Factors affecting the rate of photosynthesis in leafs

ASSIGN BUSTER

Photosynthesis is the process in which light is converted to the chemical energy of sugars. It can be summarized in the following equation :

This process occurs in the chloroplast of plant cells which are primarily found in the leaves. Photosynthesis is the building up of sugars using carbon dioxide and water as the raw materials. The energy for the process comes from

light and a green pigment called chlorophyll allows the plant to

transfer the energy from light to sugar.

AIM

:

To measure the effect of light intensity on the rate of photosynthesis in leaf disc.

RESEARCH QUESTION

:

What is the effect of different light intensity on the rate of photosynthesis of fresh leaf disc when the other factors that can affect the rate of photosynthesis are remained constant?

HYPOTHESIS

:

As the distance of fresh leaf disc from the source of light is increasing (indicate the lower in light intensity), the time taken for the fresh leaf disc to

float on the surface of 3% sodium hydrogen carbonate will be increase indicate the decreasing in the rate of photosynthesis when the other factors are remained constant.

It is because photosynthesis is a light dependent process. At the low light intensities, this may become the limiting factor. Imagine light as a straight line which you can see with your own eyes. A plant typically has chloroplasts within their cells. So this straight line of light comes from the Sun, a natural source. It hits the surface of a green leaf. Firstly, is all of the light absorbed? No because some of the light is reflected off the surface and some light cannot penetrate the surface because it is the wrong wavelength. Most of the light gets in. Does that mean all of the light hits the chloroplasts? No because they are small, so some light rays will miss the chloroplasts all together. It is only the light which hit the chloroplasts which will be used in photosynthesis. So, for the experiment done with a shorter distance between the light source (bulb) and the fresh leaf disc, the leaf receives more light compared to that of longer distance. So there’s a higher chance more light will hit the chloroplasts and therefore more oxygen and glucose will be produced by the plant. This means the rate of photosynthesis has been increased. However, chloroplasts are sensitive, so if they keep getting hit by light energy, they will eventually become damaged and then the rate of photosynthesis will decline.

VARIBLES

:

Units

Range

Independent Variables

The distance of pineapple leaf disc from the bottom of light bulb/ light intensity.

cm

10-60

Dependent Variables

The time taken for the pineapple leaf discs to float on the 3% sodium hydrogen carbonate solution.

second

314. 4-1250. 4

Controlled Variables

Unit

Uncertainties

Possible effect(s) on result

1.

The number of leaf disc used for each experiment.

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—

To make sure the photosynthesis rate for all test is fair and equal within all test.

2.

Diameter of each leaf disc used

± 0. 5

The leaf disc is corked by using cork borer and kept constant so that rate of photosynthesis is fair.

3.

Concentration of sodium hydrogen carbonate.

M

—

To constant and make sure the rate of photosynthesis is fair and equal, and concentration do not be part of manipulating factor for rate of photosynthesis.

4.

Surrounding temperature of experiment.

°C

± 0. 5

To make sure the temperature is not too high and suitable for optimum rate of photosynthesis.

MATERIALS

:

No

Materials

Quantity

Volume / size

1.

Pineapple leaves

6

—

2.

Sodium hydrogen carbonates solution (3%)

—

240 ml

3.

Tap water

—

—

APPARATUS

:

No.

Apparatus

Quantity

Volume / size

1

Lamp

6

Standard size

2

New 10 ml syringes

6

10 ± 1 ml

3

Stopwatch

6

± 0. 05cm

4

Cork borer/hole punch

6

± 8 mm

5

Thermometer

6

± 0. 5 °C

6

Forceps

6

Standard size

7

Measuring cylinder

6

50 ± 0. 5 ml

8

Beaker

6

100 ± 10 ml

9

Meter ruler

6

± 0. 05 cm

10.

Marking pen

1

Standard size

11.

Marking tape

1

Standard size

METHOD

:

The setup apparatus was designed as shown above.

This experiment is done at room temperature of about 28 °C in the laboratory. Before other procedures are carried out, all the lights in laboratory are switched off to avoid interference which may affect the result.

The distance between the bottom of the light bulb and the surface of laboratory table is adjusted to 10. 0 cm; with the assumption that the surface of laboratory table represents the location of 10 pineapple leaf discs before the light is switched on.

10 ml of 3% sodium hydrogen carbonate is measured using measuring cylinder.

Then, the 10 ml of 3% sodium hydrogen carbonate is poured inside a 100 ml beaker.

From inside the beaker containing 10 ml of 3% sodium hydrogen carbonate, 10 ml of 3% sodium hydrogen carbonate is taken out using new 50 ml syringe.

Then, 10 of approximately 8 mm pineapple leaf discs is cut out from the pineapple leaf using cork borer/hole punch to give the same diameter for all

5 discs. Now, your thumb or finger is placed over the small hole at the tip of the syringe and its plunger is slowly pulled out.

After each disc is cut out, it is immediately transferred into the 50 ml syringe containing 10 ml of 3% sodium hydrogen carbonate solution. After all 10 pineapple leaf discs are transferred into the syringe; the plunger is pushed back inside the syringe.

With all the pineapple discs still inside the syringe and your finger or thumb is still at the small hole at the tip of the syringe, the plunger is pushed in and out to compress and expel the air.

After that, the content of the syringe was poured into the beaker which contain the rest of 3% sodium hydrogen carbonate solution; minimizing contact with air. The pineapple leaf discs are checked so that they are not on top of each other.

Then, the beaker is immediately placed right below the adjusted lamp.

The lamp is switched on and the stopwatch is started simultaneously.

The time taken for each disc to rise is recorded.

Steps 1 to 12 are repeated by varying the light intensity. To vary the light intensity, the distance from the bottom of the bulb to the pineapple leaf disc is varied to 20 cm, 30 cm, 40cm, 50cm and 60 cm.

DATA COLLECTION:

Distance of the beaker to the light source, d/cm (±0. 5cm)

Time taken for each pineapple leaf discs to float on the surface of 3% sodium hydrogen carbonate for Trial 1, t/s (±0. 1s)

Disc 1

Disc 2

Disc 3

Disc 4

Disc 5

Disc 6

Disc 7

Disc 8

Disc 9

10. 0

314. 4

346. 8

349. 8

353. 4

354. 6

354. 6

358. 8

360. 6

367. 2

20. 0

473. 4

480. 6

498. 0

512. 4

518. 4

518. 4

526. 2

527. 4

539. 4

30. 0

601. 2

647. 4

648. 6

654. 6

658. 8

674. 4

679. 2

684. 0

690. 6

40. 0

713. 4

718. 8

720. 6

724. 8

725. 4

729. 6

741. 0

741. 0

750. 0

50. 0

849. 6

889. 8

889. 8

901. 8

907. 2

907. 2

907. 2

929. 4

930. 6

60. 0

1080. 6

1100. 4

1135. 8

1153. 8

1164. 6

1181. 4

1189. 8

1189. 8

1206. 0

Quantitative Analysis Of Experiment

Distance of leaf discs from light source, cm (±0. 5 cm)

Observations

10. 0

At the edge of the leaf discs, some bubbles are seen after a few minutes. A lot of bubbles are produced and the leaf discs rise to the surface after a while.

20. 0

Some bubbles are released at the edge of the leaf discs after a few minutes. Then, one by one the leaf discs rises to the surface after a few minutes.

30. 0

Tiny bubbles are released at the edge of the leaf in a short period of time. After that, the leaf discs from the bottom to the surface.

40. 0

The leaf discs rises one by one and float to the surface after quite a long period of time. Bubbles are produced quite slowly at the edge of the leaf discs.

50. 0

The production of bubbles is slower and the leaf discs rises to the surface after a long period of time.

60. 0

The production of bubbles is very slow and the leaf discs rises to the surface after a very long period of time

DATA PROCESSING

:

The calculation of average time taken for the leaf discs to rise.

In order to get the time taken for the leaf disc to rise, an average reading from all ten reading needed to be calculate and the average will be used to calculate the average time taken for the leaf disc to rise. The calculation, are obeying formula as stated below:

Based on the formula above, the average time taken for the leaf disc to rise in respective temperature is calculated. The average time taken that has been calculated from above formula is shown below:

Temperature of surrounding/°C

Average time taken for the leaf disc to rise in respective temperature.

10

352. 74

20

513. 48

30

672. 72

40

731. 64

50

906. 06

60

1165. 26

Table 1: Calculation Average time taken for the leaf disc to rise in respective temperature.

Since we have calculated the average time taken for the leaf disc to rise in the surface of sodium hydrogen carbonate solution, the next step is to calculate the rate of photosynthesis of the leaf disc. The formula shown below is obeyed:

By obeying the formula as shown above, the rate of photosynthesis is calculated and the calculated rate of photosynthesis is shown below:

Distance of leaf discs from light source, cm

(±0. 5 cm)

Rate of photosynthesis of leaf discs,

s-1

10. 0

0. 002835

20. 0

0. 001947

30. 0

0. 001487

40. 0

0. 001367

50. 0

0. 001104

60. 0

0. 000858

From the above calculation, next we need to calculate the standard deviation of the rate of respiration photosynthesis of leaf discs in the different light

intensities, and stated as uncertainties if the average time taken itself. The calculation used is using GDC, by following these steps:

1.

First press button ‘ STAT’ then press button ‘ ENTER’

2.

Insert the data (in table 2) for 10°C temperature inside the table then press button ‘ ENTER’

3.

After insert the data press again button ‘ STAT’ then press ‘>’ to calculate

4.

Choose 1-Var Stats then press button ‘ ENTER’ twice

5.

‘ σx’ shows the standard deviation of the time taken for the indicator solution to change colour from purple to greenish for 10 °C temperature.

6.

Use all this steps for all the temperature (20°C, 30°C, 40 °C, 50 °C, and 60 °C)

The data of uncertainties calculated above, is shown below, as calculate:

Distance of leaf discs from light source, cm

(±0. 5 cm)

Standard deviation

10. 0

0. 000132

20. 0

0. 000086

30. 0

0. 000099

40. 0

0. 003900

50. 0

0. 003130

60. 0

0. 000038

The next calculation involved is calculation of light intensity, which relates the distance of light source from leaf disc, and obeying given formula:

And by obeying the formula as stated above, the calculation is as follow:

Temperature of surrounding/°C

Working calculation of rate of respiration

10

20

30

40

50

60

Table 2: Calculation of light intensity.

DATA PRESENTATION

:

DISCUSSION

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1.

When the light source is 60. 0 cm away from the surface of the sodium hydrogen carbonate solution, the average time taken for the leaf discs to rise to the surface of the sodium hydrogen carbonate solution is the longest, which is 1165. 26 s. This shows that the rate of photosynthesis of the leaf discs under this light intensity is the lowest, which is 0. 00086s-1 ± 0.

000038 s-1. When the light is further away from the leaf discs, the chloroplasts can only trap a smaller amount of light to carry out photosynthesis. Thus, when less light is trapped, the rate at which photosynthesis occurs will decrease.

2.

When the light source is 50. 0 cm away from the surface of the sodium hydrogen carbonate solution, the average time taken for the leaf discs to rise to the surface of the sodium hydrogen carbonate solution decreases, which is 906. 06 s. Hence, the rate of photosynthesis increases, which is 0. 00110s-1 ± 0. 00313s-1. With the light source closer to the sodium hydrogen carbonate solution, the chloroplast manages to work with a greater amount of light. This increase in light intensity increases the rate of photosynthesis.

3.

This trend repeats itself when the light source is 40. 0 cm away from the surface of the sodium hydrogen carbonate solution. With this increasing light intensity, the chloroplast manages to work with more light and this excites more electrons in the chloroplast and the whole process of photosynthesis occurs at faster rate which is 0. 00137s-1 ± 0. 00390s-1.

4.

When the distance of the light source from the surface of the water is at 30. 0 cm and 20. 0 cm, the rate of respiration increases with the rate being higher at 20. 0 cm away from the surface of the sodium hydrogen carbonate solution. The light intensity is higher at 20. 0 cm compared to 30. 0 cm away

from the sodium hydrogen carbonate solution. The rate of photosynthesis for 20. 0cm and 30. 0cm is 0. 001947s-1 ± 0. 000039s-1 and 0. 001487s-1 ± 0. 000099s-1. Thus, the rate of photosynthesis is higher when the distance of the light source is 20. 0 cm away compared to 30. 0 cm from the sodium hydrogen carbonate solution surface.

5.

When the distance of the light source is 10. 0 cm away from the sodium hydrogen carbonate solution, the rate of photosynthesis is at its highest level. At this level of light intensity, the leaf discs optimize the amount of light which it can use to carry out photosynthesis. The rate of photosynthesis at this moment is 0. 002834s-1 ± 0. 000132s-1. The process of photosynthesis takes the least amount of time to occur under this level of light intensity, thus it has the highest rate of photosynthesis.

6.

The number of leaf discs used in this experiment is kept constant for all the levels of light intensity. This is to make sure the competition for light remains the same for all levels of sodium hydrogen carbonate solution. Besides that, the level of sodium hydrogen carbonate solution in the beaker remains the same for all levels of light intensity so that all the leaf discs rise to the water surface by the same distance so that it will enable the calculations to be standardized. The temperature of the surroundings are kept constant for all levels of light intensity so that it does not cause any form of deviation in the sense that it will have an effect on the rate of photosynthesis.

LIMITATION

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1.

Not all the leaf discs are in good condition or fresh, causing difference in results of the experiment.

2.

The number of leaf discs used is not sufficient to measure the rate of respiration. The result obtained is not so reliable and the experiment took a long period to complete.

3.

There are other light sources that may affect the result of the experiment and cause it to be inaccurate.

SUGGESTION

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1.

Only fresh leaf discs that are in good condition should be used.

2.

The number of leaf discs used should be increased so that more results can be obtained and the average taken will give a more accurate measurement of the rate or photosynthesis.

3.

Conduct the experiment in a dark room which has a minimum source of light so that it wouldn’t affect the experiment.

CONCLUSION

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As a conclusion, when the light intensity increases, the time taken for the leaf discs to rise will be shorter, the rate of photosynthesis of the leaf discs will increase. This is because an increase in light intensity will cause more light to be absorbed by the chlorophyll in the leaf discs and thus, increasing the rate of photosynthesis. However as the light intensity continues to increase, it will have no more effect on the rate of photosynthesis, this is because other factors will become the factors limiting photosynthesis. The hypothesis is accepted.