Investigation to show that changing light intensity alters the effect the rate of photosynthesis.

Aim

The aim of this investigation is to show that changing the amount of light a plant gets, effects the rate of photosynthesis. This will be done in this experiment, by placing a lamp near a plant and counting the bubbles let of by the plant. The lamp will be the source of light, while the bubbles will be the rate of photosynthesis. The bubbles are oxygen, which is a by-product in photosynthesis, which tells us how fast photosynthesis is taking place.

Background information

The planning and prediction of this experiment was based on information which I was taught in school and using a number of books. Before performing this experiment, I did other experiments related to photosynthesis and plants. The Book I used was Biology revision guide, GCSE double science. Encarta 98 was also used for information. Some of the basic information is mentioned below.

Photosynthesis in plants provides food for animal. Plants (chlorophyll) traps the suns light and uses CO2 and water and turns it into energy (glucose), oxygen is a by product.

The equation for PS

$$\text{Carbon dioxide + water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{glucose + oxygen}$$

The rate of PS is affected by three factors, not enough light slows down the rate of PS, and too little CO2 also slows it down, the Temperature has to be just right for photosynthesis as well.

The number of 02 bubbles produced measures the rate of photosynthesis. Light intensity is the amount of light and is inversely proportional to distance, so Light intensity is $1/d^2$

Plan

List of equipment needed

- Measuring cylinder
- Lamp
- Meter ruler
- Black scissors
- Paper clip
- Stop watch
- Elodea in water in a beaker
- Cello tape
- Sodium bicarbonate (this will be prepared by my teacher) solution
- Glass rod
- Thermometer

Method

1) Cut black paper according to the size of the measuring cylinder, but leave a strip of gap. This is done to make sure no other light enters the cylinder and to keep the variables constant, than seal it onto the cylinder using sello tape.

2) Add sodium bicarbonate solution into the solution

3) Cut a piece from the elodea in the water. Than quickly transfer into the sodium bicarbonate solution. Before transferring add a paper clip and the weed should be upside down to allow the o2 bubbles to escape. After placing the weed in the solution, using a glass rod position it so the weed is by the gap and is upside down.

4) Than place a meter ruler besides the gap in the measuring cylinder. Place a lamp 10 cm away from the cylinder. Than as a soon as the lamp is turned on, start the stop watch and count the number of o2 bubbles produces in 5 minutes for more accuracy, as more bubbles are more bubbles are produced in 5 minutes than 1 minute. The reason why O2 bubbles are let out, is because h2 is used up in Ps and the oxygen is a waste product of photosynthesis

5) Than after 5 minutes move the lamp 20 cm away from the cylinder, this is to change the light intensity, than count the number of bubbles produced in five minutes.

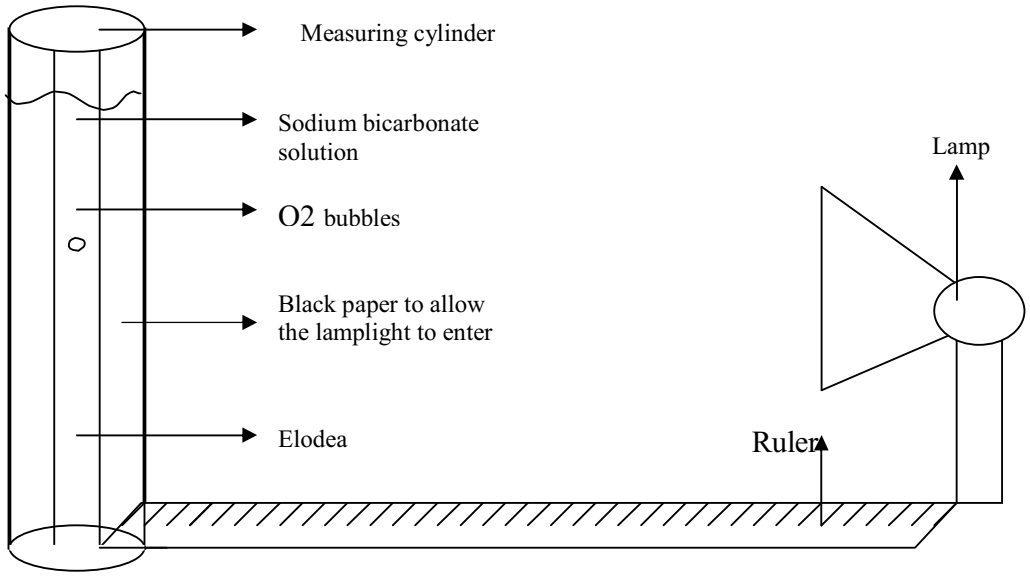
6) Do the same for 30 cm away from the lamp and 40 cm and 50 away from the lamp. The more the range of results the more the accurately can you come to your conclusion. Than work your way back by moving the lamp 40, 30 cm, 20 cm, and 10 cm, Make sure each light intensity (distance) has two readings. Than find an average out of the two results to make the results reliable. Also calculate the average number of bubbles per minute from the readings of 5 minutes.

Table of results (example)

Number of cm away from the cylinder	No of bubbles produced per minute **1st trial**	**2nd trial**	No of 02 bubbles produced per min	d^2	$1/d^2$ (Light intensity)

Since in this experiment we change one variable the other variables such as co2 concentration, temperature, and amount of elodea all need to be constant to the most accurate readings. There will be a thermometer used to see whether the temperature does change throughout the experiment. The thermometer will be placed in the cylinder and a reading will be taken at 0 seconds and at 5 minutes. The same piece of elodea will be used for each set of results.

Diagram

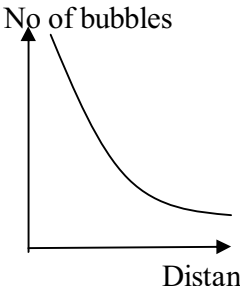


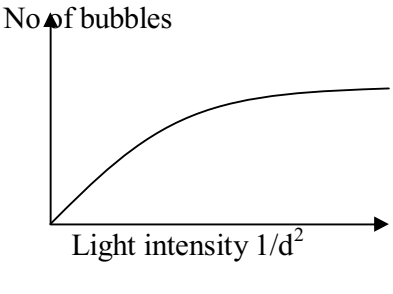
In this experiment the independent variable is light intensity i.e. distance the dependent variable is the rate of ps (amount of o2 bubbles produced).

To keep the experiment accurate and reliable, the following things should be take account of.

- The meter ruler should be place and stuck on with sello tape to make sure the ruler doesn't move and the readings are accurate
- The stem should be cut fresh
- The experiment should be repeated for reliability
- The stopwatch being used should be to the hundredth.

Predictions of the graphs after the results are obtained.





The reason why I have predicted the following shown above in a simple sketch is because when the distance increases, the plant receives less energy, light source is a type of energy for the plant for the process photosynthesis, the more the energy the more the photosynthesis, the more the PS there will be more waste products, meaning more o2 bubbles will be produced. I also predict that number of bubbles will steady when it reaches a light intensity, this is shown in the graph above as well the reason being is that the plant has a limit, it has a maximum amount of light intensity, and can only take a certain amount of energy.

Analysing evidence and drawing to conclusions

The table of results after performing the experiment

Number of cm away from the cylinder	No of bubbles produced		No of 02 bubbles produced per min	d^2	$1/d^2$ (LI)
	1st trial (Per 5min)	2nd trial (Per 2 min)			
10	51	22	10.4	100	0.01
20	27	10	5.2	400	0.0025
30	12	5	2.4	900	0.001
40	6	3	1.3	1600	0.000625
50	3	1	0.6	2500	0.0004

From the following results, I came to a conclusion that the smaller the distance the faster the rate of photosynthesis. This is shown in the table above, when the distance is 40 cm the number of bubbles per minute is 1.3, but when the distance is smaller at 20 cm the number of bubbles per minute is 5.2, when the distance gets even smaller at 10 cm, the number of bubbler per minute is 10.4, this clearly shows the pattern in this investigation. The closer the lamp the more energy is received, so the elodea will take in more light therefore the plant will do more Photosynthesis, if more PS is done, more O2 will be let out. On the following page are two graphs one showing number of bubbles produced against light intensity and the other one number of bubbles against distance.

Overall what I predicted and expected to happen during the experiment did happen, I predicted that the less the distance of the lamp away from the plant the more the rate the photosynthesis. In my results this was also shown, that the more the distance the faster the rate of Photosynthesis. Also the sketch graphs, which I drew nearly, matched the graphs, which I drew for my results. The only difference was that the light intensity against rate of photosynthesis graph started off with a steady growth and slowly curved and the point where it stopped growing was barely visible. Whereas in my prediction of that graph, the curve stopped growing and the steady bit of the graph can clearly be seen.

Analysing the graphs

Graph "Distance Against Number of O2 Bubbles Produced Per Minute"

This graph shows once again that the closer the light to the Elodea the faster the rate of O2, this line of best fit is a curve. This graph shows the results more clearly and is a good visual aid.

Graph No of 02 bubbles produced per min against light intensity (1/d2)

This is the graph that shows the results for our investigation more accurately, since its comparing light intensity directly with rate of Photosynthesis whereas the distance O2 bubbles produced per minute is not too accurate at telling us conclusion. As the light intensity increases the rate of Photosynthesis also increases steadily but only to a certain point. In this graph we start seeing that the point where increasing light will not affect the rate of photosynthesis.

Evaluating Evidence

Overall this investigation worked out well, because from the results I had obtained, I could see a pattern and what I had predicted matched with my results, there was also a scientific explanation, which explained my results.
The method I used was reliable, but there were some parts, which may suggest it may not have been entirely reliable and changed, could be made. The fact that the stopwatch was to the hundredth seconds and that all the variables were remained constant made it reliable. The meter ruler was also cello taped, to make sure the readings were right, also when the lamp was moved along the meter ruler, we made sure that each time it was positioned at the same place as the other distances. In my investigation I also repeated the readings, and found an average to make sure I had correct results. But the method of counting the oxygen bubbles was slightly inaccurate, because the naked eye can't see tiny bubbles given off by the elodea; this makes the results obtained slightly inaccurate. To improve the method, next time this experiment should be done, more time should be taken in performing it, for example, the lamp should be positioned at each distance for say half an hour, and to measure the rate of photosynthesis, we should see how much the water level dropped in that half an hour, than the experiment should be repeated for each distance.

In my investigation they were not any anomalous results which proved my method was accurate, I also feel I had the correct results, because they were not any anomalous results, my graphs show smooth curves. But I still feel perhaps there is a chance that my results are not entirely correct because I was not able to control the variable, temperature. During the investigation the temperature of the water in the cylinder changed from 22 degrees to up to around 24 degrees. To extend this investigation, I could perhaps do another similar experiment which could provide more evidence to prove my conclusion, perhaps try the same experiment but with other types of plants, to make sure that each plant follows the same rule. It could be that for another type of plant light intensity doesn't affect the plant, or it affects it in a different way.