

Interactive sugar-piping

Until now it only went up. In the last 10 articles about transport and logistics in the plant we followed the water from the earth into the leaves; the roots absorb the water and via the stem it is transported up - this all done by the vaporization on the leaves. When the vaporization of the leaves continue, water is disappearing from the plant and leave a hole (underpressure). So the water is sucked up without losing energy and with one disadvantage, the direction of the transport is not variable: always from the roots (only here is an opening for water) to the leaves (only here water vaporizes).



With the water also the inorganic nutrition components like nitrogen, phosphor, potash and micro elements from the plant medium go into the leafs. Here, in the chemical factories in the leaf cells, the inorganic dead minerals are changed into organic matters, that give energy (sugar), catch light (leaf green), keep the plant stable (cellulose) or even fulfill active and independent tasks in the plant (enzymes and DNA). Or in the case of our plant, produce the oils, we desire so much.

Most organic matters are produced in the leaves, because the light is caught here. The light-energy

can not be transported over a long distance, which is why the place of production is close to the sources of energy.

So, the green parts of the plants always have enough organic material as long as there is light. But how does it work in the roots? They can not do photosynthesis because they are in the dark (and because of that they are not green) and have no chance on their own production of sugars and enzymes.

Doesn't a root need sugar? A root needs a lot of sugar, to grow continuously. In the beginning of this series 'transport and logistic in the plants' we already determined that as long as the plant is growing, the roots daily make new hair roots. To remind you: hair roots are the only connection of the plant to the outside world. Only by the hair roots the water and nutrition can be absorbed. Hair roots only live for a few days and have to be continuously renewed and this is done by the plant by growing a little. On that new piece of root grow new hair roots. The old hair roots shrink and die. So the connection to the outside is closed and a little bit more to the front re-opened.

This costs a lot of energy and because the root has no own sugar, it has to be fed by the other parts of the plant. This means a transport in the opposite direction, form the leafs to the bottom.

Clearly other ways of transport are needed.

There has to be a parallel piping system to guarantee a transport downwards, to provide the roots with energy of the sugars. And not to forget the stems. Here is a lot of growing, and elder plants have woody stems which are green but still active. Also here the energy has to be delivered as a sugar.

By a simple experiment (see picture 2) it can be cleared where the different pipes in the stems are located.

If a stem at the outside is cut around, the plant stays well for a long time and shows no shortages. On the other hand a plant with a completely cut stem would dry out and die.

The plant of the experiment is completely tended by the central cylinder with water and nutrition salts. So it will be stable and the photosynthesis is working and the plant can build up sugars.

Because of the injury at the outside the sugars cannot reach the bottom of the plant and the roots starve slowly. Then there can be no absorption of



water and the whole plant dries out.

The experiment clears two things: there are more independent systems of transport and the pipe downwards is around the central cylinder. The width of a sugar capillary is around one hundredth mm (10 µm). This makes the research of sugar pipes very difficult, because it is difficult to make a test. The solution of this problem is quite simple: we let the specialists help: green fly.

The green fly is capable to tap sugary pipes very precisely. If the green fly is just sucking, one cuts with a scalpel the proboscis of the green fly and the sugar juice is leaking for several hours, even days. In this way a sufficient amount of juice can be tapped for a decent analysis.

The composition of the energy juice: water and organic molecules, no salts.

90% of the organic molecules are sugar, mainly the same sugar that is in high concentrations in sugar beet and sugarcane and that we use for the coffee. The rest of the juice contains amino acids, but in small concentrations and large enzymes and also pieces of DNA.

The transport up and down is completely different.



The pipes of the evaporations exist of dead material. The sugar juice flows in pipes that exist out of living cell connections. The control force of the evaporation is a simple physical phenomenon, the control of the tending pipes are not easily understood and work 'intelligent'.

The sugar juice always flows from the place where it is produced to the place where it is needed. And the place where it is needed can change, for instance when the light is different and the plant has to grow into another direction. The plant adjusts the tending of sugar to every change from outside (also when the plant is injured) and it is guaranteed that only the healthy growing parts with enough energy are taken care of. The transport of the sugary juice costs energy (on the contrary to the evaporation) and active mechanisms of pumping can influence the rate of flow, depending on the needs. So there has to be a communication between place of production (leaf) and place of work (for instance root) possible to adjust the pipes actively to the new input. So they speak about a system of communication that connects with the whole plant.

In which way we can influence this supply of energy will be the theme of a next article.