

Investigating the effect of nitrate on cress plants

Aim

In this investigation the effect of nitrate concentration on the growth of plants will be investigated. This will include the finding of the minimum concentration to have a positive effect on the growth. The plants that I am going to study are cress and the nitrate that I will be using will be sodium nitrate.

Background information.

Plants have five requirements for living: -

Carbon dioxide, this is needed for photosynthesis.

Oxygen, this is needed for respiration.

Organic nutrients, a few plant cells make their own nutrients, such as glucose by photosynthesis.

Inorganic ions and water, all plants need these to grow and they are taken up by the roots and up the stem and soluble from soil water.

Water, raw material for photosynthesis and manufacturing osmotic potential of cells and support of the plant.

The factor that I am going to investigate will be how nitrates will affect how cress seeds grow.

Plants require nitrates to make essential amino acids. Proteins that are made from these amino acids are essential in cells because they are an important part in cell structure (plasma cell membrane). This means that plants need nitrates to grow. I think that because nitrates help a plant to grow, if I increase the concentration of the nitrate the growth of the plants will increase. I also think that there will be a limiting factor towards the growth, this will be the point when the nitrate will start to either inhibit growth or even kill the growth of the plant.

Nitrates are dissolved in soil water and passed into cells by active uptake.

Active transport is the movement of molecules or ions across a differentially permeable membrane against a concentration gradient. Energy is needed, in the form of ATP, to counteract the tendency of these particles to move by diffusion down the gradient. Cambridge advanced sciences, biology 2 page 5.

Active transport in plants happens in the root hairs. The water in the soil is relatively dilute and so it has relatively high water potential. The cytoplasm and cell sap in the root hair have a number of organic and inorganic substances in them for example sugars and proteins. Therefore ions such as nitrate diffuse down a concentration gradient, through the partially permeable membrane, into the cytoplasm and vacuole of the root hair.

Active transport is made possible by special transport proteins, which help move many inorganic ions from the soil to the root hair.

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Active transport can therefore be defined as the energy-consuming transport of molecules or ions across a membrane against a concentration gradient (from a lower to a higher concentration) made possible by transferring energy either into or out of the cell, depending on the particular molecules or ions and transport protein involved. Cambridge advanced sciences biology 1 page 59.

If the energy available from ATP is limited, then the rate of active transport is decreased and the transport molecules in the cell membrane will not be working to their full potential.

The large numbers of very fine hairs on the root thus increasing the surface area that is in contact with soil water, thus increasing the rate at which the ions and minerals are absorbed. However, these root hairs are very delicate and only function for a few days before being replaced by new ones as the root grows. When the nitrates move from the root to the xylem they a passive process called facilitated diffusion. This happens by,

The diffusion of a substance through protein channels in a cell membrane, the proteins provide hydrophilic areas that allow these molecules or ions to pass through a membrane that would otherwise be less permeable to them. Cambridge sciences biology 1 page 255.

Preliminary study

To find out what growing medium I am going to use for my investigation, I decided to do a study to see in what sort of growing medium my seeds will grow better in. I choose to use cotton wool and jay cloth to be my mediums; these mediums will be contained in petri dishes.

I will make sure that both sets of seeds will get the same amount of water and I will water them everyday. I took care to make sure that the petri dishes and the mediums were sterile because I don't want to have any mould to be established in my dishes. I left the seeds to germinate a couple of days, and then I checked to see which of my growing mediums were growing better. I found out that the cotton wool medium was better established and I think this is because there are more fibres in the cotton wool that are loose and can allow the cress to let their roots embed themselves into that the jay cloth, which has compressed fibres and very few loose fibres for the root hairs to embed themselves between.

I also had to be careful about which medium allows me to tease the seedlings out without any damage caused to the roots.

Therefore in my main study I am going to use cotton wool as my medium because the seeds grow more effectively in it because of the loose fibres and the roots aren't damages when I tease them out of the cotton wool and water can be held for a longer time.

Step by step of how I am going to do my investigation.

Step 1. Collect five petri dishes and seeds for my investigation. Place the cotton wool into the dishes – making sure that the depth is the same in the dishes for fair testing. Any more or any less could result in anomalies in my results.

Step 2. Make up the nitrate solutions using 1M of sodium nitrate and distilled water, using table below

Molar	Nitrate solution cm	Water cm
0.00	0	25
0.25	5	20
0.50	10	15
0.75	15	10
1.00	20	5

Fig.1

Step 3. Add the same amount of solution in each dish – labelling each dish with what concentration of nitrate is in each one.

Step 4. Leave for 4 days watering everyday so the seeds can germinate.

Step 5. When the seed start to germinate, I can then start to measure the rate at which they grow. To do this I must take out 3 cress seedlings at a time stretching them, (making sure I don't snap the end of the root), against a ruler and measure how long they are.

What equipment will I need?

Petra dishes – this will contain my growing medium, they are sterile so I will be able to avoid moulds becoming established and affecting my results.

Cress seeds – this is the plant that I am going to be investigating. I will be using 18 cress seeds during my investigation.

Nitrate solution – this will be varying in concentration and will be my independent variable.

Distilled water – to dilute the solutions.

My dependant variable will be length of cress seeds.

To make sure that all my results are fair I must be able to control my variables. This means I must be aware of what the environment is like around the petri dishes and what sort of light is available. This is because different photosynthetic reactions take place at different light intensities. All petri dishes must be kept together so they encounter the same environment. I must also make sure that there is not cross contamination, this means I must wash out the cylinders after making up the solutions.

Results table to show effect of nitrates on cress seedlings.

Length of seedlings cm

Nitrate solution cm	Water cm	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
0	25	1.0	2.0	3.0	4.0	5.0	6.0
5	20	0.8	1	1.5	2	2.3	3.0
10	15	0.1	0.8	1.0	1.4	1.6	2.0
15	10	0.1	0.1	0.2	0.3	0.4	1.0
20	5	0.1	0.1	0.2	0.2	0.3	0.3

Fig.2

Length of seedlings cm

Nitrate solution cm	Water cm	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
0	25	1.0	2.1	3.2	4.0	5.1	6.2
5	20	0.5	0.8	1.0	1.4	1.6	2.1
10	15	0.1	0.4	0.5	1.0	1.2	1.4
15	10	0.1	0.4	0.8	0.9	1.0	1.3
20	5	0.1	0.1	0.2	0.5	0.5	0.6

Fig.3

Length of seedlings cm

Nitrate solution cm	Water cm	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
0	25	1.1	2.0	2.9	4.0	4.9	6.1
5	20	0.3	0.5	0.6	1.0	1.5	2.0
10	15	0.1	0.3	0.4	0.9	1.0	1.4
15	10	0.1	0.2	0.5	0.6	0.9	1.0
20	5	0.1	0.2	0.5	0.9	1.0	1.2

Average Length of seedlings cm

Nitrate solution cm	Water cm	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
0	25	1.1	2.1	3.1	4.0	5.0	6.2
5	20	0.4	0.7	0.8	1.2	1.6	2.1
10	15	0.1	0.4	0.5	1.0	1.1	1.4
15	10	0.1	0.3	0.7	0.8	1.0	1.2
20	5	0.1	0.1	0.3	0.5	0.6	0.7

Fig.5

how nitrates affect the growth of cress seeds

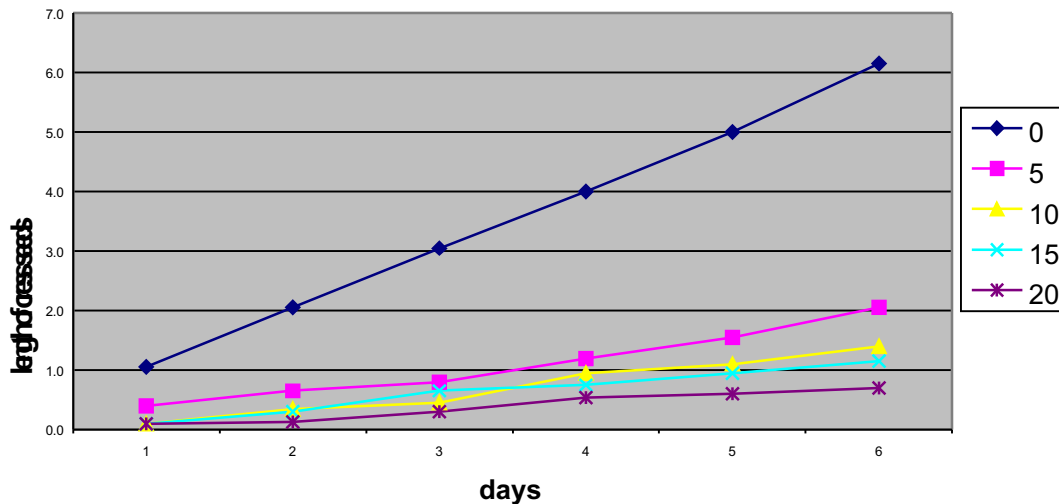


Fig.6

Conclusion.

The results from this investigation were significant in the respect that it didn't agree with my prediction. As the concentration of nitrate increased, the rate of growth decreases. A table and graph were produced using the data that I have found. Looking at the graph you can see that as I increased the nitrate concentration the growth of the seeds went down. The slope of the graph shows that the growth of the highest nitrate concentration has the shallowest slope and the slope gets steeper as the concentration decreases. My graph (see graph paper) was drawn showing lines of best fit, this is a diagonal straight line through the origin. This shows the rate of growth from this I was able to calculate the gradient of the lines. The table below shows my findings.

Table to show gradient of lines on graph.

Concentration (M)	Rate of growth cm/day (gradient)
0	1.04
0.25	0.35
0.5	0.22
0.75	0.2
1	0.15

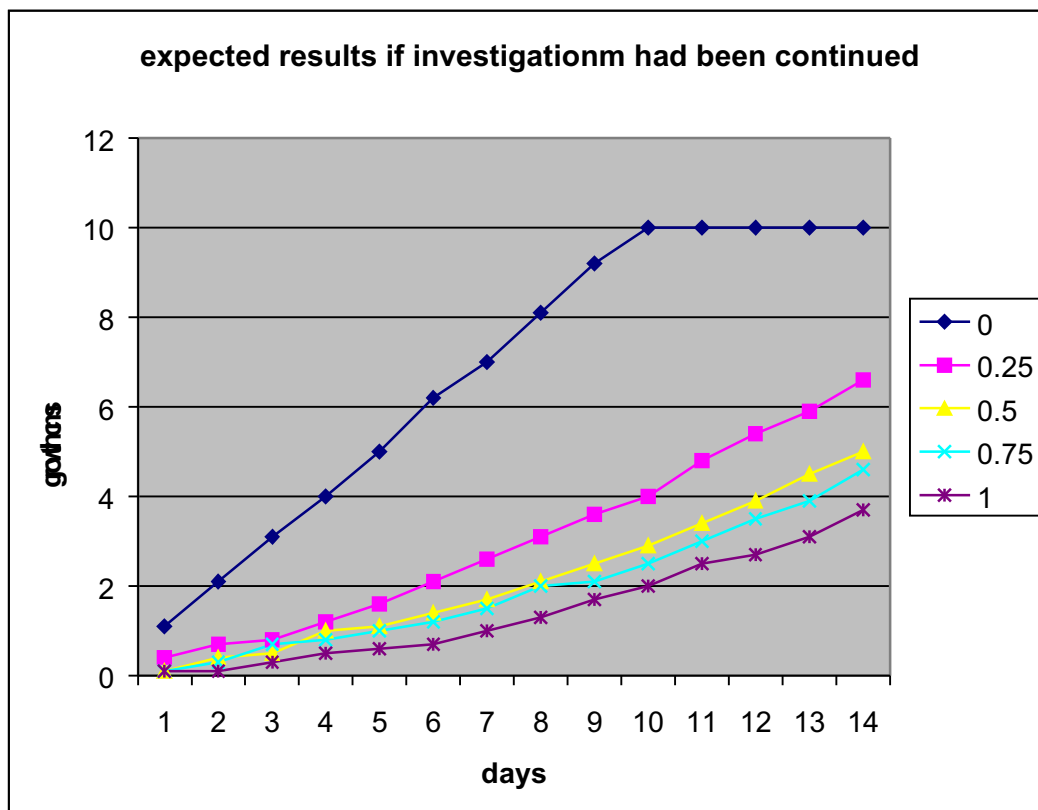
Looking at the rate of growth table I have found that the seedlings exposed to the higher concentrations is much slower than the seeds that have not been exposed at all. This may be because of a number of reasons, which I am going to list below.

- The internal food stores that contain energy are in some ways inhibited from being used by the seedlings by the high concentration outside the root hairs.
- The high concentrations outside the root hairs may make osmosis slow.

- The food stores in the cells may be inhibited and unable to open up and generate the energy needed for active uptake of the nitrate ions.
- In my prediction I stated that, *if the energy available from ATP is limited, then the rate of active transport is decreased and the transport molecules in the cell membrane will not be working to the full potential.*

I can also see that for the higher concentrations of nitrates the results look like there is a curve forming. This means that if I carried on my investigation I might find a growth spurt and see the seeds growing at an increased rate and the seeds that weren't exposed to the nitrate to level out in growth.

If I carried on my investigation this would be the graph that I would expect to find.



Evaluation

In my opinion I think that my investigation was a well thought out and planned one. There were no anomalies in this investigation. The method that was carried out was a safe one and I managed to get some good results to create a graph from. The errors of this investigation are that I may have not pulled the seeds tight enough across the ruler to measure them. Another error is that I may have pulled a part of the root hair off when I teased the seedlings out of the cotton wool. The results I got were good enough to create a graph that looks like there is a curve forming, looking at the second graph I have drawn on the computer, if I carried on my investigation for another 8 days the graph shows what the graph might look like.

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I think possible ways in which my investigation could be improved are;

- Wait for about 3 days to let the seeds germinate and start to grow. Then add the nitrate solutions.
- Try out different environments for the seeds to grow.
- Leave the investigation to carry on for about one month.
- Try and use smaller concentrations of nitrate solutions to find the inhibiting concentration.

I think that my overall conclusion was safe. This is because all my results were as accurate that I can make them. I realised about all the limitations that I have mention throughout my investigation and I cam up with a conclusion that didn't match my prediction because of the strength of nitrate solutions.

Bibliography

Cambridge Advanced Sciences – Biology 1
Cambridge Advanced Sciences – Biology 2