SOIL FORMATION – Part-2

Introduction & Types of Soil

In our last interaction we had learnt about soil, its various profiles and the processes involved in its formation. We had also discussed the factors affecting soil formation.

Today will deal with the types of soil, the various physical and chemical properties of soil and its importance.

TYPES OF SOIL

Soil can be categorized into various types. These are sandy soils, silty soils, clay soils, loamy soils, peaty soils and chalky soils.

Sandy Soils: Sandy soils are free draining, with the largest particles. They are fine and hard. The soil feels gritty. It does not bind very well. It is poor in holding water and easily warms up in the spring season. Sandy soils are very low in nutrients, as they are usually washed away. The degree of aeration depends on the sizes of the particles, which vary a lot. It is usually formed from the weathering or disintegration of bedrock such as shale, limestone, granite and quartz.

Silty Soils: Silty soil is finer, smoother in texture and holds water better than sandy soils. It also holds up nutrients and makes it better for crop cultivation. Silty soil is heavier than sandy soil, and almost midway between the properties of sandy and clay soils. It is formed when fine sediments - dust, organic matter and debris - are carried by water or ice and then deposited. When silt is deposited and cemented with time, it forms siltstone. Silt particles are so small and not easily seen by the eyes. It leaves a bit of residue on touching them.

Clay Soils: The particles that make up clay are the finest and they bind very well. It has very little air spaces. Clay is very sticky when wet, and can be molded into any shape and form. When they dry, they are hard like rock. Clay soils do not drain very well. Clay is believed to form in places where rock is in contact with water, air or steam. For example, sediments on sea or lake bottoms may become clay soils with time.

Loamy Soils: Loamy soil is a mixture of sand, clay and silt particles and has the ability to retain water. It is high in calcium, aeration and ideal for most crops and vegetables. This soil is full of nutrients from decomposed organic material. It is soft and easy to cultivate.

Peaty Soils: Peaty soils are acidic and as a result, do not support decomposition very well. It is dark in color and rich in organic material, although it contains less nutrients than loamy soils. It retains water very well.

Chalky Soils: Chalky soils are alkaline with a pH of about 7.5. It is not acidic and often stony with chalk or limestone bedrock. It is free draining because of its coarse and stony nature. It is not good for crops to grow in as it lacks manganese and iron.

Physical and Chemical Properties of Soil

Soil has various physical and chemical properties.

Physical Properties

The physical properties of soil include horizonation, soil colour, soil texture, soil structure, and bulk density.

1. **Horizonation:** Soil “horizons” are discrete layers that make up a soil profile. They are typically parallel with the ground surface. In some soils, they show evidence of the actions of the soil forming processes.

O-horizons are dominated by organic material. Some are saturated with water for long periods or were once saturated but are now artificially drained; others have never been saturated.

A-horizons are mineral layers that are formed at the surface or below an O–horizon. They exhibit obliteration of all or much of the original rock structure. They may show one or both - accumulation of humified organic matter or properties resulting from cultivation.

2. Soil Color: In well aerated soils, oxidized or ferric (Fe+3) iron compounds are responsible for the brown, yellow and red colors in the soil. When iron is reduced to the ferrous (Fe+2) form, it becomes mobile, and can be removed from certain areas of the soil. When the iron is removed, a gray color remains, or the reduced iron color persists in shades of green or blue. Upon aeration, reduced iron can be reoxidized and redeposited, sometimes in the same horizon, resulting in a variegated or mottled color pattern. These soil color patterns resulting from saturation, called "redoximorphic features", can indicate the duration of the anaerobic state, ranging from brown with a few mottles, to complete gray or "gleization" of the soil.

3. Soil Texture: Soil texture refers to the proportion of the soil "separates" that make up the mineral component of soil. These separates are called sand, silt, and clay. These soil separates have certain size ranges:

* Sand = < 2 to 0.05 mm

* Silt = 0.05 to 0.002 mm

* Clay = < 0.002 mm

4. Soil Structure:

Just like other physical properties, soil structure also varies. It may be granular, platy, blocky, prismatic, columnar, massive or single grained.

Granular Soil Structure – Granular soil structures are roughly spherical, like grape nuts, usually 1-10 mm in diameter. They are most common in A-horizons, where plant roots, microorganisms, and sticky products of organic matter decomposition bind soil grains into granular aggregates

Platy Soil Structure - Platy soil structures are flat peds that lie horizontally in the soil. Platy structure can be found in A, B and C-Horizons. It commonly occurs in an A-Horizon as the result of compaction.

Blocky Soil Structure - Blocky soil structures are roughly cube-shaped, with more or less flat surfaces. If edges and corners remain sharp, it is angular blocky. If they are rounded, it is subangular blocky. Sizes commonly range from 5-50 mm across.

Prismatic Soil Structure - Prismatic soil structures are larger, vertically elongated blocks, often with five sides. Sizes are commonly 10-100mm across. Prismatic structures commonly occur in fragipans.

Columnar Soil Structure - Columnar soil structures are units similar to prisms. They are bounded by flat or slightly rounded vertical faces. In contrast with the tops of prisms, the tops of columns,, are very distinct and normally rounded.

Massive Soil Structure – Massive soil structure is compact, coherent soil not separated into peds of any kind. Massive structures in clayey soils usually have very small pores, slow permeability, and poor aeration.

Single Grain Soil Structure – In some very sandy soils, every grain acts independently. There is no binding agent to hold the grains together into peds. This is called ‘single grain soil structure’.

5. Bulk Density: Bulk density is the proportion of the weight of a soil relative to its volume. It is expressed as a unit of weight per volume, and is commonly measured in units of grams per cubic centimeters (g/cc).

Chemical Properties

Chemical properties of soil include cation exchange capacity or CEC, and soil reaction or pH.

1. Cation Exchange Capacity (CEC)

Some plant nutrients and metals exist as positively charged ions, or “cations”, in the soil environment. Among the most common cations found in soils are hydrogen (H^+), aluminum (Al^{+3}), calcium (Ca^{+2}), magnesium (Mg^{+2}), and potassium (K^+). Most heavy metals also exist as cations in the soil environment. Clay and organic matter particles are predominantly negatively charged (anions), and have the ability to hold cations from being “leached” or washed away. The adsorbed cations are subject to replacement by other cations in a rapid, reversible process called “cation exchange”.

Cations leaving the exchange sites enter the soil solution, where they can be taken up by plants, react with other soil constituents, or be carried away with drainage water.

2. Soil Reaction (pH)

The “pH” is a measure of the active hydrogen ion (H^+) concentration. It is an indication of the acidity or alkalinity of a soil, and also known as “soil reaction”. The pH scale ranges from 0 to 14, with values below 7.0 acidic, and values above 7.0 alkaline. The most important effect of pH in the soil is on ion solubility, which in turn affects microbial and plant growth. A pH range of 6.0 to 6.8 is ideal for most crops because it coincides with optimum solubility of the most important plant nutrients.

Importance of Soil

Soils are essential for life, because they provide the medium for plant growth, provide habitat for many insects and other organisms, act as a filtration system for surface water, store carbon, maintain atmospheric gases and play a vital role in agriculture, construction of buildings, pottery making, medicine and production of beauty products.

Let us take a closer look at each of these:

1. Medium for Plant Growth

Soils support roots and keep them upright for growth. They provide plants with essential minerals and nutrients. They provide air for gaseous exchange between roots and atmosphere. They protect plants from erosion and other destructive physical, biological and chemical activity. Soils also hold water (moisture) and maintain adequate aeration.

2. Habitat for Insects and Other Organisms

Insects and microbes, very tiny single cell organisms, live in the soils and depend on them for food and air. Soils are homes to a diverse range of organisms such as worms and termites. They provide the needed moisture and air for breakdown of organic matter. They provide a home for many organisms such as insects to lay and hatch eggs and rodents to give birth to new offspring.

3. Filtration System for Surface Water

Water flows across the earth's surface and into water bodies when the snow melts or when it rains. A lot of this water gets soaked and infiltrates into the ground. As it continues its way downwards through the many layers in the ground, it is filtered from dust, chemicals and other contaminants.

4. Carbon Store and Maintenance of Atmospheric Gases

Soils help regulate atmospheric Carbon dioxide by acting as a carbon store. On a global scale, soils contain about twice as much carbon as the atmosphere and about three times as much as vegetation. This results in the accumulation of organic matter in the soil which is high in carbon content. Nitrogen, phosphorus and many other nutrients are stored, transformed and cycled in the soil.

5. Agriculture

Soil has vital nutrients for plants. As a result, it is used in agriculture to nourish plants. The roots of a plant receive nutrients from the soil to help it grow. According to North Carolina Department of Agriculture and Consumer Services, 13 essential plant nutrients come from the soil.

6. Building

Soil is an important part of the building process. Soil compaction, which increases the density of the soil, is done as part of the building process. The purpose of the compaction is to improve the load support Lack of compaction can lead to structural failure. Soil can also be used as building materials such as adobe and red bricks.

7. Pottery

Clay soil is used in making ceramics or pottery. When water is added to clay soil, it can be used to create the ceramics. Once formed, you can leave it to dry and it will retain its shape. Any type of ceramic can be created with clay soil, such as a vase, bowl, cup or sculpture.

8. Medicine

Healthy, living soils contain thousands of different species of bacteria and several of these are important producers of antibiotics.

Bacillus subtilis is found in topsoil and has probiotic like properties. Medicines created by soil include skin ointments, tuberculosis drugs and anti-tumor drugs.

9. Beauty Products

Some beauty products are made with soil. Commonly used beauty products where soil is an ingredient include blush and foundation. Soil rich in clay can also be used in facial masks and toothpastes.

CONCLUSION

Today we have dealt with the types of soil, the various physical and chemical properties of soil and its importance.

I hope you are now clear about the topic.