BC Agriculture in the Classroom Foundation

Activity

Watering and Plant Growth

Students will design and carry out an experiment to determine how altering watering conditions (temperature, amount, size of droplet, time of day, mulching, type of soil, etc.) can affect plant growth.

Suggested Grade/Subject Levels

Science 7

Science 8

Science 9

Environmental Science 11

Science for Citizens 11

Environmental Science 12

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Adaptation of a lesson found in Get Growing! Activities for Food and Garden learning

Curricular Competencies

- Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest.
- Formulate multiple hypotheses and predict multiple outcomes.
- Collaboratively and individually plan, select and use appropriate investigation methods, including field work and lab experiments, to collect reliable date (qualitative and quantitative)
- Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data.
- Experience and interpret the local environment.
- Seek and analyze patters, trends and connections in data, including describing relationships between variable and identifying inconsistencies
- Construct, analyze and interpret graphs, models and/or diagrams
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence.
- Analyze cause-and-effect relationships
- Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables and possible alternative explanations and conclusions.
- Describe specific ways to improve their investigation methods and the quality of the data.
- Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modelled.
- Communicate scientific ideas, claims, information and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions and representations.

Content Connections

Science 7	• Survival needs: all organisms need space, food, water and access to resources in order to survive.
Science 8	• Characteristics of Life: living things respire, grow, take in nutrients, produce waste, respond to stimuli and reproduce. • Photosynthesis and Respiration
Science 9	• Matter cycles within biotic and abiotic components of ecosystems: Eg. water
Environmental Science 11	• Diversity of local ecosystems: abiotic and biotic factors • Sustainability of local Ecosystems: Unsustainable and sustainable ecosystem practices • Conservation and Restoration of Ecosystems: Ecological restoration principles and practices
Science for Citizens 11	• Agriculture practices and processes: environmental impact
Environmental Science 12	• Soil quality • Land use practices

Teacher Background

For land plants and animals, the concern of water loss is a constant survival challenge. Water is required for countless cellular processes and is necessary for plants to grow and photosynthesize. Just like humans loose water every time they exhale, plants loose water every time they open their stomata (small pores on the underside of leaves) to allow carbon dioxide and oxygen to enter and exit. Plants must balance this water loss by absorbing water through their roots. *Capillary action* pulls the water up through special veins, called *xylem,* all the way up to the leaves. As water evaporates from the leaves, it creates a steady pull on the water molecules, creating a continuous process. This process of absorbing water, moving it up through the stem, and then out through the leaves is called *transpiration.* In large Redwoods, hundreds of gallons of water move along their trunks, causing the trees to actually shrink or swell depending on the time of the day. About 95% of the water absorbed by plants through their roots evaporates and is lost from the plant through its leaves.

The rate of transpiration is affected by a number of conditions:

1. Temperature – higher temperatures, transpiration increases and more water is lost through evaporation and it can result in wilting. At lower temperatures, the transpiration rate decreases.
2. Humidity – Water evaporates more quickly into dry air than into air already saturated with water.
3. Wind and Air movement – Increasing air movement increase evaporation and therefore transpiration.
4. Moisture in the soil – decreasing soil moisture usually decreases transpiration. However, since transpiration is a constant process, if the soil moisture is too low, the plant will wilt and die.
5. Plant type – plants adapted to grow in dry environments (eg. cacti and succulents) have sunken stomata or stomata surrounded by hairs called *trichomes* that help to decrease transpiration rates and prevent water loss.

Knowledge of this process can help us understand how to keep our own plants and gardens healthy.

For instance, watering thoroughly (penetrating 10cm of soil) once or twice a week will help promote deeper, more robust root growth. Frequent shallow watering will encourage roots to grow at the surface, decreasing the stability of your plant and increasing the chance of water evaporating before the plant can absorb it.

Soil structure can also affect the rate of water absorption. Health soil contains a mixture of small and large particles, and plenty of air space. Small water droplets can penetrate into small crevices and maintain the mixed particle structure of the soil. A heavier flow of water can cause lighter particles to float to the surface, sealing it and creating a barrier to future watering.

A thorough watering in the morning can often sustain a plant for the day, and because winds are typically lower at this time of day there is reduced evaporation. If you can't water in the morning, water in the late afternoon so that plants have a chance to dry before nightfall (minimizing fungal growth).

Covering the soil with mulch helps to minimize water loss on hot days, prevents weed growth, and insulates during cold weather period.

Overwatering fills all of the air space (plants need oxygen just like animals) and can cause nutrients to leach from the soil and contribute to groundwater contamination.

Materials

- 2 pots with a small bean plant per group
- Various materials depending on the chosen experiment including: sand, clay, potting soil, watering cans, jugs, mulch, thermometer, instruments to measure humidity and wind speed etc.
- Student handouts:
    - Why Water?
    - Watering Experiment Report (for grades 7 and 8)

Procedure

1. Have students brainstorm with a partner how different parts (roots, stems, leaves) of the plant use water. For younger students, guide them through filling in the handout *Why Water?*
    - Water acts as a *solvent*, dissolving minerals and nutrients so that they can be absorbed through the roots.
    - Water is a reactant in photosynthesis $6CO_2 + 6H_20 \rightarrow C_6H_{12}O_6 + 6O_2$
    - Water is necessary to replace water lost in *transpiration* so that the plant doesn't wilt.
    - Water is necessary to support the plant, because when cells fill with water they become rigid (think of a balloon full of water) keeping the plant upright and strong.

2. Review the Scientific Method – Hypothesis, Experiment, Record, Analyze Data and Draw Conclusion.

3. In partners, have students choose one of the following watering variables and design an experiment to test whether each of the factors or conditions affect plant growth. For younger students use the Watering Experiment Report Handout to help guide them, older students should design their own data tables to reflect their chosen experiment. They should be collecting data for approximately 10 days.

    a. Water temperature
        Suggestion: Water plants in one pot with cold tap water. Water plants in another pot with water that has been left in a container outside to match the daytime temperature. Which plants grow better? Why?
    b. Amount of water
        Suggestion: Water plants in one pot with a little bit of water each day. Water plants in another pot more thoroughly every 3 days. Which watering plan worked best? Why might this be?
    c. Size of water droplets
        Suggestion: Water plants in one pot with a watering can that has fan sprinkler head. Water plants in another pot with a bucket or cup. Which worked better for the soil and the plants? Why?
    d. Time of day
        Suggestion: Water plants in one pot every morning. Water plants in the other pot at the end of the school day. What was the impact of each watering plan? Which was better? Why?

e. Mulching
   Suggestion: Mulch plants in one pot. Leave plants in another pot without mulch. Test the soil each day using the poke test. Which needs water first? Why?
f. Weather
   Suggestion: Record air temperature, humidity, wind and use the poke test to determine whether the plants need water. Graph the results and determine if there is a relationship between the weather and watering.
g. Type of Soil
   Suggestion: Fill one pot with a sandy soil, one with a clay soil and one with a potting soil. Use the poke test to determine whether they need water or not. When you water, measure out the quantity of water you use so that each time a plant is watered it's getting a standard amount. Which one required the most frequent watering? How did each soil type react to the watering? Explain which one is ideal.
h. Too much water
   Suggestion: Water plants in one pot normally whenever the poke test says it needs it. Water plants in another pot everyday with lots of water. Compare the effect on the plants.

After students have collected data for ten days, have the students analyze their results and report on their findings. What can the class conclude about the ways to water and to conserve water?

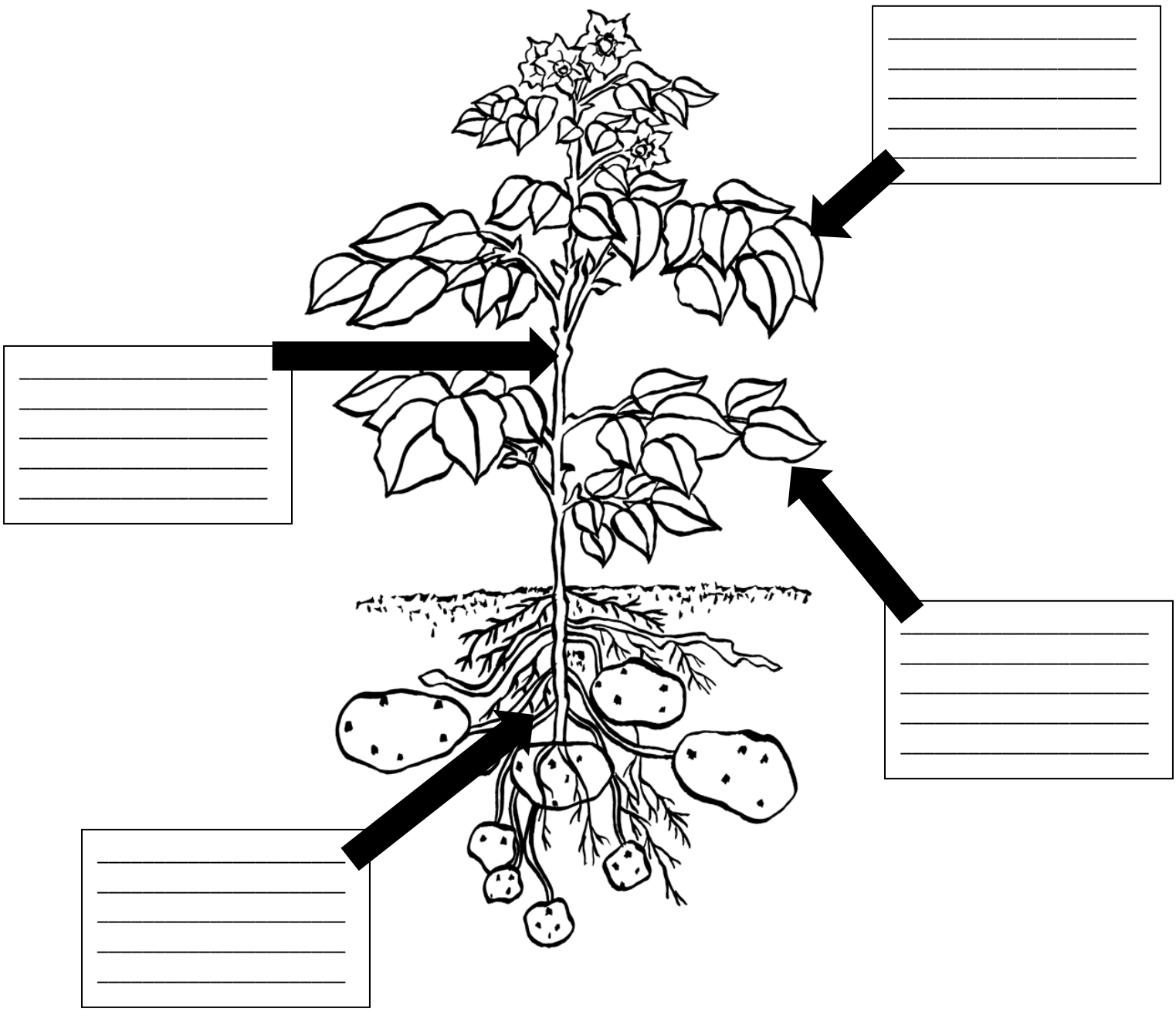
Extension Activities

Science 7/8	Investigate watering practices in the agriculture industry and what they do to prevent water loss.
Science 9	Create a poster demonstrating the water cycle as it pertains to plants.
Environmental Science 11	Design an experiment to test the effect of changing other abiotic factors on plant growth Research xeriscaping or "dry landscaping" a technique of planting in dry climates using vegetation that require little to no supplemental irrigation.
Science for Citizens 11	Investigate watering practices in the agriculture industry and what they do to prevent water loss.
Environmental Science 12	Investigate watering practices in the agriculture industry and what they do to prevent water loss. Investigate plants that are native to the local area and use the information to design a garden with reduced water needs.

Why Water?

Name: _____

As a class brainstorm and discuss the various reasons why plants need water. Think about each part of the plant (root, stem, leaf) and how it might use water differently. Once you have your 4 reasons, fill them into the appropriate boxes.



Watering Experiment Report

Name: _____ Date: _____

Watering variable being tested: _____

Hypothesis: _____

_____

Materials: _____

_____

_____

Procedure: _____

_____

_____

_____

_____

_____

Observations:

Date	What I observed
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Conclusion:

_____

_____

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