Section A-Research paper

SOIL TEXTURE: PANACEA FOR AGRICULTURE

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ABSTRACT

The authors have made an intrinsic start in this paper to review soil texture as a panacea for agriculture. There are a lot of influencing factors to affect desired production of agriculture. Textural analysis is just like nucleus in relation to upgradation in agriculture. Soil texture is very-very important for production of agriculture. Soil texture consists of generally sand, silt and clay. It specifically refers to the proportion of clay, silt, and sand with diameters less than 2 mm. Sand, loamy sand, and gravel are the textural classes listed from coarsest to finest. Loam, sandy loam, clay loam, silty clay, loam Sandy clay, silty clay, and clay are all types of clay. Clayey soil has a high water holding capacity, as well as high plasticity, stickiness, and swelling, whereas sandy soil lacks these properties. Water, along with nutrient supply, is the most important way in which soil texture affects plant growth. There are so many important soil physical property which are discussed as: mass volume relationship of soil constituents, dry bulk density, total weight bulk density, dry specific volume, porosity, void ratio, soil wetness, mass wetness, volume wetness, water volume ratio, degree of saturation, air filled porosity, total porosity, particle size distribution, Stoke's law, soil structure and aggregation, soil structure management, soil color, soil consistency, soil plasticity, plasticity indices, soil compaction, soil crusting, hydration, swelling, specific surface, soil tilth and tillage, soil conditioners, soil water, total soil water potential, gravitational potential, pressure potential, matric potential, pneumatic potential, osmotic potential, soil moisture, water capacity, hysteresis, Darcy's law, hydraulic conductivity, hydraulic fluidity, Reynold number, soil water diffusivity, infiltration, redistribution of soil moisture, soil water balance, evaporation, groundwater drainage, solute transport, diffusion, hydrodynamic dispersion, soil air, soil aeration, thermal properties of soil, soil temperature, soil rheology. Further it has been elaborated in detail about influencing factors which affect the production of agriculture.

Keywords- Soil, texture, porosity, specific surface, hydraulic conductivity.

INTRODUCTION:

The size of the particles in a soil is what defines it. It is known that more than eighteen essential elements are present in the soil. i.e. Molybdenum (MoO^{2-}) and nickel, zinc (Zn^{2+}), cupper (Cu^{2+}), chlorine (Cl^{-}), cobalt (CO^{2+}), hydrogen (H_20), oxygen (O_2,H_20), nickel(Ni^{2+}), nitrogen (NO^{+},NH^{+}), phosphorus (H_2PO^{-},HPO^{2}), potassium (K^{+}), calcium (Ca^{+}), magnesium (Mg^{+}), sulfur (SO^{2-}), iron (Fe^{2+}), manganese (Mn^{2+}), boron (HBO_3), carbon (CO_2), further it has been noted that seventeen elements considered essential to plant as well as soil growth **(Havliin JohnL. *et al.* 2019).**

Soil exhibits physical properties, chemical properties and geographical properties. Moisture content is the nucleus of all parameter. When soil moisture is used as an input, the results are slightly better than when brightness temperature is used. Soil moisture and texture have much stronger physical connections than brightness temperature and texture. At a particular time and location, soil moisture and dielectric behaviour are influenced by the precipitation history, soil heterogeneity and texture, which affect water holding capacity, topography, slope, and variation of the land surface, which affect runoff and infiltration, and vegetation and land cover, which affect evapotranspiration and deep percolation.

Microwaves have a negligible impact on the energy budget of the Earth's atmosphere system. In this remote frequency range, microwaves' mode of travel and interaction with the atmospheric environment and the earth's surface make it a valuable tool for obtaining information about dielectric properties and soil moisture. It is a critical parameter for the earth's energy budget and hydrological cycle.

Soil has a lot of fundamental property i.e. soil texture, sand ,silt, clay, inorganic constituents, particle density, organic composition, bulk density, pore space, soil temperature, moisture constant, resistivity, surface roughness, soil air, humus, soil penetration depths, emissivity, microwave brightness temperature, dielectric constant, bound water layer, salinity, shape, specific surface, size analysis, electro kinetic property of clay, flocculation and stability of clays, heat of wetting, viscosity, thixotropy, swelling, soil constituency, plasticity, soil cracking, soil stress, soil strain, soil puddling, soil tillage mechanics. Soil texture sand, silt, and clay plays important role. The soil textured study of these fundamental property helps in determining the values of different physico chemical parameters and nutrients concentrations **(Deshmukh Sushant et al. 2015).** It has been noted that physical and chemical qualities exhibit significant variation in dielectric property and that these dielectric properties can be used to forecast soil fertility and health in relation to the research of microwave dielectric characteristics of soil in north-eastern Chhattisgarh. **(Shrivastava Rajesh et al. 2018)** influences ODR mainly through concerned effect on soil water. Regarding microwave remote sensing dielectric properties of soil of Chhattisgarh have been analyzed as well as elaborated in detail with different chapters.

Fig.1: Map of Chhat

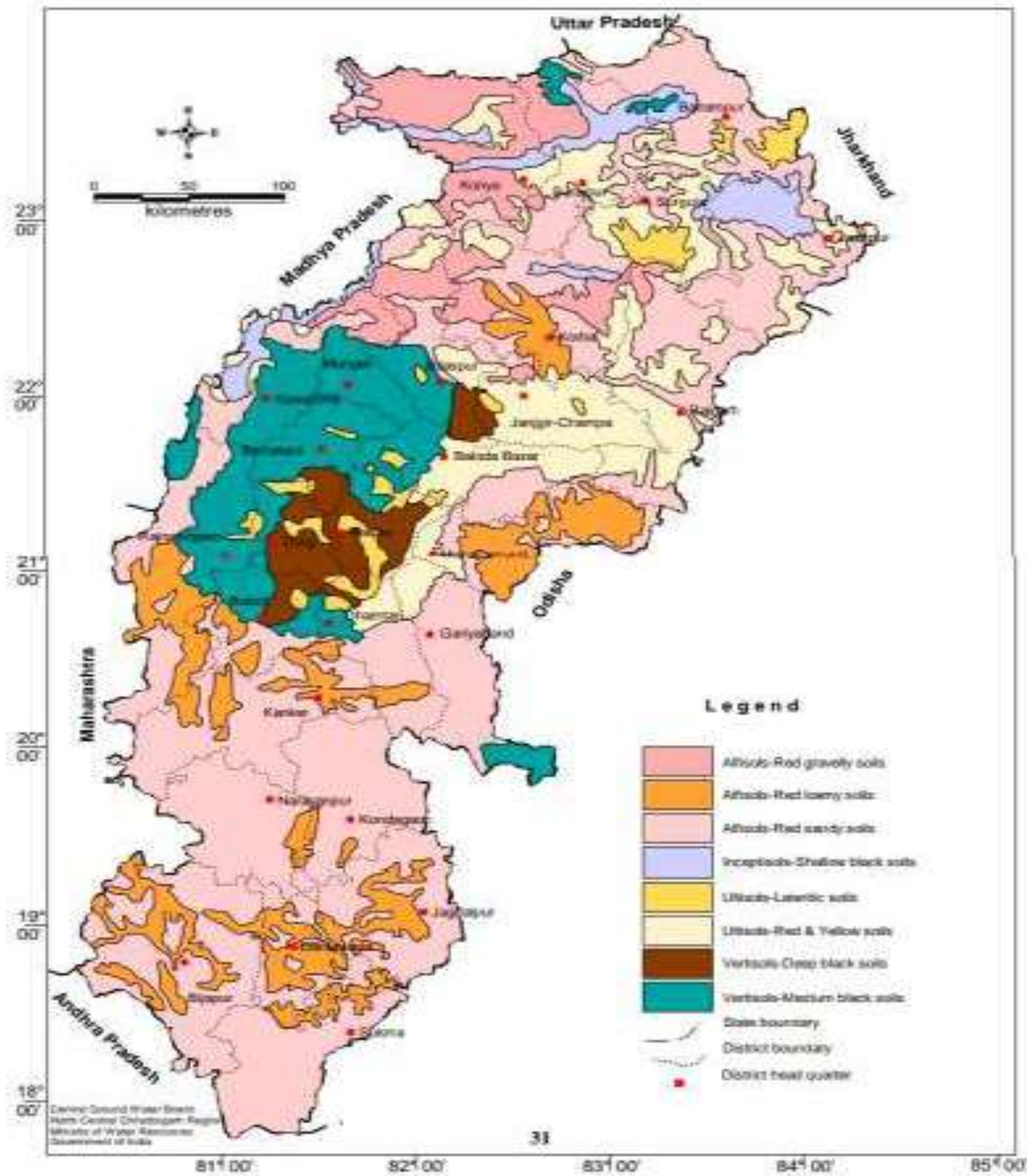

Fig.2: Soil map of Chhattisgarh

As a medium for plant growth, soil is a dynamic natural body generated across the surface of the ground by the weathering of rocks, the composting of mineral and organic materials, and the processing of specific chemical, mineralogical, and biological qualities. The physical characteristics of a soil are determined by the quantity, dimensions, organisation, shape, and mineral makeup of its particles. This feature is also influenced by the presence of organic matter and the size of the pore spaces; in mineral soil, it is challenging to alter particle size. As a result, clay soil stays clay and sandy soil stays sandy. A simple principle serves as the foundation for particle size analysis: In water with suspended soil particles, and their velocity of setting is proportional to the square of the radius "r" of each particle. as shown **(Durgude Anil G. 2014),**

$$V=K.r^2$$

Where **"K"** is a constant.

Stokes' law is the name given to this equation. The velocity of falling particles, according to Stoke, is proportional to the radius square root rather than the surface.

Structure has a significant impact on the soil's properties and conditions, including aeration, porosity, heat transfer, and water flow. The former's land underwent structural rather than textural modifications as a result of his ploughing, cultivating, draining, liming, and manuring practises. Soil particles can be either single grains or aggregates. The majority of particles in sandy or silty soil are single individual grains, whereas they are granulated in clay soil. Individual particles are almost always solid. Soil promotes higher plant growth by acting as a medium for plant roots and supplying nutrients. These are necessary for the whole plant. In hydrologic systems, its qualities play a major role in determining how water behaves. It is the recycling process of nature. Little mammals, reptiles, tiny insects, and microscopic cell creatures are just a few of the living things that call it home.

1.General properties and characteristic of soil:

On the surface of the ground, soil is a natural body made up of liquid, gases, minerals, and organic stuff that occupies space. It can be identified by horizons, or layers, which can be seen in relation to the original material as a result of expansion, losses, transfers, and transformations of matter and energy, or by the capacity to sustain rooted plants in a supportive environment. The following are a few significant general traits and qualities of soil: **(Ghildiyal B.P. and Tripathi R.P.2018)**.

1.1Specific Surface:

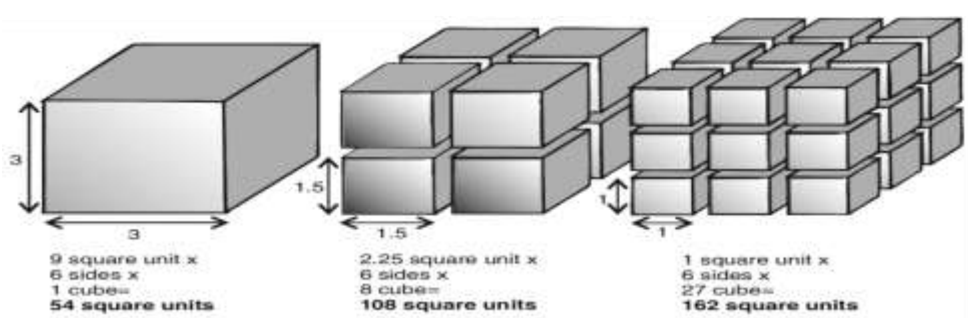

Fig.3 Specific Surface

Physical behaviour of soil like water retention or cation exchange depends to a great extent on the surface area of the soil particle. Soil differs markedly in texture, type of clay mineral and the amount of organic matter. Larger particles of sand and silt have much less surface area as compared to clay and other collides. Surface area is generally expressed as specific.

1.2 Density:

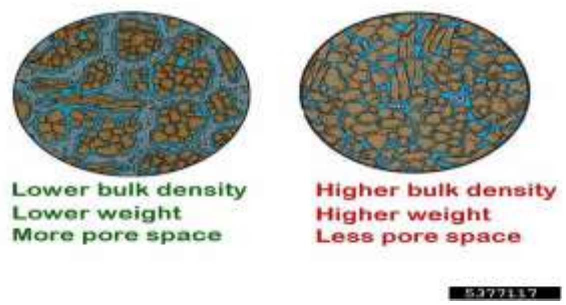

Fig.4: Soil Density

The particle density of soil solids is known. Soil particle density (pp). The mass per unit volume of soil particles is defined as solids. Some tropical soils which are rich in iron oxide may have higher particles density where soil rich in organic matter may have lower values. The density of different soil constituent is given below **(Ghildiyal B.P. and Tripathi R.P.2018)**.

Soil characteristics	Density(gcm^{3}))
Humus	1.3-1.5
Clay	2.2-2.6
Orthoclase	2.5-2.6
Quartz	2.5-2.8
Calcite	2.6-2.8
Dolomite	2.8-2.9
Muscovite	2.7-3.0
Biotite	2.8-3.1
Apatite	3.2-3.3
Pyrite	4.9-5.2
Hematite	4.9-5.3

Table 1: Soil Charectristic

1.3 Size analysis:

Primary particles are the discrete units comprising the soil solids. These are generally clustered together as secondary particles or aggregates. The complete particles size analysis the soil involves two main processes –

(a) Dispersion or the separation of soil mass into its components or primary Particles and stabilizing the suspension.
(b) Fractionations or grading of different particle size, groups, or soil separates.

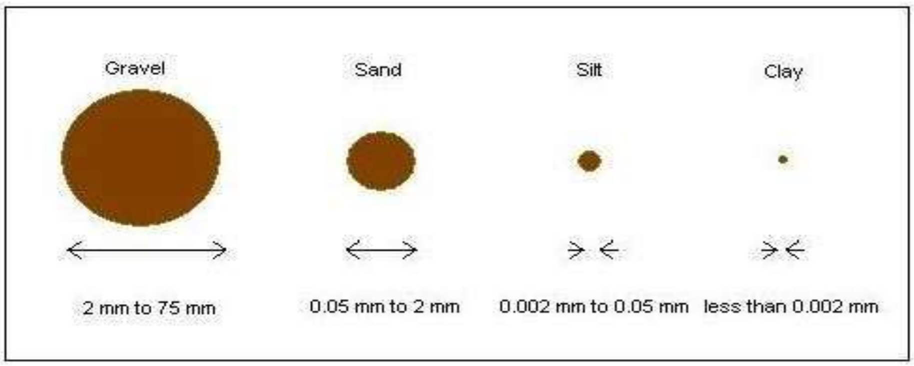

Fig.5: Size of Soil.

1.4 Heat of wetting of soil:

When a dry soil mass comes into contact with water vapour the water molecule, are observed till equilibrium is established between the two. The moisture content of such hydroscopic bodies in closely related to temperature and vapour pressure.

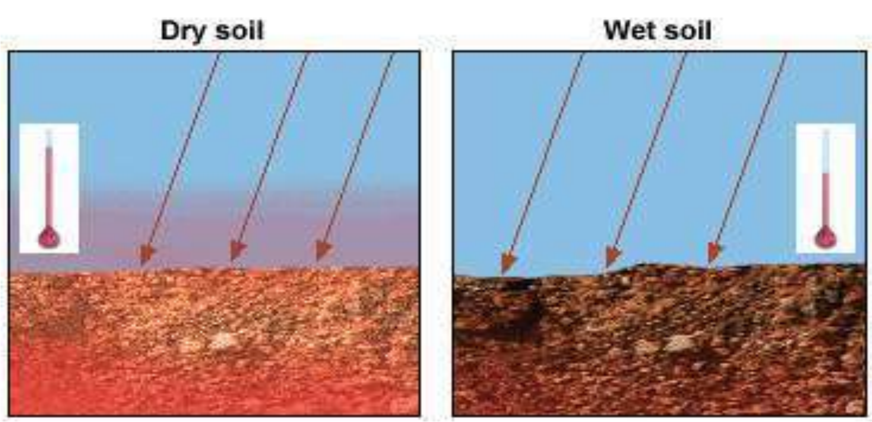

Fig.6: Heat of wetting of Soil

1.5 Viscosity:

When a fluid flows along a stream line over a fixed horizontal surface, the layer closest to the fixed surface is stationary, and the velocity of the layers increases as one moves away from the fixed surface. Under such conditions, the layer immediately beneath is moving slower than the layer above. The result is that some of the momentum of the layer above is transformed to the layer below tending to destroy the relative motion of the two layers. Due to this internal friction the external force must be continuously applied in order to maintain the moment. The retarding influence of stationary or slow-moving layer of a fluid or relatively faster moving one is called the viscosity. The relation in between soil type and viscosity is given in below table (**https://images.app.goo.gl**).

Soil type	Viscosity index, I_{vx}
Sandy silt	0.018
Silt	0.025–0.032
Clayey silt	0.015–0.038
Silty clay	0.017–0.034
Clay, medium (intermediate) plasticity	0.03
Clay, high plasticity	0.04
Clay (bentonite)	0.06
Peat	0.07

Table 2: Soil types and viscosity index

1.6 Thixotropy:

When small quantities of electrolytes are added to a colloidal system or a concentrated ferric oxide sol, a pasty gel is formed, which have property of liquefying. When this has shaken sets again to the gel formation standing. This phenomenon observed in some colloidal systems like gelatin sols or bentonite clay suspensions is known as thixotropy.

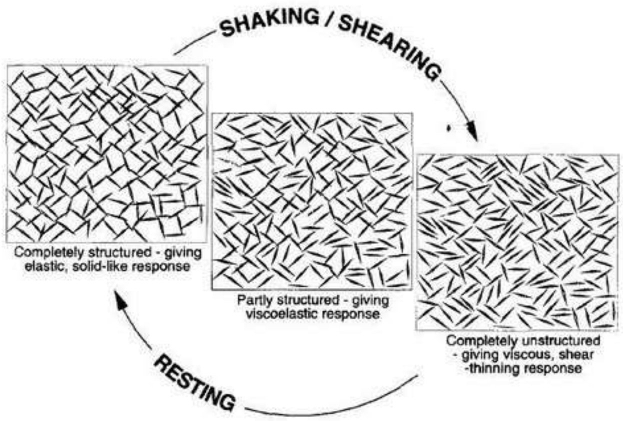

Fig.7: Thixotropy of Soil

1.7 Plasticity:

Soils can change from solid to liquid depending on their water content, passing through some distinguishable intermediate stage such as the plastic stage. When a soil is in the plastic stage, the water content is high enough that it can change shape without causing surface cracks or raptures. It is also represented as a body's ability to undergo dislocation of its smallest structural particles as a result of externally applied force without disrupting their coherence.

PI	Various	Soil Properties
0	Non plastis	Sand
< 7	Low plasticity	Silt
7 – 17	Medium plasticity	Silt clay
> 17	High plasticity	Clay

Table 3: Plasticity of Soil.

1.8 Soil Strength:

Soil compaction is a physical deformation (volumetric strain) and in the static sense, itis the resistance to increase in bulk density. Any material has a specific strength it's defined as the more stress it can sustain. There is a limit of stress in every material, if limit of stress increase failure occurs. Strength examination can be executed for tensile, compressive and shear stress. Soil has miner tensile strength so tensile strength rarely done. It is a geotechnical problem that soil mass is in compression, but it's rarely fail in compression. Its shear where soils fail not compression, this is there as on soil

Strength examination executed in shear not in compression **(http://www.yourarticlelibrary.com/soil/).**

1.9 Shear Strength:

Soil shear strength refers to its resistance to shearing stress. It measures the resistance of the soil to deformation caused by the continuous displacement of its individual particles. Particle interaction is the primary determinant of soil shear strength. Soil shear strength is made up of the following components: **Frictional component:**

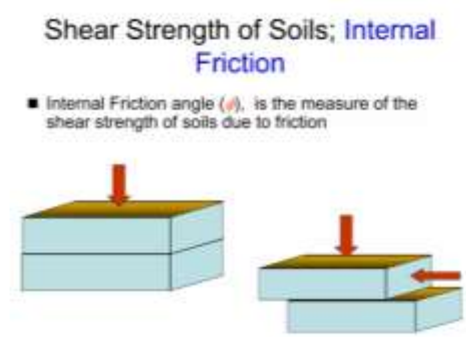

Fig.8: Shear Strength of Soils.

(1) Cohesion components:

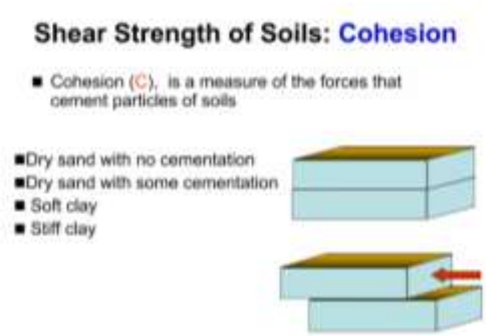

Fig.9: Shear Strength of Soils.

1.10 Soil Puddling:

The process of working soil with water to make impressions on it is known as puddling. Intensive tillage breaks down courser aggregates into smaller particles, resulting in a decrease in mean particle size. Puddling stresses the soil in the wet range, orienting the particles, destroying the now capillary pore space, and decreasing the apparent specific volume of soil. **(Naphade, J.D. and Ghildyal B.P. 1971).**

Fig.10: Soils Puddling.

1.11 Colour:

The soil colour considerably affects the radiant energy absorption. Darker-colored soils absorb more radiant energy than lighter-colored soils. As a result, dark-colored soils tend to keep a higher temperature during sunny days.

Fig.11: Soil colour.

Because good absorbers are also good radiators. Dark-colored soils also have a higher energy loss. The final temperature would be determined by the soil's other thermal properties. **Soil Organic Matter:**

Soil organic matter is critical to the maintenance and improvement of soil properties. Organic matter transformation and synthesis of humus in soil are usually through in warm and humid condition as compared with those under temperate regions. Soil organic matter includes humus and humus like substance in soil. Soil organic matter is one of the major sources of nutrient element for plants. In this respect, nitrogen is probably the most important.

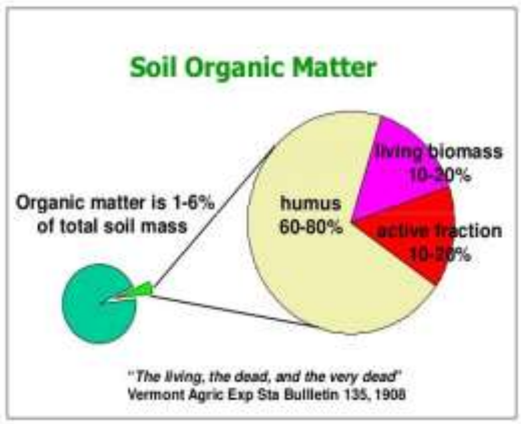

Fig.12: Soil Organic Matter.

1.12 Soil Colloids:

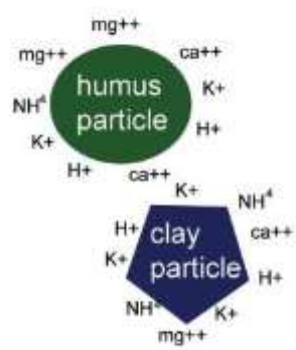

Fig.13: Soil colloids.

A colloid is a two phase system in which each phase is either soil or liquid or gas and one of the two is present in exceedingly high proportions, The dispersion medium is one letter, and the disperse phase is another. The most common colloidal system has a solid disperse phase and a liquid dispersion medium, usually water.

1.13 pH of soil:

The pH of a soil water system is an approximation of the active fraction of hydrogen ions present in the soil phase, where they remain undissociated, as in weak acids. Actual measurement shows that pH of soil suspension increases as dilution and decrease on concentration, but the increase or decrease is rather small.

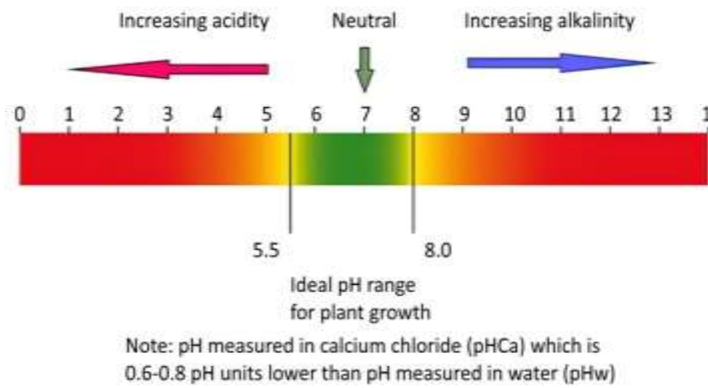

Fig.14: pH of Soil.

1.14 Soil acidity:

Ionizable hydrogen causes soil acidity. Exchangeable hydrogen ions which along with other such cation are present in soil to neutralize the negative charge arising from isomorphous substitution are one of the sources. Soil Alkalinities: Soil reaction is alkaline when the pH of a soil is more than 7.

1.16 Soil Enzymes:

Soil microorganisms participate in a variety of biological transformations in soil via various biochemical reactions such as hydrolysis, oxidation, reduction, and so on. Soil enzymes, which are produced as a result of microorganism activity, catalyse these reactions.

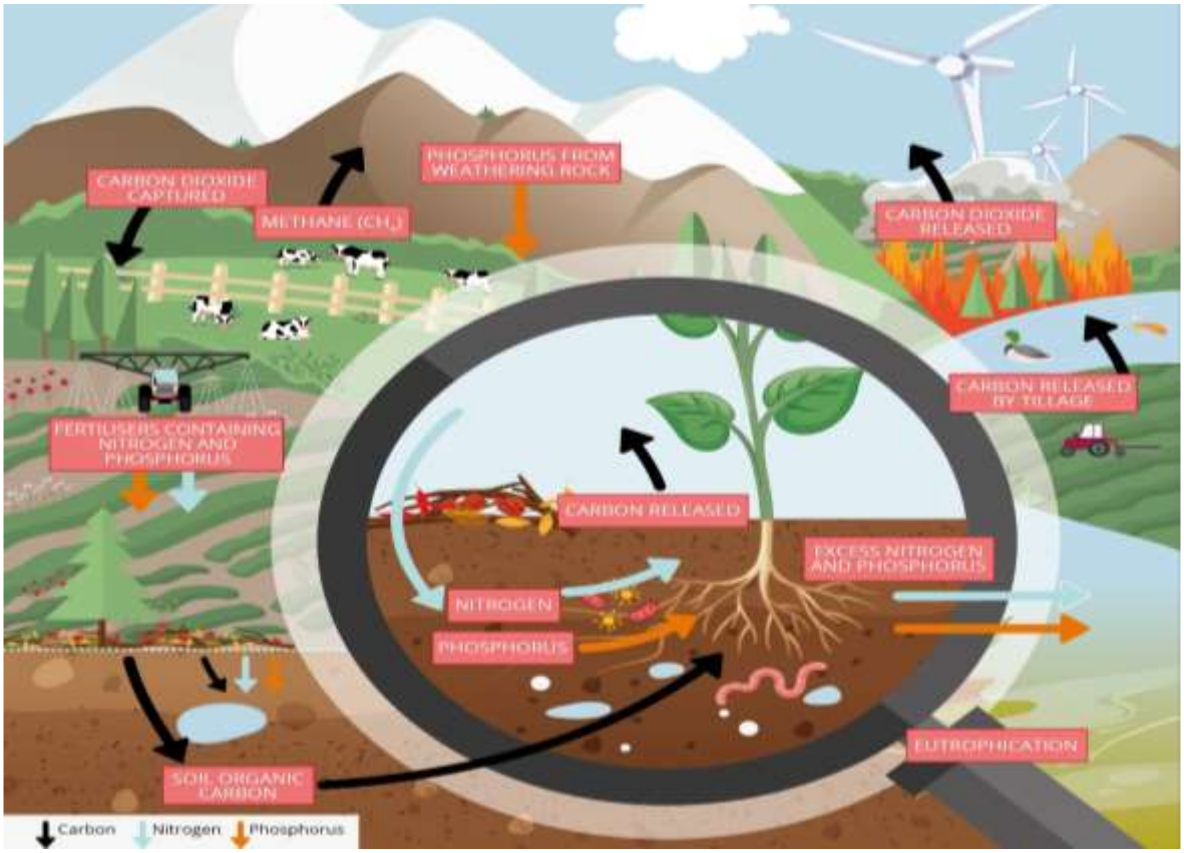

Fig.15: Soil Enzymes.

1.17 Soil Bacteria:

Bacteria are unicellular primitive organisms that lack chlorophyll. They have a straightforward design, consisting of a protoplasmic mass encased in a semipermeable cell membrane. The most prevalent microorganism in soil is a bacterium, which has a diameter of 0.5 to 1 micron and a length of 1 to 10 microns.

1.18 Soil Fungi:

The heterotrophic plants known as fungi are bigger than bacteria. Saprophytic organisms eat dead organic material tissues. They are crucial for the nutrition of the soil and plants. Almost anything of an organic origin that bacteria cannot break down in soil will be broken down by fungi, which are specialised scavengers. Many fungi also act as homes for bacteria.

Soil Texture:

Soil textural class names are used to convey an idea of the textural makeup of soil and to indicate their physical properties. These are classified into three major fractions: sand, silt, and clay. A soil is given a name based on the proportion of these three fractions to indicate its textural composition. Soils are classified into textural classes based on this, such as sand, clay, silt, and loams.

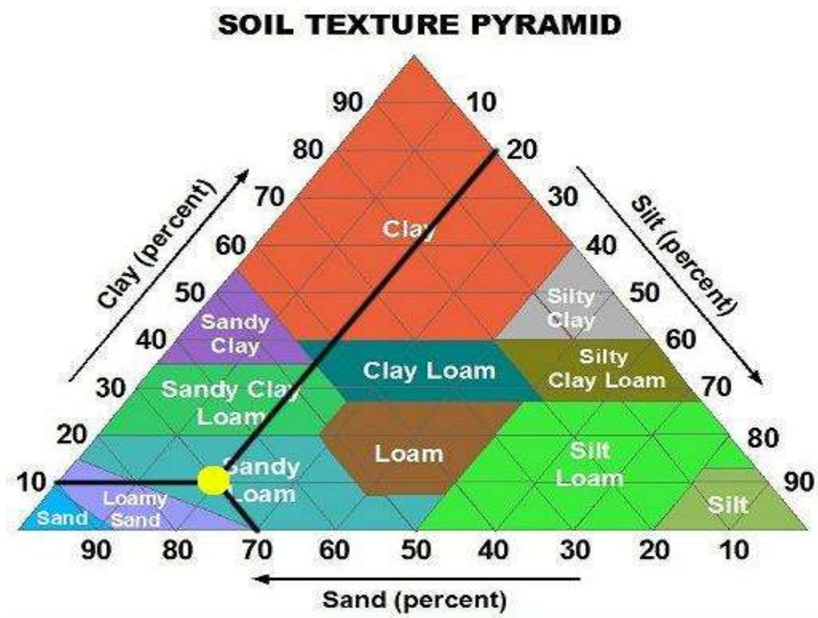

Fig. 16: Pyramid of Soil Texture.

1.19 Sand:

Any soils that have a sand separate that makes up at least 70% of the soil's weight and a clay separate that makes up 15% or less of the soil are included in the sand group. The characteristics of such soils are typically those of sand, as opposed to the stickier nature of clays. Although in practise, two other materials—loamy fine sand and loamy very sand—are also utilised, sandy and loamy sand are recognised as two separate textural groups in this category.

1.20 Silt:

Soils in the silt group contain at least 80% silt and 12% or less clay. In fact, the silt group dominates the properties of this group. This group contains only one textural class, silt.

1.21 Clay:

A soil must contain at least 35% clay separate and, in most cases, not less than 40% clay to be classified as clay. The characteristics of clay separates dominate in such soils, and the class names are clay, sandy clay, and silt clay. Sandy clay may have more sand clay. Similarly, the silt content of silty place typically exceeds the clay fraction.

1.23 Loams:

The more complicated soil textural class is the loam group, which has many sub-groups. An ideal loam is a mixture of sand, silt, and clay particles with roughly equal proportions of the properties of those separates. Sand, silt, and clay are the dominant physical properties of loam soils. It should be noted that the loam does not have an equal proportion of sand, silt, and clay. It does, however, have roughly equal amounts of sand, silt, and clay.

1.24 Hydration of soil water structure and properties:

Water is an important component of soil. It appears to be a part of the soil Pore space, assisting in plant nutrition, microbe nutrition, and profile development. It dissolves the salts found in soil and veins, which run off as sediment into streams and lakes. Understanding the physical properties of water is critical for understanding its state, function, and behaviour in soil plant systems.

1.25 Soil consistency:

Soil consistency soil consistency is the physical property of soil that is many faced by its resistance to flow when water contain in the soil is such that the soil is not freely flowing the force of cohesion and adhesion between soil particles come into play. Soil consistency can thus be thought of as the result of cohesion and addition forces acting on different water contents. It refers to the soil's resistance to the force that tends to deform it. Depending on the amount of water present, search phrases like "hard cloudy tribal soft mela sticky plastic world" and similar ones are frequently used to describe the consistency of soil. The state of consistency between solid and liquid ranges has been classified into several stages. Limits have been imposed to demonstrate convincingly the limits of soil water content for various states of consistency.

1.26 Liquid limit:

The liquid limit is the amount of water in which soil is almost liquid but has a low sharing strength. This is also referred to as the upper plastic limit. In theory, it is defined as the water content at which a clay soil's behaviour changes from plastic to liquid. At this point, the water film has thickened to the point where flow is reduced and water fails to fill the majority of the soil pore space. At this point, the soil transforms from liquid to plastic clays, losing its ability to flow as a liquid.

1.27 Plastic limit:

The plastic limit is the lowest water content at which soil turns plastic and starts to crumble at a diameter of 1 by 8 inches. The maximum amount of water present at this limit is determined by the quantity and type of colloidal material present. This limit is also referred to as a slower plastic limit; at this point, enough water is available to provide a field around each particle, allowing particles to rotate and slide over one another.

1.28 Shrinkage limit:

The soil's water content determines the maximum amount of shrinkage. when soil changes from being semi-solid to being solid. The water content in which the volume of soil remains constant after being drawn when damp soil dries is known as the shrinkage limit. It loses water and strings to comprehend this thought. A soil mass saturated with water so that the soil water tension is 0 and the meniscus is a plane surface as trying proceeds a meniscus begins to form at the surface with the resulting tension in the water.

1.29 Heat of wetting soil:

Heat of wetting means when dry soil mass comes in contact with water vapour, the water molecules are observed till equilibrium is established between the two. The moisture content upsurge hygroscopic bodies are closely related to temperature and vapour pressure. If heat is applied to a hydroscopic body, it loses moisture. This heat absorbed at the constant temperature is equivalent to the work done, to separate the water molecule from the surface does. If heat must be applied to a hygroscopic body to separate the water molecules, heat must be used during the absorption of water

molecules. This evolution of heat with dry soil is placed in water is known as heat of wetting soil. Soil texture is very-very important for production of agriculture. Soil texture consists of generally sand, silt and clay. It specifically refers to the proportion of clay, silt, and sand with diameters less than 2 mm. Sand, loamy sand, Sandy loam, loam, clay loam, silty clay loam are the textural classes listed from coarsest to finest. Sandy clay, silty clay, and clay are all types of clay. Clayey soil has a high water holding capacity, as well as high plasticity, stickiness, and swelling, whereas sandy soil lacks these properties. Water, along with nutrient supply, is the most important way in which soil texture affects plant growth. Besides above parameters there are so many important soil physical property which are discussed as

- Mass volume relationship of soil constituents
- Total weight bulk density
- Dry specific volume
- Void ratio
- Soil wetness
- Mass wetness
- Volume wetness
- Water volume ratio
- Degree of saturation
- Air filled porosity
- Total porosity
- Particle size distribution
- Soil structure and aggregation
- Soil structure management
- Plasticity indices
- Soil compaction
- Soil crusting
- Hydration

- Swelling
- Soil tilth and tillage
- Soil conditioners
- Soil water
- Total soil water potential
- Gravitational potential
- Pressure potential
- Matric potential
- Pneumatic potential
- Osmotic potential
- Water capacity
- Hysteresis
- Darcy's law
- Hydraulic conductivity
- Hydraulic fluidity
- Reynold number
- Soil water diffusivity
- Infiltration
- Redistribution of soil moisture
- Soil water balance
- Evaporation
- Groundwater drainage
- Solute transport
- Diffusion
- Hydrodynamic dispersion
- Soil air soil aeration
- Thermal properties of soil
- Soil rheology

Conclusions:

It has been concluded that the mentioned parameters affect the agricultural production at a stretch. Such parameters are as, mass volume relationship of soil constituents, dry bulk density, total weight bulk density, dry specific volume, porosity, void ratio, soil wetness, mass wetness, volume wetness, water volume ratio, degree of saturation, air filled porosity, total porosity, particle size distribution, Stoke’s law, soil structure and aggregation, soil structure management, soil color, soil consistency, soil plasticity, plasticity indices, soil compaction, soil crusting, hydration, swelling, specific surface, soil tilth and tillage, soil conditioners, soil water, total soil water potential, gravitational potential, pressure potential, matric potential, pneumatic potential, osmotic potential, soil moisture, water capacity, hysteresis, Darcy's law, hydraulic conductivity, hydraulic fluidity, Reynold number, soil water diffusivity, infiltration, redistribution of soil moisture, soil water balance, evaporation, groundwater drainage, solute transport, diffusion, hydrodynamic dispersion, soil air, soil aeration, thermal properties of soil, soil temperature, soil rheology, size analysis, viscosity, thixotropy, soil strength, shear strength, cohesion component, soil colloids, pH, soil acidity, soil alkalinity, soil enzyme, soil bacteria, soil fungi . Further it has been elaborated in detail about influencing factors which affect the production of agriculture.

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