How Does Light Intensity Affect The Levels Of Photosynthesis In Canadian Pond Weed

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:

(light)

The fact that all plants need light in order to photosynthesise has been proven many times in experiments, and so it is possible to say that without light, the plant would 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. Therefore, 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.

Predictions

I predicted that as the intensity of light increased, so would the rate of photosynthesis. In addition, I assume that if the light intensity increases, the rate of photosynthesis will increase at a proportional rate until a certain level is reached, and the rate of increase will then go down. Eventually, a level will be reached where an increase in

light intensity will have no more effect on the rate of photosynthesis, as there will be another limiting factor, in this case probably temperature.

Research and Information

Light intensity is to be varied by increasing and decreasing the distance from the light source to the plant. The volume of oxygen produced (rate of photosynthesis) is to be measured by finding the volume of oxygen produced in a minute (by counting bubbles produced), and therefore finding the rate of photosynthesis. The level of CO2.This can affect the rate of photosynthesis, since if there is too little CO2, it can become the limiting factor, therefore reducing the practicality of the experiment. In this case, as long as the experiment is done over a short period of time, the amount of carbon dioxide used up by the plant will not be sufficient enough to cause the carbon dioxide concentration to become the limiting factor. If my experiment were to be performed over a longer period of time, for instance 24 hours, I would add a fixed amount of Sodium hydrogen carbonate to the water, to ensure a large enough supply of carbon dioxide. Water is also required in the photosynthesis reaction, when there is a shortage of water, the plants' stomata close to prevent further water loss. This closing of the stomata cells also leads to little carbon dioxide being able to diffuse through. Clearly, in a water plant, like the pondweed, as long as the plant is fully submerged in water at all times, there will be no problem.

Method

Apparatus list

Desk lamp

Light meter

Test-tube

Beaker

Cold water

Stopwatch

Funnel

Paper clip

Cut a stem of Canadian pondweed of about 3cm in length. Attach the pondweed to a paper clip then place the weed in a beaker filled with cold water and then place a funnel over the weed. Fill a test tube with water and place it on top of the funnel spout ensuring no air is in the top of the test tube. Record the temperature at the beginning and end of each experiment, as a precaution against any rise in temperature, which is unexpected. 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 with a light meter. When bubbles are being produced at a steady rate, clear any previous bubbles from the test tube by refilling it and replacing it as before free from trapped air. Start the stopwatch, and wait for 1 minute. Count the bubbles, which have been collected at the top of the test tube. Repeat for all other readings, and then repeat all readings a second time to get an average result for each intensity.

Using the described method, I found the following results:

Results for main experiment

Distance (Cm)	Light intensity (Lux)	Bubbles 1	Bubbles 2	Average bubbles
10	945	53	56	54.5
15	639	47	45	46
20	310	44	41	42.5
25	208	36	39	37.5
30	149	32	29	30.5

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 decreased as the light intensity decreased. This was because photosynthesis is a reaction, which needs energy from light to work, so as the amount of energy available from light decreased with the fall in light intensity, so did the amount of oxygen produced as a product of photosynthesis.

From these results, I am able to say that an increase in light intensity does certainly increase the rate of photosynthesis. As light intensity increases, the rate of photosynthesis is being limited by certain factors, such as carbon dioxide and temperature. These factors do not immediately limit the rate of photosynthesis, over time as temperature rises or falls and CO2 I used.

Overall, my graph and my results support my predictions fully. My idea that the rate of photosynthesis would increase with light intensity was comprehensively backed up by my results.

Evaluation

Although I feel that my experiment was sound overall, I thought there were many points at which the accuracy was not perfect. My experiment was not accurate enough to justify my prediction, 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 do not hugely affect the experiment as it was not meant to be one hundred percent perfect.

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.

Another error would have been due to background light in the lab. We could have reduced this error by closing all blinds in the laboratory, but due to practical reasons, we could not perform the experiment in total darkness, and we therefore experienced light pollution from other student's experiments. This would have had a very marginal effect on my results as a whole, but to eliminate this problem completely, it would have been necessary to perform the experiment in a totally dark room.

A further inaccuracy was in the heat generated by the lamp. As I have earlier described, temperature has a very noticeable effect on the rate of photosynthesis, and so any increase in the temperature of the pond water would have had serious effects on the accuracy of my results. To ensure this did not happen, I monitored the temperature of the water before and after every reading, to check that the temperature did in fact not rise. It turned out not to be a problem, as over the short period of time taken by my experimental readings, the temperature did not rise at all. However, if I were to extend the time of my experiment to 5 minutes for each reading for example, I would have to find some way of keeping the temperature constant. One way of doing this would be to place a Perspex screen between the lamp and the plant, which would absorb most of the heat, while allowing the light energy to pass through.

As I mentioned in my planning, carbon dioxide concentration could have been an error in the experiment, however, I feel that due to the short period of time taken, there is very little chance that the concentration would ever have been so low as to have become the limiting factor. Again if I were to carry out the experiment over a longer time period, it would have been necessary to add sodium hydrogen carbonate to the water to increase the carbon dioxide concentrations.

Overall, I felt that due to the small volumes of oxygen involved, my experiment was not as accurate as it could have been, however I believe it was accurate enough to support and justify my prediction. Improvements could have been made as I have stated, mainly by simply increasing the time taken.