Demonstrations: Soil Chemistry

DEMONSTRATION OVERVIEW

The following demonstrations provide visual representations and visual analogies for the concepts presented in the outline. When possible, they should be integrated into the lectures.

MAGNET DEMONSTRATION

Detailed Lecture Outline Reference: D 1

PURPOSE

To show how unlike charges attract and like charges repel

MATERIALS

- 2 bar magnets, preferably labeled

METHODS

Hold the negative ends of the magnets together, show how they repel, then hold the negative to the positive and show how they attract.

pH DEMONSTRATION

Detailed Lecture Outline Reference: G 1

PURPOSE

To demonstrate different methods of measuring pH

MATERIALS

- pH meter
- Colorimetric pH test kit (I use the Hellige-Truog)

METHODS

Measure the pH of the soil sample using the different techniques. Compare the results. Explain why differences may occur.

ACID DEMONSTRATION

Detailed Lecture Outline Reference: H 2

PURPOSE

To show how to test for the presence of carbonates in the soil

MATERIALS

- Soil sample with free carbonates
- Dilute hydrochloric acid or vinegar

METHODS

Drop some acid onto the soil to show how it effervesces

SALT CRUST EXAMPLE

Detailed Lecture Outline Reference: I 3

PURPOSE

To show how high salt concentrations might show up in the soil

MATERIALS

- Salt crust

METHODS

Pass some samples of salt-encrusted soil around

CONDUCTIVITY DEMONSTRATION

Detailed Lecture Outline Reference: I 3

PURPOSE

To demonstrate that saline soils conduct electricity

MATERIALS

- Saline soil sample
- Nonsaline soil sample
- Distilled water
- 2 beakers or jars
- Table salt
- Conductivity tester: Any kind of device that shows that electricity will pass through a saline soil but not a nonsaline soil will do. I use one that combines a light bulb and a voltmeter, but a small horn could also work.

METHODS

1. Prepare the two samples (saline and nonsaline) by placing them into separate jars and mixing in distilled water until a smooth paste is created.
2. Place the electrodes of the tester into the nonsaline sample. Notice that the light bulb does not light.
3. Remove the electrodes and rinse them with distilled water. Then place them into the saline soil. Notice that the light bulb lights.
4. Remove electrodes from sample and rinse them with distilled water. Place them back into the nonsaline sample. Stir in table salt until enough has been added to make the light bulb light up.

Note: The operation can be simplified by having four electrodes. Use alligator clips on the tester wires to connect them to the electrodes.

Assessment Questions

TRUE OR FALSE

1) The bulk of a plant is made up of minerals extracted from the soil.

   True False

2) Clay soils can hold more nutrients than sandy soils.

   True False

3) The main source of nitrogen in the soil is rocks.

   True False

4) Phosphorus becomes a pollutant when it is leached into the groundwater.

   True False

5) Alkaline soils are predominant in the arid western states.

   True False

MULTIPLE CHOICE

1) Which one of the following refers to the nutrient-holding ability of the soil?

a. Alkalinity
b. Cation Exchange Capacity
c. Available Water Capacity
d. Nutrient Loading

2) Leaching of bases out of a soil causes the soil to become

a. Alkaline
b. Acid

3) Salinity problems are most likely to occur in

a. Dry environments
b. Upper New York state
c. Tropical rainforests
d. Humid areas

4) Which of the following is NOT a plant nutrient?

a. Nitrogen
b. Copper
c. Aluminum
d. Potassium

5) Nutrients needed in large quantities by plants are called

a. Meganutrients
b. Micronutrients
c. Macronutrients
d. High end nutrients

6) Certain plant nutrients are called micronutrients because

a. They are too small to see with the naked eye
b. They are not all that important to the plant
c. They are only needed in small quantities

7) Which one of the following plant nutrients comes from the air?

a. Carbon
b. Potassium
c. Hydrogen
d. Copper

8) Which of the following affects nutrient availability? (circle all correct responses)

a. pH
b. Soil organic matter content
c. Texture
d. Soil moisture

9) An ion with a positive charge is called a(n)

a. Cation
b. Anion
c. Onion
d. Positron

10) Clay particles tend to have a

a. Positive charge
b. No charge
c. Negative charge

ASSESSMENT

1) How can knowledge of the climate of an area help you make an initial assessment of soil fertility?

2) Your plants are showing signs of iron deficiency. You check the soil pH and it is 8.0. What would most likely be the best way to eliminate the iron deficiency and why?

3) You know that the air around you is full of nitrogen, yet your garden regularly shows signs that it could use a little of it. How can you harness some of the nitrogen for your garden?

4) Is adding a large quantity of nitrogen-rich amendments to your garden before you plant necessarily a good thing to do? Why or why not?

5) What is the most important thing you can do to a mineral soil in order to ensure an adequate supply of and maximum availability of plant nutrients?

Assessment Questions Key

TRUE OR FALSE

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   b. No charge
   c. Negative charge

ASSESSMENT

1) How can knowledge of the climate of an area help you make an initial assessment of soil fertility?
   - *Humid areas tend be more heavily leached, have lower pH and lower fertility*
   - *Dry areas tend to have higher base saturation, higher pH, more fertile*
   - *Warm areas tend to have more highly weathered soils as compared to cooler ones, lower relative fertility*

2) Your plants are showing signs of iron deficiency. You check the soil pH and it is 8.0. What would most likely be the best way to eliminate the iron deficiency and why?
   - *Lower the pH so that the iron in the soil can become more available (usually done by adding sulfur or acid organic materials). If iron supplements are used they, too, will be unavailable due to the high pH unless chelated forms of iron are used.*

3) You know that the air around you is full of nitrogen, yet your garden regularly shows signs that it could use a little of it. How can you harness some of the nitrogen for your garden?
   - *Nitrogen-fixing green manures*
   - *Intercrop with nitrogen-fixing plants*

4) Is adding a large quantity of nitrogen-rich amendments to your garden before you plant necessarily a good thing to do? Why or why not?

   No.
   - *Large amounts of nitrogen without plants to take it up can lead to losses by leaching (polluting groundwater) or volatilization (polluting air)*
   - *Too much nitrogen can burn seedlings*
   - *An imbalance of nitrogen with respect to other nutrients is unhealthy for the plants*

5) What is the most important thing you can do to a mineral soil in order to ensure an adequate supply of and maximum availability of plant nutrients?

   Maintain high levels of organic matter and foster biological activity

Organic matter helps by

- *Buffers micronutrients, keeping them from becoming toxic or imbalanced*
- *Chelates certain micronutrients to keep them available to plants*
- *Increases cation exchange capacity*
- *Supplies certain nutrients such as nitrogen, phosphorus, and sulfur*
- *Improves physical condition of soil (air and water relationships enhanced), which helps to ensure maximum availability of nutrients*
- *Buffers the effect of high or low pH*

Biological activity helps by

- *Breaking down certain compounds to release nutrients*
- *Breaking down organic matter*
- *Some micro-organisms are involved with nitrogen fixation*
- *Organisms can help move otherwise immobile nutrients through the soil*

Resources

PRINT RESOURCES

Brady, Nyle C. 1974. *The Nature and Property of Soils, Eighth Edition*. New York: Macmillan Publishing Co., Inc.

A good general soils text, used for introductory soils classes at universities. Might be too technical for some.

Brady, Nyle C., and Weil, R.R. 1999. *The Nature and Property of Soils, Thirteenth Edition*. Upper Saddle River, New Jersey: Prentice-Hall, Inc.

This is the most recent edition; covers some new subject matter and has improved charts and graphs. A good general soils text, used for introductory soils classes at universities. Might be too technical for some.

California Fertilizer Association. 1985. *Western Fertilizer Handbook*. Danville, IL: The Interstate Printers & Publishers, Inc..

This book contains general information about soils and more detailed information about plant nutrients and fertilizers. Some parts may be difficult to understand. Emphasis is on inorganic fertilizers. Newer editions are available.

Foth, Henry D. 1984. *Fundamentals of Soil Science*. New York: John Wiley & Sons.

Gershuny, G. 1993. *Start with the Soil*. Emmaus, Pennsylvania: Rodale Press.

A general book on soils and soil management geared toward organic gardeners. Easy to read and understand.

Hanson, B., S. R. Grattan, and A. Fulton. 1999. *Agricultural Salinity and Drainage*. Publication 3375. UC Irrigation Program. Oakland, CA: University of California Division of Agriculture and Natural Resources.

An indispensable reference for anyone farming in an area where salinity might be a problem.

Parnes, Robert. 1990. *Fertile Soil: A Grower's Guide to Organic and Inorganic Fertilizers*. Davis, CA: agAccess.

Probably the best reference here on plant nutrients, with good coverage of organic amendments. Some useful reference charts in the appendices.

Stell, Elizabeth P. 1998. *Secrets to Great Soil*. Pownal, VT: Storey Communications, Inc.

An easy to read primer on soils, composting, and basic gardening techniques. Lots of diagrams.

Troeh, F. R., and L. M. Thomposon. 1993. *Soils and Soil Fertility, Fifth Edition*. New York: Oxford University Press.

A general soils text used in introductory soils classes. Might be too technical for some.

WEB RESOURCES

NITROGEN

www.extension.umn.edu/distribution/cropsystems/DC3770.html

www.fifa.asn.au/public/soil_fertility/fifa_14.html

lawr.ucdavis.edu/classes/SSC111/lect11.html

helios.bto.ed.ac.uk/bto/microbes/nitrogen.htm

PHOSPHORUS

www.extension.umn.edu/distribution/cropsystems/DC6288.html

www.extension.umn.edu/distribution/cropsystems/DC6795.html

biology.rwc.uc.edu/HomePage/BWS/ChemII/Phos.html

www.fifa.asn.au/public/soil_fertility/fifa_13.html

lawr.ucdavis.edu/classes/SSC111/lect13.html

ess1.ps.uci.edu/~reeburgh/fig4.html

www.soil.ncsu.edu/sera17/publications/sera17-1/index.htm

www.ipipotash.org/

POTASSIUM

www.fifa.asn.au/public/soil_fertility/fifa_11.html

www.extension.umn.edu/distribution/cropsystems/DC6794.html

www.agcentral.com/imcdemo/07Potassium/07-06.htm

Sulfur

www.fifa.asn.au/public/soil_fertility/fifa_12.html

www.agcentral.com/imcdemo/08Secondary/08-04.htm

CARBON

lawr.ucdavis.edu/classes/SSC111/lect10.html Calcium, pH, and liming

www.statlab.iastate.edu/survey/SQI/pdf/08d3.pdf

www.psu.edu/ur/NEWS/news/liming.html

MISCELLANEOUS NUTRIENTS

www.agcentral.com/imcdemo/09Micronutrients/09-02.htm

www.agric.gov.ab.ca/agdex/500

interactive.usask.ca/skinteractive/modules/agriculture/soils/index.html

edis.ifas.ufl.edu/BODY_MG091

www.fifa.asn.au/public/publications.html

eap.mcgill.ca/MagRack/COG/COGHandbook/COGHandbook_1_3.htm (Organic field crop handbook)

www.agcentral.com/imcdemo/Contributors/Con-2.htm (Page full of links to graphics and figures)

www.uog.edu/soil/

www2.hawaii.edu/~nvhue/sustain_ag/sustag895.html (Organically Acceptable Inputs to Improve Soil Fertility)

DEFICIENCY SYMPTOMS

www.uark.edu/depts/agronomy/purcell/nutrients2.html (Mobile versus immobile nutrients in cotton)

www.penpages.psu.edu/penpages_reference/29401/29401166.html (text only)

www.hortnet.co.nz/publications/guides/fertmanual/dguide1.htm (good photos)

www.public.iastate.edu/%7Erkillorn/nutrie%7E1.htm (good photos)

INSTITUTIONS

Cooperative Extension Service or Farm Advisors Office

Staff from these agencies will be aware of crop nutrient needs and problems in your area. They can assist you with nutrient deficiency symptoms and known plant nutrition problems in your area.

Soil and Plant Tissue Labs

These labs can test your soil or crop for deficiencies. Some websites containing listings of laboratories –

www.attra.org/attra-pub/soil-lab.html

organicgardening.com/library/soil_test_labs.html

www.cals.cornell.edu/dept/cnal/znalnoam.html