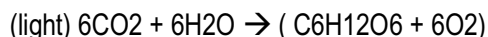


How does light intensity affect the rate of photosynthesis?

In my investigation I aim to determine whether intensity of light would affect the rate of photosynthesis in a plant.

Introduction

Photosynthesis can only happen if light is present, and takes place in the chloroplasts of green plant cells. Photosynthesis is the production of simple sugars from carbon dioxide and water causing the release of sugar and oxygen. The chemical equation for photosynthesis can be expressed as:



The reason that light intensity may affect the rate of photosynthesis is that as light (energy), falls on the chloroplasts in a leaf, it is trapped by the chlorophyll, which uses the energy for chemical reactions in the plant. Therefore the amount of light that falls on the plant will change the amount of energy absorbed, so affecting the energy available for the chemical reactions.

However light is not the only factor that affects photosynthesis; light intensity, temperature, the amount of chlorophyll in the leaf/plant and carbon dioxide concentration.

Predictions

I predict that as the intensity of light increased, so will the rate of photosynthesis. Also I believe that the rate of photosynthesis will be directly proportional to the light intensity because it stands to reason that if light intensity increases consistently so will photosynthesis. Eventually, however, I believe that temperature will come into play and the light will heat up the water thus affecting the results.

Risk assessment

- Care must be taken around sodium hydrocarbonate
- Goggles must be worn
- Care must be taken in an experiment contain electricity and water.

Preliminary work

To establish an appropriate range of distances at which to set my light for my experiment, I did a preliminary investigation in which I recorded the number of bubbles of oxygen given off in a given time at various light intensities. To alter the light intensity, I placed a lamp at various distances from the plant.

Results of preliminary experiment

Distance (cm)	Number of bubbles per minute (average after three readings)
100	2
80	3
60	4
40	6
20	13
10	22
0	30
Amount of bubbles at background	1

This is a very quick, simple and efficient way of obtaining an idea of the trends for the graph, and the most appropriate distance for the measurements.

In my main experiment I have decided not to use measurements over 25 cm's because it shows that anything (on average) over that distance is close to background photosynthesis so it will be hard to distinguish between the two. The distance in cm will be 0, 5, 10, 15, 20, 25 & background.

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The input variable used in this experiment will be light intensity. The output variable will be the volume of oxygen given off in b.p.m. The control is the colour of the light (background research showed me that plants respond differently to different coloured lights so the light will be kept constant kept constant, also the same water was used throughout another constant variable. The last constant variable was temperature and although it may change slightly due to the light it will not great enough to affect the results (the experiment will be kept at room temperature).

Apparatus

- Desk lamp
- Canadian pond weed
- Scissors
- Tap water
- Test-tube
- Cold water
- Stopwatch
- Paper clip
- Meter rule
- Sodium Hydrocarbonate
- Spatula



Method

A stem of Canadian pondweed of about 3cm in length and placed in a test tube full off water (the paperclip was used to weigh one end of the weed down). Added to the water was a spatula full of sodium hydrocarbonate to speed up the reaction. The lamp was set up at the furthest distance from the plant (this was so it took longer for the water to change in temperature). The apparatus was left for exactly one minute for the reaction to begin and then the stopwatch was started and, for 1 minute the number of bubbles were counted.

Observations

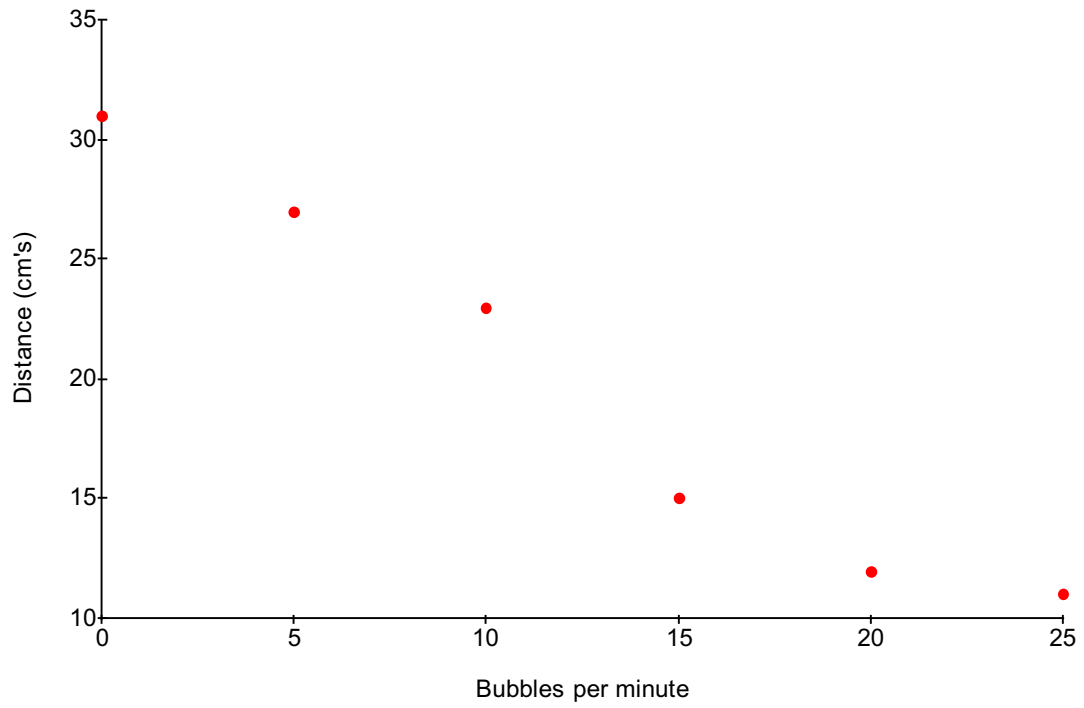
Distance of light from plant (cm's)	Number of bubbles per minute (exp 1)	b.p.m. (exp 2)	b.p.m. (exp 3)	b.p.m (average)
25	8	14	11	11
20	16	10	10	12
15	20	13	12	15
10	24	22	23	23

5	27	28	26	27
0	28	31	34	31

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How light intensity affects photosynthesis



Analysis

From the results obtained I have been able to draw a graph of my findings. The graph shows a direct pattern between light intensity and photosynthesis: As the light intensity increased so did the rate of photosynthesis. I believe this is the case because photosynthesis is a reaction and needs energy from light to work, so as the amount of energy available from light increased with the rise in light intensity, so did the amount of oxygen produced as a product of photosynthesis e.g. the faster the reaction. The graph also shows that the photosynthesis to light intensity ratio is not directly proportional as stated in my predictions I know this because the graph shows a curve, not a straight line. However, the first three readings do show a straight line, the curve comes after them when it is possible the temperature may have changed. This is something that could be investigated in greater detail.

From these results, I am able to say that an increase in light intensity does definitely increase the rate of photosynthesis.

The gradual shallowing of the curve can be attributed to the other factors limiting the rate of photosynthesis. As light intensity increases, the photosynthetic rate is being limited by certain factors, such as carbon dioxide and temperature. Overall, the graph and my results support my predictions fully.

Evaluation

I feel that my experiment was overall successful, the correct results were obtained and I learnt interesting and enlightening facts about photosynthesis. However, I believe there are several points where the experiment could have been done better .

One factor that could have been more accurate was the distance between the light and the pondweed, a metre rule can have quite a large degree of inaccuracy and was perhaps the most useful tool used. It is possible that the error could have been up to 0.5cm and I think this could have a reasonably large affect on the results as the light is moved closer to the weed. If this experiment were to be repeated I would without a doubt use more accurate and reliable measuring equipment. Another 'weakness' to the experiment was measuring the exact amount of oxygen given off. Granted, with the equipment available to us that was impossible and so our results can only be a reliable estimate. If the experiment were to be repeated I perhaps would use a syringe to obtain more reliable reading for the volume of oxygen. Temperature was another inaccuracy in this experiment as the heat given off by the lamp could have affected the heat of the water and this would have affected the rate of photosynthesis. This could explain why my graph was a curve as opposed to a straight line, that is something to be investigated further. A way round the temperature problem would be to place a Perspex block between the lamp and the plant, which would absorb most of the heat, while allowing the light energy to pass through. The final inaccuracy apparent, though a small one, was in the time keeping. The main problem here was in when exactly to begin the minute. If for one reading, the minute was started just after one bubble had been produced, and in another reading it was just before, the readings could be influenced and would have had a negative effect on the accuracy of my results. Next time I could ensure that in each case I started the stopwatch just after a bubble had been produced, so increasing the accuracy.

Overall I believe however my investigation was reliable and successful, the correct results were obtained and no injuries or breakages occurred. I have also had ideas on how to extend my enquiries further. I could perhaps try to link in some of the other limiting factors to the same experiment such as temperature and maybe perhaps used heavy water instead of H_2O . Whether I investigate further or not I can say I have successfully found that the rate of photosynthesis increases with the light intensity.