B1 Water cycle – Evaporation from plant leaves

Evaporation plays a key role in the global water cycle. Water falls to the Earth as precipitation, covering the requirements of flora and fauna. This water originates partly from evaporation from oceans and partly from evaporation over land masses. The volume of precipitated water that is stored again in the ground or the volume that is evaporated depends greatly on the amount of vegetation. Even in just the past 50 years, vast expanses of land have been altered as a result of agricultural use and urban development. Negative climatic effects are becoming increasingly noticeable. In this experiment, you can examine the influence that temperature and vegetation have on the rate of evaporation.

1 Apparatus and materials

- Bright lamp, optional
- 1 bowl, aluminum
- Clippings from various plant leaves (without dew or rainwater)
- Clock
- Damp soil, not wet
- 1 digital thermometer
- 1 plastic cup (clear), 500 ml

Attention: After you have completed the experiment, return the materials or dispose of them properly as instructed by your teacher.

2 Safety information

The materials may be used only as instructed by your teacher or as described in the experimentation instructions.

3 Conducting the experiment

The experiments are conducted in teams of two. Read the instructions before you begin an experiment. Prepare all necessary materials in advance. Different teams should investigate the extent to which the evaporation rate depends on the leaf texture. Use the provided plant clippings for this purpose. If you have plants growing in pots, you can also experiment with them. Some teams should also conduct the experiment with damp (not wet) soil.

Fig. 1: The transparent cups are each filled at least half way with plant clippings or soil.

Fig. 2: The filled cups are placed in the sun or the light cone of a bright lamp.

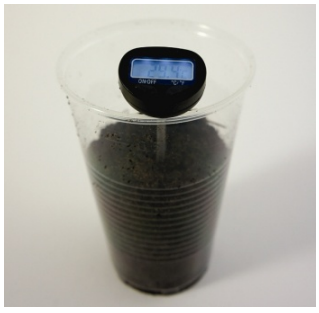

Fig. 3: Temperature measurement inside the cup after exposure to light.

Step-by-step instructions:
Each group should use clippings from a different plant and one group the soil.

- Fill the cup at least half way with the clippings or soil. The clippings should be dry on the outside so that you can be sure that the evaporated water comes from the plant itself.
- If experiments are done with different plants, all groups must be sure to fill their cups to the same level and to press down the clippings with the same degree of compression to ensure that the results can be compared.
- Place the aluminum pan over the cup as a lid and turn the pan and cup over together so that the upside-down cup is sitting on the aluminum pan.
- First place the cup in the shade and wait 5 minutes.
- In the meantime, you can prepare a lab report. In it, you should record your experiment and your results as precisely as possible (e.g., sketch, information on how your plant material differs from other groups' plant material, ambient temperature, sun exposure).
- Now place the cup in the sun (**Note:** If the sun is not shining, the experiment also works with a bright lamp). The sunlight heats up the plant material, while the surface of the cup and the ambient air remain at room temperature (greenhouse effect).
- (If you use a lamp for the experiments, all groups must use lamps with the same brightness. Adjust the distance of the lamp from the cup (approx. 5 – 10 cm) and the angle of illumination so that the entire cup is positioned in the lamp's light cone).
- After approx. every 15 minutes, check whether you can see an effect on the surface of the cup.
- If you do not notice anything after 45 minutes, allow your cup to cool down. To do so, you can place it in the shade or, better yet, cool it with a towel or paper soaked in cold water.
- Finally, measure the temperature inside your cup using the digital thermometer.

4 Observation

Record your observations in your lab report. Did you notice a little or a lot of evaporation (compared with the other teams)? Compare the temperature inside your cup with the ambient temperature.

5 Analysis

Consider the following:

a) To what extent does the evaporation rate depend on the leaf surface?
b) Which plants in the experiment would you expect to transpire the most water?
c) How does the temperature influence evaporation?
d) What can you conclude from the experiment with soil?
e) Does the ground dry out faster if it is thickly covered with plants or it is bare?

6 Questions

6.1 General

a) How do plants absorb the water that they then evaporate?
b) Explain why certain plants naturally thrive only in certain geographical regions with particular climatic conditions. As an example, you could use two very different plants, such as cacti and tomatoes to do so.
c) Why does water condense on the surface of the cup, even if the cup is not cooled?
d) Why does the experiment work better if the surface of the cup is cooled?
e) On hot summer days, why it is usually cooler in the shade of a tree with a thick canopy of leaves than in the shade of a fabric sun umbrella?

6.2 Probing question on climate change, based on the example of Paraguay

In the last 30 years, 60 percent of the tropical rain forest in Paraguay has been cleared and the land is now being used to cultivate primarily soy as fodder for animals in Europe. In the past, it rained nearly every day in the rain forest. Today, there are droughts and poor harvests. Why?

6.3 Probing question on climate change, based on the example of biomass from monocultures

Since fossil fuels (coal, natural gas, oil) are scarce resources, some people are trying to tap into alternative sources of energy by cultivating so-called energy crops. These plants (e.g., soy, sunflowers, corn) are being grown in monocultures.

a) How do people succeed in making solar energy technically available using these plants?
b) What negative consequences do these monocultures have on the climate?
c) What are the consequences for the people living in these countries where monocultures are cultivated?