Roots like it acid

Gymnasium Burgdorf, Klasse 16c

1. Introduction

The root is the organ of a plant that typically lies below the surface of the soil. Its main function is the absorption of water and inorganic nutrients, the anchoring of the plant body to the ground and supporting it and storage of food and nutrients.
A root has: root hair, epidermis, epiblem, cortex, endodermis, pericycle and the vascular tissue in the centre of a root to transport the water.
The distribution of vascular plant roots within soil depends on plant form, the spatial and temporal availability of water and nutrients, and the physical properties of the soil. The deepest roots are generally found in deserts and temperate coniferous forests; the shallowest in tundra, boreal forest and temperate grasslands. Some roots can grow as deep as the tree is high. The majority of roots on most plants are however found relatively close to the surface where nutrient availability and aeration are more favourable for growth. Rooting depth may be physically restricted by rock or compacted soil close below the surface, or by anaerobic soil conditions.
The salinity of roots is usually higher than in the surrounding soil, so that the water diffuses easily.
Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as from leaves but also from stems and flowers. At very high humidity and persistently high root pressure transpiration is no longer possible, so that the plant pushes out the water directly on the hydathodes; this process is called Guttation.
The term root crops refers to any edible underground plant structure, but many root crops are actually stems, such as potato tubers. Edible roots include cassava, sweet potato, beet, carrot, rutabaga, turnip, parsnip, radish, yam and horseradish. Spices obtained from roots include sassafras, angelica, sarsaparilla and liquorice.
Sugar beet is an important source of sugar. Yam roots are a source of estrogen compounds used in birth control pills. Important medicines from roots are ginseng, aconite, ipecac, gentian and reserpine. Several legumes that have nitrogen-fixing root nodules are used as green manure crops, which provide nitrogen fertilizer for other crops when ploughed under.
Trees stabilize soil on a slope prone to landslides. The root hairs work as an anchor in the soil.
Roots can also protect the environment by holding the soil to prevent soil erosion. This is especially important in areas such as sand dunes.
Hundreds of millions of plants are propagated via cuttings annually including chrysanthemum, poinsettia, carnation, ornamental shrubs and many houseplants.

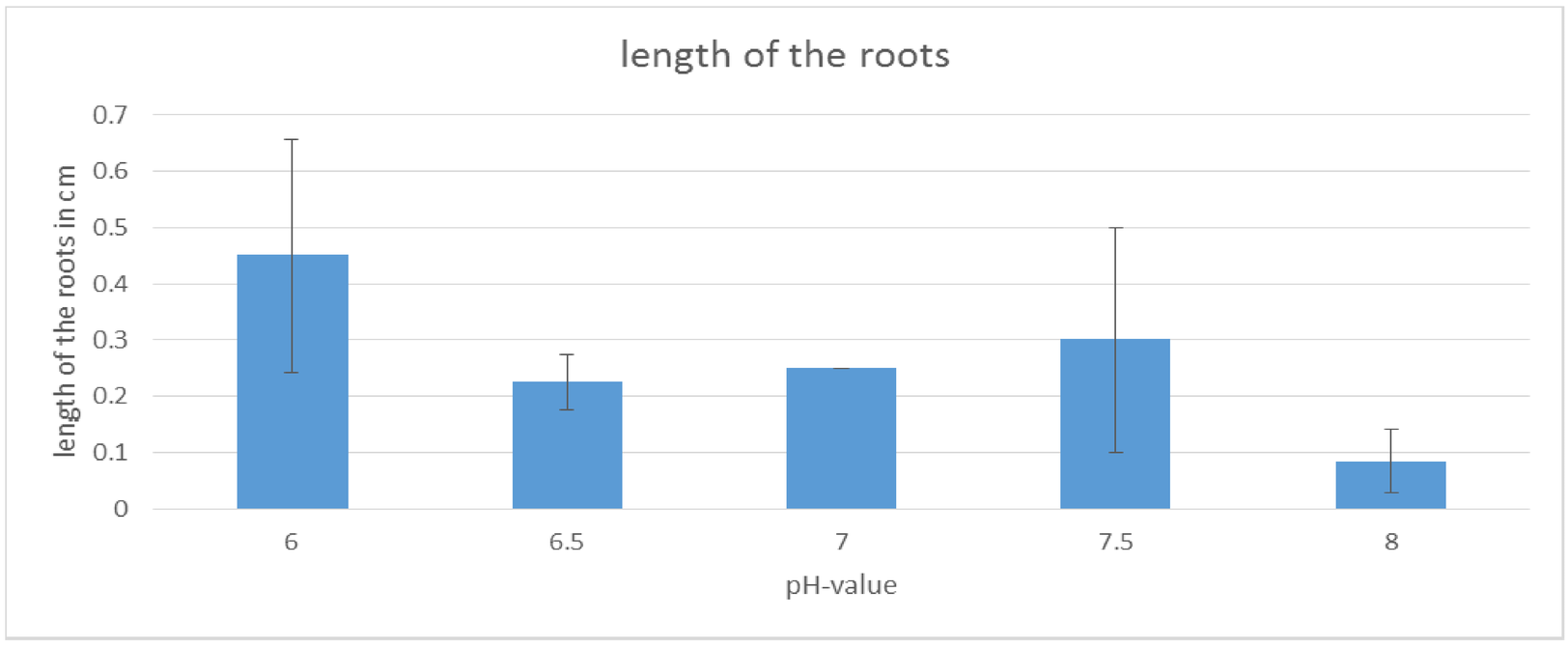
2. Material and Methodes

Main Experiment:
Sodiumhydrogenphosphate and sodiumdihydrogenphosphate ions were put into the water to get the desired puffered pH-Value (see pic. 2). But first the correct portion of ions had to be calculated and weigh with a scale. After that, the cress seeds were fixed on a filter paper which is connected with a carton. At least, each of the five papers had six seeds on the surface. Every paper were put into five different beakers of which the ground is covered with 1cm of water with the right pH-Value. There was a beaker with pH = 6, one with pH = 6,5, one with pH = 7, the next had pH = 7,5 and the fifth had pH = 8. Then the beakers were closed with a glass pane to save the water from evaporating. After a week, the results can be checked. We measured the length of the root of every sprout.

Control Experiment:
The same prepared solutions like in the experiment before (except pH = 8) were put into smaller beakers. Then, new cress seeds were put on the top of a paper role which is laid in the water. The seeds were placed exactly at the position over the edge of two beakers, so they had the choice between two different pH-Values (see pic. 3). After one week, the results are ready for the evaluation. Every seed made his decision for one of the pH-values. For every beaker and thus for every pH-value the number of root growing in it was counted.

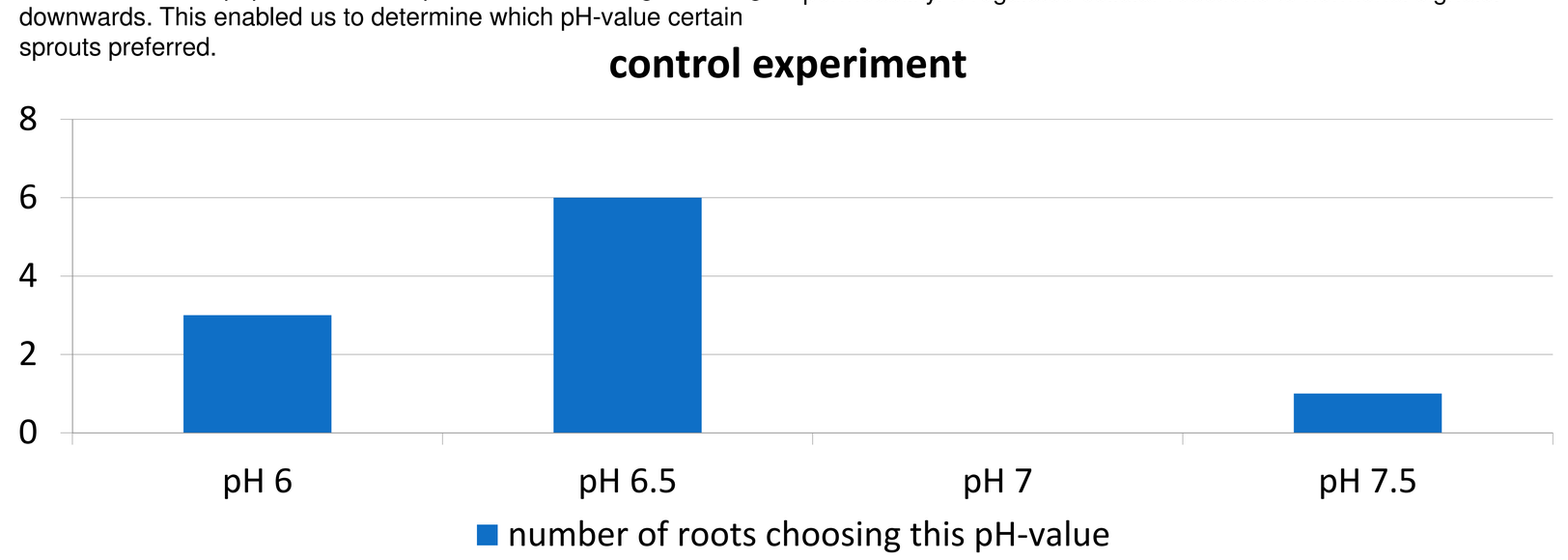
Pic 1: Our sprouts growing in the biology laboratory

3. Results



Main Experiment:
The diagram above shows the results of the experiment with the pH-value.
The blue posts show the average length of the roots in the particular pH-value.
With the pH-value of 6, the roots grow the most (0.45cm on average) and with a pH-value of 8, they grow the least (0.08cm on average).
The black lines show the standard deviation of the lengths. For each pH-value there were six seeds planted.

Control Experiment:
The plants prefer pH-value of 6.5 (See diagram below). The plants also grew well with a pH-value of 6. With a pH-value of more than 7 our plants didn't grow.
Between the cups of pH-value 7.5 and 6 one sprout grew a root that was so long that it reached the cup with the pH-value of 6.5. This isn't representative for the whole experiment, but it gives a hint which pH-value roots prefer.
Because the solutions with different pH-values got mixed up in the middle of the filter paper the seeds spouted roots which grew straight downwards. This enabled us to determine which pH-value certain sprouts preferred.



Pic. 2: Công and Simon preparing the puffer solutions

4. Interpretation

The diagram shows that the optimal pH-value for cress seeds lies between 6 and 6,5. As in the control experiment can be seen the cress plants prefer an acidic environment.
The surface charge of soil particles determines the ability to bind nutrients. The most soil particles have a negative charge. Positively charged ions like potassium (K^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}) bind to these soil particles and therefore can not be washed out easily by water oozing through the ground.

The protons of the acid replace the mineral nutrients like potassium (K^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}) that are important for the plants. The mineral nutrients are released from the soil particles and become available for the roots. That is why plants prefer an acidic environment.
Plants need magnesium ions because it activates many enzymes and it is an important component of the chlorophyll molecule.
Potassium is important for the stability and development of the cell wall and to maintain the structure of the cell membrane and its permeability. It regulates cellular reactions to hormonal signals.

5. Reference list

Campbell, N. A., 2011, Campbell Biologie, gymnasiale Oberstufe, Chapter 37, Pearson
http://en.wikipedia.org/wiki/Root (retrived: 27th apri 2015)
http://de.wikipedia.org/wiki/Guttation (retrived: 27th apri 2015)
http://de.wikipedia.org/wiki/Transpiration (retrived: 27th apri 2015)

Pic 3: Control Experiment: Plants can choose between different pH-values