Acid Rain and Plant Growth

Learning Outcomes

Students will demonstrate knowledge of the pH scale through experimenting with acids. Students will determine the effects of acid solutions on the rate of plant growth.

QCC Standards

Grade 7:

Science Process Skills Standards 1 & 2

16.1 Identifies the characteristics and structure of vascular plants, e.g., ferns and seed plants (gymnosperm vs. angiosperms).

17. Describes and compares various life processes of plants: asexual and sexualreproduction, photosynthesis, cellular respiration, growth and response to environmental stimuli.

Grade 8:

Science Process Skills Standards 1 & 2

5.1 Identifies ways human beings cause and can correct pollution of water bodies, the atmosphere (acid rain, ozone layer, and greenhouse effect) and the land (soil pollution, and chemical/nuclear waste).

5.2 Examines the effects pollution from cities have on weather and the effect of burning fuels on the atmosphere, melting of polar ice caps, and predicting earthquakes.

16.1 Identifies parts of the water cycle.

16.2 Describes the formation of a river system.

16.3 Describes the distribution and quality of fresh water on the Earth.

Applied Biology & Chemistry 1:

Science Process Skills Standards 1 & 3

20.4 Links the physical and chemical properties of water to its function as transporter of nutrients inside plants and animals.

20.5 Assesses the impact of water quantity of used by different sectors of society: domestic, industrial, and agricultural.

Applied Biology & Chemistry 2:

Science Process Skills Standards 1 & 3

12.1 Locates the main vegetative and reproductive parts of plants.

13.5 Relates the process of DNA replication and mitosis to different methods of vegetative propagation.

Biology:

Science Process Skills Standards 1 & 3

7.2 Lists the reactants, products, and other requirements of photosynthesis.

19.1 Lists and describes distinguishing characteristics of gymnosperms and angiosperms.

19.2 Describes the structure and function of roots, stems, leaves, and flowers.

19.3 Explains the process of sexual and asexual plant reproduction (e.g., pollination, fertilization, germination).

19.4 Describes the importance of seed plants for food, medicine, and other products.

25.1 Identifies and explains the interactions of biotic and abiotic factors in an ecosystem.

National Standards

The energy for life primarily derives from the sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes.

The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.

Materials from human societies affect both physical and chemical cycles of the earth.

Background & Definitions

Water can become acidic when certain chemicals are mixed into it. In nature, this may occur when chemicals from industrial processes as sent into the air, mix with water vapor, and enter the water supply through rain. Organisms all need water to function properly, but that water must be within a range as far as its acidity is concerned. The concentration of an acid is measured on the pH scale. Values below 7 are considered acidic; those above 7 are basic (or alkaline). Pure water has a value of 7. Plants are affected by acidic water when their roots take it in. If there is too much acid, the function of the organism may become disrupted.

Materials & Equipment

4 cups or jars
pH paper
baking soda/ammonia
stirring spoon
distilled water
vinegar
measuring cups
cuttings of a philodendron plant (1 leaf and small amount of stem)
cuttings of a begonia or coleus plant (1 leaf and small amount of stem)
notebook and pencil

Web Resources

http://www.epa.gov/airmarkets/acidrain/
http://www.ns.ec.gc.ca/msc/as/as_acid.html
http://bqs.usgs.gov/acidrain/
http://www.aqd.nps.gov/ard/lessons.html

Safety

Safety goggles required when handling chemicals and glass.

Duration

Portions of 2 weeks. (30 minutes setup)

Procedure

1. Mix 1 teaspoon of vinegar with 2 cups of distilled water.
2. Check the pH with either pH paper or meter, which should be about 4. If it is below pH 4, add a sprinkle of baking soda, or a drop of ammonia, mix, and recheck the pH. If it is above 4, add a drop or two of vinegar, mix, and again recheck the pH.
3. Measure the pH of the distilled water using either pH paper or a garden soil pH testing kit. If the pH is below 7, add about 1/8 teaspoon baking soda or a drop of ammonia, stir well, and check the pH of the water with the pH indicator. If the water is still acidic, repeat the process until pH 7 is reached. Should you accidentally add too much baking soda or ammonia, either start over again or add a drop or two of vinegar, stir, and recheck the pH.
4. Label each cup or jar:

-- water philodendron
-- acid philodendron
-- water begonia (or coleus)
-- acid begonia (or coleus)
5. Pour about a cup of distilled water into the ones labeled "water", and pour a cup of the vinegar mixture into each of the two cups labeled "vinegar".
6. Place a cutting of each plant into each cup, making sure to match the plant type and the label. Cover the stem and the leaf with the liquid. Place the cups where they will receive light.
7. Check the plants every few days to make sure that the plants are still covered by the liquid. Add more liquid as needed.
8. At the end of the first week, compare the new root growth of all plants to one another. Repeat again at the end of the 2nd week.

EXTENSION

Prepare solutions of different pH at intervals of one (such as 7, 6, 5, 4, 3, 2, 1). Determine the limit of acidity that each plant is able to tolerate.

Research and discuss controversies related to acid rain. Topics might include issues related to the rights of producers of industrial chemicals versus the rights of those in other states who are affected by acid rain.

Procedure adapted from Environmental Protection Agency Web Site:
http://www.epa.gov/airmarkets/acidrain/experiments/exp7.html

Student Sheet

Overview

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Questions

1. What is the difference in plant growth when in acid compared to distilled water?
2. Do the two different plants respond equally in the acid water? In other words, does it appear that one plant may deal with acidity better than the other? Explain.
3. If there are differences, how might genetics provide an explanation for this?
4. Why are many people concerned about acid rain?