Video: Using water sustainably through science

Student video resource worksheet

Level

7

Curriculum Area

Science

Print Resource

Learning experience

- considering issues relating to the use and management of water within a community
- recognising that water management plays a role in areas such as farming, land management and gardening

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Lesson overview

The lesson will provide students an opportunity to investigate water use in soils and plant.

Students will

- View content that presents the current technology used to assist with irrigation techniques
- Investigate an experiment aimed at looking at soil moisture retention in different soils
- Investigate water use by plants
- Collect data and draw conclusions about water use

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Lesson outcomes

Students will be able to:

- Develop an fair test
- Record all observations
- Write up a science experiment
- Draw conclusions and present in a report

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Teacher background

One of the main functions of soil is to store moisture and supply it to plants between rainfalls or irrigations. Evaporation from the soil surface, transpiration by plants and deep percolation combine to reduce soil moisture status between water applications. If the water content becomes too low, plants become stressed. The plant available moisture storage capacity of a soil provides a buffer, which determines a plant's capacity to withstand dry spells.

Poor structure, low organic matter, low carbonate content and presence of stones all reduce the moisture storage capacity of a given texture class.

Clays store large amounts of water, but because they have high wilting points, they need significant rain to be able to supply water to plants. On the other hand, sands have limited water storage capacity, but because most of it is available, plants can make use of light showers regardless of how dry they are before the shower. Plants growing in sand generally have a denser root system to enable them to access water quickly before the sand dries out (Source: http://bettersoils.soilwater.com.au/module2/2_1.htm (http://bettersoils.soilwater.com.au/module2/2_1.htm)).

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Lesson steps

Download Worksheet (http://hellofriday.com.au/newsite/piefa/pdf/water-tech-w1.pdf)

1. In preparation read through Appendix 1: ‘Experiment 1’ and gather all the materials for the experiment
2. Get students to watch video Titled 'How is science solving sustainable water issues in a changing environment?' https://www.youtube.com/watch?v=egPIxgBsCLo&feature=em-upload_owner (https://www.youtube.com/watch?v=egPIxgBsCLo&feature=em-upload_owner)
3. Outline for the students information from the teacher background
4. Provide students with **Video Resource student worksheet (/pdf/water-tech-w1.pdf)**. Experiment 1 is on Soil Moisture, and Experiment 2 is ‘Transpiration and Stomata density across different plant species’
5. An additional part to this Experiment 1 could include students designing their own soil mixture that has the highest water holding capacity. You may like to have a few categories such as: highest water capacity, high commercial application, innovative design etc.
6. Experiment 2 (Appendix 2, Experiment 2) is outlined to investigate ‘Transpiration and Stomata density across different plant species’. This is an additional experiment for the class.
7. For Experiment 2, additional video and slide show can be viewed
    1. Stomata and photosynthesis slide show (the pores that are spoken about in this presentation are the stomata) http://www.scootle.edu.au/ec/viewing/R11893/index.html (http://www.scootle.edu.au/ec/viewing/R11893/index.html)
    2. Grapes and stomata (good video) http://splash.abc.net.au/home#!/media/1423231/ (http://splash.abc.net.au/home#!/media/1423231/)

8. Answers to be completed by students for both experiments are located on the student worksheet

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Appendix 1

Experiment 1:

Soil moisture

Materials:

- 3 plastic pots
- 3 plastic containers
- 3 sheets of fine wire mesh, slightly larger than the size of the cover of the plastic container
- 600 ml of water
- 1 sack of sand
- 1 sack of clay
- 1 sack of silt soil
- 1 weighing machine
- 1 measurement cylinder
- 1 marker pen

NB: Sourcing the types of soil you may need to visit a garden centre. If you are collecting samples, you may also like to have them tested at the garden centre for composition.

1. The 3 pots are labelled A, B and C. The sand is placed inside pot A up to 20mm from the top. Similarly the clay soil and silt soil are placed in pots B and C up to 20mm from the top of the pot. NB: if you cannot get these three soil types, select 3 different soil types in your area. You may also need to visit a local garden centre.
2. The pots A, B and C are put outside in the hot sun to dry and for the soil to settle down in the pots for 2 days. After the second day, the weight of the pots is measured and recorded. (Alternatively, you can pre oven dry the samples before putting them into the plastic containers.)
3. The pots A, B and C are placed on the wire mesh and plastic collection container. Using the measuring cylinder, 200ml of water is slowly poured into each of the pots and they are allowed to drain for 4 hours.
4. After 4 hours, the amount of water in the collection containers is noted using the measuring cylinder and the weight of pots A, B and C are checked and recorded.

The independent variable is the type of soil used. The dependent variable is the amount of water retained in the soil. This is determined by measuring the water drained using the measuring cylinder and also checking the weight of the pot. The constants (control variables) are the amount

of water used, the amount of soil used and the time taken for the water to drain from the soil.

Extra activity:

Students could design their own ‘plant growing medium’. You may like to have a few categories, and identify what can and cannot be used, and what is the measure of success.

Categories may include: categories such as: highest water capacity, high commercial application, innovative design etc.

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Appendix 2

Experiment 2:

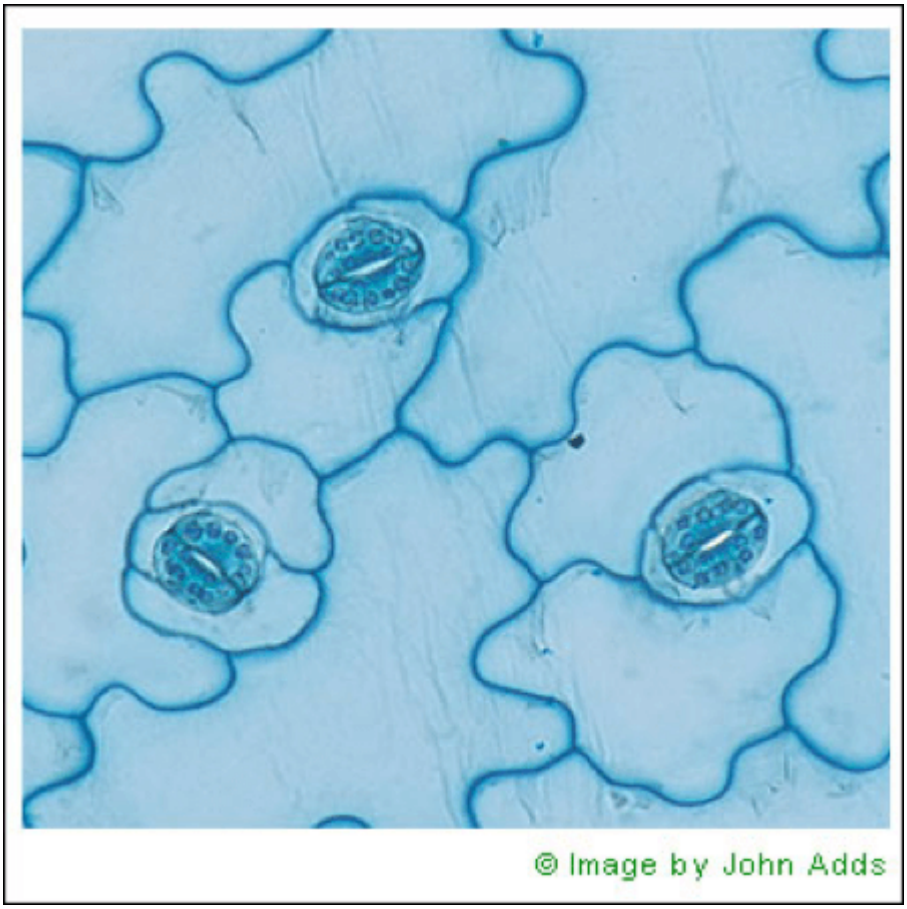
Transpiration and Stomata density across different plant species

Measuring Stomatal Density (http://www.saps.org.uk/secondary/teaching-resources/299-measuring-stomatal-density- (http://www.saps.org.uk/secondary/teaching-resources/299-measuring-stomatal-density-))
Stomata control the movement of gases in and out of a leaf, making carbon dioxide available for photosynthesis, and controlling the loss of water from the leaf through transpiration.

Stomatal density varies between monocots and dicots, between plant species, and between the underside and topside of the leaves on a plant.

Background Information

The image shows a surface view of the lower epidermis of Kalanchoe (Kalanchoe sp.), a dicotyledonous plant. Three stomata and their associated guard cells are shown.



Source: http://www.saps.org.uk/secondary/teaching-resources/299-measuring-stomatal-density- (access 27/9/16)

Each pore or stoma is surrounded by two sausage-shaped guard cells, which change shape to control the size of the stomatal aperture.

The stomata of most species open in daylight and close in the dark. Those plants that use CAM photosynthesis (an adaptation to reduce water loss in arid conditions), stomata close during the heat of the day, to reduce evapotranspiration, and open at night to absorb carbon dioxide for use in photosynthesis.

Suggestions for investigations

Suggested questions that may be posed to students:

Does the density vary over a leaf surface?

Does the density vary between different leaves of the same plant? . . . or between different plants of the same species? (For example: the Brassicaceae: B. oleracea v. capitata (cabbage), v. gemmifera (brussels sprout), v. italica (broccoli), v. botrytis (cauliflower). All these leaves are available from supermarket

Does the density vary between plants from different habitats?

Materials:

- Plant leaves
- Clear fingernail polish
- Clear cellophane tape (clear package sealing tape)
- Microscope
- Microscope slides

NB – Some leaves that you may like to try include: Baby spinach leaves, Lettuce, Brassica sp., or you may like to try plant leaves that are common to your area. If you are selecting native plants many have thick cuticle layers to protect from moisture loss, so may be a little more challenging to see stomata.

Procedure:

Part 1 (http://www.biologycorner.com/worksheets/stomata.html (http://www.biologycorner.com/worksheets/stomata.html))

- Obtain a leaf from a plant; generally any plant will work for this procedure.
- Paint a thick patch of clear nail polish on the leaf surface being studied. Make a patch at least one square centimeter.
- Allow the nail polish to dry completely.
- Tape a piece of clear cellophane tape to the dried nail polish patch. (The tape must be clear. Do not use Scotch tape or any other opaque tape. Clear carton-sealing tape works well.)
- Gently peel the nail polish patch from the leaf by pulling on a corner of the tape and peeling the fingernail polish off the leaf. This is the leaf impression you will examine. (Only make one leaf impression on each side of the leaf, especially if the leaf is going to be left on a live plant.)
- Tape your peeled impression to a very clean microscope slide. Use scissors to trim away any excess tape.
- Because of the size of stomata, you will need a reasonably good microscope for this. Magnification will depend on the leaf material that you are using, and the size of the stomata.
- Scan the slide until you find a good area where you can see the stomata. Each stoma is bordered by two sausage-shaped cells that are usually smaller than surrounding epidermal cells. These small cells are called guard cells and, unlike other cells in the epidermis, contain chloroplasts.

Part 2 - *You will need to obtain a plant kept in the dark for the next part of the lab.*

- Comparison of stomata between plants stored light and dark conditions

- Get the students to make a prediction about the stomata under light and dark conditions. Will plants have more stoma open during the day than during the night?
- Repeat experiment for a plants leaves that have been kept in the dark

Results:

Sketch. Label the Stoma and Guard Cells (Can you see anything else? Chloroplasts?)

Part 1	Part 2
Light	Dark

2. Estimate the number of stomata on your sample.

Recording data

Table:

Plant	Number of Stomata
Light	
Dark	

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