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Factors that affect the growth in duckweed.

PLANNING SECTION

Introduction

For healthy growth plants need several substances. Three important mineral ions that can only be obtained from the soil through their roots are nitrates, phosphates and potassium. Nitrates are essential for making amino acids and for the 'synthesis' of proteins. Phosphates are essential as they have an important role in reactions involved in photosynthesis and respiration. Potassium is also important as it helps the enzymes involved in photosynthesis and respiration to work.

The three main minerals are needed in fairly large amounts, but other elements are required in much smaller amounts. Iron and magnesium are the most important as they are needed to make chloroph yll.

Without photosynthesis, along with minerals, plant growth wouldn't take place. Photosynthesis produces glucose for 'food' and takes place in the leaves of all green plants. Glucose is combined with nitrates (collected from the soil) to make amino acids, which are then made into proteins. Protein amino acid contains carbon, hydrogen, oxygen and nitrogen. Along with potassium, phosphorus and sulphur make up the important substances that travel through the roots and up the stem.

Photosynthesis needs carbon dioxide, water, light and chlorophyll to continue the process. Without iron and magnesium chlorophyll couldn't be made and therefore the plant would die.

Diffusion takes place in the leaves, through the stomata. The membranes allow substances in and out as particles from an area of high concentration move to an area of low concentration. This takes place in the example of NO4. There are excess amounts in the leaf and so it diffuses into the air, as there is less of it in the air outside.

The more nitrogen present in the soil means that there is more protein for the plant, which therefore makes the plant grow bigger, along with photosynthesis. I am going to investigate whether Baby Bio, a fertiliser containing NPK, helps the duckweed increase i n growth. I am using the type Lemma minor, which will absorb the NPK through its roots.

Aim

To investigate the effect of Baby Bio on plant growth.

Prediction

Once duckweed reaches a certain size it divides. The products of photosynthesis, such as gluco se, can be joined with amino acids to make proteins such as NPK. The phosphorus in NPK enables plants to make ATP (adensosine tri phosphate). If there is no phosphorus then ATP will not be present and therefore the plant will die. These chemicals are transported through the xylem vessels to wherever it is needed. The duckweed absorbs nitrates (NO3) and phosphates (PO4) through its roots, as they cannot take them from the air. They are both soluble in water.

Too much protein also kills duckweed as shown in the graph below. The graph is the shape of a sigmoid.

There are different stages in the growth of duckweed that go from A $\rightarrow$ F, and are joined by enzyme pathway. If there is too much nitrogen then it blocks the enzyme pathway, and the duckweed die.

If one magnifies the cell membranes of duckweed, the channels appear very small. However they are very selective as well and the cell membranes are semi-permeable. Osmosis and diffusion will take place in the petri dishes to try and get identical volumes of molecules inside the leaf, and outside. In my introduction I spoke about what happens in diffusion. Below is a diagram of what happens in diffusion and osmosis.

Whether water enters the cell by osmosis or not will depend on the balance between external and internal solute concentrations and the state of the cell. If the solutions on each side of the semi-permeable membrane are equally concentrated then there will be no movement of water across the membrane. This is called an equilibrium state.

The variables that can be changed are:

- Light
- Carbon dioxide
- Water
- Temperature
- Minerals

The factor that I am going to investigate is the NPK and I will use Baby Bio, as it is soluble in water. I am going to do a range of drops bel ow and above the stated amount of 10 drops. I will take 3 repeats of each result so that I can calculate the mean change and this will hopefully allow me to increase the reliability of my data. This will be measured once a week over a period of 3 weeks. I am going to take results from 6 different petri dishes, with different concentrations of drops. These will be 0 drops, 4 drops, 8 drops, 12 drops, 16 drops and 20 drops. The drops will be put into 500cm3 of distilled water, it'll be stirred, and then 10cm3 of the solution will be put into the petri dishes.

The recommended amount of Baby Bio is 10 drops so it would be possible to assume that any duckweed that is in a petri dish with less than 10 drops will grow slower than if 10 drops were used, and that any duckweed that is in a petri dish with more than 10 drops will die.

I predict that less than 10 drops of Baby Bio will not have much effect on the duckweed, and more than 10 drops will cause the duckweed to die.

I took some of this information from my CGP revision books, SAP's website and SAM Learning.

Apparatus

- 18 petri dishes
- Baby Bio
- 500cm3 Distilled water
- 2 Pipettes
- 1 Beaker
- Duckweed – Lemma minor

Method

- Take the duckweed from the water, dry it out using paper towels and weigh it on a small piece of paper towel – make sure the bit of paper is weighed first
- Put 500cm3 of distilled water into a beaker and add the amount of drops needed, starting with 4 drops and going up to 20 drops
- Stir it and then put 10cm3 of the solution in each pe tri dish for the 3 tests for each concentration of Baby Bio
- Do this for each concentration, making sure each dish is labelled
- For the next 3 weeks weigh the duckweed in each dish, making sure it is dried out before
- Keep a record of the results

Fair Testing

To try and keep this test as fair as possible I am going to keep the amount of water in the petri dishes the same. Also I am going to weigh the duckweed at the same time each week. The mass of the duckweed will vary in each petri dish, as it deemed quite hard to get the mass to be the same each time.

OBSERVING SECTION

Results

A table to show how the mass changed over a period of 21 days.

ANALYSIS SECTION

Conclusion

The results shown in the graphs are not very accurate. Ther e are big range bars situated on all graphs apart from 7 days, which seems to have the tightest set of results. The graphs for 14 days and 21 days are similar to my prediction graph. There is a sigmoid shape emerging, however it shows that the duckweed started to decrease in mass, or die, after 4 drops. In my prediction I stated that less than 10 drops of Baby Bio will not have much effect on the duckweed, and more than 10 drops will cause the duckweed to die. My results clearly prove my prediction wron g however the results are not particularly accurate.

There are 2 things that I think may be the reason why my results do not support my prediction. The first reason is because the duckweed didn't have enough carbon dioxide, which slowed down photosynthes is. Carbon dioxide is a substrate for the enzymes in a plant to work. The more carbon dioxide a plant has, the faster the rate of photosynthesis goes. Once the light intensity on a plant reaches its optimum level, the rate of photosynthesis can only be increased if the levels of carbon dioxide are increased.

The second reason is because the concentration levels in the duckweeds cells were not exactly right and therefore the cells didn't function properly. The cells could not get the same v olume of molecules inside the cell and outside therefore, diffusion was incomplete.

EVALUATING SECTION

Evaluation

The experiment did not go very well as my results did not support my prediction, which in theory they should have done. Therefore my results proved to be inaccurate, making the whole experiment also inaccurate. My method was very unsuitable and also unreliable. We did not have a reliable way of drying the duckweed, and the concentration of water was not kept the same throughout the experimen t. There are definitely a few things that could be done to insure the method is suitable and reliable.

The evidence shown in the graphs are not very reliable. In the first graph it shows the results for 0 days. This means that the graph cannot be teste d for reliability, as it is the start of the experiment. In the graph showing the results for 7 days, the sigmoid shape isn't present. All the range bars however, are fairly tight. In the graph for 14 days I do not have the results for 16 and 20 drops. A sigmoid shape can be seen, however the range bars are very big. At 4 drops, the lowest value is 0.143g and the highest value is 0.333g. Also on the graph for 21 days there is a big range bar at 0 drops, the lowest value is 0.020g and the highest value is 0.230g. When talking about the tightness of the range bars, we have to consider the mass at the beginning of the experiment. The duckweed have grown, however they seem to start to die at 21 days when all the results decrease apart from T1 at 8 drops, and T1 and T2 at 12 drops. They seem to be dying from the osmosis effect.

There is not enough reliable evidence to support a firm conclusion because our method wasn't very good. This is because:

- We didn't look at the duckweed at regular intervals
- We didn't sieve the duckweed properly
- We patted the duckweed dry – it squashes them + they die above 320C
- We had errors transferring the duckweed to the balance
- We weighed duckweed on wet filter paper
- The water evaporated, which increased osmosis

To improve the experiment we need to:

- Find a better method of weighing
- Use a fresh concentration of solution so that it will be constant
- Use filter paper to sieve duckweed
- Use forceps to transfer duckweed to dry filter paper on the balance, and then back to the petri dish

We could do the same experiment but instead of weighing, we could count the number of leaves. Or we could use squared paper to find the surface area by taking a sample of 10 or 20 – this would give a good range. Another way is to harvest 100 duckweeds, dry them in the oven, and then weigh the dry mass of the dead duckweed. We would weigh different samples from the same conditions every week. However, by taking more out, the duckweed left behind have less competition for nutrients. So we could put 100 duckweeds in 6 petri dishes with the same concentration and would prove to be more accurate over a period of 6 weeks. The fertiliser increases the growth up to a point. We could put the duckweed at the bottom of a graduating tube, fill it up with water, and measure the amount of oxygen each week.