Lesson 3: Soil Color

Color is one of the most noticeable properties of the soil. The organic matter content, climate, soil drainage, and mineralogy affect soil color. Most soil minerals are naturally white or light gray. Color is strongly influenced by humus and iron compounds. They change the outer color of the soil much like a coat of paint.

Importance of Soil Color

Soil color gives clues about the nature of the root zone (the normal depth of root penetration into the soil). Dark colors mean favorable amounts of humus. Gray colors suggest unfavorable wetness. Brown and red colors indicate favorable air-water relations.

Soil Matrix Color

The **soil matrix** refers to the main body of soil in a horizon. In uniformly colored horizons, all the soil in the horizon has the same matrix color. Some horizons, however, have two or more colors. The matrix color is the dominant color, the one that covers the greatest area and gives an overall impression of the horizon's color.

The color of most soils depends on whether the soil is moist or dry. Moist soil is nearly always darker than dry soil. One can always moisten a dry soil, but one might not always have time to wait for a moist soil to dry out to determine the color. To be consistent, therefore, always evaluate the color of the soil when it is moist. One or two drops of water will be enough to moisten a small sample of the soil.

The apparent color of a moist soil may also depend on the amount of sunlight striking the sample. The color may seem to be a little darker on an overcast day or in a shadow than on a sunny day or in open sunlight. Some variation is unavoidable, but the soil color always should be determined using the greatest amount of light available. Shades of brown, red, yellow, and black make up the majority of soil colors.

Soil color can be grouped into four broad classes: 1) dark brown, very dark brown, black; 2) light brown, brown, yellowish brown; 3) red, reddish brown; and 4) dark gray, light gray, white.

Descriptive names are used for these classes because everyone sees colors a little differently. There is a fairly accurate way to describe soil color, but it requires a Munsell soil color chart that is quite expensive. This method is described briefly at the end of this lesson.

Dark Brown, Very Dark Brown, Black

These colors are caused by accumulations of organic matter in soils. Humus coats the soil particles, giving them a dark color. Usually, the darker the color, the more organic matter the soil contains, and the more fertile and productive is the soil.

Dark colors are typical of A horizons (the surface layer of soil). See Plates 2 and 8, pp. 50-A and 50-B. In northern Missouri soils, nearly all A horizons have this color.

That is not the case in much of southern Missouri. Organic matter content is lower; therefore, the soils are lighter in color. In general, if the lighter-colored soils have been cultivated, and much crop residue has been mixed into the Ap horizon (plow layer), then the color is probably brown or very dark brown. If the soil has not been cultivated and there is not much native vegetation, then the A horizon is likely to have a light brown color.

Some soils have black colors extending well down into the subsoil. That is usually an indication of wetness. In wet soils, organic matter breaks down very slowly and the soil is darkened by the partially decomposed organic matter that accumulates.

Some very clayey, sticky soils may be black, too. In these soils, organic matter is mixed throughout the entire soil, and the soil is black, even though the organic matter content is not particularly high.

Light Brown, Brown, Yellowish Brown

These are the colors of well-aerated soils. **Well-aerated** means that air moves freely into and out of the pore spaces of the soil. As microbes and plant roots use up oxygen in soil pores, oxygen from the air above the soil moves in to replace it. Well-aerated soils, therefore, provide a healthy environment for plant roots.

Brown colors are due to iron oxide coatings on mineral grains (soil particles). Chemically, they are the same as a coating of rust on a piece of iron. These iron oxide coatings require plenty of oxygen in soil pores. If water should fill soil pores and remain there for a long time, oxygen cannot reach the iron coatings, causing the soil to turn gray. That is why brown colors indicate that the soil has good air-water relations and has not been saturated for long periods of time.

Brown colors are typical of B and C horizons (lower horizons) that are well-aerated. See Plates 2 and 8, pp. 50-A and 50-B. This is true all over Missouri. As long as there is not enough organic matter to darken the soil and there is plenty of oxygen to maintain iron oxide coatings, the soil will nearly always be brown or red.

Red, Reddish Brown

These colors are also caused by iron oxide coatings, and they also indicate well-aerated soil. The soil is red, rather than brown, only because the chemical form of the iron oxide is a little different.

Most red soils are very old soils and are very strongly weathered. See Plates 5 and 9, pp. 50-B and 50-C. They are more leached, more acidic, and less fertile than soils having brown colors.

Red soils occur on some of the uplands of southern Missouri. Except for the A horizon, all the other horizons in these soils usually are red. Red soils are rare in northern Missouri, but there are a few areas where the soils formed in limestone residuum and have red subsoils.

Dark Gray, Light Gray, White

Dark gray soils are wet soils. When soil pores are full of water, oxygen cannot get in. Gradually the yellow-brown coatings are removed from mineral grains and are leached away. The gray color is the natural gray color of the uncoated mineral grains, darkened a little by organic matter. Dark gray is typical of B and C horizons in wet soils. See Plates 11 and 12, p. 50-C.

E horizons (subsurface layers) are always lighter in color than the horizon above them because E horizons have lost organic matter and are leached. Some E horizons occur in wet soils. See Plates 11 and 13, pp. 50-C and 50-D. Iron is reduced and leached from the soil by water moving horizontally on top of a clayey subsoil. Other E horizons may occur in well-drained soils. In these soils, different chemical processes cause the loss of iron oxide coatings from mineral grains. These E horizons have bright-colored B horizons below them.

There are some parent materials (loess and glacial till) common in northwest Missouri that are naturally gray. It should be noted that this color is not a result of wetness. See Plate 30, p. 50-H.

Mottling

Some soil horizons have spots of one color in a matrix of a different color. The spots are called **mottles**, and the soil is said to be **mottled**. Some mottles appear as splotches of reddish-brown color in a gray matrix. See Plate 7, p. 50-B. Others appear as gray mottles in a brown matrix. See Plate 14, p. 50-D. In either case, mottles show that the soil has a seasonal high water table some time during the year, usually during winter and spring months.

Mottling Caused by Water

A **seasonal high water table** is the top of a zone of water-saturated soil. In this zone of saturated soil, all the soil pores are full of water. Without a supply of air, iron oxide coatings are removed from soil particles, and gray colors develop.

When the water table drops, oxygen enters the soil through root channels and large pores. Iron changes back to the yellow-brown form and coats the soil particles in contact with the air. The result is a yellowish-brown mottle surrounded by gray soil.

The depth to mottles and the abundance and brightness of the mottles are keys to the degree of wetness of the soil. This will be discussed more fully in the section on internal soil drainage in Lesson 11. There are, however, situations in which mottles do not indicate wetness.

In recent USDA soil guides, mottles caused by soil wetness are called **Redoximorphic features**. Redoximorphic features are of several kinds. Two of the more important ones are the bright-colored mottles of yellowish brown to red that are caused by oxidation, or iron, and gray mottles that are caused by the reduction of iron. See "Transformations" in Lesson 2. Redoximorphic, often referred to as Redox, is from the words "reduction" (red), "oxidation" (ox), and "amorphous" meaning not having a definite form or shape.

In technical soil descriptions, the bright-colored mottles will be referred to as iron accumulations and the gray mottles as iron depletions. They are described by giving the Munsell color notation, size, and abundance.

Mottling Caused by Chemical Weathering

One situation in which mottles do not indicate wetness is caused by the chemical weathering of rocks. Each different mineral that makes up a rock reacts differently to chemical processes. Some minerals turn yellow, some turn red, some turn gray, and some are destroyed. The result of rock weathering can be a mixture of colors that may look like mottles caused by wetness, even though the soil is quite well drained. Many Cr horizons (soft bedrock) have this kind of mottling.

The key to correctly interpreting causes of soil mottling is to study other factors of the soil and the landscape very carefully. Concave (bowl-shaped) depressions, low-lying areas, or broad, flat terraces are landscapes that are likely to have wet soils. Mottles in these soils probably are mottles caused by wetness. Soils that have horizons that restrict water movement are also likely to have mottles caused by wetness.

Soils on rounded hilltops and sloping hillsides shed water. They are likely to be well drained. Many of these soils are not very deep to bedrock. In these soils, the lower horizons may very well contain weathered rock fragments that look like mottles. The closer one gets to bedrock, the more mottled it might look. Brown colors throughout the soil (in addition to the shape of the landscape) indicate that these mottles are not from wetness. Remnants of original rock layering might be seen, which is another clue indicating that color variations are not caused by wetness.

Coatings on Soil Aggregates

One false interpretation of color patterns is caused by coating on soil aggregates. Organic matter coatings, clay coatings, or moisture films darken the surface of soil aggregates, particularly in B horizons.

Do not confuse these coatings with mottles. Do not judge the color of the soil matrix by the color of the coatings. Always break open a soil aggregate, and judge the color of both the matrix and the mottles from a freshly exposed surface.

Mottle patterns in soil are described in Figure 3.1 using four properties: abundance, size, contrast, and color.

Technical Descriptions of Soil Colors

The more technical method of describing soil color uses Munsell color notations. These notations use three variables: hue, value, and chroma.

Hue – Color, such as red or yellow, or an intermediate color.
Value – Relative darkness or lightness of a color, from black to white.
Chroma – Relative purity of a color, from dull to bright.

The Munsell color notation uses symbols like 10YR 4/6. The first part (10YR) designates the color, yellowish red. The numerator of the fraction (4) is the value. This is the relative darkness of the color on a scale of 0 to 10 (0 = black, 10 = white). The denominator (6) is the chroma. It is an index of the brightness of the color on a scale of 1 to 8 (1 = dull, 8 = bright). Therefore, 10YR 4/6 denotes a dark, yellowish-brown soil.

Figure 3.1 – Guide for Describing Mottles

ABUNDANCE – The percentage of exposed surface area occupied by mottles.
Classes
- ◊ *Few:* Less than 2 percent of the exposed surface
- ◊ *Common:* 2–20 percent of the exposed surface
- ◊ *Many:* More than 20 percent of the exposed surface

SIZE – The approximate diameter of individual mottles.
Classes
- ◊ *Fine:* Diameter less than 5 mm
- ◊ *Medium:* Diameter 5–15 mm
- ◊ *Coarse:* Diameter more than 15 mm

CONTRAST – The relative difference between the mottle color and the matrix color.
Classes
- ◊ *Faint:* Mottles are evident only on close examination. Mottle color and matrix color are very nearly the same.
- ◊ *Distinct:* Mottles are readily seen, though not striking. Mottle color and matrix color are different, though not widely so.
- ◊ *Prominent:* Mottles are so conspicuous that they are the outstanding visible feature of the horizon. Mottle color and matrix color are widely different.

COLOR – Mottle colors are described the same way as the soil matrix colors. The most common mottle colors are yellowish brown, dark reddish brown, red, and gray.

The Munsell Color Company makes small color chips for each combination of hue, value, and chroma. See Plate 15, p. 50-D. Chips of those colors that are most frequently observed in soils are arranged in special books of soil color charts. To determine soil color in the field, simply match the color of a soil aggregate with a chip of the same color. Then record the symbol for that chip. Technical descriptions of Missouri soils published either in soil survey reports or as single-sheet Official Soil Descriptions (OSDs) use this more precise method to consistently record soil colors.

Summary

This chapter discusses the importance of soil color and describes how the matrix color of soil is identified. Soil color can be grouped into four broad classes: 1) dark brown, very dark brown, and black; 2) light brown, brown, and yellowish brown; 3) red and reddish brown; and 4) dark gray, light gray, and white. The presence of organic matter has an effect on soil color, usually making it darker. Other factors also can have an effect on soil color. Mottling, spots in a soil matrix of a different color, is described. Causes of mottling are discussed, and ways to identify mottles are given. Mottle patterns in soils are described according to abundance, size, contrast, and color. Lastly, the Munsell color notation system is briefly described.

Credits

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Vepraskas, Michael J. *Redoximorphic Features for Identifying Aquic Conditions,* Tech Bulletin 301. Raleigh: North Carolina State Agricultural Research Service, May 1994.