James Fung 12th November,2002

Biology investigation --- the effect of cubes taken at different distance from the centre of the root on the percentage increase in mass

Result

Distance from the centre of the root /cm (x)	Increased in mass / %			
	1	2	3	Average (y)
1	6.7	6.9	6.5	6.7
2	5.5	5.6	5.7	5.6
3	4.2	4.2	12.3	6.9
4	2.5	2.5	2.5	2.5
5	1.9	2.0	2.4	2.1
6	0.1	0.3	0.2	0.2

Fig.1

Analysis

In analysis the result obtained, I have drawn out a graph, Fig.1, which show that the information that I got was almost a straight line. This implies that as the distance of cubes taken from the centre of the root increases, the percentage increased in mass decreases, by considering individual distance, a same sort of pattern appears. When those cubes are taken from 1 cm from the root, they have an average of 6.7% of increased in mass, those taken at 2 cm from the root increased by 5.6% while cubes taken at 4 cm from the centre of root have increased by 2.5% in mass. In order to understand what happened, the knowledge in the movement of molecules has to be known.

Diffusion is the net movement of molecules or ions from a region of higher concentration to a region of lower concentration, i.e. the net movement of molecules or ions down a concentration gradient. However, normal diffusion is not available for substances travelling in or out of the root cells. This is because the cells are semi-permeable, so most of the molecules and ions are too big to pas through. But instead osmosis occurs.

Osmosis relates to the diffusion of water molecules moving down the water potential gradient. It is the net movement of water through a partially permeable membrane from a solution of less negative water potential (a dilute or hypotonic solution) to a solution of more negative water potential (a concentrated or hypertonic solution) until an equilibrium state (isotonic solution) is reached.

There are always some molecules and mineral ions dissolved insides the root cells. When the root cubes are taken from the root and placed into a beaker of pure water, we refer the solution inside the root cells as hypertonic solution no matter how many substances are dissolved as pure water has a water potential of 0, which is a hypotonic solution. When this is the case, water moves into the root cells by osmosis.

Take this a little bit further, this movement of water can be explained using the symplast pathway. The symplast pathway describes the movement of water via the cytoplasm by osmosis. Mineral ions are in very low concentration in the soil water, so they are absorbed by root hair by active transport across the whole root, which in turn makes the concentration of minerals inside the root higher. After active transport, the further in the cell is located, the lower the water potential it has, the higher concentration in the root means that the water potential is lower (more negative) than the water potential in soil. Water movement is driven by osmosis travelling into the root cell.

Now, bringing all the theory back to the experiment. When those cubes are taken out from the root, we expect the one which is the nearest to the centre of the root has the lowest potential while the one which is the further has the higher water potential. This means that when they are out into pure water, the lower the water potential of a cube, the more water it absorbs in a certain time interval.

Evaluation

In order to taken an average result, 3 values have been recorded throughout the whole experiment for each particular distance from the centre of the root. This is believed to be quite reliable. However, there are still sources of errors and limitations, which might have contributed to the inaccuracy. And they could be:

1) sizes of cubes --- although I aimed in cutting out the same size of root cubes each time, bigger or smaller sizes taken were unavoidable. When a smaller piece was taken, it means that the surface area of the new cubes is smaller comparing to the theoretically size. However, the volume of the new cube decreases by a bigger fraction. So the new cube has a bigger surface area to volume ratio and this increases the rate of osmosis and enables the cube to absorb more water

2) distance of cubes from the centre of the root --- if the distances were not accurate enough, the water potential would be different, which means that the amount of water absorbed might be different from expected

3) position of cubes insides the solution --- if some cubes were not completely sink insides, the topsides of those cubes might not be covered by water. And this could have reduced the percentage of water being absorbed

4) period of time for cubes to stay in solution --- it was difficult to determine exact time allowed for cubes to be in water, a lightly longer time in water may mean that a little more water absorbed

5) accuracy of scales --- scales used to measure the mass of the cube before and after were accurate to 2 decimal places, and this could be a minor limitation where the level of significance was not enough

With the theory of osmosis I described above, I reckon that what I found was quite similar to what I had learnt. Put aside that sources of error mentioned, by referring to the table, it is pretty obvious to notice an anomaly in the results, which I have highlighted in red.

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There is a general trend in decreasing in the percentage increased in mass down the column trial 1, 2 and 3 with the exception of 12.3%. and this has led to the abnormal average, which I have highlighted in blue in the table and circled in Fig.1.

If I had a chance to do the experiment, apart from just trying to reduce all the possible errors leading to inaccuracy, I would instead make a prediction first and always bare the knowledge of water movement in mind. Whenever an anomaly comes across, repeat that particular distance and prove that the result is an anomaly by contradiction.

The End