

How does light intensity affect the rate of photosynthesis?

Introduction

Green plants don't exude food from the soil they make their own, using sunlight. This is called photosynthesis, which means "making through light". This occurs in the cells of a green plant, which are exposed to sunlight. Four things are needed to make this process work and this gives two things: the four things needed are light from the sun, carbon dioxide diffuses from the air, water from the soil and chlorophyll in the leaves. This gives out oxygen which is released into the atmosphere and glucose which is used for biomass and energy. The word equation for the process of photosynthesis is:



The energy which is produced is used to build up smaller molecules into larger molecules. Here are some uses of energy :

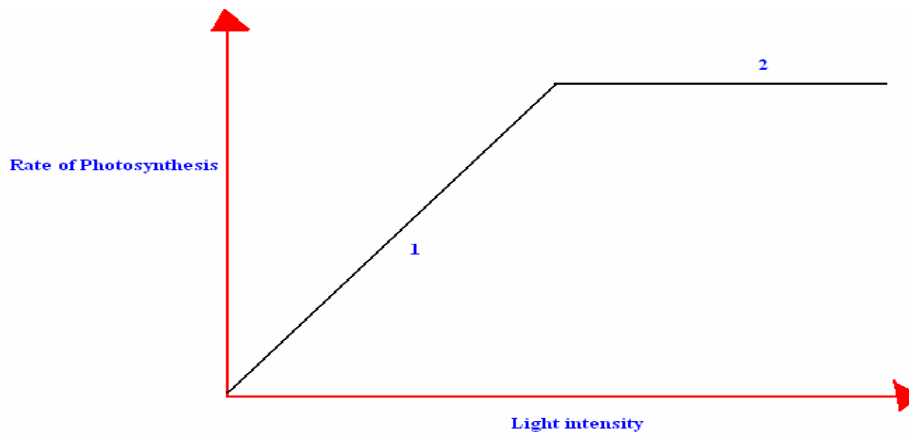
- Sugars into starch
- Sugars into cellulose- needed for cell walls
- Sugars, nitrates and other nutrients for protein - for growth and to make to enzymes
- Sugars into lipids for storing in seeds

Factors affecting photosynthesis

Temperature, carbon dioxide concentration and light intensity can interact to limit the rate of photosynthesis. Any one of them, at a particular time, maybe the limiting factor. Carbon Dioxide can have an effect on the plant because plants need carbon dioxide to photosynthesize. Temperature has an affect but if the sunlight was low then the temperature will be low so the carbon dioxide can be the limiting factor.

The one we need to concentrate more on which is our aim is about light intensity.

Here is a diagram to show what I mean by this and also with it explains what the diagram shows.



- 1) Here as the light intensity increases so does the rate of photosynthesis. This means that the light is limiting the rate of photosynthesis.
- 2) Rise in light intensity now has no effect. Light intensity is no longer the limiting factor. This means carbon dioxide or temperature must be the limiting factor.

Hypothesis

I predict that the more intense the light, the higher the rate of photosynthesis. To photosynthesise, plants need light. It provides the energy for the process to happen. Chlorophyll is an enzyme and it speeds up the reaction. If a plant does not get enough of either of these things, photosynthesis will not happen as quickly, if at all. Therefore, I predict that when the light is not very intense we will not see so many bubbles being produced. This is because the plant will not have so much energy (derived from light) to activate photosynthesis. All reactions require certain activation energy, and if this is not reached the reaction will occur more slowly. I think that as we move the lamp away (and therefore reduce the light intensity) from the pondweed the number of bubbles produced will decrease steadily. For instance, say at 10cm distance 50 bubbles are counted, it is likely that at 20cm distance 25 bubbles will be counted, as the lamp is twice the distance away. This means the rate of photosynthesis is halved but we are measuring the light intensity and so this will not mean the rate of photosynthesis is halved. I think that if we move the lamp any further away than 50cm no bubbles at all will be produced because there will simply not be enough light for photosynthesis to work but we are only doing it till 17cm which will give us enough results.

When I am doing my experiment I will measure the amount of oxygen made which will be measured by the bubbles.

I will vary the distance apart from the beaker to the lamp. The equipment I will be using are as follows: a large beaker, a healthy pondweed plant, a lamp, water, a stopwatch, a pinch of sodium bicarbonate which will give the plant more carbon dioxide.

Plan

I will vary the distance of the lamp to the beaker which will help me to measure the light intensity using the equation: $E=1/d^2$.

The things I will keep the same are: the water, the weed, the lamp, the beaker and the place where I did the experiment the same which will make it a fair test.

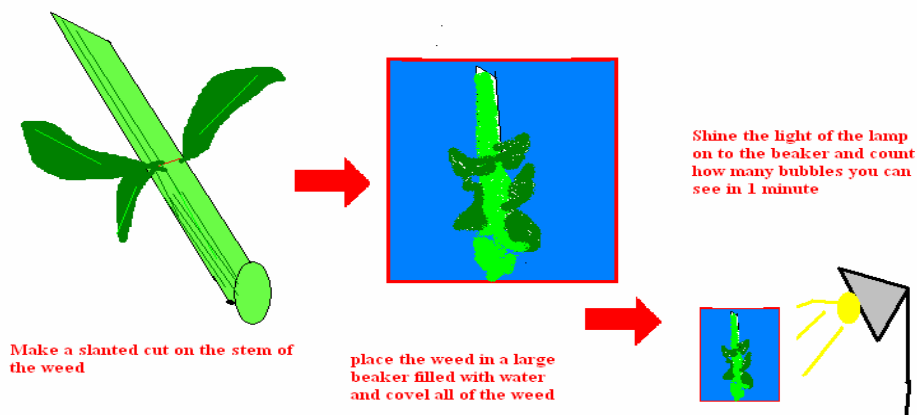
I will measure how many bubbles come up in 1 minute.

What I expect to happen is in the hypothesis above and also I have showed my expected results in my graphs. I will repeat the experiment twice. I will vary the distance because this will show us that the further the lamp is the rate of photosynthesis will decrease. This does not mean that if I move the lamp away from 5 cm to 10 cm that the light intensity will be half. I will keep the weed the same because if we use different weeds then it will not be a fair test because some plants are better and quicker than others. We will keep the water the same because then the temperature can differ and also we will have to keep on adding sodium bicarbonate and we can't always get the exact amount. What I expect to happen is explained in the hypothesis.

We will be able to do a trial experiment 1st which will show us that the experiment is set up and it is working. We will do the experiment twice which will help us work out averages and also if there are anomalous results we will find out what went wrong and redo that bit of the experiment again.

What we need to do in order to get the experiment working .

- 1) Set up the apparatus as shown in the diagram



- 2) When the weed has settled down and is producing bubbles then start the clock and time it for 1 minute and see how many bubbles have come up. Do this twice so we get an accurate result.

- 3) The change the distance of the lamp from the beaker and do this experiment.

Safety

Take care of the light bulb, which may get very hot. As we will be using electricity (for the light bulb) and water at the same time, special care must be taken.

Aim

Our aim is to find out how light intensity affects the rate of photosynthesis.

Method

As in plan- everything which was supposed to be in the method in the plan.

Results

Distance from lamp (cm)	Number of oxygen bubbles produced in 1 minute		
	1	2	Average
5cm	180	144	163
7cm	150	148	149
9cm	144	148	146
11cm	148	128	138
13cm	120	124	122
15cm	100	112	106
17cm	88	96	92

Here are Anisha's group's results

Distance from lamp (cm)	Number of oxygen bubbles produced in 1 minute			Average
	1	2	3	
2cm	125	120	130	125
4cm	112	115	107	111
6cm	96	90	98	95
8cm	86	83	78	82
10cm	65	70	52	62
12cm	49	58	48	52

Here is the light intensity for:

Our group

5cm= 0.04

Anisha's group

2cm=0.25

7cm=0.02

4cm=0.06

9cm=0.02

6cm=0.07

11cm=0.006

8cm=0.016

13cm=0.006

10cm=0.001

15cm=-0.004

12cm=6.94

17cm=0.005

Conclusion

From my graphs and also my results table I can reach to a conclusion. My results show that the light intensity does affect the rate of photosynthesis. We compared our results with Anisha's group's results and also I drew graphs of their group and this also clearly states that the light intensity affects the rate of photosynthesis. My experiment did work and also to make more carbon dioxide Mr Leaver told us to add sodium bicarbonate. I also did some research and I found that this experiment is used to find out if light intensity affects the rate of photosynthesis. Also I used a book which sir gave to us which explains the experiment. My experiment produced these results because we had a stop watch and we only started the stopwatch when the bubbles had started coming out. We had to change how we did the experiment because the bubbles were coming out very rapidly and we couldn't count them for 1 minute because we were bound to blink and so then we would miss a few and lose count. We then asked Mr Leaver who suggested to us that count them for 15 seconds and then times that by 4 which gave us what we would get after a minute. I can prove this conclusion with my results. My conclusion shows that my prediction was correct. I can prove this with my hypothesis and also I had done a graph before the experiment which showed what I expected and when I got my results I added the average to see if my prediction was correct and it was.

Evaluation

My results were accurate and they were reliable. There were no unexpected results and our results were suitable to get the results I needed. If I did the experiment again I would measure the temperature because an artificial light which was the lamp gives out 12 joules per second of light energy and 48 joules per second heat energy because it was a filament bulb. If we used a low energy bulb then it would have given 12 joules per second light energy and 3 joules per second heat energy. Because we used a filament bulb we had more heat than light and so the temperature can be a limiting factor in some cases. To make it a fair test we could have used a low-energy bulb which is more efficient and less heat is given out but they are too expensive. I

had enough results to reach a conclusion and my results prove that light intensity affects the rate of photosynthesis: the further the light the slower the rate of photosynthesis.

The change I suggested could have made the results more reliable because if a filament bulb which we were using gives out 4 times as much heat then light then the limiting factor can be the temperature. If we use the low energy bulb then that give 4 times less heat and more light which we need. If we do the investigation again I would use a low -energy bulb to get more accurate and reliable results. I have carried out a fair trial.