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Biology course work

Aim: effect of different light intensity on the amount of oxygen produced by pondweeds.

Introduction:

Oxygenating plants can obtain the energy for synthesis directly from the sun's radiation. It is then used to build up essential organic compounds from inorganic molecules. Such organisms are called photosynthetic and possess special pigments, which can absorb the necessary light energy. Photosynthesis is the source of energy and organic materials for other organisms besides plants. So it can be seen that the ultimate source of all metabolic energy is the sun and photosynthesis is responsi ble for the maintenance of life on earth.
Photosynthesis in green plants is the process in which energy from the sun is transformed in to chemical bond energy in organic molecules. It is a process in which energy is transduced from one form to another and results in the inorganic molecules, carbon dioxide and water, being built up into organic molecules. Oxygen is produced as waste product. In green plant, the first stable organic molecules to be formed in photosynthesis are simple sugars, which can be used as a source of energy or used in the synthesis of other organic molecules.

No photosynthesis occurs in the absence of light, respiration continues and the net gas exchange of a green plant will show uptake of oxygen and release of carbon dioxide. At very low light intensities, some photosynthesis will occur using the carbon dioxide released by respiration. As light intensity increases, so the rate of photosynthesis increases until the amount of carbon dioxide released from respiration is equal to the amount used up in photosynthesis. At this light intensity, known as the light compensation point, the rate of carbon dioxide production during respiration is equal to the rate at which carbon dioxide is taken up for photosynthesis. At light intensities higher than this there will be a net uptake of carbon dioxide and release of oxygen.
As the light intensity increases further, the rate decreases and then reaches a plateau, where further increase in light intensity has no effect on the rate of photosynthesis. At this stage, either another factor has

become limiting or light saturation has been reached. This is shown by the graph below.

Hypothesis

The amount of oxygen produced will be different in each pondweed as the light intensity changes. (Elodea crisper will produce more oxygen than Elodea denser and copa) this is due to the fact that the leaves of the crisper are curled giving it more surface area therefore light intensity doesn't have to travel far.

Null Hypothesis

There will be no difference in the amount of oxygen produced in each pondweed.

Pilot

Equipments

1. Glass jar
2. Measuring cylinder
3. Metre ruler
4. Bench lamp
5. Pond weeds

Safety Precautions

There is no chemicals used in this experiment or anything that will cause any danger, but make sure that a lab coat is worn at all time, handling the glass jar carefully and the funnel. Turning the light off when it is not in use, also when handling the scissor it should be handled carefully.

Method

The experiment involves the effect of light intensity on the amount of oxygen produced by three different types of pondweed. The reason that three plants are used than two is that one of the elodea produces more oxygen than the other two therefore one of them is used for control.
In this experiment a statistical test is used to calculate the rate of oxygen between the plants. The stats test that is used is t- test. The reason that this test is used is that it allows two of the pondweeds to be compared.
Before starting the experiment, the area of each plant is measured. To do this the leaf of the plant is drawn on a graph paper and the number of square is counted to get the area. Five drawings are done for each leaf to get an average area (this is shown on the graph). This is multiplied by the total number of leafs on the stem to get the area of the stem. After the rate is collected it is compared with the area of the leaf then a factor is worked out for each leaf to draw the graph and compare the leaves. This is to keep the area of the plant constant and make the experiment fare.

Fill the jar with water take one stem of one of the pond weed, cut the end of the stem and put it in the jar. Cover the weed with a glass funnel so that the bottom of the funnel is not immersed in the water. Measure a distance of 30mm (This is latter changed in to numbers 1 to 6 which is then used as the distance of the light intensity which is $1/d^2$). Therefore the distance between the lamp bench and the glass jar, which contains the leaf, is 30mm, make sure that the light is coming from the side. To start the experiment a set number of bubbles are timed. First pondweed to start with will be the copa because it produces less oxygen and it can be compared with the elodeas. The numbers of bubbles that are timed are twenty. The watch is started as soon as the first bubble is released and it is counted until it reaches twenty and the watch is stopped the time is collected in minutes at first and then converted in to seconds. This is done five times to get an average time, which is in seconds. After five readings the distance is reduced by 5mm and the new distance is now 25mm and the process is repeated again for another five readings. The experiment is repeated till the last distance is reached which is 5mm from the bench lamp. This is shown on the result table.

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Result

copa

Distance	1(5mm)	2(10mm)	3(15mm)	4(20mm)	5(25mm)	6(30mm)
Time in (min)						
1	1:10	1:24	1:40	1:53	1:59	2:05
2	1:09	1:20	1:25	1:56	2:08	2:24
3	1:07	1:22	1:32	1:50	1:56	2:14
4	1:10	1:24	1:31	1:50	2:08	2:10
5	1:11	1:27	1:30	1:59	2:00	2:02
Average	1:94	1:234	1:316	1:536	1:862	2:11

Elodea denser

Distance	1(5mm)	2(10mm)	3(15mm)	4(20mm)	5(25mm)	6(30mm)
Time in (min)						
1	0:16	0:21	0:20	0:11	0:12	1:08
2	0:15	0:23	0:19	0:18	0:17	0:59
3	0:12	0:21	0:21	0:27	0:22	0:57
4	0:13	0:22	0:21	0:38	0:32	0:58
5	0:17	0:22	0:21	0:22	0:28	0:45
Average	0:146	0:218	0:204	0:232	0:222	0:654

Elodea crisper

Distance	1(5mm)	2(10mm)	3(15mm)	4(20mm)	5(25mm)	6(30mm)
Time in (min)						
1	0:21	0:18	0:20	0:18	0:21	0:32
2	0:22	0:20	0:19	0:20	0:21	0:17
3	0:22	0:18	0:20	0:21	0:18	0:18
4	0:20	0:22	0:20	0:19	0:23	0:18
5	0:19	0:23	0:19	0:19	0:20	0:20
Average	0:208	0:202	0:196	0:194	0:206	0:21

The tables below show the average time in seconds and the distance of each pondweed before it converted in to intensity and rate.

copa

Distance	1	2	3	4	5	6
Time(sec)	116:40	74:04	78:96	92:16	111:72	126:60

Elodea denser

Distance	1	2	3	4	5	6
Time(sec)	8:76	13:08	12:24	13:92	13:32	39:24

Elodea crisper

Distance	1	2	3	4	5	6
Time(sec)	12:48	12:12	11:76	11:64	12:36	12:60

The result tables below show intensity against rate of each pondweed. Intensity = $1/d^2$ and rate = 1/time.

copa

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate	0:0086	0:0135	0:0127	0:0109	0:009	0:0079

Elodea denser

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate	0:1142	0:0765	0:0817	0:0718	0:0751	0:0255

Elodea crisper

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate	0:0801	0:0825	0:0850	0:0859	0:0809	0:0794

Ratio factor for each pond weed

The reason that a factor ratio is being found out is that the elodea denser has more leaves than the elodea crisper and the copa this giving it more surface area than the rest of the other two pond weeds. To do this the rate of the pond weeds are compared and a factor is being worked out. To get a factor the rate ratio of the smallest is compared with the other two.

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After getting the ratio it is either divided by the largest rate or multiplied to the smallest rate

Elodea denser	Rate	0:1142	0:0765	0:0817	0:0718	0:0751	0:0255
copa	Rate	0:0086	0:0135	0:0127	0:0109	0:009	0:0079
	Ratio	13	7	6	7	8	3

Average ratio of 1:9

Elodea crisper	Rate	0:0801	0:0825	0:0850	0:0859	0:0809	0:0794
copa	Rate	0:0086	0:0135	0:0127	0:0109	0:009	0:0079
	Ratio	9	6	7	8	9	10

Average ratio of 1: 10

From the average ratio it is seen that the ratio between copa, elodea denser and elodea crisper is 1:9:10 therefore multiply the copa by eight to make the same surface area as the other two.
After multiplying the ratio of the copa by eight the result will look like this.

Copa

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate	0.1216	0.108	0.1016	0.0872	0.072	0.0632

Elodea Denser

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate	0.1369	0.0917	0.0971	0.0862	0.0901	0.0306

Elodea Crisper

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate	0.0801	0.0825	0.0850	0.0859	0.0809	0.0794

Plan Rewritten from the pilot

The same plan is used from the pilot and the experiment is carried out. The result recoded as usual, this time only the average result is put in the result table and the rest is calculated. This is due to the fact that it already done in the pilot there is no need to show all the working out. As it is seen in the pilot there is a little change in the rate of elodea crisper no matter how much the light intensity changes. But it is still used in the experiment to show that there is something else that is affecting the rate of photosynthesis other than light. This will be explained in the evaluation. This will also allow me to do the statistical test, which is the t-test by comparing only tow of the pondweeds and is the copa and the elodea denser.

Result

Copa

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate						

Elodea Denser

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate						

Elodea Crisper

Intensity	1	0.25	0.1111	0.0625	0.04	0.0278
Rate						

Analysis

The graph shows that the rate does not fit in a straight line. This is due to the fact that most of the rates are concentrated at one area, making it hard to draw a straight line. But they are closer to the line of best fit. There are also some anomalies in the result, which will be mentioned in the evolution. The rate for the elodea crisper are all in the same area showing that there is something else that is affecting the rate of photosynthesis rather than light, this is also going to be mentioned in the evaluation.

The t-test is going to be used to analyse the result to see whether to reject the hypothesis or the accept it.

Number (n)	Copa x_1	X_1^2	Elodea Denser x_2	X_2^2
1				
2				

3				
4				
5				
6				

Total for each column
$\sum x_1 = 0.5533$
$\sum x_1^2 = 0.0536$
$\sum x_2 = 0.5326$
$\sum x_2^2 = 0.00614$

Mean for x_1 and x_2
$X_1 = 0.5533/6$
$= 0.0922$
$X_2 = 0.5326/6$
$=0.0089$
Mean squared
$(X_1)^2 = (0.0922)\ 2$
$= 0.0085$
$(X_2)^2 = (0.0089)^2$
$= 0.000079$

Calculating the variance (s^2)
$\sum x^2/n - x^2$

$S_1^2 = (0.0536/6) – (0.0089)$
$= 0.000033$

$S_2^2 = (0.00614/6) – (0.000079)$
$= 0.00102 – 0.000079$
$= 0.00094$

Value of $t = \dfrac{(x_1 – x_2)}{\sqrt{(s_1^2/n_1) + (s_2^2/n_2)}}$

$= \dfrac{(0.0922 – 0.0089)}{\sqrt{(0.000033/6) + (0.00094/6)}}$

$= 0.0833/0.0127$
$= 6.56$

This value is checked against the critical value for the t-test. The degrees of freedom for this investigation are calculated as follows:

$DF = n_1 + n_2 - 2$
$= 6 + 6 - 2 = 10$
Looking at the table the critical value at $p = 0.05$ is 2.23. Since the value of t is greater than this value, the null hypothesis is rejected.

Evaluation

The t-test shows that the hypothesis has been correct. The result for the experiment were not accurate as there were some anomalies this is shown in the graph as all the line did not fit in a straight line. This might be due to several reasons one being the fact that there were two anomalies in the rate of the elodea denser. The rate of distance two should have been more than the rate of distance three as it seen in the result distances two is 0.0917 and three is 0.0971 and also the rate of four and five. The one of distance four is 0.0862, which should have been more the one for five, which is 0.090, this is because at distance four the light intensity is stronger than at distance five. This might have been an error of recording down the time or the fact that there is something else that is affecting the rate rather than intensity of light itself. To correct this mistake in future accurate reading is collected. There is also the fact that instead of getting a straight-line curve there is difficulty in drawing the line, as most of the points are concentrated in one area. To make a difference in the future and for this to work the light intensity can be changed. There was also something else that was noticed during the experiment, the rate of elodea crisper was less than that of Copa and Elodea Denser and also they were closer together, it did not change much as the intensity changed. This due to the fact there is something else that is missing the rate of oxygen production (photosynthesis) rather than light intensity.
But as it is shown in the t-test the hypothesis is accepted and this shows that light intensity has an effect on the rate of oxygen production.
To get an accurate reading on the amount of oxygen bubbles produced different apparatus can be used which will give an accurate reading. The apparatus being photosythometer will give a quantitative result.
To set up the apparatus the plant will be supported by tying carefully to a glass rod using cotton, can be inverted in a large beaker full of water. The cut end should be no more than about 1cm below the surface of the water. When illuminated, a stream of bubbles should emerge from the cut end of the shoot. A pinch of sodium hydrogencarbonate is added to provide carbon dioxide and ensure it is not a limiting factor; the temperature can also be kept constant by using a thermometer. The syringe that is

connected to the capillary tube is filled with water. When it is re ady darken the laboratory and start with bench lamp close to the plant. Allow some time for the plant to equilibrate, and then collect the oxygen given off for suitable period of time. Using the plunger carefully draw the bubbles into the capillary tube so that the volume or the length of the bubble can be measured. This can be repeated different distances.

Bibliography: Genetics, Evolution and Biodiversity by John Adds