• Soil Living organic matter (Soil Biota)

Soil is now believed to be dynamic or living system. Soil contains several distinct groups of microorganisms and amongst them bacteria, fungi, actinomycetes, algae, protozoa and viruses are the most important. But bacteria are more numerous than any other kinds of microorganisms. Microorganisms form a very small fraction of the soil mass and occupy a volume of less than one percent. In the upper layer of soil (top soil up to 10-30 cm depth i.e. Horizon A), the microbial population is very high which decreases with depth of soil. Living organisms present in the soil are grouped into two categories as follows.

1. **Soil flora (micro flora)** e.g. Bacteria, fungi, Actinomycetes, Algae and

2. **Soil fauna** (micro fauna) animal like eg. Protozoa, Nematodes, earthworms, moles, ants, rodents .Relative proportion / percentage of various soil microorganisms are: Bacteria-aerobic (70%), anaerobic (13 %), Actinomycetes (13%), Fungi /molds (03 %) and others (Algae Protozoa viruses) 0.2-0.8 %. Soil organisms play key role in the nutrient transformations

Soil Microflora

1- Bacteria;

It is the most abundant groups, and usually more numerous than others. Soil bacteria numbers vary between $10^8 – 10^9$ cell/ gm of soil, however, in an agriculture field their number goes about 3×10^9 cell/ gm of soil , which accounts for about 3 tons of wet weight/ acre.

Based on its regular presence soil bacteria are divided into two groups:

- Soil indigenous (true resident), or autochthonous.
- Soil invaders or allochthonous.

Bacteria are also classified on the basis of physiological activity or mode of nutrition, especially the manner in which they obtain their carbon, nitrogen, energy and other nutrient requirements. They are broadly divided into two groups :

. **a**) Autotrophs and **b**) Heterotrophs

Autotrophic bacteria are capable synthesizing their food from simple inorganic nutrients, while **heterotrophic** bacteria depend on pre-formed food for nutrition. All autotrophic bacteria utilize Co2 (from atmosphere) as carbon source and derive energy either from sunlight **photoautotrophs,** eg. *Chromatrum. Chlorobium. Rhadopseudomonas* or from the oxidation of simple inorganic substances present in soil (**chemoautotrophs** e g. *Nitrobacter, Nitrosomonas,*

Thiaobacillus). Majority of soil bacteria are heterotrophic in nature and derive their carbon and energy from complex organic substances, decaying roots and plant residues. They obtain their nitrogen from nitrates and ammonia compounds (proteins) present in soil another nutrients from soil or from the decomposing organic matter. Certain bacteria also require amino acids, B- Vitamins, and other growth promoting substances also.

Bacteriai number and variety influenced by soil type, microenvironment, organic matter, cultivation processes. They are found in a high number in cultivated soil than virgin land, in a maximum in rhizospheric space than in non – rhizospheric region, possibly due to aeration and availability of nutrients. The inner region aggregates contained high level of G - ve bacteria , while the outer region contains high level of G + ve bacteria, thus may be due to ; polymer formations , motility, surface charge, and life cycle of bacteria
Bacteria do not occur freely in soil solution, but are closely attached to soil particles by motility apparatuses (flagella and pilli), or by extracellular polysaccharides , or may be embedded in organic matter.
Bacteria have some major roles in soil such as:
1 Miniralization of elements.

2- N2 – fixation from atmosphere.

3- Stabilization of mineral ions.
4- Biotransformation of chemicals.

5- Biogas formation.

Example of some soil bacteria*: **Agarobacteriun, Arthobacter, Bacillus, Alcaligenes, Erwinia, Corynebacter, clostridium, Nitrosomonas, Nitrobacter, Rhizobium, Thiobacillus.***

Rhizosphere
It is a zone of increased microbial growth and activity in soil around of plants, it may extended several inches into soil around root system of growing plants. The M.O growing in this zone is under the influence of roots often quantitatively and qualitatively. Therefore the rhizosephere is **a** unique sub sterrean habitat for m.o the microflora of one plant differ from the other plant , the rhizospheric region can be divided in to two zones;
- Inner rhizosphere , which is in close vicinity of root surface.
- Outer rhizosphere, embracing the immediate adjacent soil.

The outer epidermal walls of living roots and root hairs are covered with mucilage and cuticle, also organic and inorganic compounds , which accumulated in root cells

cytoplasm and diffused out which is known as root exudation, these exudates contain carbohydrates, organic acids, enzymes, flavonones, and root hairs are continuously sloughed – off during secondary thickening, all these compounds constitute a food base for m. o.

The rhizospheric m. o. have either beneficial or harmful effects on developing of plants, the m.o. are intimately associated on rhizoplan, therefore any toxic or beneficial substances produced by them has direct effect on plants.

Some of possible effects are briefly;

• The m.o. catalyze the reactions in rhizosphere and produce CO2, and form organic acids that in turn solubolize the inorganic nutrients to plants.

• Aerobic bacteria utilize O2 and produce CO2, therefore lower O2 and increase CO2 tension that reduce roots elongation and nutrient and water intake. • Some of rhizospheric m.o. produces growth – stimulating substances and release elements in organic forms through the process of mineralization.

• Some of rhizospheric m. o. secretes plant regulators such as ; indole acetic acid, gibberellins, cytokinnens.

• They influence phosphorus availability through immobilization, however, when plants suffer from nutrient scarcity during summer in tropical area, the rhizospheric microflora release the immobilized nutrients, therefore they act as a sink between soil and plant roots in nutrient poor systems.

• Rhizospheric m. o. changes the availability or toxicity of sulfur in soil.

• The products of rhizosrheric zone m. o. metabolism sometimes have toxic effects on plants developing , these termed as the phytotoxins.

2- Fungi

In most aerated and cultivated soil, Fungi share a major part of total microbial biomass, because of their large diameter and extensive network of mycelia, however, population of soil fungi ranging from 2×104 – 1×106 cell/ gm of dry soil. Soil fungi possess filamentous mycelium composed of individual hyphae. The fungal hyphae may be aseptate (Mastigomycotina and Zygomycotina) or septate (Ascomycotina, Basidiomycotina & Deuteromycotina). most commonly encountered genera of fungi in soil are; *Alternaria, Aspergillus, Cladosporium, Cephalosporium Botrytis, Chaetomium, Fusarium, Mucor, Penicillium,*

Most of these fungal genera belong to the subdivision Deuteromycotina / Fungi imperfect which **lacks** sexual mode of reproduction. these soil fungi are aerobic and

heterotrophic, they require abundant supply of oxygen and organic matter in soil. Fungi are dominant in acid soils, because acidic environment is not suitable for the existence of either bacteria or actinomycetes. The optimum PH range for fungi lies-between **4.5 to 6.5.**

Fungi drive their growth nutrient from organic matter, lining animals (including; protozoa, arthropods, nematodes, etc.), and from living plants, establishing different types of relationships. The most important relationship between fungi and plants in soil is Mycorrhiza, which is a symbiotic relationship that occurs in plant root systems, and in two types of association;

Endotrophic; the fungi mycelia grows into the root tissue of associated plant.

Ectotrophic; the fungi mycelia ensheathes the root system, or can form like tubercles around rootlets, with limited penetration of hyphea into root tissue. Fungi in soil play variety roles, some of these roles are:

1- Mycorrizal fungi supplies minerals to associated plants, likewise fungi receives benefit from plants exudation, like some carbohydrates.

2- Production of fungistatic products including antibiotics.

3- Certain fungi belonging to sub-division Zygomycotina and Deuteromycotina are Support soil microenvironments biobalance by their feeding practices on protozoa and nematodes.

4- Contributes in soil aggregation that protects soil particles from weathering effects.

5- Degrade some of tough plant residues, like lignine's

Actinomycetes

These are the organisms with characteristics common to both bacteria and fungi . Actinomycetes are unicellular like bacteria, but produce a mycelium which is non-septate and more slender, like true bacteria they do not have distinct cell-wall , (cell wall is without chitin and cellulose commonly found in the fungi). On culture media unlike slimy distinct colonies of true bacteria which grow quickly, actinomycetes colonies grow slowly, show powdery consistency and stick firmly to agar surface. They produce hyphae and conidia /sporangia like fungi.

. Actinomycetes are numerous and widely distributed in soil and are next to bacteria in abundance. Plate count estimates give values ranging from 10^4 to 10^8 per gram of soil. They are sensitive to acidity(low PH) optimum PH range 6.5 to 8.0, and water logged soil conditions. The population of actinomycetes increases with depth of soil . (eg. Thermo actinomycetes ,Streptomyces). Actinomycetes genera which are agriculturally and industrially important are present in only two families of Actinomycetaceae and Strepotmycetaceae. the common genera of actinomycetes are Streptomyces(nearly 70%), Nocardia and Micromonospora ,Actinoplans, Thermoactinomycetes.

Role **of actinomycetes in soil:**

1. decompose all sorts of organic substances like cellulose, polysaccharides, protein, fats, organic-acids etc.

2. Organic residues added soil are first attacked by bacteria and fungi and later by actinomycetes, because they are slow in activity and growth than bacteria and fungi.

3. They decompose the more resistant and indecomposable organic substance and produce a number of dark black to brown pigments which contribute to the dark colour of soil humus.

4. They are also responsible for subsequent further decomposition of humus (resistant material)in soil.

5. They are responsible for earthy / musty odor / smell of freshly ploughed soils.

6.Many genera species and strains synthesize number of antibiotics like Streptomycin, Terramycin, Aureomycin etc. (eg. Streptomyces if actinomycetes produce/

7. some species of actinomycetes could causes disease in plant "Potato scab" in potato.

4- Algae

Algae grow where adequate amount of moisture and light present due to their need of photosynthesis process, most of them prefer growth in neutral to alkaline soil (pH 7 – 10). The prominent genera in soil are ; *Anabaena, Nostoc, Calothrix, Oscillotoria, Scytonema*.

Algae roles in soil can be listed as the follow:

1- Revolutionized the failed of agriculture due to their photosynthetic capacity, that act as a source of carbonic and nitrogenous organic matter in soil.

2- Many of algae species used commercially as biofertilizers.

3- Soil algae used in reclamation of sodas soil and alkaline soil types