GCSE Biology - Photosynthesis Coursework

Aim

The aim of my experiment was to determine whether or not the intensity of light would affect the rate of photosynthesis in a plant. To do this, I placed a piece of Canadian pondweed in varying light intensities, and observed the amount of oxygen being given off. I used Canadian pondweed because of its unusual quality of giving off bubbles of gas from a cut end, when placed in water.

Introduction

Photosynthesis occurs only in the presence of light, and takes place in the chloroplasts of green plant cells. Photosynthesis can be defined as 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:

$$6\ CO_2 + 12\ H_2O + light \rightarrow C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$$

Carbon dioxide + water + light energy → glucose + oxygen + water

Photosynthesis can not occur without light the plant will simply die. The reason that light intensity does affect the rate of photosynthesis is because as light, and therefore energy, falls on the chloroplasts in a leaf, it is trapped by the chlorophyll, which then makes the energy available for chemical reactions in the plant. Thus, as the amount of sunlight, or in this case light from a bulb, falls on the plant, more energy is absorbed, so more energy is available for the chemical reactions, and so more photosynthesis takes place in a given time. There are many factors, which affect the rate of photosynthesis, including light intensity, temperature and carbon dioxide concentration. The maximum rate of photosynthesis will be constrained by a limiting factor. This factor will prevent the rate of photosynthesis from rising above a certain level, even if the other conditions needed for photosynthesis are improved. It will therefore be necessary to control these factors throughout the experiment so as not to let them affect the integrity of my investigation into the effect of light intensity.

Prediction

I predict that as the light intensity decrease the rate of the reaction decrease the amount of the bubbles but I believe that as the light intensity goes up to certain point it will have no effect on photosynthesis.

Preliminary work

I found a suitable range of distances at which to record results 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. I also therefore needed a way of accurately measuring the light intensity, and I did this

using a photometer. I recorded the unit of light intensity at each distance. I got the following results:

Results of preliminary experiment

Distance (Cms)	Light intensity	Number of Bubbles
5	60w	12
10	60w	12
15	60w	13
20	60w	14
25	60w	16
30	60w	18
35	60w	20
40	60w	23

Method

The variables are:

Input variables – light intensity is to be varied by increasing and decreasing the distance from the light source to the plant

Output variables – volume of oxygen produced (rate of photosynthesis) is to be measured by finding the volume of oxygen produced in a minute, and thus finding the rate of photosynthesis

Temperature – Enzymes are used in the photosynthesis reactions of a plant. Therefore, temperature will increase the rate of photosynthesis, until a point at which the enzymes denature. Although performing the experiment at a temperature slightly higher than room temperature, perhaps 25°C, would have a positive effect on the accuracy of the readings I took, as it would reduce the percentage error, by increasing the volumes, I decided that the inaccuracy of maintaining a constant temperature would outweigh any advantages. I am therefore going to perform the experiment at room temperature, checking the temperature frequently, in case the heat given off from the light should slightly raise the temperature, in which case I shall simply refill the beaker with more water after each experiment.

Apparatus list

Desk lamp

Audus apparatus
Canadian pond weed
Knife
Clamp
Pond water
Thermometer

Test-tube
Beaker
Cold water
Stopwatch

Cut a stem of Canadian pondweed of about 3cm in length. Fill a test -tube with pond water, and place it in a clamp, and then in a large beaker of cold water. Connect the end of the pondweed to the Audus apparatus. Insert a thermometer into the beaker, and record the temperature at the beginning and end of each experiment, merely as a precaution against a significant rise in temperature, which is not expected. Set up a lamp at a set distance from the plant, ensuring that this distance is from the filament of the lamp to the actual pondweed, rather than the edge of the beaker. The light intensity was measured in the same way as described in the preliminary experiment, and assumed to be the same at any point at any particular distance. When bubbles are being produced at a steady rate, clear any previous bubbles from the tubing by moving the syringe. Start the stopwatch, and wait for 1 minute. Move the bubbles, which have been collected at the bend in the tubing to the part of the tube with a scale. Find the length of the bubble collected. Repeat for all other readings, and then repeat all readings a second time to get an average result for each distance.

Main Results

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5	60w	12
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Analysis

My graph was in the form of a best-fit curve. I drew it as a curve rather than a straight line because of the clear pattern of the points. This meant that the rate of photosynthesis increased as the light intensity increased. This was because photosynthesis is a reaction, which 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.
My graphs showed that the relationship between the light intensity and the rate of photosynthesis was non-linear, as both graphs produced a best-fit curve. However, as I expected in my hypothesis, it does appear that for the very first part of the graph, the increase in rate is in fact proportional to the increase in light intensity (i.e. a straight line) and I can show this by taking some readings from the graph:

Evaluation

Although I feel that my experiment was sound overall, I thought there were many points at which the accuracy was not perfect. As I have already stated, my preliminary experiment was not accurate enough to justify being used as my main experiment, mostly due to the fact that I was relying on all the bubbles being the same size, which they clearly weren't, however many of the smaller inaccuracies also apply to my main experiment.
Firstly, the distance between the light sources and the Canadian Pondweed were not measured to a very high degree of accuracy, especially when you note the fact that the distance should have been measured exactly from the filament of the light bulb to the centre of the plant, and it is possible here to find a per centage error. I estimate that the error could have been up to 0.5cm and I will find the percentage error for the largest and smallest reading using this estimate.