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PHYSICAL AND BIOLOGICAL CHARACTERISTICS OF SOIL: A PERSPECTIVE STUDY

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ABSTRACT

Soil is also a natural resource; soil management is very important. Because soil fertility depends on three basic factors namely physical, chemical and biological. Because soil conservation is the need of the hour, it means that the quality of soil is decreasing due to many reasons like modern farming technology, chemical ingredients used in agriculture, contaminated water, various contaminated water from factories. We can see the effect of this on agricultural production. Therefore, it is considered very important to study soil characteristics to maintain soil quality. Natural characteristics of soil are related to various factors such as crop growth, water drainage, moisture retention, and plant nutrients. Also, physical properties affect chemical and biological behavior. Although man-made causes are considered to be the most important factors behind the decline in soil fertility, studying soil characteristics is an important basis. For this reason, the above paper is being done from the point of view of making a theoretical study of soil characteristics. The information in this research paper is based on secondary data.

Keywords: Soil, Physical, Chemical, Biological, Characteristics, Speculative

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1. INTRODUCTION

The social, economic and political development of any region depends on its natural and human resources. Natural resources include various elements such as air, water, soil and plants and animals. On the other hand, human resources depend on various human factors such as human technology, human skill, and literacy. The natural and human wealth of any country is the national wealth of that country. At the same time, soil is also a natural resource, its planning is very important for proper utilization of this resource. The most important natural resource is soil.

Humans and animals, natural beauty all depend on this soil. In short, all the various human activities depend on it. Therefore, although soil is a natural resource, it is being degraded or its quality is deteriorating due to extensive misuse in present times, so there is a need for soil conservation. Soil is also considered as the basis of life on earth, quality soil is considered as the core for agriculture or food production process. Plants or crops grow or produce well in soil that is healthy. Plants get nutrients from two natural sources in the soil, one is organic matter, and the other is minerals. In addition to providing nutrients and habitat for soil-dwelling life, soil organic matter holds water in soil particles. Nutrients hold the soil particles together. Chemical properties of soils are primarily dependent on soil organic matter, soil colloidal properties, and soil reactivity and fabric activity in acidic soils and basic soils, of course, the chemical components of the soil are considered very important, so that the proper balance of nutrients in the soil is maintained. At the same time, it is called the store house of nutrients in the farm. Chemical and physical properties and biological properties affect soil nutrient formation. So, these three factors are considered important for the proper functioning of the soil. Soil is a mixture of various minerals, organic matter, gases, micro-organisms and matter, on the combination of which the function of the soil depends. The topsoil is made up of organic remains, soil and rocks. The layer on which plants grow is considered as soil. Soil is considered as a very important core for plant growth and life. Soil formation is caused by various physical, chemical and biological processes such as weathering and erosion etc. Although soil is a natural entity, it is a dynamic one. Soil is formed by the processing of parent rock by natural factors. It consists of mineral and organic matter, chemical, physical and biological properties of this parent rock transform it into soil. Soils are primarily important for five factors: biomass productivity, ecosystem formation and resilience, water purification, pollutant deoxidization, and cycling of C, N, P, S, and H2O (Velayutham and Bhattacharyya, 2000). Human resources have overused natural resources. We are currently feeling the effects of this. In this we mainly see the increase in various types of pollution, we get rain as a result of various factors like air, soil, water etc. Mainly in this research paper it is considered to study the characteristics and quality of soil. Therefore, to maintain the quality of the soil, it is necessary to study the characteristics and elements of the soil.

2. OBJECTIVE

The main feature of this research is to study the Physical, chemical and biological characteristics of soil.

1) The study of soil characteristics is studied from a theoretical point of view.
2) To study theoretically the Physical, chemical and biological components of soil.

3. METHODOLOGY

The choice of study method is dependent on achieving the objective of the research paper. Table number 01 explains the study methodology of the research the said research relies on secondary data. For this, various sources such as websites, journals, and books have been used. The objective is to study the physical, chemical, biological properties of soil. Speculative approaches have been considered to study the above objectives as well as to study the characteristics of the soil (Table no 01).

Table 1

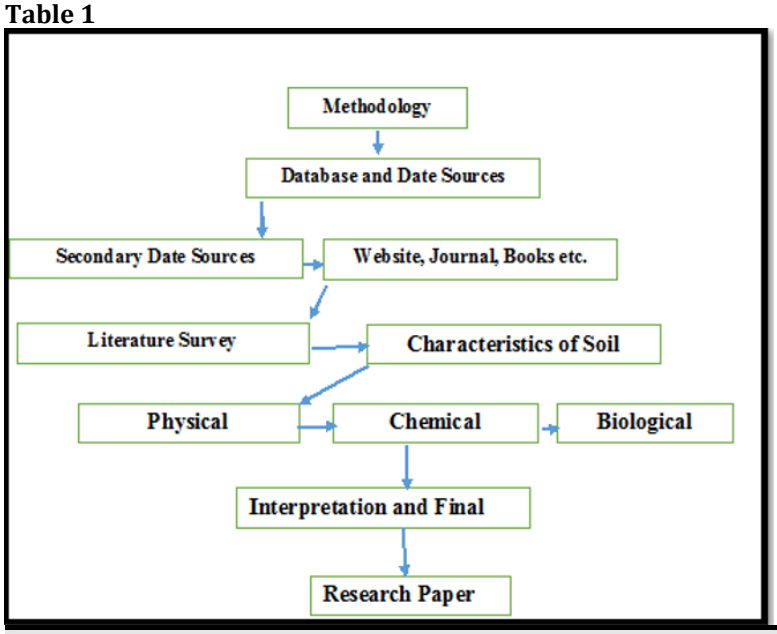
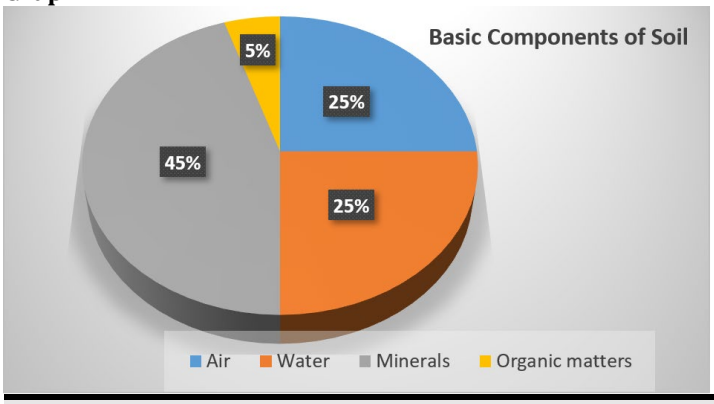


Table 1 Methodology of Research
Source Design by Researchers

4. CHARACTERISTICS OF SOIL

Soil structure depends on the nutrient system, the minerals and organic matter in the soil, holding the nutrients. Stored in soil is an easily accessible source of important nutrients for plants. Air in the soil also plays an important role as it is an important factor. At the same time, micro-bacteria present in the soil produce additional nutrients in the soil. Soil mainly consists of three basic elements in which minerals, organic matter, water and air are considered as important elements. Soil is approximately 45% minerals, 5% organic matter, 25% percent water, and 25% percent air. These percentages are generalizations only. Soils are actually very complex and dynamic components. Crop growth or plant growth depends on the organic matter present in the soil.

Graph 1

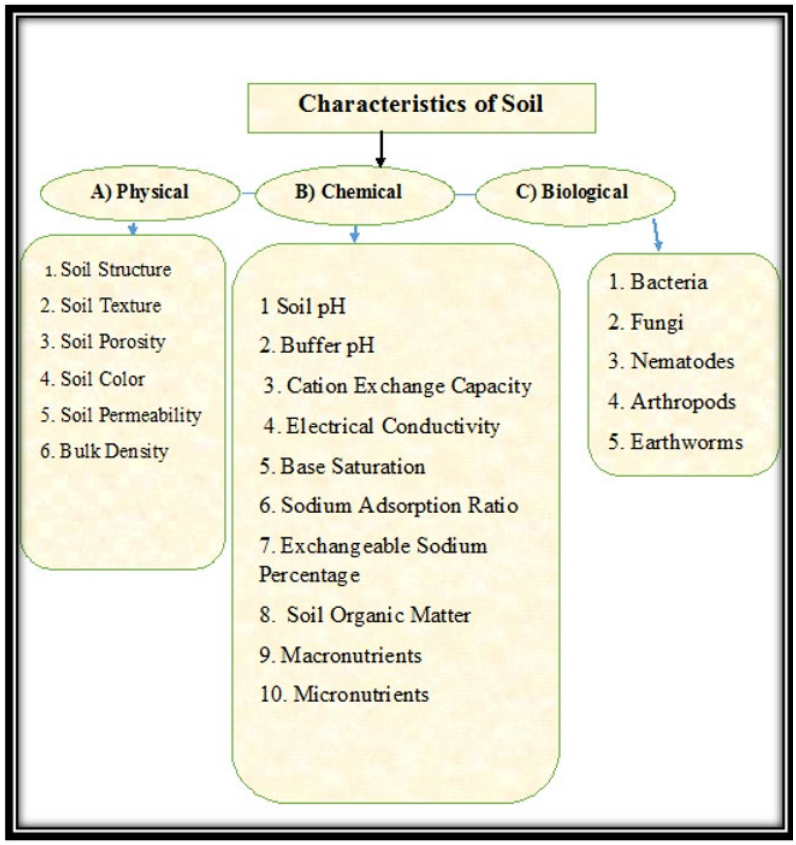


Graph 1 Basic Components of Soil

In the characterization of soil, mainly three factors namely physical, chemical and biological will be studied. Physical characteristics mainly consist of 02 elements, chemical characteristics consist of 10 elements and biological characteristics consist

of 05 elements. Physical characteristics are Soil Structure, Soil Texture, Soil Porosity, Soil Color, Soil Permeability, and Bulk Density. Chemical characteristics are Soil pH, Buffer pH, Cation Exchange Capacity, Electrical Conductivity, Base Saturation Sodium Adsorption Ratio, Exchangeable Sodium Percentage, Soil Organic Matter, Macronutrients and Micronutrients. Biological characteristics are Bacteria, Fung, Nematodes, Arthropods and Earthworms.

Graph 2



Graph 2 Characterization of Soil (Physical, Chemical and Biological)
Source Design by Researchers

1) **Physical characteristics of Soils:** Four elements are important for soil formation mainly minerals, organic matter, water and air as well as these elements are considered important for making the soil profile. Organic matter is the basis of most plant life.

- **Soil Structure:** Soil texture is defined by the aggregate or mixture of sand, silt, and clay particles. All these types of soil particles together look like a big ear, and it is called soil structure. "Aggregation of soil particles can occur in different patterns, resulting in different soil structures". Soil texture is defined by the aggregate or mixture of sand, silt, and clay particles. All these types of soil particles together look like a big partial and it is called soil texture. Soil texture mainly depends on the type of soil particles and the cohesiveness of the soil. The availability of minerals in soil is based on the particle size and their distribution. For example, sand, silt and chicken soil.

Figure 1

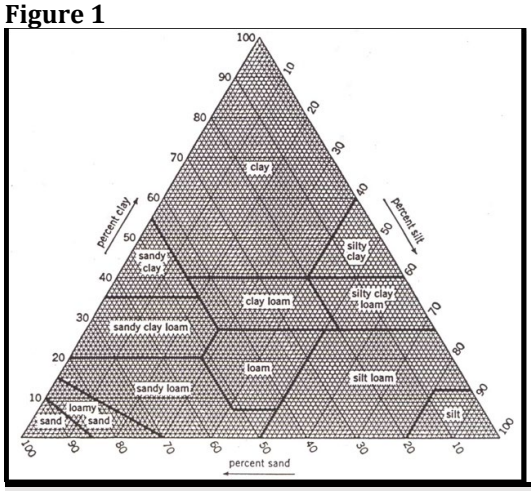


Figure 1 Diagram of U.S.D.A. Soil Textural Classes

- **Soil Texture:** Texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil. Texture influences the ease with which soil can be worked, the amount of water and air it holds, and the rate at which water can enter and move through soil. all particles less than 2 mm, from larger particles such as gravel and stones. Fine earth is a mixture of sand, silt and clay.

Table 2

Table 2 USDA Textural Classes of Soils

Common names of soils (General texture)	Sand	Silt	Clay	Textural class
Sandy soils (Coarse texture)	86-100	0-14	0-10	Sand
	70-86	0-30	0-15	Loamy sand
Loamy soils (Moderately coarse texture)	50-70	0-50	0-20	Sandy loam
Loamy soils (Medium texture)	23-52	28-50	Jul-27	Loam
	20-50	74-88	0-27	Silty loam
	0-20	88-100	0-12	Silt
Loamy soils (Moderately fine texture)	20-45	15-52	27-40	Clay loam
	45-80	0-28	20-35	Sandy clay loam
	0-20	40-73	27-40	Silty clay loam
Clayey soils (Fine texture)	45-65	0-20	35-55	Sandy clay
	0-20	40-60	40-60	Silty clay
	0-45	0-40	40-100	Clay

USDA textural classes of soils

- **Soil Porosity:** The space around mineral and organic soil particles or volume of pores in the total volume of soil occupied by air and water. Pore types are macro, capillary and micro. Pore size distribution can be used to predict water holding capacity, plant available water, infiltration rate and air to water ratio. Soil porosity is affected by organic matter levels, aggregation, shrinking and swelling of clay particles, dispersion caused by low calcium levels versus sodium and magnesium, tillage, and traffic.

Figure 2

Figure 2

Source https://www.ndsu.edu/soilhealth/wp-content/uploads/2014/07/Soil-Health-Fact-Sheet_Physical-Properties.pdf

- **Soil Color:** Color can be used as a clue to mineral content of a soil. Iron minerals, by far, provide the most and the greatest variety of pigments in earth and soil (see the following table).

Table 3

Mineral	Formula	Size	Munsell	Color
goethite	FeOOH	(1-2 μm)	10YR 8/6	yellow
goethite	FeOOH	(~0.2 μm)	7.5YR 5/6	strong brown
hematite	Fe_2O_3	(~0.4 μm)	5R 3/6	Red
hematite	Fe_2O_3	(~0.1 μm)	10R 4/8	Red
lepidocrocite	FeOOH	(~0.5 μm)	5YR 6/8	reddish-yellow
lepidocrocite	FeOOH	(~0.1 μm)	2.5YR 4/6	Red
ferrihydrite	$Fe(OH)_3$		2.5YR 3/6	dark red
glauconite	$K(Si_xAl_{4-x})(Al,Fe,Mg)O_{10}(OH)_2$		5Y 5/1	dark gray
iron sulfide	FeS		10YR 2/1	black
pyrite	FeS_2		10YR 2/1	black (metallic)
jarosite	K Fe3 (OH)6 (SO4)2		5Y 6/4	pale yellow
todorokite	MnO4		10YR 2/1	black
humus			10YR 2/1	black
calcite	CaCO3		10YR 8/2	white
dolomite	CaMg (CO3)2		10YR 8/2	white
gypsum	CaSO4× 2H2O		10YR 8/3	very pale brown
quartz	SiO2		10YR 6/1	light gray

Sources nrcs.usda.gov

- **Soil Permeability:** The permeability of a soil is a measure of the ability of soil to allow water to pass through it. It is typically represented by the letter 'k' and is measured as the volume of water (m3) that can pass through an area (m2) per second (m3/ m2/s, or more simply m/s). Soil permeability is a measure of the ease with which air and water move through the soil. A consistent and moderate supply of water, along with deep and spreading root growth are some of the benefits of good drainage or permeability. Plants need good internal soil drainage to grow.

Figure 3

Soil Type	Description	Permeability (k) (equivalent rainfall rate)	Suitability
Cobbles and boulders	Permeability may be greater as flow may be turbulent	1 m/s	Excellent
Gravels	Uniformly graded coarse aggregate with zero fines and minimal sand	10^{-1} to 10^{-2} m/s (>3600 mm/hr)	Very Good
Gravel sand mixtures	Clean, well graded, with minimal fines (e.g. crushed stone or 'Type 3' road aggregate)	10^{-3} to 10^{-4} m/s (3600 to 360 mm/hr)	Good
Clean Sands	Sands with low silt or clay content	10^{-4} to 10^{-6} m/s (360 to 3.6 mm/hr)	Good to moderate
Silt mixtures	Mixtures of sand, silt and clay (topsoil is typically in this category)	10^{-6} to 10^{-10} m/s (<3.6 mm/hr)	Moderate to poor
Clays	Pure clays	10^{-10} to 10^{-12}	Practically Impermeable
Artificial	Bituminous mixtures, cement stabilised soil, geosynthetic liners	$<10^{-12}$	

Figure 3 Typical Permeability of Soils

- **Bulk Density:** The soil bulk density (BD), also known as dry bulk density, is the weight of dry soil (Msolids) divided by the total soil volume (Vsoil). The total soil volume is the combined volume of solids and pores which may contain air (Vair) or water (Vwater), or both. The average values of air, water and solid in soil are easily measured and are a useful indication of a soils physical condition. Soil BD and porosity (the number of pore spaces) reflects the size, shape and arrangement of particles and voids (soil structure). Both BD and porosity (Vpores) give a good indication of the suitability for root growth and soil permeability and are vitally important for the soil-plant-atmosphere system (Cresswell and Hamilton, 2002; McKenzie et al., 2004). It is generally desirable to have soil with a low BD (<1.5 g/cm3) (Hunt and Gilkes, 1992) for optimum movement of air and water through the soil. Bulk density measurements can be done if you suspect your soil is compacted or as part of fertilizer or irrigation management plans factsheet. Bulk density of a soil is defined as the weight per unit volume of soil. A unit volume of soil includes both the solids and the pore space. Bulk density is important because it reflects the porosity of a soil. Loose, porous soils have lesser bulk densities than tight, compacted soil.

Figure 4

Tools for measuring bulk density:

- A steel ring (e.g. a tin ≈10 cm height x 7 cm diameter)
- A shovel or trowel
- Calculator
- Oven proof dish
- Oven or convection microwave
- Plastic bag for sampling
- Ruler
- Marker pen
- Scissors
- Kitchen scales or balance (grams)

2) Biological characteristics of Soils

An incredible diversity of organism's make-up the soil food web ranging in size from the tiniest one-celled bacteria, algae, fungi, and protozoa, to the more complex nematodes and micro-arthropods, to the visible earthworms, insects, and small vertebrates. While some soil fauna can cause diseases in plants, the vast majority of

soil fauna and flora are critical to soil quality. They affect soil structure and, therefore, soil erosion and water availability. They can protect plants from pests and diseases and are central to decomposition and nutrient cycling. The maintenance of this living aspect of the soil is essential to the maintenance of a healthy field.

- **Bacteria**

Bacteria are the most numerous types of soil organism: every gram of soil contains at least a million of these tiny one-celled organisms. One of the major benefits bacteria provide for plants is in making nutrients available to them.

- **Fungi**

Fungi come in many different species, sizes, and shapes in soil. Some species appear as threadlike colonies, while others are one-celled yeasts. Many fungi aid plants by breaking down organic matter or by releasing nutrients from soil minerals. Fungi are generally quick to colonize larger pieces of organic matter and begin the decomposition process. Arbuscular mycorrhizal (my-cor-ry¢-zal) fungi are beneficial soil organisms that contribute to many aspects of soil health. Mycorrhizal fungi form a symbiotic association with plant roots. Symbiosis is a close association between different species. Mycorrhizal fungi are especially effective in helping plants acquire phosphorus, a nutrient that is highly immobile in the soil.

- **Nematodes**

Nematodes are abundant in most soils, and only a few species are harmful to plants. The harmless species eat decaying plant litter, bacteria, fungi, algae, protozoa, and other nematodes. Like other soil predators, nematodes speed the rate of nutrient cycling.

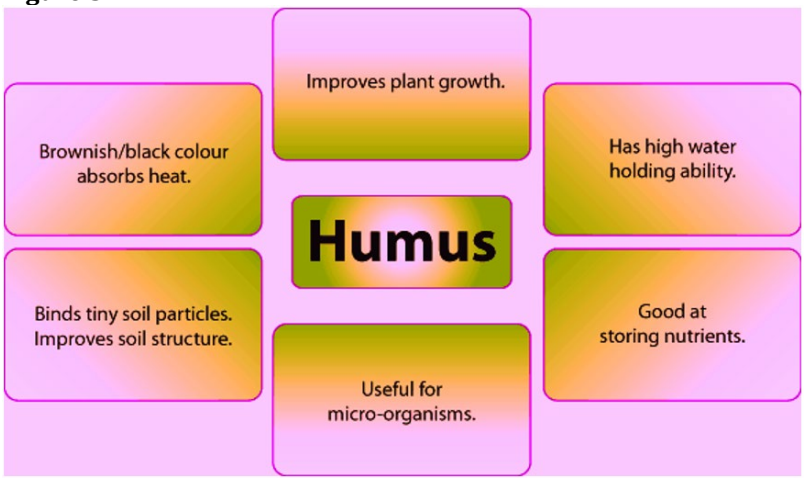
- **Arthropods**

Arthropods are species of soil organisms that can be seen by the naked eye. Among them are sowbugs, millipedes, centipedes, slugs, snails, and springtails. These are the primary decomposers. Their role is to eat and shred the large particles of plant and animal residues. Some bury residue, bringing it into contact with other soil organisms that further decompose it.

- **Earthworms**

Earthworm burrows enhance water infiltration and soil aeration. Fields that are “tilled” by earthworm tunneling can absorb water at a rate four to 10 times that of vineyards lacking worm tunnels. This reduces water runoff, recharges groundwater, and helps store more soil water for dry periods.

Figure 5



5. CONCLUSION

Soil health is popular subjects with farmers. Soil is a complex mixture of minerals, organic matter, liquids, gases, and microorganisms that all work together to support life. It is the top layer of the earth's surface made up of organic remains, clay, and rock materials on which plants grow. It promotes plant growth and life. It is constantly evolving due to a variety of physical, chemical, and biological processes.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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