

# BACK TO THE ROOTS

Neue Kantonsschule Aarau G3B



## Background Information



### Physiology

Even though the plant's roots remain in the soil and are usually not seen by eye, they play an important role in the plant's life span. They are responsible for:

- the uptake of water and minerals
- the attachment of the plant to the ground
- the storing of nutrition for times of shortages

There are various types of root forms, each depending on the environment, in which the plant grows and on the sort of plant, which generates the root:

- **Dicotyledonous plants:** They have taproots with several shoots on it. (e.g. beans, *Solenostemon scutellarioides* which we are going to use)
- **Monocotyledonous plants:** Plants with a root system that consists of many equal roots. (e.g. corn)

Gravity and light are important for a plant's orientation because the roots grow in the direction of the earth's center and the rest of the plant grows towards the light to be able

to conduct photosynthesis.<sup>1</sup> This process is called gravitropism.<sup>2</sup>

In the root meristem cell division occurs which is responsible for the root's growth.

### Guttation

At night, plants close their stomata through which water evaporates during the day. As a plant can only store a limited amount of water, it has to get rid of the surplus water by another technique, which is called guttation. Through osmotic pressure in the roots, the spare water is pressed out through the so-called hydathodes, which can be found at the tip and margins of leaves. Guttation mostly takes place at night but in very moist areas it can also occur during the day.<sup>3</sup>

### Reproduction

Plants can reproduce in two ways:

- **Sexual reproduction:** The growth of seeds through pollination and fertilization result in non-identical offspring with genetic variation.<sup>4</sup>

- **Asexual reproduction:** This is done by putting a shoot (a part of the stem or a leaf) into soil or water. The roots will develop from the undifferentiated cells in the meristem and a genetic clone of the original plant will be formed with no genetic variation. This can be used to easily duplicate a plant with a favorable trait.<sup>5</sup> Economy uses this process to its advantages (e.g. in agriculture).

We wanted to investigate the aspect of asexual reproduction in combination with root growth and asked us the following research question:

**To what extent does the mass of new grown roots depend on the cutting position of shoots from *Solenostemon scutellarioides*?**



Figure 1: Root of a *Solenostemon scutellarioides*

## Variables



### Independent Variable:

Distance of the cut from the upper most leaves [cm]

### Dependent Variable:

Mass of new grown roots [g]

### Controlled Variables:

- **Room Temperature:** The room temperature is kept constant at 23° C. There is no variation in temperature for the different samples and repeats.
- **Time:** The different cuttings have the same amount of time to form roots (10 days).
- **Watering:** All the plants get the same amount of water and are watered consistently every morning (100ml per day).

## Material



- Mettler Precision scale
- Ruler (30cm)
- 5 pots (diameter 25 cm, height 30cm)
- Knife
- Tap water for watering the plants (30ml per day)
- Disinfectant
- Soil (Universal soil without peat, 40L, from Landi Schweiz)
- 25 *Solenostemon scutellarioides* plant branches



Figure 2: Experimental setup

## Method



- 1 Take 25 branches and cut off all leaves except the upper most leaves. From these leaves measure down 7/8/9/10/11 cm. From there go up to the next knot point, measure down 0.6 cm and then cut off (see figure 1). Repeat this 5 times per length and disinfect the knife after each cutting to prevent the transfer of bacteria.
- 2 Put these cuttings into the pots, prepared with an equal amount of soil (2cm below edge). Put each group of cuttings into their own pot. (HINT: Label the pots with the appropriate length before starting your experiment. This will help to prevent confusion of the different samples.)
- 3 Make sure that all the cuttings are exposed to an equal amount of sunlight (similar position) and get 100ml of water each day.
- 4 After 10 days remove the plants from their areas and weigh the roots. Do this by making a cut where the roots start, gently remove the soil from the root with water and put the towed root on the scale.
- 5 Record the collected data to evaluate it later.

## Analysis

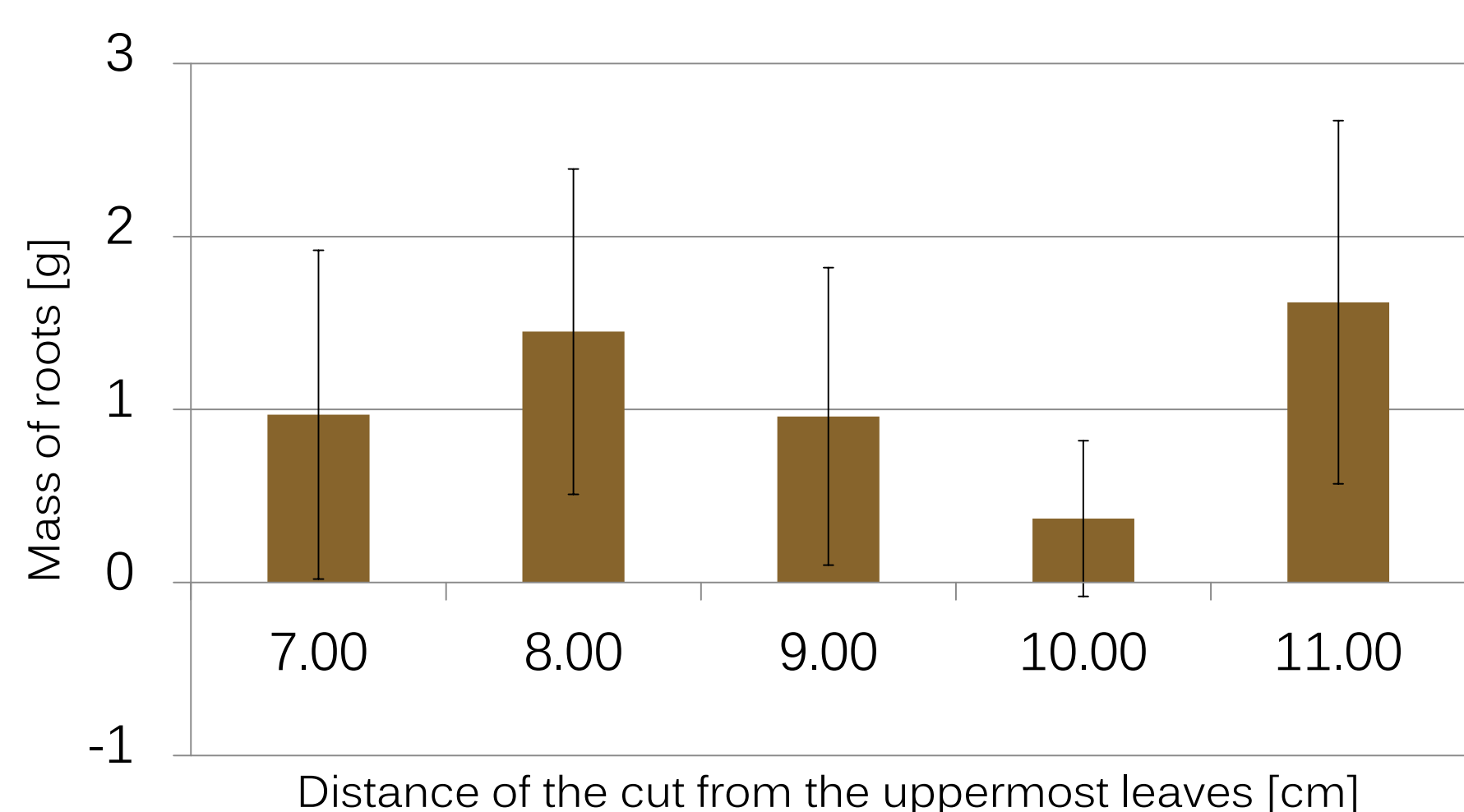


Figure 3: Mean of the collected data and standard deviation

- Uncertainty of scale:  $\pm 0,01g$ , uncertainty of distance from uppermost leaf:  $\pm 0,5cm$
- In figure 3 we can see that there is no consistent trend.
- Lightest roots: cut at 10cm
- Heaviest roots: cut at 11cm
- Cut at 7, 8 and 9cm results in medium mass of roots
- In the raw data it can be seen that there were some plants that did not grow any roots at all. This might be because we did not hit the right place where the meristems were.

## Conclusion



The distance of the cut from the upper most leaf does not significantly influence the further root growth of the *Solenostemon scutellarioides* shoots.

## Evaluation and Improvements



The cuts were made 0.6cm below a nodality, but in the case of *Solenostemon scutellarioides* the meristem cells are distributed throughout the branch. Therefore it was likely, that we did not always cut at a point where meristem cells were. Thus there was not always a growth of roots. We could change the independent variable to the distance from one nodality and then try to find out how the meristem cells usually are distributed throughout the branch.

## Bibliography

1. 2011. DLR – Article: "WAICO - oder warum Wurzeln nach unten wachsen". Retrieved May 9, 2015 from [http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10338/533\\_read-619/#/gallery/469](http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10338/533_read-619/#/gallery/469).
2. Chen, R. et al. 1999. *Plant physiology* – Article: "Gravitropism in Higher Plants". Retrieved May 9, 2015 from <http://www.plantphysiol.org/content/120/2/343.full>.
3. Painter T. *Home Guides* – Article: "What Are the Causes of Guttation in Plants?". Retrieved May 9, 2015 from <http://homeguides.sfgate.com/causes-guttation-plants-50855.html>
4. Rost, T. L. et al. 1979. *Botany – A brief introduction into plant biology*. 2nd edition. p 157. John Wiley & Sons, New York.
5. *Deep Green Permaculture* – Article: "Propagating Herbaceous Plants from Cuttings". Retrieved May 9, 2015 from <http://deepgreenpermaculture.com/diy-instructions/propagating-herbaceous-plants-from-cuttings/>.