Light wavelength effect on the photosynthetic rate of elodea essay sample

Introduction:

The rate of photosynthesis varies greatly with changes in wavelengths of light. Light’s colour is determined by its wavelength of light, and thus it is possible to devise an experiment to determine which wavelengths of light are most productive for photosynthesis than others.

In this experiment I use a plant called Elodea (pond weed). Elodea is native to North America and it is also widely used as aquarium vegetation. The basic structure of these plants are whirls of leaves around a stem that form a chain of long segments connected to looks like pipe cleaners with usually a diameter of about half an inch or so, depending on the species of elodea plants. Silty sediments and water rich in nutrients favour the growth of American waterweed in nutrient-rich lakes. I use this plant because it will grow in a wide range of conditions, from very shallow to deep water, and in many sediment types. It can even continue to grow unrooted, as floating fragments.

The purpose of this experiment is to see under what conditions the elodea plants grow and photosynthesize the best. To accomplish this, the plants were subjected t different light colours (Blue, Green, Red and purple). This test will allow us to see which wavelength (colour) will allow the most light the elodea plant needs to flourish. Besides the light factor I also decided to put a 100 watt lamp above each plant so I get a high light intensity to speed up the rate of photosynthesis.

Aim:

The purpose of this experiment is to find out under what wavelength (different colour of light) the elodea plants are able to grow and photosynthesise the best. This experiment was consisted of 4 different colours of light, Blue, Green, Red and Purple.

Hypothesis:

I predict that the plant under blue and purple light will have a higher photosynthetic rate because according to the colour spectrum, they are of shorter wavelength thus they have a higher energy. The red light and green light will have lower photosynthetic rate because red light has a shorter wavelength (lower energy) and the green light is absorbed by the plants chlorophyll pigment.

Apparatus:

4 Ice cream containers

4 cellophane plastics (red, blue, purple and green)

4 100 watt light bulbs

4 Stands to hold the light bulb

Ph meter

Method:

1. Measure 500 ml of water using a beaker.

2. Measure the ph of water using the ph meter.

3. Fill each ice cream container with 500 ml of water.

4. Place the 10 cm segment of elodea plant in each container.

5. Cover each ice cream container with a cellophane plastic (purple, blue, green and red)

6. Place a stand next to each container; attach a 100 watt light bulb to each stand 20 cm above each container.

7. Plug the 100 watt light bulb into the socket and switch it on.

8. Measure the ph of water in each container after 5 days.

The above is the method I used for my first set of experiment. For my repeat experiments I made some changes.

In each experiment that I did 4 segments of elodea where used each segment was cut to exactly 10 cm long and each elodea segment was placed in an ice cream container covered with a different coloured plastic cellophane for the next 5 days.

In order to test the light colour effect on the photosynthetic rate of the plant I decided to cover the ice cream container with coloured cellophane, I chose four colours Green, Red, Blue and purple. I then filled each ice cream container with 500 ml of water and put above each container a 100 watt lamp attached to a stand distanced 20 cm from the container.

Initially I decided to measure the ph of water after 5 days but the results were not successful as you can see in my results table. I repeated the experiment, but this time I decided to remove the 100 watt lamp and instead of measuring the ph of water measure the number of bubbles on each plant everyday and on the fifth day the elodea segments were removed from the container, measured and recorded again to see the amount grown (in length) during the five-day period.

Some safety factors:

Make sure your hands are dry when plugging the lamp.

Keep the ice cream containers (filled with water) away from the socket.

Results:

I averaged the number of bubbles altogether eg I had 3 recordings for every colour per each set of experiments. I did 3 experiments so altogether I collected 9 results for every colour so I added all the 9 results and divided the outcome by 9. I also averaged the results for the length grown for each colour by adding all my results together and dividing the outcome by 3. Here are my averaged data results. (For my daily results refer to my log book).

Table 1: Light colour and the average number of bubbles per day.

Light Colour Average Number of bubbles

Blue 16. 89

Green 8

Red 10. 44

Purple 14. 56

It can be seen from this table that the blue colour group had the most average bubbles per day.

Graph 1: Light Colour vs average number of bubbles per day (Table 1. Graph)

Table 2: Light colour and the average length grown (cm) in five days.

Light Colour Length grown (cm)

Blue 1. 2

Green 0. 2

Red 0. 5

Purple 0. 9

It can be seen from this table that the blue colour group had the most average Length grown (cm).

Graph 2: Light colour vs length grown (cm), (Table 2. Graph)

Discussion:

In this experiment I wanted to find out in what condition the elodea plant can grow and photosynthesis the best. I first did some research on the elodea plants niche. I find out that the elodea plant is a genus of aquatic plants. It is native to North America and is an important part of lake ecosystems. It provides good habitat for many aquatic invertebrates and cover for young fish and amphibians. Waterfowl, especially ducks, as well as beaver and muskrat eat this plant. Elodea is a fast growing aquatic plant, it has a high photosynthetic rate and it leaves entirely under water but it can even continue to grow unrooted, as floating fragments.

Elodea often overwinters as an evergreen plant in mild climates (like New Zealand). Keeping that in mind I set up an experiment to find out under what light colour (blue, green, purple and red) elodea can photosynthesis the best. I did some research on different light wavelengths and found out that the blue light has the lowest wavelength therefore it has more energy followed by purple, green and red. So I predicted that the plants under blue and purple colour cellophanes will have a higher photosynthetic rate.

The results from my very first experiment were unsuccessful. I decided to measure the ph of water after 5 days to see if there are any changes in ph. I thought that the water in the container that had plant with the highest photosynthetic rate would become acidic because more carbon dioxide is produced by the plant in respiration. I got the same ph 8 for all the containers. I also realised that my plants are dying because of the high temperature produced by the 100 watt lamp. So for my next set of experiment I decided to remove the lamp and instead of measuring the ph of water measure the length grown after 5 days and also the number of bubbles present on the plant everyday. (My second method was successful).

From the results that I collected in my log book for my second method it can be seen that the number of bubbles on the leaves of the plants generally decreased each day as the days passed. This is probably caused by the lack of oxygen and carbon dioxide circulation inside the ice cream containers. The ice cream containers were sealed for 5 days so the level of carbon dioxide in the container was probably not enough to sustain photosynthesis and therefore causing the plant to produce fewer bubbles.

Conclusion:

From this experiment, I can see that there is a significant variation in the effectiveness of different wavelengths of light upon photosynthetic rate. By conducting this experiment, I was expecting to see as I mentioned in my hypothesis a heightened photosynthetic activity using purple and blue light. This is because these colours contain more energy, for according to the colour spectrum, they are of shorter wavelengths, and the shorter the wavelength, the more energy is present. The data I collected and my graphs show that my hypothesis was right. The blue and purple colour produced a higher number of bubbles and the elodea segments under blue and purple colour length growth was also higher, as you can see in my results table. How ever the green light photosynthetic rate was lower than the red light photosynthetic rate. Green light has a shorter wavelength than the red light but it had a lower rate because chlorophyll, the photosynthetic site, reflects the green colour and absorbs all others. This explains why the Elodea plants are green.

As shown by this experiment, photosynthetic rate varies greatly depending on the different colours of light used. This is because different colours are determined by different wavelengths, and some wavelengths are shorter than others. Thus, these short wavelengths have more energy and thus are optimal for photosynthetic activity. Therefore varying wavelengths of light have drastic affects on the rate of photosynthesis.

In this experiment it happens to be the blue light, for it contains the most energy. It should be noted that I used a very dark blue cellophane colour; my purple cellophane colour was light so it is possible that if I used darker purple colour cellophane it might have produced a different results.

Evaluation:

My first set of experiment was not successful at all; I got the same ph (8) after 5 days for all the different light colours and found out that the plants were getting damaged from the 100 watt bulb. Because of this for my repeat I had to make some major changes, I removed the lamp and decided to measure the length grown in each segment of elodea after 5 days. And the number of bubbles on the elodea segment everyday.

From the results that I collected in my log book for my second method it can be seen that the number of bubbles on the leaves of the plants generally decreased each day as the days passed. This is probably caused by the lack of oxygen and carbon dioxide circulation inside the ice cream containers. The ice cream containers were sealed for 5 days so the level of carbon dioxide in the container was probably not enough to sustain photosynthesis and therefore causing the plant to produce fewer bubbles. What can be done to correct this is to poke small holes on the sides of the ice cream container; this will allow the air to circulate. This would then allow white light through but making the holes small and on the side of the container will reduce the amount of light through that is not of the colour group.

Another error that was in my experiment was the fact that the elodea plants were bought from two different stores. Because of this, the plants from one store can be of a completely different species than the plant of the other store. To eliminate this built in error, what can be done is to order the plants ahead of time so that one store does not run out of the materials and so there will not be a need to go to another store.

This data might only be valid on aquatic plants, so for the next experiment, the same tests can be applied to land plants that require soil. Then a comparison can be made between the similarities of aquatic photosynthesis and growth to that of terrestrial plants. Other follow-up experiments that can be done are to test other colours instead of the ones in this experiment like black lights and UV lights and light intensities of a wider range or an experiment to test the effect of temperature variations on the elodea plants.