What roots want

Gymnasium Thun-Schadau 17gAH

They are noiseless, unnoted and almost invisible in our daily life: roots. We nearly have the feeling that roots are useless and unnecessary. But they're one of the main organ of the plants which surround us everywhere. Imagine a meal without roots, you couldn't eat carrots, French fries or even sugar. These were just some examples, where you eat a root, but almost everything couldn't exist without roots, so you can see they are essential for every living organism.

In modern science they show us how plants can get their essential nutrient with complex processes. They use a carrier protein to transport ions against the concentration gradient. Notice that only 2% of minerals in the soil are available for roots, so the concentration of dissolved ions in the cells of a root is higher than in the surrounding milieu.(1) That makes it impossible to transportate the ions passive into the cells like they do with water, energy is necessary to keep this process running. This energy gets produced when an adenosine triphosphate changes into an adenosine diphosphate plus a phosphate-group.(2)

Guttation is caused by the roots pressure, which is necessary to maintain the water and nutrient supply of the upper part of the plant. Transpiration is another way to lose water, in form of steam. Guttation functions by the emission of liquid water, normally through hydrathoden which need the roots pressure to press out water through the leaves. Guttation normally happens when air moisture is high and transpiration doesn't work anymore. For tropical plants, guttation is very important because in the rainforest the air is very wet and warm, so transpiration is efficient enough.(3)

We thought about the root growth and we wanted to make experiments to see in which direction roots grow. It was our aim to research the behaviour of roots and see what they like and dislike. Roots dislike the sunlight and grow into the dark.(4) So we thought out an experiment about phototropism to check if it is true that root grow away from light.

The principle of gravitropism says that roots change the direction of their growing in the direction which gravity attracts them because they want to grow into the soil.(5) In a second experiment we checked if this process works, when we change the vertical direction of small plants.

Gravity

Methods

At first we attached a filter paper on a small glass plate. Then we wetted the filter paper and put ten cress seeds on each plate. After this we put them in a plastic box with some water on the bottom and let them grow for two days.

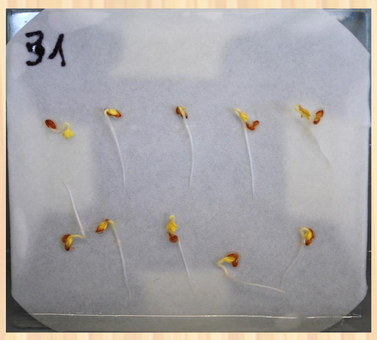


Figure 1: Cress seeds on a glass plate with filter paper

Valid for all the experiments:

We took 6 glass plates per experiment so this means there were 60 cress plants per experiment. Those 6 plates were laid in a separate plastic box. After two days we turned the glass plates by 90°.

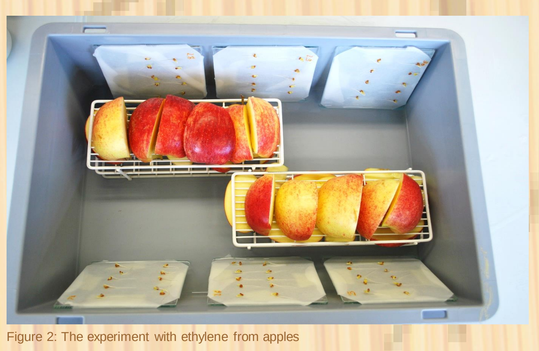


Figure 2: The experiment with ethylene from apples

Ethylen from Ethephon:
We prepared a 0.1% solution and covered the bottom with it. We closed the box with plastic film in order to make it air-tight.

Ethylen from apples:
We put some apple slices into the box without them to touch the water. We closed the box with plastic film in order to make it air-tight.

Cutting off the root tip:
We cut off 0.5 mm of the root tip. We did this with a razor blade under the microscope.

Normal:
Under the same conditions we didn't turn the glass plates to make sure that our results have a scientific value.

90°:
We didn't change the conditions.

3*90°:
We didn't change the conditions but we turned the glass plates two more times by 90° every 12 hours.

Figure 3: Final result from the cress seeds which we turned 3*90°

Results & Interpretation

All our experiments showed that the gravity of the earth has a big influence on the roots. We also realized that it is quite hard to affect the roots in their growth, but it isn't impossible.
We draw the conclusion that plants couldn't survive without gravity. They would grow in the wrong direction and couldn't get enough water and nutritive substances because the roots could grow in the wrong direction.

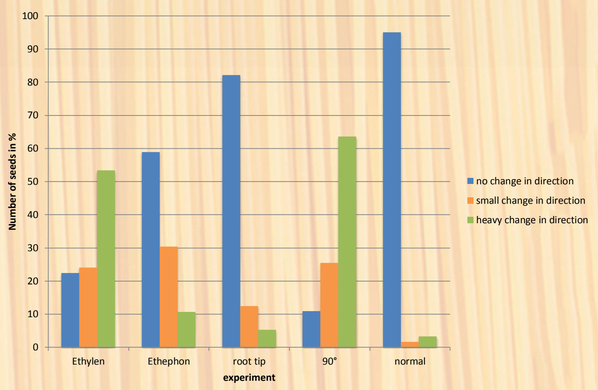


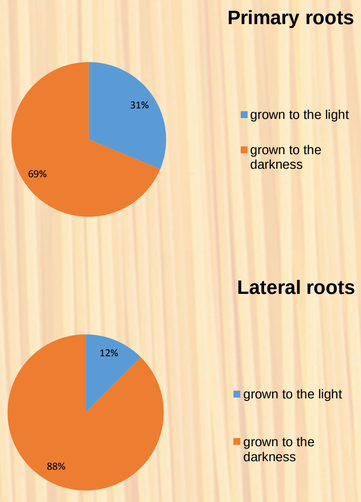
Figure 4: In the graphics you can see the different experiments about the gravitropismus with cress seeds. Each column shows the changes of the growing. Ethylene is produced by apples and Ethephon is a synthetic material. N=60

Darkness

Methods

We adapted our method from the book " Versuche zur Bewegungsphysiologie der Pflanzen" written by L. Browner and W. Rau. To make sure that the roots have enough water and can grow freely, we put 16 *Sinapis* seeds in beakers with water, and to make sure they stay afloat, they were put into little holes in Styrofoam. To assure that the light was coming only from one direction, we taped black cardboard to the beakers. Only a small stripe was left for the light to enter. The lights were put near the ground so the light could shine almost horizontally.
They were left to sprout for 12 days. For verification we also grew another 16 seeds in complete darkness.
Or controlled variables were the temperature, the moisture and the setup. Our independent variable was the light.

Results & Interpretation



There are 69% primary roots and
88% lateral roots which have grown into the darkness. The ones left in complete darkness for verification made a small curve to one side, then turned around to grow to the opposite side.

That means that not only the sprout can sense light, but also the root. The root is guided by gravitropism, growing downwards as a response to gravity, and by phototropism, growing towards darkness. That ensures that the plant gets the nutrition it needs from the earth.

Figure 5: A Sinapis seed that grew with horizontal light - the light was coming from the right

Figure 6: A Sinapis seed where the primary root grew to the ground and the lateral root grew to the light – the light was coming from the right

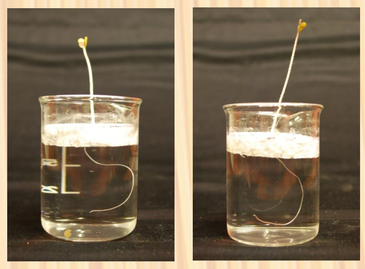


Figure 7 and 8: Two Sinapis seeds grown in the darkness for verification

Recources:

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