Biology Coursework : How light intensity affect photosynthesis.

Plan

Photosynthesis is the chemical process, which takes place in every green plant to produce food in the form of glucose. Plants use water and carbon molecules and the suns energy to join together to form glucose, which is sent around the pl ant to provide food. Cells in the root or stem can use the glucose to make energy, if the plant does not need to use all the glucose immediately then it is stored which is difficult because glucose is hard to store in water. Plants have adapted with this p roblem by joining hundreds of glucose molecules together to make a starch compound. Starch does not dissolve in water very well so it makes a better food store.

Photosynthesis takes the palisade mesophyll cells in the leaf of a plant. It is these cells that contain the green chloroplasts and are very well adapted to their task. They are near the upper side of the leaf where they can obtain the maximum amount of light, they are packed very closely together and contain a green pigment called chlorophyll, and these absorb the sunlight and therefore help greatly to the production of photosynthesis. The cells are arranged like a fence, these help the energy entering the surface (top) of the leaf to travel a long way through the palisade cells. To obtain the most sunlight as possible, leaves have a large surface area and the more sunlight the plant receives, the better it can photosynthesise.

Glucose can provide energy or carbon, which can develop other molecules in the plant. The chemical equation for photosynthes is is:

$$\text{Carbon dioxide} + \text{Water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose and Oxygen}$$

$$6CO2 + 6H20 = C6H1206 + 6O2$$

My aim of this investigation is to fin d out whether light intensity on a plant affects the rate at which it produces photosynthesis.
The experiment has many different independent variables such as:

- **Light intensity**: The higher the amount of light the faster the rate of photosynthesis.
- **Temperature**: Will probably cause enzymes and cells in plant to denature at points of 45 °C.
- **Carbon dioxide concentration** : The higher the amount of carbon dioxide the greater chance of a faster rate of photosynthesis.
- Size of leaves: If a plant acquires a larger le af, then it gains a larger surface area to gain energy in form of sunlight therefore producing a faster rate of photosynthesis.
- **Volume of water**: Photosynthesis rates vary under different volumes of water.
- **Amount of time kept under a certain condition** : Rate of photosynthesis will vary if kept at different time length periods.

I will choose to vary the light intensity but keep all other variables the exact same. They will not be changed. The temperature will be kept at 37 °C (normal room temperature); the car bon dioxide concentration will be kept constant by the addition of the compound, hydrogen carbonate (HCO_3^-) which contains the essential amount of carbon needed for the plant. This is done because if the carbon amount is too low then the process of photosy nthesis cannot occur effectively. But if there is too much then this too will cause problems to the life of the plant, so a 'pinch' of hydrogen carbonate must be used.

I will use a water plant (Canadian pondweed) as these types of plants can easily survive in water and this will be necessary for my experiment. Otherwise any plant that could not survive in water would die and therefore not be suitable for my experiment.

The size of the leaves will be similar but I will attempt to keep all leaves equal in ar ea and volume. This is so then photosynthesis can occur equally as if there is a bigger leaf then that particular leaf has a greater probability of obtaining sunlight for photosynthesis due to its surface area.

The volume of water will be at …….. cm^3 this is to ensure a fair test. The amount of time I will conduct my investigation for is 1 minute per experiment, this is for a fair test and so no unreliable results occur.

There are a number of possibilities onto how I could record or do the exper iment. Here are my assumptions:

- **Growth**: I could measure how much the plant grows, but then again this will take too long and therefore is unsuitable for a short experiment.
- **The amount of oxygen produced:** again this will take too long for a short -term experiment. Although it is quite reliable
- **Rate of bubbles produced:** This measure the amount of bubbles produced from the plant, and is counted.

I believe the idea where the rate of bubbles is counted is the best idea for this short experiment. I would use the others but they are too much time consuming, although reliable and probably effective. When I change the light intensity I will measure the rate of photosynthesis

I will do five different experiments at different light intensities and each experiment will be repeated three times each, therefore enabling me to derive an average and also a total of fifteen experiments. Before I do my experiment I will make sure that I leave the light source on the plant a minute before so photosynthesis is ready to begin, the refore this will produce a fair reliable test.

For this idea I will need the following apparatus; a test tube, a plant (with leaves: Canadian pondweed), water, light source (lamp) which can vary its intensity, lightmeter, hydrogen carbonate (powdered form), meter rule (100 cm). An additional piece of apparatus which is a piece of material that will allow light to pass through it but absorb or block the heat so therefore the variable of temperature is kept constant.

Here is my following diagram of the apparatus:

My hypothesis is those if the intensity of light is increased then so will the rate of photosynthesis. Furthermore, I hypothesised that if the light intensity increases, the rate of photosynthesis will increase at a proportional rate u ntil 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 further effect on the rate of photosynthesis, as there will be another limiting factor, in this case probably temperature. The temperature may be too high which will denature the enzymes taking part in the process of photosynthesis. The chloroplasts will no longer be able to absorb any light so the rate will stay at its optimum level or even decre ase. At this point light is no longer limiting. Basically, if the light intensity is increased then the energy for photosynthesis is greater, therefore the more energy there is present on the plant the more effective the rate of photosynthesis will be as m ore energy is supplied to it.

The procedure was done as following;

- Set up apparatus as shown in diagram (Before apparatus is set -up cut the end of the Canadian pondweed off. This is so the oxygen bubbles are able to rise to the top of the test tube and therefore be recorded).
- Turn on light source (lamp) at suitable distance from plant, measured by the metre rule so it gives more accuracy.
- Measure light intensity by lightmeter and record observations on the face of the lightmeter.
- Next apply the light to test tube, with plant inside it (upside down) which is in water. The plant must be upside down because then the bubbles can be seen quicker and easily therefore resulting in a far more reliable experiment. Also the lamp may be moved up and down constantly so the light reaches the plant but it is preferred to leave the lamp alone. This is due to the fact that if you move the lamp then you are; then, changing its distance from the plant and therefore altering the amount of light intensity the plant rece ives which will make the experiment unreliable. Patiently wait until bubbles can be seen, then count and record total amount of bubbles until a given time limit (1 -minute) is reached.
- Record observations and repeat two more times and take average to g ive a concordant of reliable results.
- Continue until five light intensity results, which are repeated three times each, have been observed and recorded (also averaged). Record total amount for each experiment.

The following safety precautions had been considered; electricity from the light source and water from the test tube. It would be very dangerous if water and electricity would coincide with one another, as this would provide some injury to a student, as water is quite a good conductor. Another possible safety precaution is that the use of heat, as the light intensity increases then the heat output also increases, this may cause burns to students. Although they may not be significant burns it is still a possibility. After analysing the precautions I have concluded that the risk assessment is quite great.

Observations

Temperature of water: 21.6ºC

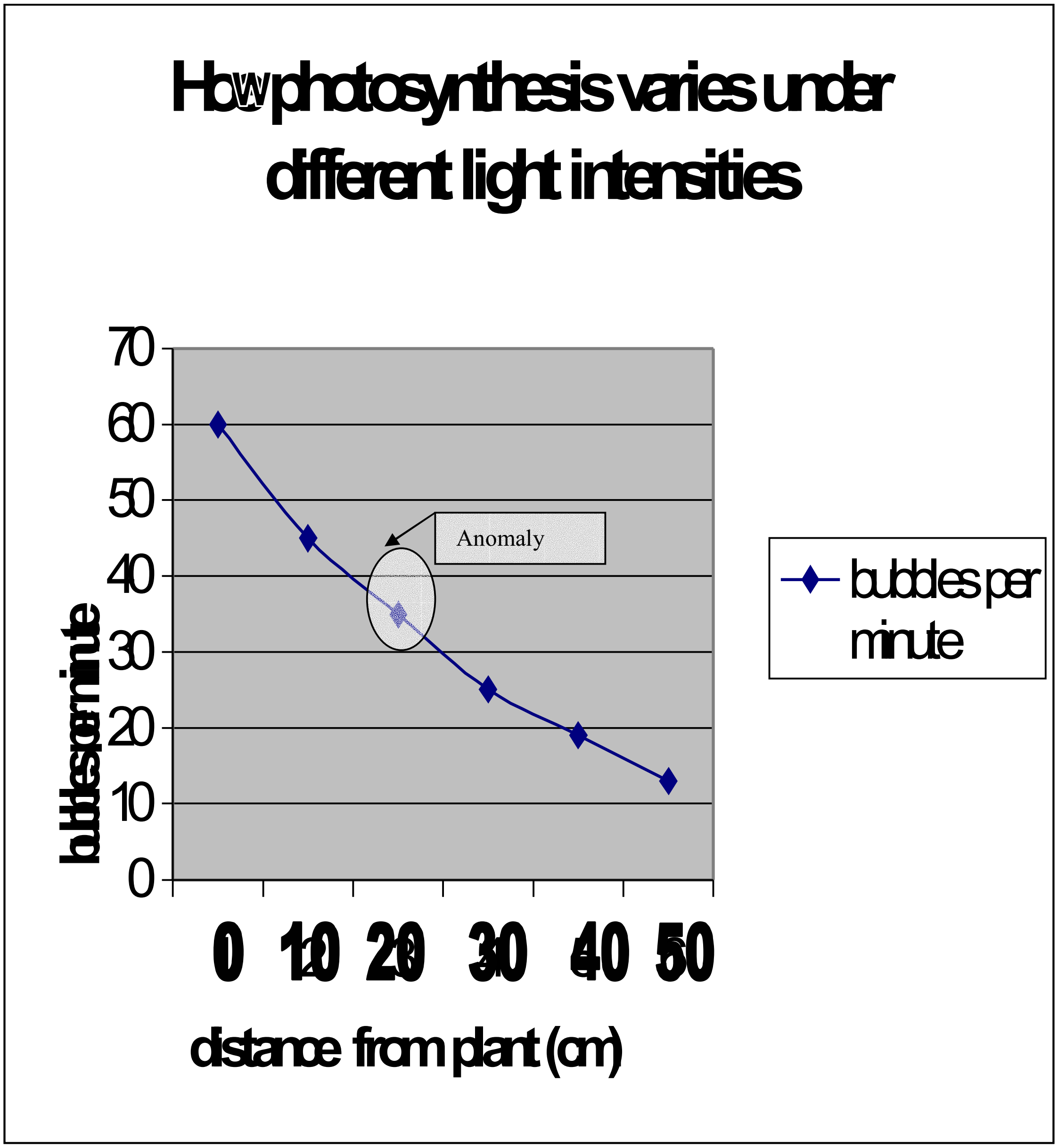
Distance from plant (cm)	Temperature (ºC)	Light Intensity (%)	Rate of bubbles (first attempt)	Rate of bubbles (second attempt)	Rate of bubbles (third attempt)	bubbles per minute (average)
0	26.4	65	61	60	60	60
10	23.8	64	49	45	41	45
20	22.8	63	46	36	34	35
30	22.6	89	23	24	24	24
40	2.5	84	20	19	18	19
50	22	82	17	13	13	13

Distance from plant (cm)	O B S E R V A T I O N S
0	Very fast rate of bubbles. About 1 bubble per second. The bubble sizes varied from large to small, although majority were small bubbles
10	Quite fast rate of bubbles produced mainly small bubbles with few larger sized bubbles.
20	Fast rate of bubbles, majority of small bubbles
30	Slow/average rate of bubbles. Slow at start but faster at end of experiment. All bubbles small sized.
40	Relatively slow rate of bubbles, all small sized.
50	Very slow rate of bubbles, plant matter also floating on top. Faster at end of experiment. Bubbles are all small sized.

Here are my preliminary results. I used these as a basis or guideline for my final assessment of the results, they were quite similar.

Distance from plant (cm)	Bubble per minute
0	72
10	61
20	45
30	22
40	9
50	2

Conclusion


How photosynthesis varies under different light intensities
Anomaly
70
60
50
40
30
20
10
0
0 10 20 30 40 50
distance from plant (cm)
bubbles per minute

I have found that when I increased the light intensity the rate of photosynthesis increased. Similarly, when the distance from the plant was increased, the light intensity became less, therefore the rate of photosynthesis decreased.

This is shown on the graph (above):

My graph shows that when the light intensity is decreased the rate of photosynthesis decreases. This is shown by the negative correlation on the graph. This is because when the light intensity is less then the amount of light energy, which is a vital factor in the process of photosynthesis, is also less. This then does not allow the suitable amount of light energy to be distributed to the chlorophyll, in the leaves, in the plant, which therefore does not produce a suitable quality of rate of photosynthesis (distances 30cm-50cm from plant).

However when the light intensity is quite great (at points 0cm – 20cm from plant) then the effect on rate of photosynthesis is great. There is more light energy supplied to the chlorophyll, in the leaves, in the plant, which therefore produces a higher rate of photosynthesis due to the presence of a greater amount of light energy. As I have mentioned before the light energy is a vital factor in the process of photosynthesis, so a greater amount will therefore have a greater rate of photosynthesis.

I noticed that the amount of bubbles for each of the first experiments (shown in table) were greater than the amount for the second and third experiments. There could be a possibility that the rate of photosynthesis decreases over a certain period of time.

The graph shows that a smooth curve is being formed until the point '20cm', this is an anomaly. Without this result the graph would relatively be a smooth curve (see graph).

The gradient of the whole of the curve is 42/50, which is equal to '0.84'.

The gradient for the points 40cm –50cm is 8/10, which is equal to '0.8'. This shows that the gradient is very similar to one another and therefore quite reliable.

The gradient for 10cm –30cm is 21/20, which is equal to '1.05'. This is not as accurate but is still fairly close to the whole gradient.

My results do match my prediction in the sense that when the light intensity increases so does the rate of photosynthesis. My predictions support this point.

But my predictions are not supported in the sense that the graph is not directly proportional between light intensity and rate but it is actually a curve. I believed it would be directly proportional but it is not.

Evaluation

The experiment I did was successful and it worked. Both the preliminary and the 'professional' experiments were quite accurate and similar to one another suggesting that they were reliable.

I believe my measurements were accurate because we repeated each experiment three times and took an average, which shows a degree of accuracy and reliability of the experiment. The amount of bubbles was counted carefully too, which shows accurate measurements. Also, whenever possible, if an anomaly occurred in one of the experiments then instead of taking the average of all three results I took the concordant value (two value closest together). Otherwise the whole average would be incorrect due to one incorrect reading; this further provides accuracy of the experiment and reliability of my conclusion. (For example the readings of my results for the 'distance of 50cm from the plant' are as follows; 17, 13, 13. I chose 13 to be the aver age as they are similar the first result is an anomaly).
Also I kept most variables (i.e. - carbon dioxide amount) constant and thus provided a fair reliable test. I used a lightmeter too for accurate results, which are to one decimal place.

I trust my conclusion as the overall experiment was done quite accurately and reliably with minimum error.

The result that was a bit high was the reading for '20cm from the plant'; (this is 'circled' on the graph) this is an anomaly. Another anomaly was in the first experiment for '50cm' from plant, as its value was too high compared to the remaining two results. This was dealt with easily as I took the concordant value.

There were anomalies because the reading of the bubbles could be incorrect due to human error. Also the amount of carbon hydroxide which was put in might not have been the exact same thus causing anomalies as this affects the process photosynthesis due to carbon dioxide being one of the main component for photosynthesis.
Another factor is that the Canadian pondweed I used was not the same one I used throughout the whole experiment. This would certainly cause anomalies as different plants have different abilities to produce photosynthesis.

The conclusion is reliable because I have quite accurate and reliable measurements with good scientific understanding applied to it.

My method was very good and it provided some very good results. If I re-did the experiment I would use the same plant throughout the experiment, use the exact amount of carbon hydroxide and also take an average after five results, therefore a total of twenty-five experiments.

An alternative way of measuring the same outcome variable is to use a manometer. This would have been much better and very accurate in measuring the rate of photosynthesis. This would overcome problems such as counting the bubbles and less chance of human error. The experiment would have provided very reliable results.

Here is a diagram of what I would do.