Soil Charge Demonstration (I.B.)

Which ions will stay in the soil?

One of a farmer's greatest costs is the agronomy expense to test soil for fertility. Fertilizers and pesticides need to stay in the soil to increase crop yield. Solid soil particles behave as ion exchange sites because they have charged surfaces. These charged surfaces can attract molecules with the opposite charge. If the charge is not adequate for nutrient holding, these nutrients will be lost to leaching and crop yield will decrease.

Plants absorb nutrients through **cation** (a positively charged ion) and anion (negatively charged ion) exchange. This action occurs when the root hairs pump hydrogen ions (H+) into the soil. These hydrogen ions displace cations attached to negatively charged soil particles so that the cations are available for uptake by the root, moving from an area of higher concentration in the soil solution to an area of lower concentration in the plant, either through diffusion or facilitated diffusion. Cation exchange capacity is considered more important because the capacity is much larger than the anion exchange capacity in agricultural soils due to the amount of negative surface charge of weathered clay particles.

Materials
6 volt battery
copper strips (¾ inch wide)
alligator clips
clay-water slurry (clay & distilled water)
small beaker

Procedure
1. Cut 2 lengths of copper strips about 8 inches long.
2. Using the alligator clips, attach one copper band to the positive pole of the battery and attach the second copper band to the negative pole. Be sure that the insulation of the alligator clips is not in the slurry.
3. Place the other ends of the bands in a small beaker filled to the top with clay that has been mixed with distilled water to the consistency of glue. Make sure that you are using the stickiest clay you can find or purchase.
4. After 10 minutes, check to see whether the clay particles have moved to the band attached to the positive or negative pole. Remember that unlike charges are attracted to one another. (Organic matter has the same charge as clay).

These ions are commonly added from limestone, fertilizers or acid rain to soils.

H_2PO_4 (immobile anion)

NH_4^+ (immobile cation)

NO_3^- (mobile anion)

K^+ (immobile cation)

AL^{+3}

Cl^- (mobile anion)

Ca^{+2} (immobile cation)

Mg^{+2} (immobile cation)

$SO4^{-2}$ (mobile anion)

Mn^{+2}

Reflection
1. Which nutrient ions listed above will attach to charged sites (exchange sites) on soil particles?

2. What effect will those ions have on the ability for plants to absorb nutrients from the soil?