Transpiration of leaves with Cobra4 (Item No.: P4110360)

Curricular Relevance

Area of Expertise: Biology

Education Level: University

Topic: Plant Physiology / Botany

Subtopic: Water Balance

Experiment: Transpiration of leaves with Cobra4

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	40 Minutes	2 Students

Additional Requirements:

- Rose or similar plant (with thick leaves)
- Plastic bag
- Knife
- Android tablet or iPad
- PHYWE measure App

Experiment Variations:

- with Computer with USB port, Windows

Keywords:

Transpiration, Water and nutrients transport, Influence of wind, Temperature, Humidity and type of leaves

Overview

Principle

The purpose of plant transpiration is to transport water and nutrients from the plant roots to the leaves. In this experiment plant transpiration is investigated by means of pressure decrease measurements. Pressure decrease is brought about by vegetal discharge from the leaves into the environment. It is the basis of the continuous water current from the soil. In this experiment compare the transpiration of leaves under various environmental conditions.

Fig. 1: Experiment set-up

Equipment

Experiment with Cobra4 Wireless/USB-Link with Android tablet or iPad

Position No.	Material	Order No.	Quantity
1	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
2	Cobra4 Sensor-Unit Pressure, 7 bar absolute	12647-00	1
3	Holder for Cobra4 with support rod	12680-00	1
4	Support base, variable	02001-00	1
5	Support rod, stainless steel, 500 mm	02032-00	3
6	Boss head	02043-00	2
7	Universal clamp	37715-00	1
8	Test tube,200x30 mm,side arm,PN29	36331-00	1
9	Rubber tubing, i.d. 6 mm	39282-00	1
10	Plasticine, 10 sticks	03935-03	1
11	Rubber stopper 26/32, 1 hole 1,5 mm	39258-09	1
12	Beaker, low, BORO 3.3, 1000 ml	46057-00	1
13	digital magnetic stirrer with heating, stainless steel, 280 °C, 100-1500 rpm	FHO-RSM10HS	1
14	Rubber bands, 50 pieces	03920-00	1
15	Hot/cold air blower, 1800 W	04030-93	1
16	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material:			
	Android tablet or iPad		
	PHYWE measure App		
	Rose or similar plant (with thick leaves)		
	Plastic bag		
	Knife		

Android iPad

GET IT ON Google Play Download on the App Store

Experiment with Cobra4 Wireless/USB-Link and PC

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Position No.	Material	Order No.	Quantity
1	curricuLAB measureLAB	14580-61	1
2	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
3	Cobra4 Sensor-Unit Pressure, 7 bar absolute	12647-00	1
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15	Rubber bands, 50 pieces	03920-00	1
16	Hot/cold air blower, 1800 W	04030-93	1
17	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material:			
	Computer with USB port, Windows		
	Rose or similar plant (with thick leaves)		
	Plastic bag		
	Knife		

Tasks

1. Compare the transpiration of leaves under various environmental conditions and generate pressure curves.
2. Discuss the differences between the different pressure curves.

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Set-up and procedure

Set-up

- Set up the equipment as in Fig. 1.
- Use one of the two support rods which is attached to the support base to hold the test tube.
- Attach the Cobra4 Wireless/USB-Link to the Cobra4 Sensor-Unit Pressure to the holder on the other support rod in such a way that the air intake nozzle of the Sensor-Unit Pressure is positioned approx. 2 cm higher than the hose connector of the test tube.
- Use a short piece of hose to connect the air intake nozzle of the Sensor-Unit Pressure to the hose connector of the test tube.
- Fill the test tube with water and fasten the rubber stopper without any formation of air bubbles in the test tube.
- Connect the Cobra4 Wireless/USB-Link to the tablet in the wireless WiFi mode after switching it on.
- Start the software . The Cobra4 measuring device will be automatically detected.
- - Select the measurement window of your choice. It is best to choose the measurement window with the measurement graph.

Fig. 2: Selecting the Sensor-Unit Pressure in the measure APP

Procedure

Experiment 1

- Cut off a small leafy shoot or a soil-plant just above the soil. Peel from the lower part of the shoot with a knife and cut the end off at a slant (45°).
- Quickly push the shoot through the stopper and seal the stopper well with plasticine.
- Without delay, remove the hose from the air intake nozzle of the Sensor-Unit Pressure, fit the stopper with plant on the test tube (avoiding air bubble formation in the test tube) and fit the hose back on the Sensor-Unit.
  Caution! Do not let any water penetrate into the pressure sensor while doing this!
- Start measurement (ideal running time: at least 100 s, but longer is better – measurement was made for 1000 s in the example given).
- Take the initial and final pressures from the measured values and calculate the difference.

Experiment 2a: (Preparation as for Experiment 1)

- Expose the plant to a cold flow of air from the dryer during measurement.

Experiment 2b:

- Set the dryer to hot air and expose the plant to the hot flow of air from the dryer during measurement.

Experiment 3:

- Bring ½ litre of water to boiling and collect the steam that is given off in a plastic bag for some seconds (Caution! Do not allow the plastic bag to touch the hot beaker!).
- Put the plastic bag over the plant, close it with an elastic band and start measurement.

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Result and evaluation

Results and evaluation

Results

- Experiment 1: With the plant used in this part of the experiment and in still air, the pressure decreased by approx. 2.8 kPa over a measurement time of 1000 s (Fig. 3).

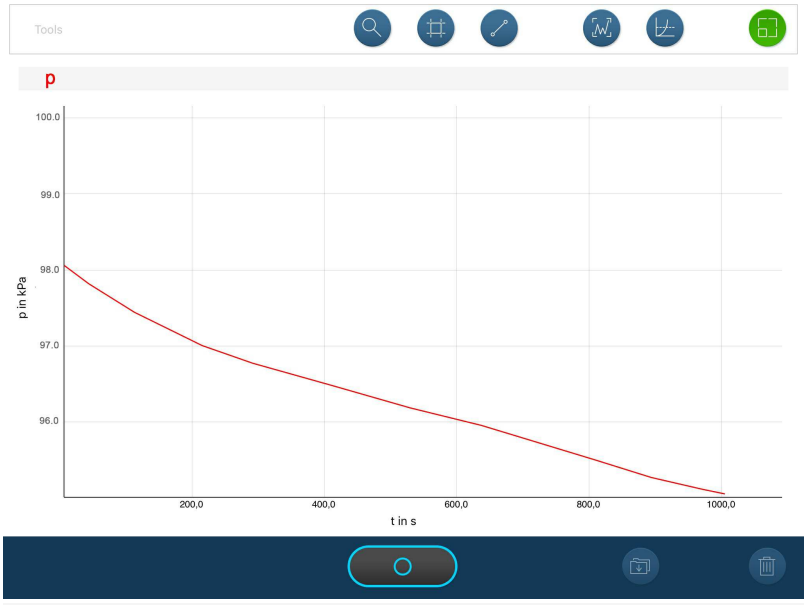

Fig. 3: Measurement result (Experiment 1) – Plant transpiration in still air

- Experiment 2: During the same length of time in a cold flow of air, the pressure decreased by approx. 3.8 kPa (Fig. 4), in a hot flow of air by approx. 6.3 kPa (Fig.5).

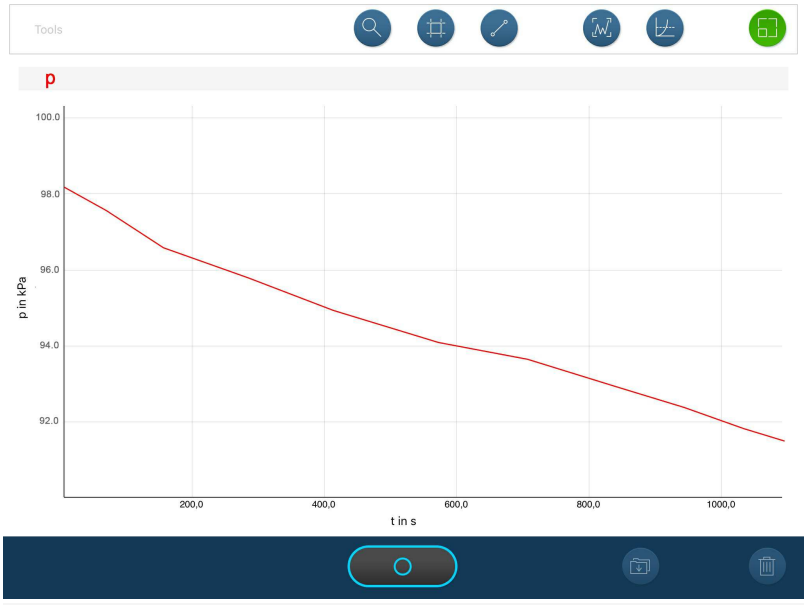

Fig. 4: Measurement result (Experiment 2b) – Plant transpiration in a flow of cold air

Fig. 5: Measurement result (Experiment 2b) – Plant transpiration in a flow of hot air

- Experiment 3: No transpiration took place in steam (Fig.6).

Fig. 6: Measurement result (Experiment 3) – Plant transpiration under very high air humidity

Evaluation

Plants "sweat" just as people do and are thereby physiologically and morphologically suited to their specific environment. They transpire at high temperatures and pass water to the environment. Transpiration serves for the transport of water and nutrients. The underpressure that is caused by transpiration draws water up from the roots, nutrients are transported from there through the stem to the leaves. In nature, wind plays an important role in the transpiration of plants. For example, plants that grow on windy hillsides are more lignified and plants that grow in the desert sink their stomata into small leaf hollows that are additionally matted and covered with a layer of wax, so that the transpiration caused by the hot desert winds is kept as low as possible. Transpiration is greatly limited when a plant is exposed to high air humidity as the surrounding air is already saturated with water. Plants that exist in areas subjected to such humidity have stomata that protrude to increase their transpiration.

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- Use a short piece of hose to connect the air intake nozzle of the Sensor-Unit Pressure to the hose connector of the test tube.
- Fill the test tube with water and fasten the rubber stopper without any formation of air bubbles in the test tube.
- Set up a connection of the Cobra4 Wireless/USB-Link to the PC either wirelessly or with the USB cable and switch it on.
- Start the software . The Cobra4 measuring device will be automatically detected.
- Choose the experiment from the start screen by selecting `Load Experiment`. Accordingly, choose “PHYWE experiments”, search for “P4110360”, and select desired folder containing the experiment. All necessary presetting will be loaded.

Procedure

Experiment 1

- Cut off a small leafy shoot or a soil-plant just above the soil. Peel from the lower part of the shoot with a knife and cut the end off at a slant (45°).
- Quickly push the shoot through the stopper and seal the stopper well with plasticine.
- Without delay, remove the hose from the air intake nozzle of the Sensor-Unit Pressure, fit the stopper with plant on the test tube (avoiding air bubble formation in the test tube) and fit the hose back on the Sensor-Unit.
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Experiment 2b:

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Experiment 3:

- Bring ½ litre of water to boiling and collect the steam that is given off in a plastic bag for some seconds (Caution! Do not allow the plastic bag to touch the hot beaker!).
- Put the plastic bag over the plant, close it with an elastic band and start measurement.

Result and evaluation

Results and evaluation

Results

- Experiment 1: With the plant used in this part of the experiment and in still air, the pressure decreased by approx. 28 hPa over a measurement time of 1000 s (Fig. 3).

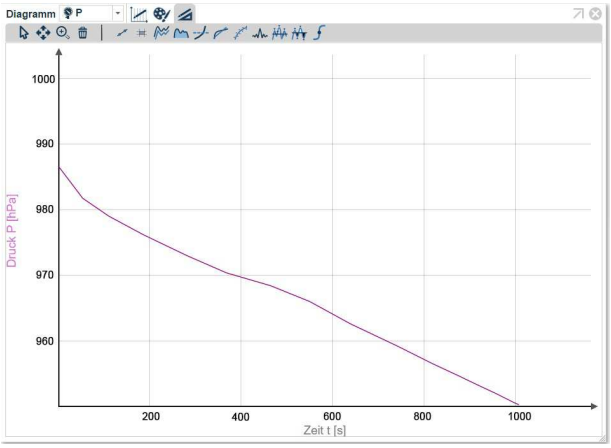

Fig. 3: Measurement result (Experiment 1) – Plant transpiration in still air

- Experiment 2: During the same length of time in a cold flow of air, the pressure decreased by approx. 38 hPa (Fig. 4), in a hot flow of air by approx. 63 hPa (Fig.5).

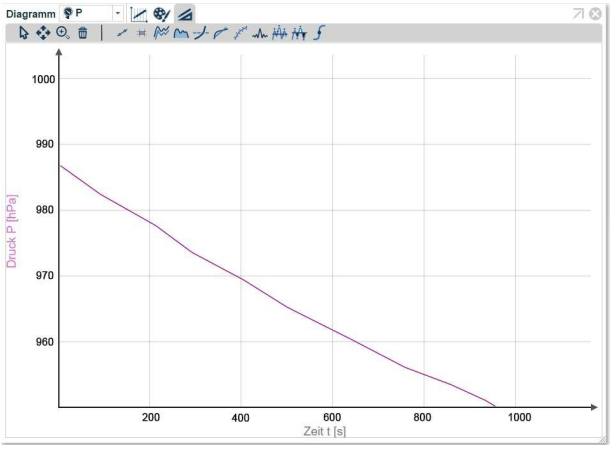

Fig. 4: Measurement result (Experiment 2b) – Plant transpiration in a flow of cold air

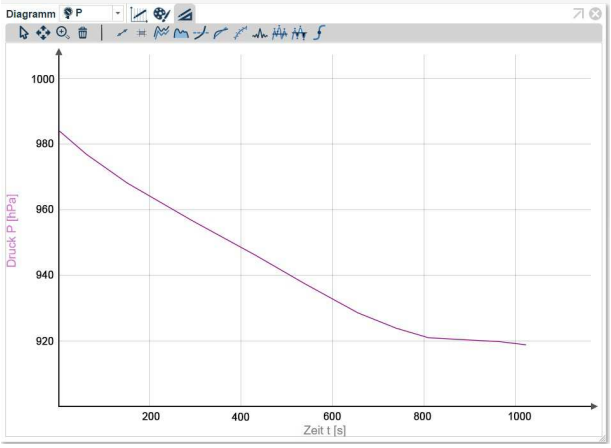

Fig. 5: Measurement result (Experiment 2b) – Plant transpiration in a flow of hot air

- Experiment 3: No transpiration took place in steam (pressure difference approx. 2 hPa, Fig.6).

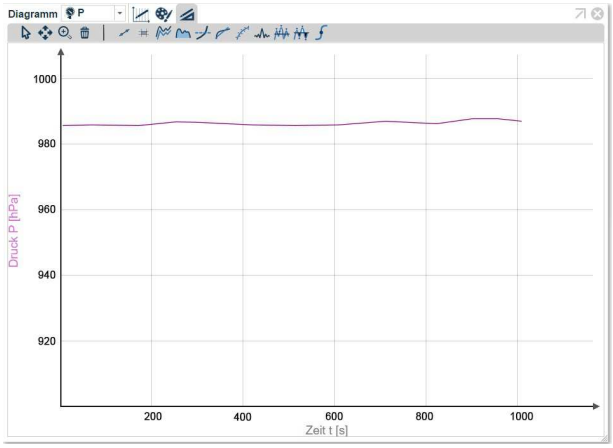

Fig. 6: Measurement result (Experiment 3) – Plant transpiration under very high air humidity

Evaluation

Plants "sweat" just as people do and are thereby physiologically and morphologically suited to their specific environment. They transpire at high temperatures and pass water to the environment. Transpiration serves for the transport of water and nutrients. The underpressure that is caused by transpiration draws water up from the roots, nutrients are transported from there through the stem to the leaves. In nature, wind plays an important role in the transpiration of plants. For example, plants that grow on windy hillsides are more lignified and plants that grow in the desert sink their stomata into small leaf hollows that are additionally matted and covered with a layer of wax, so that the transpiration caused by the hot desert winds is kept as low as possible. Transpiration is greatly limited when a plant is exposed to high air humidity as the surrounding air is already saturated with water. Plants that exist in areas subjected to such humidity have stomata that protrude to increase their transpiration.