Investigating transpiration in celery

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Introduction

Transpiration is the evaporation of water at the surface of the spongy mesophyll cells in leaves followed by the loss of water vapour through the stomata. It is important in plants to not only transport mineral ions in the water since plants have autotrophic nutrition but also to provide the leaf cells with water for photosynthesis. Additionally, to keep cells turgid and help the plant cool down. To investigate transpiration in celery I hope to dye the water in which it is placed and base my conclusions on the fact that the areas of the plant which are coloured with food dye is the route that the water has travelled.

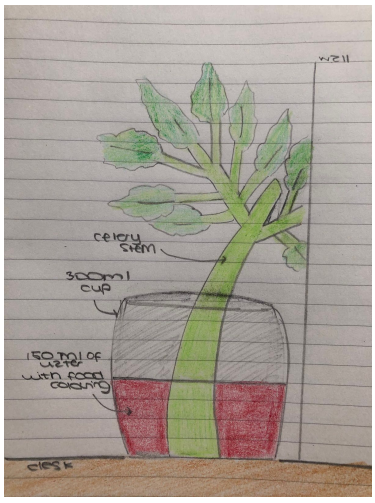
Aims

My aim is to observe the transpiration pathway in a celery plant.

Hypothesis

I think that water will be absorbed by cells in the bottom of the celery through osmosis. It will then be transported into the xylem vessels through which it will travel up the stem of the plant due to adhesion and cohesion. In the leaves, the water will move into the spongy mesophyll cells and will evaporate from their surface and leave the plant through the stomata. By using food colouring to dye the water I hope to see that the edges of the leaves are coloured since that is where the water has left the plant as water vapour as well as the xylem vessels inside the leaf since that is how the water travelled up the stem and lastly the bottom of the celery stem as that is where the water was absorbed.

Methodology



To investigate transpiration in celery I half filled two 300ml cups with water. I set up 2 identical experiments only with different coloured food dyes to make sure that they produced the same results and that my experiment was reliable. To be able to clearly visualize the route of water I added a few drops of red food coloring into one cup and blue into the other. I cut off the ends of two celery stems with a knife and placed them in the beakers. To help the stalks stand upright and prevent them from drooping I leaned them both against a wall. I left them in sunlight for 24 hours and then observed the colour changes.

Results

Part 1

Figure 1 (red dye)

Figure 2 (blue dye)

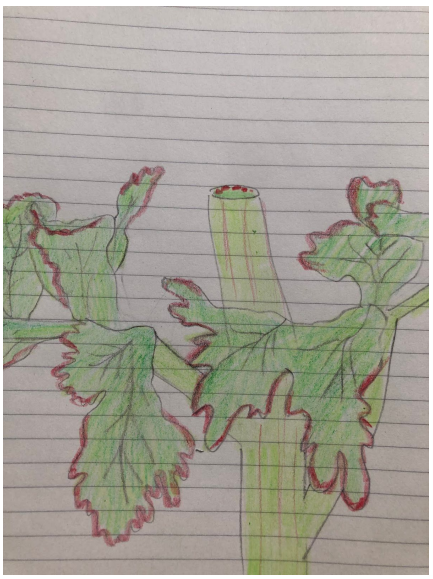


Figure 3

After 24 hours figure 1 and 2 show the appearance of the two experiments. It is very difficult to see on the pictures but like illustrated on figure 3 both the edges of the leaves as well as thin segments of the stalk appeared to be coloured with the dye. This shows that the water in the beaker was absorbed by the celery and transported through the stem in the xylem vessels and into the leaves where it left the plant.

Part 2

Figure 4 (red dye)

Figure 5 (blue dye)

Figure 6 (red dye)

Figure 7(blue dye)

I think that the red and blue food dyes in figure 6 and 7 highlight the xylem vessel. I think this because the xylem vessels are the only vascular tissues which transport water in plants. The xylem vessels contain dead cells which are arranged to form continuous vessels. They have a hollow central lumen which transports water and minerals throughout the plant. As the dye has been added to the water it travels

with the water along the stem and into the leaves through the xylem vessels which is what you can see highlighted in figure 4,5,6 and 7.

Conclusion

The coloured water in which the celery stems were placed was hypotonic to the cells which means that the external solution of water had higher water potential then the cells inside the celery causing water to move into the cells by osmosis. Osmosis is the net movement of water from a dilute to a more concentrated solution through a partially permeable membrane. This can be seen in figure 6 and 7 where parts of the bottom of the cross section have been dyed showing that water has been absorbed. Once the water enters the xylem vessels because of the suction created by water vapour being constantly evaporated from the leaf (transpiration) and the pressure being lower at the top of the leaf than the bottom water moves up the stem in the xylem vessels. Water is able to move up the stem of the leaf against gravity because of cohesion and adhesion. Water is a polar molecule and so the regions around the oxygen molecules have a slight negative charge while the regions around the hydrogen molecules have a slight positive charge. Because of the opposing charges the negative and positive regions are attracted to each other and held by hydrogen bonds. This property of water, called cohesion, made possible by hydrogen bonding in water is why the molecules of water are pulled up the xylem vessels. As one is evaporated another is pulled up from the roots creating a continuous column of water up the plant. Another property of water which allows it to move up the xylem vessels is adhesion also known as capillary action. Adhesion is what allows the water molecules to cling to the sides of the xylem vessels further allowing them to move up the stem against gravity. This ultimately creates what is called a transpiration stream which is the uninterrupted stream of water taken up by the roots transported to the leaves through the xylem where it then evaporates. Once the water has reached the leaves in the xylem vessels it passes out of the xylem into the surrounding mesophyll cells by osmosis as the water potential in these cells are lower. Some, although very little of the water transported by the xylem is used for photosynthesis, which is a process through which plants live and grow. The water then leaves the mesophyll cells and evaporates into the air spaces in the spongy mesophyll of the leaves. The water vapour then moves by diffusion which is the net movement of particles from an area of high to low concentration out of the leaf through pores in the lower surface of the leaf called stomata and is lost. The loss of water from the mesophyll cells creates a water potential gradient which draws water from surrounding cells by osmosis while receiving a continuous supply of water from the xylem vessels inside the leaf. This loss of water is referred to as transpiration. As can be seen by figure 1 and 2 as the edges of the leaves are faintly coloured with dye. This supports my hypothesis as I predicted that the water will enter the celery, travel up the stem in the xylem vessels and then evaporate and leave the leaf through the stomata.

Evaluation

I think that my results are reliable because they not only produced the expected outcome of the investigation but I also set up two experiments with different coloured food dyes, that were kept in the same conditions for the same amount of time and produced the same results. To extend the investigation however, I could have set up celery stems in different conditions varying perhaps the humidity, temperature or even light intensity to see how these factors affect the rate of transpiration.