Biology Coursework

Aim

Design an experiment to investigate if light affects the size of Ivy leaves

Plan

In this experiment I will explore how light affects the size of Ivy leaves. I will use the common Ivy called *Hedera helix*. I will take two stems of Ivy, one from the part of the garden that is exposed to lots of light, and one which exposed to little light. The Ivy leaves that are facing the south of the garden will have been exposed to high light intensities, whereas the leaves facing the North of the garden will have been exposed to low light intensities. Although the Ivy leaves are facing different directions they are still from the same soil system. I will take 15 leaves from each stem and draw around them onto squared paper. By doing this I will be able to calculate their area. I will then compare the average size of the leaves in high light intensities to the average size of the leaves in low light intensities. This should tell me if sunlight does affect the size of Ivy leaves.

Hypothesis

- **Null hypothesis:**
  - That light intensity has no effect on the size of the leaf
- **My hypothesis:**
  - The leaves are larger, because they have a higher intensity of light

I have chosen the above hypothesis, because plants cannot grow or live without photosynthesis ing.

Photosynthesis is the process of converting simple organic compounds (CO_2 and H_2O) into more complex organic compounds (glucose and oxygen), in plants:

$$\text{- Carbon dioxide + water} \xrightarrow{\text{+ Light}} \text{glucose + oxygen}$$

$$\text{-} \quad 6CO_2 + H_2O \xrightarrow{\text{+ Light}} C_6H_{12}O_6 + 6O_2$$

All plants photosynthesise, they all have chloroplasts, which contain the green pigment chlorophyll. For photosynthesis to occur there must be an energy source, and this energy source is light. It is the pigment chlo rophyll,

which traps the light. Photosynthesis takes place in the green parts of the plant, in particular the leaves. Since plants produce their own food via photosynthesis they are called autotrophs. Therefore, they are photoautotrophs, because their ener gy source is light.

In photosynthesis there are 2 main reactions that occur, the light dependent reaction and the light independent reaction. Obviously the light dependent reaction can only occur in light. The light independent reaction may not need light, but if the light dependent reaction does not occur, then the light independent reaction cannot occur, because the products of the light dependent reaction are needed in the light independent reaction.

- **Light dependent reaction:**

  - this occurs in the chlor oplasts
  - it makes ATP from iP, this is called photophosphorylation.
  - Water is split by photolysis to give H+ ions, which are picked up by the energy carrier NADPH
  - Light is what provides the energy. Therefore, the light energy excites electrons in chlorophyl l. This energy is used to generate ATP and NADPH, and photolysis makes H+ ions available for the light independent reaction.
  - Oxygen is also released from this reaction.

- Light independent reaction:

  - This occurs in the stroma
  - Light is not needed to provide the energy, because the ATP produced in the light dependent reaction is what produces the energy.

Light intensity must affect the size of Ivy leaves, because the rate of photosynthesis increases as the light intensity increases. So if the rat e of photosynthesis increases, the size of the leaves must increase. Plus light can be a limiting factor in photosynthesis.

Another reason why I think that the ivy leaves in higher light intensities will be bigger, is because of phototropism. Most plants show this. It is when a plant grows in the direction of light, as they will turn to face the light. Therefore plants seek out light, because they need light in order to live, photosynthesise and grow.

Furthermore, the chloroplasts, which contain chloroph yll, which is needed for photosynthesis, always migrate to where the light is. It does this because the light is needed for photosynthesis, which will make the plant bigger. This is why most chloroplasts are found in the leaves. So if they are found in the leaves, most growth will occur here.

As well as this, the stomata will only open in light; this is why they close at nighttime. The stomata are needed to be open, so that the carbon dioxide can enter, which is used in the process of photosynthesis. Ther efore, if they are only open in light photosynthesis can only occur in the light, so at a higher light intensity, more carbon dioxide should enter, so that more photosynthesis and growth can occur.

Lastly, in plants there is a source and a sink. The sourc e will make the glucose, needed for photosynthesis (and therefore for growth to occur), which is stored in the sink. In most plants the source is the leaf and the sink is the flower, but in Ivy plants both the source and the sink is the leaf. So the leaves must be bigger in higher light intensities, because more glucose will be made, at a faster rate, than in lower light intensities, and because the leaf is both the source and the sink, the leaves must be bigger.

Therefore, I have come to the conclusion that light must affect the size of Ivy leaves. So I think that the leaves which have been in higher light intensities, will be larger than the leaves that have been in lower light intensities, as energy in the form of light (photons -measures in Lux) is nee ded for photosynthesis to occur, and photosynthesis must occur to provide a plant with energy, so it can grow.

Equipment:

- Ivy branches
- Scissors
- Pencil
- $1mm_2$
- gloves
- pH meter
- Data logging light meter
- Ruler

Method

1) Using the ruler measure 50cm from the tip downwards on the Ivy stem/branch, which has been in a high light intensity, and cut off a leaf. Carry on cutting leaves close to this point, until you have 15. I have chosen to pick 15 leaves, because it will give me a large enough sample to perform a stat istical analysis.

2) Draw around the 15 leaves you have cut, onto $1mm^2$ paper. Once I have drawn the leaves onto the paper, I will count the squares that are more than $50^{\%}$ covered by the leaf. This should give me the area of each leaf.

3) Repeat the above to st eps for the Ivy leaves that have been exposed to a low light intensity.

I predict that the Ivy leaves that have been in a high light intensity to be bigger.

I will work out the mean and standard deviations of the two separate sets of data. I will then compare the standard deviations. A large result for the standard deviation will show that the data is spread over a larger range.

To analyse the information I will first determine whether the graphs are 'normal' or skewed. If the graph is normal I will perform a T-test, but if they are skewed I will do a Mann Whitney U-test.

After the tests have been performed I will be left with a number (P), from which I will decide whether the data is significant or not. If P is equal to or smaller than 0.05, my data is significant, and this will mean that light intensity does affect the size of Ivy leaves. However, if the result is bigger than 0.05 the data isn't significant, and so light does not affect the sixe of Ivy leaves.

Safety

There are no major safety risks in this experiment. the Ivy I am using isn't poisonous or irritant, however, some people can be allergic to Ivy sap, so I will wear gloves throughout the experiment.

The experiment will be ethical, because I am not using an endangered species of Ivy, as I am using the common type, *Hedera helix*. So the ecosystem of the habitat will not be affected.

Variables to be considered

- The independent variable in this experiment will be the amount of light each leaf gets. Although I will take the leaves from the same stem/branch, each stem will have been exposed to different amounts of light. For example the leaves on the top of the stem will have had lots of light, whereas, the ones underneath will have had less light, due to the leaves on top blocking the li ght, and therefore, providing shade. (to overcome this problem I will be taking the leaves near the tip and surface. I will try to pick the ones that are near to each other, yet have been exposed to a lot of light i.e. they haven't had a lot of shading from the other leaves I have removed.)

  Also each set of Ivy leaves (high light intensity and low light intensity) will have been exposed to a different amount of light. The Ivy leaves in the garden that were facing South will have been exposed to a lot more light than the ones facing the North. I will measure the amount of light using a light meter, and this measures light in units called Lux.

- The dependent variable in this experiment will be the size/surface area of the leaf, because this will depend on t he amount of light the leaf has been exposed to.

There are some limitations to controlling the variables in this experiment. to ensure that this test was very fair, ideally you would grow the Ivy in the same soil system, with one half of the plant in brig ht light, and the other in dim light, but this isn't feasible, it is too time consuming. To try and overcome the problems I will choose the same species of Ivy plan, grown in the same garden, in the same area and same soil system. I will also pick the leaves from the same stem site. However, the temperature, wind exposure and the amount of light each stem will have had will differ. The leaves nearest to the tip will have had the most light, and the ones nearest to the bottom will have had the most shading. The ivy leaves that are south facing will have had the most light, and so will have been in slightly higher temperatures, compared to the North facing Ivy leaves. Also the North facing Ivy leaves will have probably been exposed to more wind as well.

The following are some variables that I can control throughout my experiment:

- **PH and Moisture:** I will be taking the Ivy leaves from the same garden and from the same soil system. Therefore the pH and moisture of the soil should be the same. I will also check the pH using a pH meter. The soil that the Ivy leaves are from is very sandy, and they will have been exposed to the same moisture levels (since they're from the same soil)

- **Maturity of leaves:** some leaves will be older than others, and this could make my test unfair, because the older leaves will probably be bigger anyway. Therefore, to ensure that the leaves are of the same age I will pick my leaves from the same stem and 50cm from the tip. This means that the leaves will all be quite young, if they are from near the top/tip, as the leaves nearer the bottom are older. This will also ensure that they haven't been blocked from light by the other leaves, as much, and so they will have had maximum exposure to light. However, I am not taking the leaves straig ht from the tip, because they will all be too young, and if taken straight from the bottom they will be too old.

- **Accuracy of measurement:** I am going to take 15 leaves from each set of Ivy. This means I will have I will have enough leaves to carry out a fair and statistical test. If I choose less than 15 leaves I wont have enough to carry out a statistical test, and if I choose more, it will be too time consuming. When I have drawn the leaves onto the squared paper I will count how many squares the leaf has covered. I will only count the squares that are fully covered, or have covered 50% or more of the square. This will ensure that all the leaves have been measure accurately. The squares are 1mm ^{2} by 1mm^2, to further improve accuracy.

- **Carbon dioxide and mineral concentration:** the concentration of both these will be the same for each leaf and each set of Ivy, because all the Ivy will be from the same garden, the same area and the same soil system, and so the concentrations are bound to be the same, or at l east very similar.