Joanna Burton 10T

Investigating Transpiration in Plants

Hypothesis

I predict that the plant will loose more water through transpiration when the fan is closer to the plant. I think that the distance of the fan from the plant and the water loss are ***inversely proportional***, that is the ***greater*** the distance between fan and plant, the ***smaller*** the percentage loss of mass.

I predict also that at a certain distance, the fan will no longer have an effect, or minimal effect, on the transpiration of the plant and the water loss will be constant. At this point the best fit line will be a near-horizontal line close to the axis, showing virtually zero water loss (excluding evaporation and other effects). These two predictions together suggest that the best fit for the two trends described will be a curve as shown..

Analysis (see graph overleaf)

The graph shows the relationship between the distance of the fan from the plant, and the % change of mass in the plant.

From the graph, I can see that:-

1. The plant is losing water/transpiring when placed near a fan, because all the % changes in mass are negative numbers, and this shows the mass is going down.
2. There is an anomalous result at 100cm. This is so far away from the other readings that it should be disregarded.
3. There is a pattern in my results, disregarding the anomalous result. I can see that there is the greatest water loss when the fan is closest and least at the furthest distance. For example, at 40cm the % change of mass is -0.31%, and at 60cm the % change of mass is –0.28. It is losing more water when the fan is closest, so the water loss is ***inversely proportional*** to the distance of the fan from the plant. The line of best fit illustrates this trend.

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Explanation of Conclusion:
Transpiration happens in the lower half of a leaf, in pores called the "stomata." Inside the leaf there is a concentration of water vapour molecules. These water vapour molecules are arranged in shells outside the stomata.

The effect of wind on plants is that the outer shells of water vapour molecules are blown away into the air. More water vapour molecules from inside the leaf come out to fill the space left outside the leaf. This means the plant has to replace it by taking in more water through the roots, and transpires more.

My results show that a stronger wind causes a plant to transpire more. This is because water vapour molecules are blown away and the plant needs to replace them quicker by transpiration. They show this because loss of mass in the apparatus means that water has been lost through the plant transpiring.

We can see that there is a greater loss of mass (rate of transpiration) in a stronger wind (closer fan.)

My results support part of my prediction. I predicted that the distance of the fan from the plant was inversely proportional to the change in mass/transpiration. I can see this because the close the fan is to the plant, the more mass is lost.

The second part of my prediction was that after a certain distance the fan would have no effect on transpiration and the change in mass would be constant. My results do not show this. This could be because there are not enough results, or across a sufficient range to test this prediction. A way of carrying on the experiment to test the prediction would be to use a wider range of values for the distance of the fan from the plant. I think that if the experiment were to be carried on, there would eventually be a distance where the fan would have no or minimal effect on transpiration and the change in mass would be measured as constant. At this point the best fit line on the graph would level off, becoming the curve as described in my hypothesis.

Evaluation

Evidence Obtained:
I think that the procedure to obtain my results was quite successful because I obtained a set of results that partially show a pattern that supports my prediction.

Quality of Evidence:
As previously mentioned, it would have been better if we had more results over an extended range.

Anomalous Result :
There is one anomalous result in my experiment. It is identified on my graph with a circle around it. It is the calculated average loss in mass where the fan is 100cm away from the plant. We can see from the graph that it doesn't follow the pattern at all. In the data table, the problem appears to be with the reading for plant C, with a weight loss of over 1gm from previous weight. This is more than 4 times any other recorded loss and is probably incorrect.

Suitability of Procedure, Reliability of Data & Sources of Error:
The procedure had some good points that helped to discover the trend, and some bad points that introduced sources of error.
Good Points:-

- Use of electronic scales for good repeatable measurements of mass.
- Use of 3 plants and averaging to give more stable calculations
- Temperature recording to be able to investigate this effect
- Electric fan for consistent 'wind' source
- Equal distance between fan placings

Sources of Error:-
I consider these can be split into two groups, having potentially minor or major effect on the reliability of the data:-
Minor Potential Sources of Error:-

- Measurement of distance of plant to fan.
- Temperature variation
- Mass measurement repeatability
- Fan speed variation or setting error.

Major Potential Sources of Error:-

- The 'topping-up' procedure is a likely source of significant error. We are assuming that the topping up takes us back to the original mass every time. This is not checked and unlikely to be exactly the original value. Measuring a meniscus to a line is quite difficult and as the changes in mass due to transpiration are so small, even a small error in establishing the original water line could be very significant.
- Human error is another major potential source of error. For example, with the anomalous result, the cause could have been reading the scales wrongly, recording the wrong result down or again, the topping up procedure.

Suggested Changes To Reduce Potential Sources of Error: -
Minor Sources:-

- More accurate distance measurement with double checking and careful measuring.
- Keep temperature of the room constant by measuring the temperature at each stage and adjusting air temperature accordingly.
- Use better scales if available.
- Use a very consistent fan at the same speed setting each time.

Major Sources:-
There are two ways of reducing the error from the topping-up procedure. Both are equally effective.

- When topping up the conical flask, measure it to the original *mass* instead of the original *water line* using the syringe.
- Do not top up the liquid inside the flask after each measurement has been taken. Instead of using the original mass to calculate the percentage change in mass, use the last recorded mass.

For human error that may have occurred during the experiment, double-checking, preferably with a partner, will reduce the likelihood of measurement and recording error.

Further Work To Provide Additional Relevant Evidence:
In addition to the above improvements, the main suggestion I would make to provide additional evidence for the effects of wind on transpiration would be to have more results over a wider range of distances. This would fully test my hypothesis about the steeply reducing effect of the fan at larger distances. I would recommend additional results taken at 140cm, 170cm, 200cm, 250cm, 300cm, and 400cm. If this does not show the flattening of the curve expected, the experiment could be repeated at longer distances.

Another factor that would be interesting to investigate is the temperature effect on the rate of transpiration in the plant. To do this, I would repeat the above experiment at three different but constant temperatures. A room or cellar temperature could be controlled with the thermostat. Possible temperature range could be 5, 15 and 25 degrees Celsius.