Leanne Haines 10B

Investigating Transpiration Using a Poto-meter

An investigation is going to be done to see what effects the rate of transpiration, and how much it affects it.

Input	Outcome
Amount of Light	Rate of Transpiration
Humidity of the surrounding air	Rate of Transpiration
Wind	Rate of Transpiration
Temperature of the surrounding air	Rate of Transpiration
Number of Stomata	Rate of Transpiration
Number of Leaves	Rate of Transpiration

The outcome variable shows the distance the air bubble moved along the poto-meter. The variable that is going to be changed is the number of leaves. By changing the number of leaves we can measure 2 things. The length of time it takes the plant to pull up a certain amount of water can be measured, or a set time can be used and then the amount of water pulled up will be measured. We have decided to have a set amount of time and to measure the amount of water pulled up. The amount of light is going to be kept the same because the investigation will be done in daylight in the biology lab. The humidity can changed by putting a bag over the leaves of the plant and boiling a kettle in the bag. When the air is humid, it means that the air molecules are already partially full of water and therefore cannot hold much water when it is evaporated from the plant. So the more humid the air, the slower transpiration will be. This is not a very accurate test as there is no way of measuring how humid the air is and we can't get many results for a graph. So the humidity of the air surrounding the plant is not going to be changed. Wind is not going to be changed, as we are not going to be blowing a hairdryer around the plant, and the windows will be closed. This is also not a very accurate experiment. The experiment is going to be done at room temperature and the temperature will stay the same. We are not going to change the amount of stomata, as it will mean that we will have to assume a lot of things, which isn't very accurate. We will have to assume that there are a certain amount of stomata in a certain surface area of the leave. There is no way we would be able to count the amount of stomata accurately.

Preliminary Work

Preliminary work needs to be done so that it can help to make a prediction and give us some idea planning the investigation e.g.: the length of time to measure the rate of transpiration. For our preliminary work, a celery investigation was done. Three separate sticks of celery were placed in different conditions.

1. Leaves and no water
2. No leaves and water
3. Leaves and water

The red food dye was placed into the water so that we could see how much water was pulled up through the plant. The sticks were left for a few hours. These different conditions were used to prove that transpiration is needed to keep the plant alive. Here are the results:

1. As the celery piece has leaves, the stomata will open to get carbon dioxide but while doing this some of the water in the leaves is evaporated. Transpiration needs to take place but there is no water to be pulled up. This makes the cells go flaccid and the celery piece go limp. **This is proving that the leaves do have stomata on them and that water is needed for transpiration.**
2. There are no leaves so there are no stomata to open. The water gets up the celery stick through capillarity. The water can only get about ½ way up the stick because of the width of the xylem. If the xylem were thinner the water would get further up the celery stick. **This proves that without leaves, water will still travel up the plant through capillarity. But is not an efficient way of transporting water and nutrients around the plant as, depending on the size of the xylem, the water can only get so far up the plant.**
3. As there are leaves on the celery stick, there are some stomata, which open to obtain carbon dioxide. As they open the plant looses some water. So more water is drawn up the stem. This process is repeated until there is no water left or the celery dies from some other reason. **This proves that leaves and water are the best conditions in a plant for moving water and nutrients around the plant, as transpiration can take place effectively.**

<u>Prediction</u>

Transpiration is what takes place in the leaves of a plant and is another way the plant uses to get water and nutrients around it that are needed for photosynthesis. Also it is a way of dispersing the nutrients around the plant evenly. The leaves of the plant loose water when the stomata on the leaves open to get carbon dioxide for photosynthesis. When this happens some of the water inside the plant evaporates into the air surrounding the leaf. To prevent too much water being evaporated, the leaves have a waxy cuticle and most of the stomata are on the underside of the leaf. When the water is evaporated from the leaf, there is a shortage of water in the plant so more water is drawn up the stem to replace the lost water in the leaves. The stem then draws water up from the soil through the roots. This is also called the transpiration stream.

I think that the more leaves there are on the plant, the faster the further the air bubble will move along the poto-meter, and therefore the faster the rate of transpiration. This is because there will be more stomata and the more stomata there are the more water will be lost when the stomata open to get carbon dioxide for photosynthesis. Because of this, the plant will loose water faster and therefore need to take it up faster to replace it.

<u>Equipment</u>

Poto-meter
Part of a Laurel Bush
Graph paper

Method

The equipment was set up as shown below. A poto-meter is a device that is used to measure the speed of transpiration. Part of a laurel bush was cut off the plant and put into the poto-meter. We made sure it had an even amount of leaves on it and any odd ones were cut off. We tried to make it so that the leaves were more-or-less the same size, as this would make it easier to plot a graph. We made sure that we had 10 leaves on the plant. An air bubble was made in the bottom of the poto-meter and the stopwatch was started when the air bubble got to 0. The air bubble was timed for 2minutes and then we recorded how far it got along the scale. This was then done 2 more times, so that we had a total of 3 results to help improve the reliability of them. An average was then taken. Two leaves were then cut off the plant and the above process was repeated again and again until there were no leaves left on the plant. We have decided to take of the leaves in twos as it means that we will have enough time to do the experiment and means we have a larger range then when 1 leaf was taken off at a time. The number of leaves at which the speed of transpiration is measured, is between 0 and 10 leaves. By taken two leaves off at a time we will get 6 results, which is enough to draw a graph from. The rate of transpiration was then measured when the plant had no leaves to see if there were some stomata on the stem. When the leaves were taken off the plant they were placed onto graph paper, drawn round and then their area was found and then recorded. This was done so that we knew how much of the plant we were taking away. It wouldn't be fair if the number of leaves removed were just recorded, as the leaves were all slightly different shapes and sizes. If there were any large holes in the plant they were also drawn round but not included in the area.

The experiment was done as safely as possible, no sharp objects were used and the experiment was done carefully to help improve safety.

Results

		How far air bubble moved (cm)				
No. of Leaves	Total area removed (cm2)	Test 1	Test 2	Test 3	Average	Speed of Transpiration (mm/s)
10	0	2.1	1.9	2.2	2.1	0.18
8	148	1.3/1.8	1.4	1.4	1.4	0.12
6	282	1	1	0.9	1	0.08
4	439	0.4	0.3	0.4	0.4	0.03
2	581	0.4	0.3	0.2	0.3	0.03
0	691	0.1	0.1	0.1	0.1	0.01

As you can see, there was one anomalous point: 1.8 This point was not included in the average.

Graph 1- this is showing the distance the air bubble moved in 120 seconds / 2 minutes. It shows that the more leaves there are on the plant, the further water is pulled up the plant. This shows that the speed of transpiration slows as there are fewer leaves on the plant.

Graph 2- this is showing the speed at which water is pulled up the plant. The more leaves there are on the plant, the faster the water is pulled up the plant. The speed is slower when there are fewer leaves on the plant.

<u>Conclusion</u>

The investigation proved my prediction but did not show what I expected. I thought there would be a straight-line graph, but in fact the graph produces a curve. But I was correct in saying that the more leaves there are on the plant, the faster the rate of transpiration and the further the air bubble moved along the poto-meter. This is because there will be more stomata and the more stomata there are the more water will be lost when the stomata open to get carbon dioxide for photosynthesis. Because of this, the plant will loose water faster and therefore need to take it up faster to replace it. When the water is lost from the leaf when the stomata open, there is a shortage of water in the plant so more water is drawn up the stem to replace the lost water in the leaves. The stem then draws water up from the soil through the roots.

Both graphs produce a curve. This is probably because of the way the plant is responding, as it need s time to adjust to its change in surroundings. We have not given the plant this time. From graph 1 we can see that as the plant looses more surface area, the distance the air bubble moves decreases. There are 2 obvious anomalous points on the graph (these have been marked). This could be where the plant was adjusting to its surroundings. Graph 2 shows just one anomalous point. At this point the plant only had 2 leaves, and is obviously dying. The speed of the air bubble was more or less directly proportional to the area of the plant at first, this is probably because the plant can cope with some change and can substitute for it. But once a certain amount of its leaves have gone (which contain the most stomata) the plant will not be able to cope with the change.

Evaluation

I think the experiment done was reasonably fair. To keep the experiment fair the variables were kept constant, and only one was changed.

- The experiment was done in the lab in daylight, and the light was not changed during the experiment.
- The temperature was kept the same (as best as possible but it could not be monitored all the time).
- The windows were kept closed so there was no breeze affecting the experiment
- The humidity of the surrounding air was not changed
- In a way the number of stomata was changed, as leaves were being removed from the plant, which therefore means that stomata are also being removed from the plant.

The measurements made weren't very accurate though because sometimes the air bubble was in between the points on the measuring scale, and we had to round it to the nearest mm. This is not very accurate. I think the procedure carried out was suitable to find what needed to be found. There was only one anomalous point when taking the results, but it was not included in the average. On graph 2 there was only one main anomalous point. There are two possible reasons for this result:

1. The plant was dying and could not substitute for the change in its surroundings (loosing most of its leaves and stomata).
2. Another variable had been changed without us realising it. A window or a door could have been opened, or the temperature in the room could have risen or dropped.

But the evidence produced was sufficient enough to support a firm conclusion. To provide additional evidence for the conclusion, we could do more experiments changing each of the variables. This would then tell us how much each variable affects the speed of transpiration. We would have to find a different way to do some of the experiments, as some of them aren't very accurate.