 23 – 24. 5 oC = Transpiration rate Total Area = 9. 2 cm/h 0. 2167 m2 = 42. 5cm/h/m2 DISCUSSION By comparing the results from the experiments conducted, we could see that the average water uptake (express in distance per unit time per unit area) at 21.

5oC, i. e. 46. 1 cm/h/m2 seems to be higher than at 23.

0 – 24. 5, i. e. 42. 5 cm/h/m2.

These results seem to contradict with my hypothesis. Yet, this did not mean that the experiments were totally unreliable. As we know, there are numerous factors which can affect the rate of transpiration. Temperature is just one of the factors. For this particular experiment, the source of heat used to increase the temperature of the plant’s immediate surroundings was a table lamp.

The heat generated by the lamp may have also warmed up (increase the temperature) the water in the potometer. Increase in temperature of the water will increase the air space between its molecules. This could have caused air bubbles to form in the xylem as well. The presence of air bubbles in the xylem could have caused deterioration in the cohesion tension in the system which led to the reduction in the transpiration rate. Throughout the experiment, several precautions were done to minimise experimental error. For example, at the beginning of the experiment, the last 1 cm of the hibiscus stalk was cut with a sharp plant cutter under water to remove any blockage within the xylem when it was first cut from its stem and to prevent air bubbles from getting into the system.

The used of a sharp cutter had also prevented the xylem from being crushed which could affect the flow of water. Furthermore, the whole system were made sure to be air tight by tightening the rubber tube from the reservoir with clamp and that there were no water coming out of the rubber end where the shoot was attached to. The plant was also allowed 5 minutes lapse before the trial run and before the experiment with raising the temperature began. This enabled the plant to adapt to its experimental condition. However, every experiment will always be subjected to some human errors. Some possible errors were parallax error when distances travelled were read and in the measurement of surface area of the leaves.

These errors can be reduced and a more accurate data and results can be obtained by repeating the experiments several times. REFERENCES

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