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Dr.Asseel.Habh Soil Microbiology/ lec 1

**Defination of Soil Microbiology**

It is branch of science/microbiology which deals with study of soil microorganisms and their activities in the soil.



**Soil:**

It is the region which supports the plant life by providing mechanical support and nutrients required for growth.

 From the microbiologist view point, soil is one of the most dynamic sites of biological interactions in the nature.

 It is the region where most of the physical, biological and biochemical reactions related to decomposition of organic weathering of parent rock take place.

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**Components of Soil:**

 Soil is an admixture of  five major components : organic matter , mineral matter, soil- air, soil water and soil microorganisms / living organisms .

1. **Mineral / Inorganic Matter**: It is derived from parent rocks/bed rocks through decomposition, disintegration and weathering process.

Different types of inorganic compounds containing various minerals are present in soil. Amongst them the dominant minerals are Silicon, Aluminium and iron and others like Carbon, Calcium Potassium, Manganese, Sodium, Sulphur, Phosphorus etc. are in trace amount. The proportion of mineral matter in soil is slightly less than half of the total volume of the soil.

1. **Organic matter/components:** Derived from organic residues of plants and animals added in the soil. Organic matter serves not only as a source of food for microorganisms but also supplies energy for the vital processes of metabolism which are characteristics of all living organisms. Organic matter in the soil is the potential source of N, P and S for  plant growth. Microbial decomposition of organic matter releases the unavailable nutrients in available from. The proportion of organic matter in the soil ranges from 3-6%of the total volume of soil.

1. **Soil Water:**  The amount of water present in soil varies considerably. Soil water comes from rain, snow, dew or irrigation. Soil water serves as a solvent and carrier of nutrients for the plant growth. The microorganisms inhabiting in the soil also require water for

 their metabolic activities.

 Soil water thus, indirectly affects plant growth through its effects on soil

 and microorganisms. Percentage of soil-water is 25% total volume of soil.

1. **Soil air (Soil gases):** A part of the soil volume which is not occupied by soil particles i.e. pore spaces are filled partly with soil water and partly with soil air. These two components (water & air) together only accounts for approximately half the soil's volume. Compared with atmospheric air, soil is lower in oxygen and higher in carbon dioxide, because CO2 is continuous recycled by the microorganisms during the process of decomposition of organic matter. Soil air comes from external atmosphere and contains nitrogen, oxygen Co2 and water vapour (CO2 > oxygen). Co2 in soil air (0.3-1.0%) is more than atmospheric air (0.03%). Soil aeration plays important role in plant growth, microbial population, and microbial activities in the soil.

1. **Soil microorganisms:**  Soil is 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 upto 10-30 cm depth i.e. Horizon A), the microbial population is very high which decreases with depth of soil. Each organisms or a group of organisms are responsible for a specific change /transformation in the soil. The final effect of various activities of microorganisms in the soil is to make the soil fit

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for the growth & development of higher plants .Living organisms present in the soil are grouped into two categories as follows.

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

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

**Importance of Soil Microbiology**

Living organisms both plant and animal types constitute an important component of soil. Though these organisms form only a fraction (less than one percent) of the total soil mass, but they play important role in supporting plant communities on the earth surface. While studying the scope and importance of soil microbiology, soil-plant-animal ecosystem as such must be taken into account. Therefore, the scope and importance of soil microbiology, can be understood in better way by studying aspects like

1. Soil as a living system

2. Soil microbes and plant growth

 3. Soil microorganisms and soil structure4.

 4.Organic matter decomposition

 5. Humus formation

 6.Biogeochemical cycling of elements

 7.Soil microorganisms as bio-control agents

 8.Soil microbes and seed germination

 9.Biological N2 fixation

 10.Degradation of pesticides in soil.

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**Carbon cycle**

There is carbon in the atmosphere in the form of Co2, and in the compounds that are the bodies of wild and marine organisms and their structures, in the soil within organic matter and humus, in the water form in the form of Co3-2, Hco3 dissolved in water, (CaCo3) and dolomite (CaMg (Co3)) 2 and fossil fuels (coal, oil and natural gas) and that carbon is found within organic matter (organic carbon) and inorganic matter (carbon inorganic) begins the carbon cycle By taking green plants (products) carbon dioxide from the atmosphere in the process of photosynthesis The product of organic compounds In the plant also the process of breathing, resulting in Co2 gas, which returns to the atmosphere, and then used in the process of photosynthesis to complete the cycle back to the plant (It is noted that the carbon cycle is largely related to what happens The carbon cycle often follows more complex paths. After the carbon of the plant becomes organic, the animals feed on it, the organic matter is digested, absorbed and represented to contribute to the construction of animal tissue. Consequently, the carbon atoms in the plant become part of the cell structure of the animal that feeds on them. What happens to carbon after that? Carbon can return to the atmosphere through the breathing process and carbon dioxide is produced. The remaining carbon in the cells and tissues of living organisms is lost in part by their excretions and waste. After their death, carbon is converted into organic matter that can be returned to the atmosphere by aerobic decomposition by microorganisms.

There is a fraction of organic carbon that does not pass cycles of this type so quickly, since it can track a longer path; in marine animals, carbon enters the structure of solid parts such as shellfish shells, in the form of calcium carbonate. After long periods of time, carbon in the calcareous rocks is proved by the marine deposits of these shells. A large portion of Co2 dissolves in seawater, ocean and lake water, which can lead to calcification of calcareous rocks, ie carbon stabilization. These rocks are subjected to chemical weathering processes, leading to the return of a portion of carbon stabilized to the atmosphere in the form of Co2.

Carbon can also be trapped in organic compounds in fossil fuels when organic compounds are conserved from aerobic decomposition. When this fuel is burned, the carbon is returned to the atmosphere in th form of carbon dioxide to be recycled again. 

Another point to consider when studying carbon by nature is that the conversion rate, such as respiration, photosynthesis, etc., varies and varies from one ecosystem to another. In warm, well-lit regions, tropical plants produce high-yielding photosynthesis, which leads to diversity of consumption for different levels, which increases the amount of biodiversity. If they are close to a cold, dry, dimly lit environment, photosynthesis is slow, so productivity is slow or low, reducing living organisms and this will reduce biodiversity

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**Earthworm**

An earthworm is a tube-shaped, segmented worm found in the phylum Annelida. They are commonly found living in soil, feeding on live and dead organic matter. An earthworm's digestive system runs through the length of its body. It conducts respiration through its skin.



Earthworms are hermaphrodites: each individual carries both male and female sex organs.

Earthworms are far less abundant in disturbed environments and are typically active only if water is present.

Earthworms do not have eyes , however, they do have specialised photosensitive cells called "light cells of Hess". These photoreceptor cells have a central intracellular cavity (phaosome) filled with microvilli. As well as the microvilli, there are several sensory cilia in the phaosome which are structurally independent of the microvilli. The photoreceptors are distributed in most parts of the epidermis but are more concentrated on the back and sides of the worm.



Earthworms travel underground by the means of waves of muscular contractions which alternately shorten and lengthen the body (peristalsis). The shortened part is anchored to the surrounding soil by tiny claw-like bristles (setae) set along its segmented length. In all the body segments except the first, last and clitellum.

The major benefits of earthworm activities to soil fertility for agriculture can be summarized as:

 Biological: In many soils, earthworms play a major role in the conversion of large pieces of organic matter into rich humus, thus improving soil fertility. This is achieved by the worm's actions of pulling below the surface deposited organic matter such as leaf fall or manure, either for food or to plug its burrow. Once in the burrow, the worm will shred the leaf and partially digest it and mingle it with the earth.

 Chemical: In addition to dead organic matter, the earthworm also ingests any other soil particles that are small enough—including sand grains up to 1/20 of an inch (1.25 mm)—into its gizzard, wherein those minute fragments of grit grind everything into a fine paste which is then digested in the intestine. When the worm excretes this in the form of casts, deposited on the surface or deeper in the soil, minerals and plant nutrients are changed to an accessible form for plants to use.

Physical: The earthworm's burrowing creates a multitude of channels through the soil and is of great value in maintaining the soil structure, enabling processes of aeration and drainage.

 earthworms "act as an innumerable army of pistons pumping air in and out of the soils on a 24-hour cycle ". Thus, the earthworm not only creates passages for air and water to traverse the soil, but also modifies the vital organic component that makes a soil healthy

. Earthworms promote the formation of nutrient-rich casts (globules of soil, stable in soil . that have high soil aggregation and soil fertility and quality.

The ability to break down organic materials and excrete concentrated nutrients makes the earthworm a functional contributor in restoration projects. In response to ecosystem disturbances,

Benefits of earthworms

By their activity in the soil, earthworms offer many benefits: increased nutrient availability, better drainage, and a more stable soil structure, all of which help improve farm productivity.

 Improved nutrient availability

 Worms feed on plant debris (dead roots, leaves, grasses, manure) and soil. Their digestive system concentrates the organic and mineral constituents in the food they eat, so their casts are richer in available nutrients than the soil around them. Nitrogen in the casts is readily available to plants. Worm bodies decompose rapidly, further contributing to the nitrogen content of soil.

 Improved drainage

 The extensive channelling and burrowing by earthworms loosens and aerates the soil and improves soil drainage. Soils with earthworms drain up to 10 times faster than soils without earthworms. In zero-till soils, where worm populations are high, water infiltration can be up to 6 times greater than in cultivated soils. Earthworm tunnels also act, under the influence of rain, irrigation and gravity, as passageways for lime and other material.

 Improved soil structure

 Earthworm casts cement soil particles together in water-stable aggregates. These are able to store moisture without dispersing. Research has shown that earthworms which leave their casts on the soil surface rebuild topsoil. In favourable conditions they can bring up about 50 t/ha annually, enough to form a layer 5 mm deep. One trial found worms built an 18-cm thick topsoil in 30 years.

 Improved productivity

 Research into earthworms in New Zealand and Tasmania found earthworms introduced to worm-free perennial pastures produced an initial increase of 70–80% in pasture growth, with a long-term 25% increase: this raised stock carrying capacity. Researchers also found that the most productive pastures in the worm trials had up to 7 million worms per hectare, weighing 2.4 tonnes. There was a close correlation between pasture productivity and total worm weight, with some 170 kg of worms for every tonne of annual dry matter production.

How to encourage earthworms

Because earthworms do not like soil that is too acid, alkaline, dry, wet, hot or cold, their presence is a good indicator of soil conditions suitable for plant growth.

 Ensure soil pH (CaCl2) is above 4.5

 Earthworms do not like acid soils with pH (CaCl2))\* less than 4.5. The addition of lime raises pH and also adds calcium. Earthworms need a continuous supply of calcium, so are absent in soils low in this element. South Australian research found that earthworm numbers doubled when pH(CaCl2) rose from 4.1 to 6.7.

 pH can be measured in water or calcium chloride (CaCl2). The CaC12 method is more accurate and gives values of about 0.5–0.8 lower than water pH. A pH(CaCl2) of 4.5 measures about 5.0–5.3 in water.

 Increase organic matter

 Earthworms feed on soil and dead or decaying plant remains, including straw, leaf litter and dead roots. They are the principal agents in mixing dead surface litter with the soil, making the litter more accessible to decomposition by soil microorganisms. Animal dung is also an attractive food for many species of earthworms. The following farming practices provide food for earthworms.

 Permanent pasture: Permanent pasture provides organic matter as leaves and roots die and decay. Pasture slashings and manure from grazing animals are also good sources of organic matter in pasture.

 Green manure crops: Green manure crops are fodder crops turned into the soil to provide organic matter to benefit the following crop. The crops are grazed or slashed, sometimes pulverised, and then left on the surface or turned into the soil.

 Crop stubble: Stubble is an important source of organic matter. Burning stubble destroys surface organic matter, and this affects worm numbers. It is best to leave stubble to rot down, and sow following crops into the stubble using aerial sowing, direct drill or (at least) minimum tillage. All these techniques mean less cultivation, and this also encourages earthworms.