Soil Nutrient Activity

Field Ecology

Adapted from a lesson designed by Dr. Larry P. Wilding of Texas A&M University

For this activity, your job is to determine how different types of soils interact with different types of nutrients. The soils you will use are the dried soils you prepared earlier this week. You will also have two dye solutions – an orange solution (methyl orange) that will simulate nitrates (NO_3^-), and a blue solution (methylene blue) that will simulate ammonium (NH_4^+). You should work in groups of 3-4, but collect data and answer the questions individually.

The following facts are very important:

a. Most soil particles are slightly charged.
b. Clay particles, in general, are more charged than sand particles.
c. Opposite charges attract, while like charges repel each other.
d. The orange dye you are using has a negative charge associated with the orange color.
e. The blue dye you are using has a positive charge associated with the blue color.

For this activity, you should wear lab aprons and gloves. If you spill any dye, clean it up with soap, water, and paper towels right away. Let an instructor know if you get any dye on your clothing or skin. These dyes are not caustic (dangerous) but they will stain virtually anything they come in contact with.

In order to evaluate each soil's ability to absorb the dyes, you will need to prepare some materials.

a. You should grind your soil using a mortar and pestle. Don't stop grinding until your soil is completely broken up. Be sure to remove any organic material from the soil as it starts to break up; we want to test only the soil particles themselves, not roots or leaves that might be in the soil.
b. Wrap your soil in a coffee filter and place it in a plastic tower. Put the plastic tower into a beaker.
c. Prepare a data sheet. You should have columns for the dye color and nutrient simulation (orange/nitrates or blue/ammonium), and your observations of the water collected in the beaker. (See below for an example.)

Dye/nutrient	**Observations**
Orange/ nitrates	Water coming out was much more clear than water going in
Blue/ ammonium	Water coming out was exactly the same as water going in

d. Use a plastic pipette to slowly add colored water to your soil until a significant amount of water collects in the petri dish below the tower. Repeat for each type of dye.

Your primary task is to determine whether the two dyes are equally absorbed by the soil. The measurements / observations you make will consist of comparing the color of the water flowing out of your soil to the color of the water you put into the soil. You might need to repeat your measurements a few times in order to verify your results.

If you have enough time before clean-up, you can try diluting your solutions to see if it's possible for any of the soils to completely absorb the either of the dye colors. If you put colored water into the soil and completely clear water flows out, you've done it!

Questions:

1. Which dye resulted in the clearest water collected? (You might need to look at data from some of the other groups to answer these questions.)
2. Why might these dyes filter out more from some soils than other soils? Remember that the colored part of the blue dye is positively charged and the colored part of the orange dye is negatively charged particles.
3. Based on your response to question 2, do you think that soil is generally negatively or positively charged?
4. Most of the important plant nutrients (except nitrates and phosphates) are cationic (positively charged). Why do you think this is helpful for plants?
5. Considering question 3, what does this tell you about nutrients that are negatively charged (like nitrates)? Would they be retained in soils, or would they be more mobile and move wherever water moves in the soil system? Explain your response.
6. What does this activity tell you about the potential pollution of groundwater (underwater lakes and pockets of water) if excess nitrates were applied to lands for crop production, or fertilizers were applied to lands when a crop was not actively growing and extracting nitrates (for example - fertilizing cropland in the late fall of the year when plants aren't growing)?
7. (If you got this far …) Which dyes were you able to get the soils to completely absorb? How much did you have to dilute the dyes to get the soils to absorb them completely? What does this tell you about the amount of nutrients that soils can hold in them?