SOIL CHEMISTRY

It is defined as the branch of soil science which deals with the chemical properties of the soil and describes the chemical processes taking place in the soil.

Soil is an extremely variable and complex material with regard to its chemical properties. Chemical properties of soils include:

i) Mineral solubility
ii) Nutrient availability
iii) Soil reaction
iv) Ion exchange
v) Buffering action etc.

PROPERTIES OF SOIL COLLOIDS

It may be defined as organic and inorganic matter with very small particle size and a correspondingly large surface area per unit of mass. Therefore, colloidal system is composed of the finest clay particles and highly decomposed organic matter or humus.

SOME IMPORTANT PROPERTIES OF SOIL COLLOIDS

Clay and humus particles in soils are collectively called as colloidal fractions because of their extremely small size. Colloidal particles can only be seen with an electron microscope as their size is less than 1.0 µm.

a) Because of small size, all soil colloids expose large surface area per unit mass. Surface area of soil colloidal particle is 1000 times more than the surface area of same mass of sand.
b) Internal and external surfaces of soil colloids carry positive or negative charges. For most soil colloids, electronegative charges are dominant, although some mineral colloids in acid soils may have a net electropositive charge.
c) Soil colloids attract ions of an opposite charge towards their surfaces, e.g., negatively charged surfaces of a soil will attract cations and similarly, positively charged surfaces will attract anions.
d) In addition to adsorbing cations and anions, soil colloids attract and hold a large number of water molecules.
e) Soil colloids are chemically the most active fraction of the soil.

❖ TYPES OF SOIL COLLOIDS

Soils have many types of colloids each with particular composition, structure and properties. Soil colloids can be classified into four major types.

i) Crystalline silicate clays

These are the most dominant colloids found in soils and their structure is layered like pages in a book.

Each layer consists of 2-4 sheets of closely packed and tightly bonded oxygen, silicon and aluminum atoms. Generally, these colloids are negatively charged.

ii) Non crystalline silicate clays (Allophanes and other amorphous minerals)

These also consist mainly of tightly bonded silicon, aluminum and oxygen atoms but they do not exhibit ordered crystalline sheets. Two major clays of this type called allophone and imogolite form from volcanic ash and are characterized by both negative and positive charge as well as high water holding capacity. But the most important amorphous colloid is allophanes. These are more difficult to study than well crystallized minerals. Allophanes have been recognized as an important constituent in certain volcanic ash soils (Japan). The CEC of allophanes is highly dependent on pH and may range from 70-150 cmol kg^{-1} in neutral to alkaline soils. Allophanes have high surface area which depends upon the degree of crystallinity and pH.

iii) Iron and aluminum oxide:

These are found in many soils especially in highly weathered soils of warm, humid regions. These consist mainly of either iron or aluminum atoms coordinated with oxygen atoms. Their net charge ranges from slightly negative to moderately positive. These are also called Sesquioxides. These are commonly dominant in soils formed from parent materials rich in iron and aluminum in tropical and semitropical regions where weathering has removed much of the silica from the clay fraction. Cation exchange capacity (CEC) of these minerals is 0-4 cmol(c) kg^{-1}.

Examples of Iron containing minerals: Limonite, Goethite and Hematite

Examples of Iron containing minerals**:** Gibbsite, Boehmite and Alumina

iv) Organic colloids (Humus)

Organic colloids are important in nearly all soils and these are neither minerals nor crystalline. Humus particles are the smallest of soil colloids and exhibit very high capacities to adsorb water but almost no plasticity or stickiness. Humus has high amounts of both negative and positive charge per unit mass but net charge is always negative which varies with soil pH. The negative charge on humus is extremely high in neutral to alkaline soils. As like clay, microscopic humus particles carry negative charges to which cations are attracted. The humus micelle is composed of carbon, hydrogen and oxygen rather than aluminum, silicon and oxygen like the silicate clays. The organic colloidal particles vary in size but they may be as small as the silicate clay particles. Humus colloids are amorphous and are not stable like clay and possess high CEC ranging from 200- 750 cmol kg^{-1}.