

M&Ms Are Just Like Soil— Understanding Soil Color



Instructional Value

Grade Level: 3-5 grade but could be used in upper grades as an introduction to other color related lessons.

Type of Lesson

- demonstration (teacher demo),
- experiment (Follow procedure, get results, interpret results) - upper grades

Materials Needed

M&Ms - red, orange or yellow are best as they look like soil colors

Several clear cups

A small strainer, sieve or slotted spoon

Time

Teacher prep time - 10 minutes

Student class time - 10-20 minutes

Student Learning Objectives

- To explain why soils are colored
- To be able to show that soil color is a coating
- To explain that water can change the color of the soil

Keywords

soil color, iron oxides, rust, quartz, feldspar

Summary

Provide a brief summary (a couple of sentences) stating what the students will do and learn. - The students will learn that soil color is only skin deep so to speak. The major coloring agent is Fe-oxides or rust. It occurs on the surface of particle just as the color on an M&M is only on the surface. The color can be removed or dissolved off in water. Once removed it is unlikely for the color to return. So the particles that have no coatings help to tell a soil scientist where the soil has been saturated.

Why is this subject/activity important

- Soil color is used to identify where the water table is in the soil. This is used for many types of building projects.

Background Information

Why is this subject important - Soil color can tell us a lot about the soil and the environment. Dark black top soil indicates high organic matter contents as compared to light brown colors. The presence of gray colors in the soil is used to determine the water table depth. This is done when assessing the site for many land uses related both to agriculture and well as urban/suburban development. Often the gray colors are referred to as wetness mottles or redoximorphic features (formed from reduction and oxidation chemical reactions in the soil). Many land use decisions are based on these colors and the fact that they do not change season to season. Thus in summer when water tables are deep gray colors indicate how high the water table will rise during the wettest time of the year.

The color change from red (rusty) to gray observed in the soil is due to reduction and oxidation of Fe. This process occurs in soil but in saturated soil this occurs when Fe³⁺ is reduced to Fe²⁺ due to a microbial mediated redox reaction.

If air (O₂) is in the soil the soil is aerobic

- $4e^- + O_2 + 4H^+ \rightarrow 2H_2O$ - rusty or oxidized color persists

If all O₂ is removed soil becomes anaerobic (saturation occurs)

- Denitrification
 - o $10e^- + 12H^+ + 2NO_3 \rightarrow N_2 + 6H_2O$ - no color change
- Iron (Manganese) Reduction
 - o $2e^- + 6H^+ + Fe_2O_3 \rightarrow 2Fe(II) + 3H_2O$ - soil turns gray
- Sulfate Reduction
 - o $8e^- + 10H^+ + SO_4 \rightarrow H_2S + 4H_2O$ - rotten egg odor

Vocabulary

Fe-oxide - rust

Water table - depth in the soil where the soil is saturated

Saturation (saturated) - water in all pores; water will flow into a hole dug in saturated soil

Methods/Procedure

- Place a M&M in a sieve. They are still red (orange, yellow).
- Slowly immerse them in water and gently shake them. The water will start to turn pink as the red dye is washed off.
- Observe the color change and remove them before the underlying white coating is dissolved.
- Dry them. They are now white to pink.

Notes

- Monitor the color change as it is easy to let this go too far and wash all the coating off down to the chocolate beneath.
- A variation on this is to let a student hold an M&M in his/her mouth for a few minutes and then observe the color change.



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3. Clean up is easy as most of the students will be happy to help you “get rid of” the extra M&Ms. However the water will have dye and sugar in it so it will be sticky if it gets on hands and surfaces.
4. Remember that some students may have allergies so please do not give M&Ms (peanuts allergies) to anyone susceptible.
5. If you do not use M&Ms test the material you are using ahead of time.

Discussion Questions

1. Discuss why the color changes - it is washed off or dissolved off
2. Discuss if it is likely that the color will change back - it is not likely
3. If you see gray (uncoated) colors in the soil what can that tell you - the soil may get saturated to that depth
4. Will the gray colors in the soil still be gray even when the soil is not saturated - yes, once the color is removed it is not likely to return
5. So if you dug a hole and you saw gray colors near the surface would this be a good place to
 - i. build a house - No it may be wet
 - ii. dig a pond - yes it may be wet

Evaluation/Assessment

See discussion questions above.

Additional Resources

www.soils4teachers.org



Soil Science Society of America
www.soils.org

