

Experimenting with hydrogel at elementary school

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Summary

A hydrogel is an artificially formed crosslinked polymer consisting of potassium polyacrylate. Hydrogels are a part of human's everyday life, for example it is a part in diapers, hydrating hydrogel compresses or contact lenses. The coarse hydrogel used in the experiments is an ecological, biodegradable and non-toxic product with a neutral pH, which can be used on any plants and crops that like moist soil. The most important feature of the hydrogel is the ability to absorb up to 300 times its volume. For example, hydrogel can retain more rainwater than the soil and can supply moisture to plants for a longer period. Hydrogel can be used in both closed containers and open space of a garden. The absorbency of the hydrogel depends on the hardness and purity of the used water. In combination with rainwater or distilled water it usually achieves the best results.

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Introduction

For good growth of plants, sufficient watering is important. If there is a period of greater drought, we do not have the opportunity to water the plants repeatedly based on their needs, we are looking for a solution on how to provide necessary moisture to the plants.

One solution may be a hydrogel. Hydrogel is an artificially created polymer that is an ecological, biodegradable and non-toxic product suitable for all crops and plants. We can add hydrogel to closed containers and to open space and thus use its ability to retain water, which it is able to absorb up to 300 times its volume (Prokop, 2010).

Hydrogel provides the plant with access to water for a longer period, as it can be pulled out of the hydrogel and therefore does not need to be irrigated as often. For example, this fact can be used on school grounds, where irrigation can be taken care of by pupils alone, who most often have one hour of cultivation classes per week. (Mario Daniel Ninago et al., 2021)

To get acquainted with the hydrogel and its properties, I would suggest trying these 4 easy experiments that can be done with primary school pupils and thus increase their awareness of the possibilities of irrigation (RSC Education, 2016).

Experiment 1 - absorbency of hydrogel depending on volume

Divide pupils into groups. They will measure the same amount of hydrogel and measure the same volume of different types of fluid. It is best to compare these fluids: tap water, rainwater, distilled water, and water from rivers or streams.

At the same time, the students will throw the dry hydrogel into the water, mix the liquid gently and leave it set for 20 minutes. After 20 minutes, the hydrogel can be weighted. Based on the weight, the pupils will be able to find out which of the fluids has the hydrogel soaked the most.

The most frequent results of the experiment show that the hydrogel absorbs the most from the liquids without minerals and impurities, i.e., distilled water. Depending on the place of

residence, tap water or rainwater follows, and usually the last place is occupied by water from a stream or river, mainly due to the large number of impurities in these watercourses.

The hydrogel is also very sensitive to the salt content, and therefore in saline or in combination with some fertilizers, it only soaks up a small amount of liquid (Radwan et al., 2018).



Figure 1. Absorbency of hydrogel depending on different kind of water

The longer the hydrogel is in the fluid, the more water it will absorb. Based on the results of my previous experiment on hydrogel absorption through time, I can say that after 30 minutes, the hydrogel will expand 100 times compared to its original volume. Figure 2 shows the results of the experiment (Zábranská, 2021.)

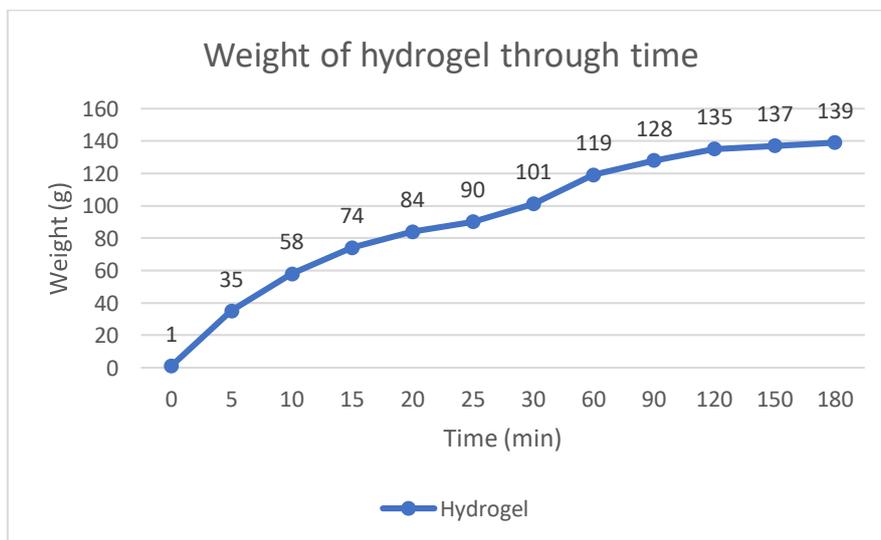


Figure 2. Weight of hydrogel through time

Experiment 2 - how much water will the soil itself retain and how much water will soil mixed with the hydrogel retain?

With the help of an illustrative experiment, it can be found out how much water is suitable for a specific volume of soil. But if it rains heavily, is there any way to keep more water in the soil?

Pupils will prepare 2 equally sized drain containers, into which they will add the same volume of soil and measure how much water they will use to water it.

Thanks to the absorbency of the hydrogel experiment, we already know that the hydrogel needs more time to absorb at least 100 times its weight, so we will water the container for at least 5 minutes.

After the excess water flows out of the container, we will discover how much water the soil itself was able to hold and how much water was absorbed by the soil with added hydrogel.

In order to obtain demonstrable results of the advantage of using the hydrogel in such a short duration of time for the experiment, we can first mix the hydrogel so that its crystals are fine and not coarse.

Since the soil itself cannot absorb as much water, more water flows out of the sample with only the soil and less water flows out of the soil mixed with the hydrogel. For this reason, it is good to use a hydrogel in the garden, because it retains more rainfall and also constantly increases and decreases its volume, thus loosening the soil. (Zábranská, 2021)

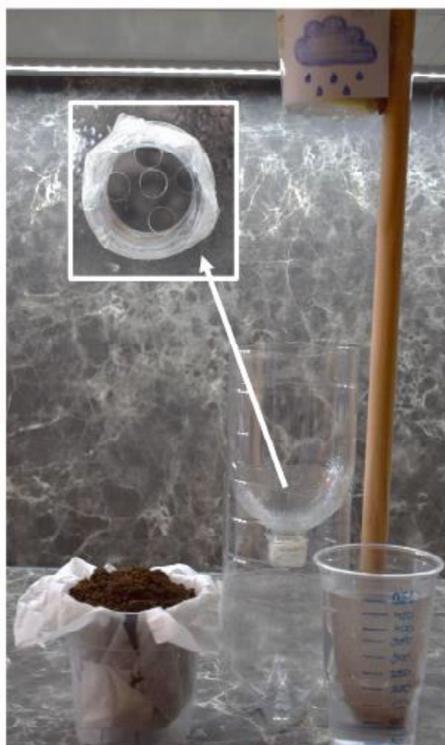


Figure 3. Example of experiment preparation

Experiment 3 - how much water does a diaper hold?

If you would like to introduce the benefits of the hydrogel to the pupils and you do not have the space to grow plants, you can use the hydrogel from a clean and unused diaper.

Disposable diapers often use hydrogel for soaking of more fluids and maintaining dry skin of the baby especially. The hydrogel used in baby diapers is very gentle, so it can absorb liquids immediately.

Pupils will write down their estimation, which can look as follows: "I think the diaper will hold milliliters of fluid.", first and then they will verify it with a simple experiment.

Depending on the type and size of the diaper, one baby diaper holds an average of 1.5 liters of water. Of course, the best way of the experiment is to gradually add a small volume of fluids to the diaper until it is clear that the fluid is no longer being absorbed.

Pupils write down how many milliliters of liquid they poured into the diaper and then they will verify if their assumption was correct.

The diaper is composed of hydrophilic and hydrophobic materials, which we can get acquainted with during the experiment, and after the diaper is no longer able to absorb more fluids, we can look inside.

Another question for students would be what other substances are found in the diaper, most often cotton or other highly hydrophilic materials.

The soaked hydrogel can be used for further cultivation experiments or added to a garden compost, which will increase moisture of the soil. (Havlík et al., 2016)



Figure 4. Demonstration of hydrogel from the diaper in the dry state and after soaking

Experiment 4 - growing basil with the help of hydrogel

Basil is an herb that likes a lot of sunlight and moist soil. Pupils are to prepare a mixture of soil and hydrogel first. They can also grow basil in the soil itself, for comparison. (Macků & Štícha, 2018)

First, they water the soil so that it is moist, and in the case of a mixture of soil and hydrogel, they will water the soil twice in a small volume of fluids in a time interval of at least 10 minutes. The basil seeds are then planted according to the instructions, most often 0.5 centimetres deep.

For at least 40 days, the students will be recording when they watered the basil and how it continues to grow. Soil moisture is well controlled with a hygrometer or wooden skewers at least.



Figure 5. Example of growing basil in different soil combinations mixed with hydrogel

Conclusion

Experimenting with hydrogel will draw pupils' attention to retaining a larger volume of water and, as a rule, to improve the growth and fertility of the plant. Pupils will also realize how much water is needed to water a certain amount of soil, based on which they will be able to calculate the price of water consumed, given the size of the garden. Therefore, the pupils will be more likely to appreciate rain showers, which will be retained more in soil mixed with hydrogel.

The experiments support group work, gaining one's own experience and knowledge, as well as getting knowledge about the water cycle, soil erosion and the prosperity of rainwater harvesting.

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