Title of the topic: Soil microbes

Short Summary of Topic

soil microorganisms are essential part of ecosystem and play crucial functions like energy exchange and chemical transformation. Furthermore, microbial communities' variety and richness serve as crucial markers of soil's dynamic changes**.**The terrestrial ecosystem is based on soil microbial populations, which are also important biogeochemical process drivers. Microbes affect the global climate, water quality, and atmospheric composition in addition to being crucial to the cycling of nutrients and soil fertility. Billions of microorganisms, including bacteria, fungus, and archaea, can be found in a few grams of soil. These creatures carry out a variety of ecological functions.Microorganisms are the indicator of soil health and soil productivity. The presence of organic matter within the soil is itself nothing until or unless beneficial microorganism's act on it and convert it into available form (humus) by releasing the different types of enzymes. Manipulating the interaction between plant and microbes is leads to an increase in plant growth as well as soil health within the ecofriendly environment. Therefore, it is concluded that soil health and crop production can only be improved by soil microbes.

Learning Objective

1. To enrich students' knowledge and train them in understanding air, water and soil Microbiology
2. To make them learn different techniques to isolate soil microorganisms

Learning Outcome

1. Students will be acquainted with the soil Microbiology
2. Students will learn different techniques to cultivate micro-organisms from soil

Introduction

Microbe distribution in soil

A vast array of life forms can be found in the dynamic habitat of soil. Plants use the mechanical support that soils provide to draw nutrients. From invertebrates like worms and insects to mammals like rabbits, moles, foxes, and badgers, soil serves as a home for a wide variety of animals. Additionally, it offers environments that are inhabited by an astounding array of microorganisms. Conditions are constantly changing as a result of interactions between all of these life forms and the soil. This permits soil habitats to continue evolving. Microorganism Distribution Despite making up less than 0.5 % (w/w) of the soil mass, microorganisms significantly influence the characteristics and functions of the soil. The microflora is responsible for 60–80% of the overall metabolism of the soil. With a diameter of less than 0.1 mm, these organisms are the smallest and most varied. Almost any natural material can be broken down by these microorganisms, which include bacteria, cyanobacteria, fungus, yeasts, myxomycetes, and actinomycetes. Microorganisms convert organic materials into nutrients that plants may absorb. A significant portion of the terrestrial biodiversity found worldwide is made up of soil organisms. An essential part of a forest ecosystem, soil microorganisms are sensitive to changes in the environment and are the primary determinant of nutrient cycling, biogeochemical cycles, and the breakdown of soil organic matter. In addition to providing valuable insights into the ecological process, the biogeochemical distribution of soil microbial communities has significant ramifications for managing terrestrial forest ecosystems and safeguarding microbial resources.

The following criteria can be used to group soil organisms: Size: their size; Species: their ancestry; and Function: their means of subsistence. A gram of topsoil could include: One billion bacteria, to be exact b) one million fungus c) up to 100 million actinomycetes d) 100 nematodes

Importance of Soil Organisms

1. Responsible for cycling of C, N and other nutrients
2. Increase soil aeration and penetrability
3. Maintain soil quality and health
4. Relocate and decompose organic materials
5. Enhance soil structure
6. Involved in disease transmission and control

Rhizosphere

The area of soil that is directly next to and impacted by plant roots is known as the rhizosphere. The ecosystem in which plants, soil, microbes, nutrients, and water meet and interact is extremely dynamic. The activities of plant roots and their impact on soil organisms cause the rhizosphere to differ from the bulk soil.

Soil microbiota

Microorganisms contribute to the availability of nutrients in soil (OM decomposition, humus formation, N-fixation, seed germination) and have an impact on the fertility and structure of various soils. control soil stability through several biochemical mechanisms breaks down chemicals and pesticides in soil contribute to a soil environment's overall ecosystem and plant growth and success. The soil contains the following types of microorganisms:

1. Bacteria
2. Actinomycetes
3. Protozoa
4. Algae
5. Fungi

1.Bacteria

It's the smallest organisms in the soil .It is a Prokaryotic (simple cell structure with no internal organelles) Bacteria are the most abundant microorganisms in the soil .Perform many biochemical processes such as Nitrogen fixation (Nitrobacter sp.),Degradation of hydrocarbon,used for remediation(Pseudomonas sp).e.g., Azotobacler, Rhizobium, Bacillus and Xanthomonas Function of Bacteria: Bacteria bring about a number of changes and biochemical transformations in the soil and thereby directly or indirectly help in the nutrition of higher plants growing in the soil. The important transformations and processes in which soil bacteria play vital role are:

1. Decomposition of cellulose and other carbohydrates,
2. Ammonification (proteins ammonia),
3. Nitrification (ammonia-nitrites-nitrates),
4. Denitrification (release of free elemental nitrogen),
5. Biological fixation of atmospheric nitrogen (symbiotic and nonsymbiotic)
6. Oxidation and reduction of sulphur & iron compounds

2. Actinomycetes

Actinomycetes are clubbed with bacteria, the class of Schizomycetes and confined to the order Actinomycetales. They are unicellular like bacteria, but produce a mycelium which is

non-septate (coenocytic) and more slender, like true bacteria they do not have distinct cell-wall and their cell wall is without chitin and cellulose (commonly found in the cell wall of fungi). Actinomycetes are numerous and widely distributed in soil and are next to bacteria in abundanceThey are heterotrophic, aerobic and mesophilic (25-30c) organisms and some species are commonly present in compost and manures are thermophilic growing at 55-65° C temperature (e.g. Thermoatinomycetes, Streptomyces). Actinomycetes belonging to the order of Actinomycetales are grouped under four families: Mycobacteriaceae Actinomycetaceae Streptomycetaceae Actinoplanaceae. In the order of abundance in soils, the common genera of actinomycetes are Streptomyces (nearly 70%), Nocardia and Micromonospora although Actinomycetes, Actinoplanes, Micromonospora and Streptosporangium are also generally encountered.

Functions of Actinomycetes

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

2. Organic residues / substances 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 / degrade the more resistant and indecomposable organic substance/matter 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 odour / smell of freshly ploughed soils.

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

7. One of the species of actinomycetes Streptomyces scabies causes disease "Potato scab" in potato.

3.Fungi

Fungi in soil are present as mycelial bits, rhizomorph or as different spores. Soil fungi possess filamentous mycelium composed of individual hyphae. The fungal hyphae may be aseptate /coenocytic (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, Verticillium, Trichoderma, Rhizopus, Gliocladium, Monilia, Pythium, etc. 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 conducive / suitable for the existence of either bacteria or actinomycetes. The optimum PH range for fungi lies-between 4.5 to 6.5. They are also present in neutral and alkaline soils and some can even tolerate PH beyond 9.0

Functions of Fungi

1. Fungi plays significant role in soils and plant nutrition.

2. They plays important role in the degradation / decomposition of cellulose, hemi cellulose, starch, pectin, lignin in the organic matter added to the soil.

3. Lignin which is resistant to decomposition by bacteria is mainly decomposed by fungi.

4. They also serve as food for bacteria.

5. Certain fungi belonging to sub-division Zygomycotina and Deuteromycotina are predaceous in nature and attack on protozoa & nematodes in soil and thus, maintain biological equilibrium in soil.

6. They also plays important role in soil aggregation and in the formation of humus.

7. Some soil fungi are parasitic and causes number of plant diseases such as wilts, root rots, damping-off and seedling blights e.g., Pythium, Phyiophlhora, Fusarium, Verticillium etc.

8. Number of soil fungi forms mycorrhizal association with the roots of higher plants (symbiotic association of a fungus with the roots of a higher plant) and helps in mobilization of soil phosphorus and nitrogen. e.g., Glomus, Gigaspora, Aculospora, (Endomycorrhiza) and Amanita, Boletus, Entoloma, Lactarius (Ectomycorrhiza).

4.Algae

Algae are present in most of the soils where moisture and sunlight are available. Their number in soil usually ranges from 100 to 10,000 per gram of soil. They are photoautotrophic, aerobic organisms and obtain CO2 from atmosphere and energy from sunlight and synthesize their own food. They are unicellular, filamentous or colonial. Soil algae are divided in to four main classes or phyla as follows:

1. Cyanophyta (Blue-green algae)

2. Chlorophyta (Grass-green algae)

3. Xanthophyta (Yellow-green algae)

4. Bacillariophyta (diatoms or golden-brown algae)

Out of these four classes / phyla, blue-green algae and grass-green algae are more abundant in soil. The green-grass algae and diatoms are dominant in the soils of temperate region while blue-green algae predominate in tropical soils. Green-algae prefer acid soils while blue green algae are commonly found in neutral and alkaline soils. The most common genera of green algae found in soil are: Chlorella, Chlamydomonas, Chlorococcum, Protosiphon etc. and that of diatoms are Navicula, Pinnularia, Synedra, Frangilaria. Blue green algae are unicellular, photoautotrophic prokaryotes containing phycocyanin pigment in addition to chlorophyll. They are common in neutral to alkaline soils. The dominant genera of BGA in soil are: Chrococcus, Phormidium, Anabaena, Aphanocapra, Oscillatoria etc. Some BGA posses specialized cells known as "Heterocyst" which is the sites of nitrogen fixation. BGA fixes nitrogen (non-symbiotically) in puddle paddy/water logged paddy fields (20-30 kg/ha/season).

There are certain BGA which possess the character of symbiotic nitrogen fixation in association with other organisms like fungi, mosses, liverworts and aquatic ferns Azolla. e.g., Anabaena-Azolla association fix nitrogen symbiotically in rice fields.

Functions of Algae or BGA

1. Plays important role in the maintenance of soil fertility especially in tropical soils.

2. Add organic matter to soil when die and thus increase the amount of organic carbon in soil.

3. Most of soil algae (especially BGA) act as cementing agent in binding soil particles and thereby reduce/prevent soil erosion.

4. Mucilage secreted by the BGA is hygroscopic in nature and thus helps in increasing water retention capacity of soil for longer time/period.

5. Soil algae through the process of photosynthesis liberate large quantity of oxygen in the soil environment and thus facilitate the aeration in submerged soils or oxygenate the soil environment.

6. They help in checking the loss of nitrates through leaching and drainage especially in un-cropped soils.

7. They help in weathering of rocks and building up of soil structure

5.Protozoa

Soil protozoa belonging to the class ciliate / ciliophora are characterized by the presence of cilia (short hair-like appendages) around their body, which helps in locomotion. Protozoa are abundant in the upper layer (15 cm) of soil. Protozoa can be split up into three categories: flagellates, amoebae, and ciliates. The important soil inhabitants of this class are Colpidium, Colpoda, Balantiophorus, Gastrostyla, Halteria, Uroleptus, Vortiicella, Pleurotricha etc. Soil moisture, aeration, temperature and pH are the important factors affecting soil protozoa.

Function of Protozoa

1. Most of protozoans derive their nutrition by feeding or ingesting soil bacteria belonging to the genera Enterobacter, Agrobacterium, Bacillus, Escherichia, Micrococcus, and Pseudomonas and thus, they play important role in maintaining microbial / bacterial equilibrium in the soil.

2. Some protozoa have been recently used as biological control agents against phytopathogens.

3. Species of the bacterial genera viz. Enterobacter and Aerobacter are commonly used as the food base for isolation and enumeration of soil protozoans.

4. Several soil protozoa cause diseases in human beings which are carried through water and other vectors, e.g., Amoebic dysentery caused by Entamoeba histolytica

Factor influencing the microbial communities in soil

Soil biodiversity reflects the mix of living organisms in the soil. These organisms interact with one another and with plants and small animals forming a web of biological activity. ... These organisms improve the entry and storage of water, resistance to erosion, plant nutrition, and break down of organic matter. The soil environment, soil microorganisms play key roles in ecosystem functioning. They are known to be influenced by biotic and abiotic factors, such as plant cover or edaphic parameters. Major factors affecting microbial communities are

1. pH

2. Temperature

3. Moisture.

4. Soil mineralogy.

5. Light.

6. Organic and Inorganic Chemicals

7. Soil Organic Matter

8. Types of Vegetation and its Growth Stages

9. Different Seasons Among the edaphic parameters, pH is the factor that most strongly influences soil bacterial communities

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