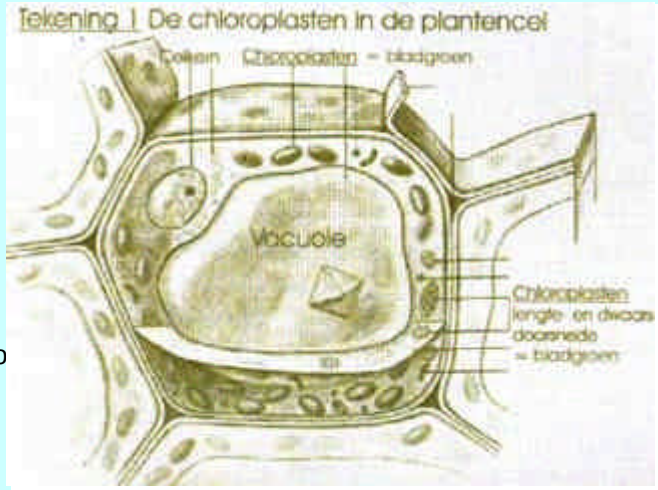
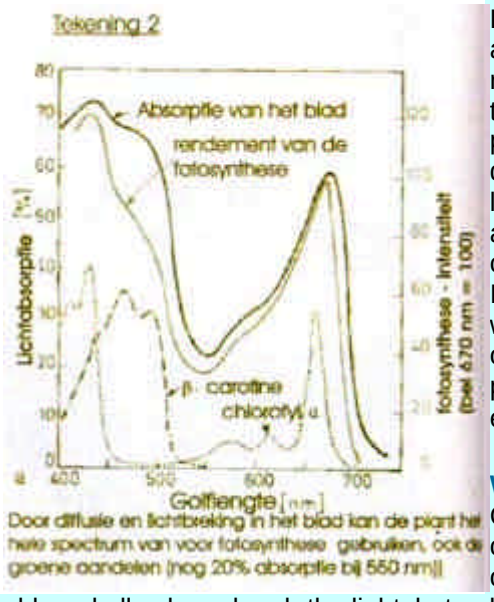
The powerstation of the plants

Nature has arranged the plants to grow. Sometimes human kind will stimulate or optimise the growing of the plant, and that is why you need knowledge about plants. For some time Siglinde explains in articles about transport and logistics in the plant, how a plant is put together and how it is functioning. In part seven Siglinde explains the power station of the plant.



The biggest difference between an animal and a plant strikes immediately. The plants are green, animals are not. The green plant-cell is full of little green parts, chloroplasts. These chloroplasts are filled with leaf green (chlorophyll) and other colors like carotene. When we break a plant cell open cautiously and isolate the chloroplasts in a test tube and irradiate it with light, after a short whil we can measure a decrease of the CO2-gas and an increase of oxygen and sugar (+ amylum). The chloroplasts have all kinds of help (enzymes) to not only catch the light of the cell but also to transpose it in chemical energy (sugar). The chloroplasts are the light- and force station of the plant. Only here photosynthesis takes place.

Photosynthesis means:
The force of light burns water. This produces energy that is used to build sugar or carbon dioxide. Oxygen is the residuary of the burning water and is expelled.
water + carbon dioxide + light = sugar + oxygen
The water is the fuel, carbon dioxide the building stone and the light the motor. If a green plant is illuminated with light, the chloroplasts begin to produce. This reaction can not be turned on and off by the plant, it just happens. But the plant can regulate the capacity to photosynthesis. It can control the supply and drainage of the CO2 and it can increase the surface of the leaf. And we can take care of the fact that the necessary building stones, the fuel and the motors are in perfect shape



Light, the motor of plants.

Last time, we heard that the color chlorophyll especially absorbs light that is not green. That is why the green light is reflected at the outside, and the plants look green. Actually the whole spectrum of visible light in the leaf is used by photosynthesis, the green parts too. The penetration by diffusion and reflection of light in the many cells changes the light in usable light portions. A plant has an enormous amount of chloroplasts (a leaf of 6 cm2 has 500 million chloroplasts with even more colors in it).
If you compare the change of CO2 and the emission of O2 with the amount of chlorophyll parts you can find that only one in 300 to 1000 leaf green molecules makes photosynthesis. Even when you raise the radiant intensity extreme, only 1:300 leaf green molecules are active .

What are the other chlorophyll molecules for?

Chlorophyll colors do not work for themselves but form color collectives that work together. Every collective has a centre of reaction (a certain chlorophyll molecule), all other chlorophyll colors absorb the light, but only give it to the direction of the light centre. The ‘surplus’ not active leaf green parts that serve as a light-antenna, light-intensifier and light-control. By these light-collectives is guaranteed that the plant can obtain also by less light enough photosynthesis and sugar construction, also called life energy.

A leaf with much light-radiation on top of the plant is smaller than a leaf that grows in the shadow, at the bottom of a plant. If we compare with a lux-meter the light-intensity on top of a plant with a part of the plant in the shadow, we can see that only a little bit of light reaches the plant.

A shadow leaf produces just as much sugar as a sun leaf. How is that possible? Figure model of the sugar production of a sun and a shadow leaf:
a sun leaf: A leaf of 5.6 cm2 uses per cm2 83 mg CO2 a day and produces 56 mg sugar per cm2. This is a total production of 317 mg sugar a day.
a shadow leaf: The leaf is bigger (15 cm2) and uses 36 mg CO2 per cm2and with this it makes 24 sugar/cm2. This is a total production of 317 mg/day.

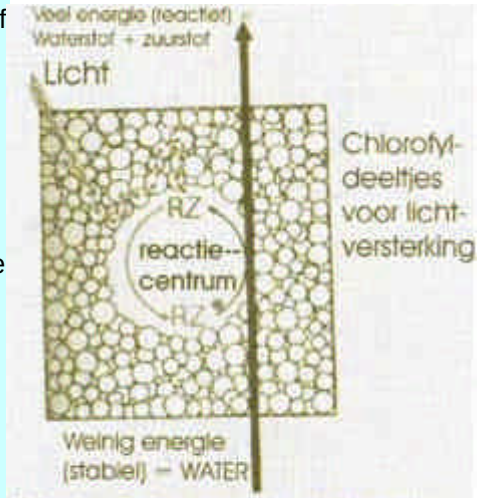
This shadow leaf produces even more sugar as the leaf in the sun. The plant is compensating less incidence of light by increasing the surface area and intensification (more antenna colors = a dark green color).

Every leaf of a plant is adjusted to the conditions of the light and the leaf green collective is developing on these matters. That is why a plant can get in trouble if the proportion of the light is changing. For instance by pulling of too many big leafs in one time or changing the position of the plant. Or if the lamps are changed in the middle of a blooming period. If it is really necessary, you have to hang the lamps a lot higher in the beginning and lower them after a few days, so the plants can get used to the light and do not have stopping times. In times of too much light it can be possible that the production of the sugar is higher than the plant can absorb. This will stop the photosynthesis, because there will develop a row. Another problem can develop when there is more light on the plants (from 600W to 1000W) but the ventilation (cooling!) and the water and nutrition is not increased. That's why the plants do not get better in spite of more light.

Light is besides an energy donor in many reactions a switch and information carrier. The duration of the light, independent of the composition, defines if a plant is going to bloom or if it is going to grow. The intensity of the light defines also how long it will get. The less light, the longer the distance between the side branches will be. Light defines, for instance, when the seed will germinate. About these light switch functions is so much to say that it goes too far for this article .

Fuel WATER

Water is the fuel for photosynthesis. Besides other functions of water like stabilisation of the plant, transport and solving matter for the nutrition (Highlife Febr./2000: the blood of the plants) it is also the fuel of the photosynthesis. The difference at photosynthesis is that the water is getting destroyed and really disappears out of the system. The water is the switch point between the light energy and the chemical energy: the stable water molecule (H2O) gets broken and divided in these elements: oxygen en hydrogen. The oxygen of the water is the residual product and is breath out by the plant. The splitting of the water takes an enormous effort. If you try to do this artificial, enormous lots of energy is needed to keep the oxygen and the hydrogen apart. Maybe you know the oxyhydrogen-reaction of the chemistry lessons, in which the teacher let the oxygen-gas and hydrogen gas flow into a box and puts a little flame with it. Under enormous profit of energy (a big boom) they instantly form hydrogen.



Tekening 3 alle pigmenten sluiten zich samen tot een collectief, het licht wordt door de omgevende chlorofylmoleculen richting reactiecentrum doorgegeven.

Important for the grower is that a plant burns water when it is light and does not burn water when it is dark. You have to watch that you have enough water in the daytime and that the roots can get air in the evening. The hemp plant is very sensitive for constant wet feet and reacts on this with choke of the roots. In the night the water is hardly absorbed and the flow in the plants is minimal. In part 4 of ‘Transport and logistic into the plants’ (Highlife Oct./1999) we could read that a plant puts all its pores open in the morning to wash down (take a cold shower). Optimal is giving the plant water if the lamps are starting

to burn, but before they get hot. You don’t have to water every day, but take care that the roots are dry during the evening.

Lack of water in the morning

Don’t wait with giving water until the plants are very dry in the morning, but look okay. If there is a small, not visible lack of water, it can have disastrous consequences when the photosynthesis takes place. After a few hours the plants will droop. This is a sight that the contingency plan of the plant is activated, the plant uses for a short time its stabilisation water, the only water it has, and will droop. To prevent a life threatening dehydration, all leaf pores get closed to diminish the photosynthesis to a minimum. During this time the plant cannot grow or bloom and spills a lot of energy. It can recover fully, but it will loose strength and time. If the lack of water takes a longer time, the plant is forced to let parts of it die, especially the big leafs and the parts close to the light.

Next time more about the effect of air and space climate to photosynthesis.