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 negatively charged.
b. Clay particles, in general, are more negatively 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 up a small (tablespoon) amount of 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. Cover the screen of a plastic tower with soil. Place a paper filter over the soil to keep it from getting scattered. Put your tower on a clean petri dish.
c. Prepare a data sheet. You should have columns for the soil type (Creek or Forest), the dye color and nutrient simulation (orange/nitrates or blue/ammonium), and your observations of the water collected in the petri dish. (See below for an example.)

Soil Type	**Dye/nutrient**	**Observations**
Creek	Orange/ nitrates	Water coming out was much more clear than water going in
Forest	Orange/ nitrates	Water coming out was less orange than water going in but was still orange

d. Fill a graduated cylinder with water. Ask an instructor to add dye to the water. Use a plastic pipette to slowly add water to your soil until a significant amount of water collects in the petri dish below the tower.

Your primary task is to determine which of these two soils absorbs the most and the least of each of the two dyes. 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'll also want to compare the color of the water flowing out of one type of soil to the color of the water flowing out of the other type of soil. You might need to repeat your measurements a few times in order to verify your results. There are only a limited number of petri dishes and plastic towers, so you'll need to reuse your materials – however, you can have two petri dishes at any given time (for comparison purposes).

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 soil / color combination had the clearest solution collected? Which soil / color combination had the most colored solution collected? (You will 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. Most of the important plant nutrients (except nitrates and phosphates) are cationic (positively charged), and soils are mostly anionic (negatively charged). Why do you think this combination of charges is helpful for plants?
4. 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.
5. What does this activity tell you about the potential pollution of groundwater (underwater lakes and pockets of water) if excess soil nitrogen fertilizers 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 early fall of the year when plants aren't growing)?
6. (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?