SOIL MICRORGANISMS

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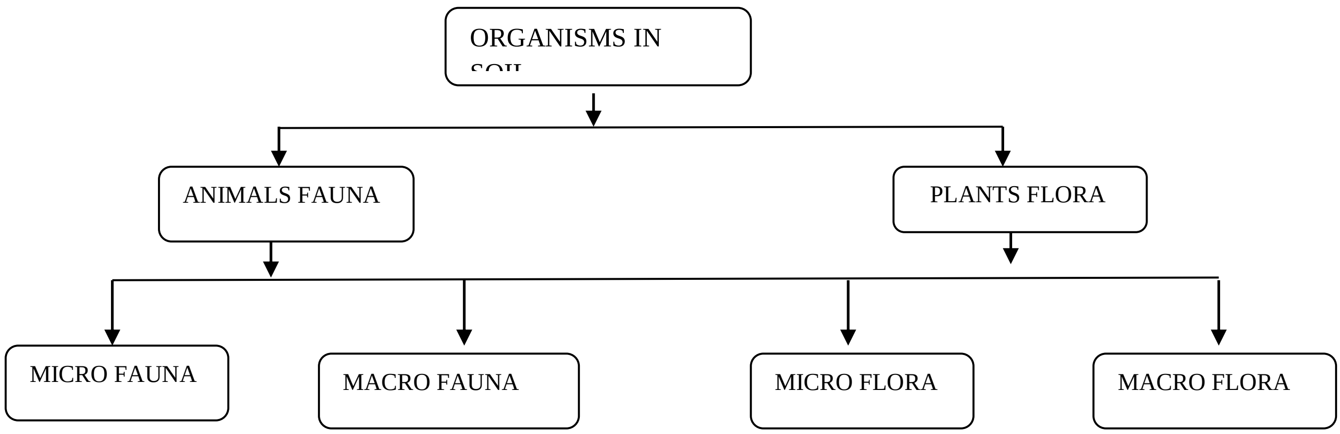
Introduction

The soil is filled with millions of living organisms which make it a living and a dynamic system. Under a microscope, it reveals a complex arrangement of soil particles and pore spaces filled with air and water. It is in these pore spaces that plant roots and millions of organisms develop, ranging from sub-microscopic to macroscopic in size. These organisms not only help in the development of soils but also carry out a number transformations, facilitating the availability of nutrients to the plants. They mineralize nutrients from dead tissues to become available to plants for growth.

Organisms in Soil

Organismns present in soil are classified into two main groups: (i) soil flora, belonging to plant kingdom, and (ii) soil fauna, the animal forms. These are further divided into two sub groups: macroorganisms, i.e. those organisms which are big enough to be seen by an unaided eye, and microorganisms which are so small that these can be seen only after magnification using a microscope. A comprehensive presentation classifying soil organisms into specific groups is given below.



Earthworms Bacteria Plant roots

nematodes Termites Actinomycetes Macro algae

rotifers Ants Fungi

Grubs Algae

Slugs & Snails

Centipedes

Millipedes

Microorganisms in soil

Bacteria

There are many bacterial genera of significance for agricultural productivity. The autotrophic bacteria like nitrifying bacteria *Nitrosomonas* and *Nitrobacter* and sulphur oxidizing bacteria *Thiobacillus* can be studied only using special growth medium.

Bacteria due to their large number and very rapid rate of multiplication play a very rapid of multiplication play a very significant role in carrying out various biochemical reactions controlling availability of plant nutrients. The processes of N2 fixation, phosphate solubilization, organic matter decomposition and synthesis of humus, nitrification and deniitrification, protein decomposition and ammonification, etc. lead to transformation of various macro-nutrients in soil and help in plant nutrition.

Cartain free-living soil bacteria can reduce the atmospheric nitrogen to ammoniacal from, thus enriching soil with plant available nitrogen. These bacteria belong to the genus Azotobacter, Azotomonas and develop freely in soil which is relatively high in organic matter. The genus Beijerenckia and Derxia are unique; they can fix nitrogen in soils which are highly acidic (pH 4.0). Clostridium fixes nitrogen under anaerobic conditions and can be of economic significance in flooded soils. Besides these free-living bacteria, there is another group belonging to the genus Rhizobium which fixes nitrogen in symbiosis with the legumes forming tiny out-growths on roots called legumes root nodules, the sites of nitrogen fixation. Azospirillum, a spiral bacterium and other besides fixing nitrogen as free-living can also fix nitrogen in association with plants in rhizosphere entering into roots without forming nodule and the process is called “associative nitrogen fixation”.

The microbiological oxidation of ammonium to nitrate is one of the most important transformations taking place in soil which helps plant nutrition since nitrogen is predominantly taken up as NO_3-ion. This transformation is mediated by a group of bacteria called ‘nitrifying bacteria’. It is a two-stage process wherein firstly ammonium is transformed into nitrite by bacteria belonging to the genus Nitrosomonas and in the second stage bacteria of the genus Nitrobacter convent nitrite to nitrate. These bacteria are aerobic in nature, Hence, supply of oxygen is essential for this process. When oxygen supplyis restricted, the activity of nitrifying bacteria goes down, lowering the nitrification rate. Any cultural practice which improves aeration results in enhancing nitrification. The optimum pH for these bacteria is between 6.5 and 7.5. Therefore, under acidic conditions nitrification is slow and is nearly negligible below pH 5.0.

Actinomycetes

Taxonomically actinomycetes are like bacteria which possess aerial hyphae like fungi. Many of the soil actinomycetes are known to produce antibiotics and have been commercially exploited to produce antibiotics of clinical importance. However, their role in biological equilibrium under natural soil conditions is doubtful as concentration of antibiotics produced by them seldom reaches concentration levels to inhibit the susceptible organisms.

Actinomycetes are nutritionally heterotrophic and are highly adaptive to degrade wide range of organic substances, particularly those which are difficult to be decomposed by other soil organisms. They are also slow growing organisms. Hence, they cannot compete with bacteria and fungi for the available nutrients and thus grow on substrates that are relatively more resistant to attack of bacteria and fungi. These organisms start functioning when easily decomposable fractions like sugars, starches, etc. are used up by bacteria and fungi and the more difficultly decomposable substances accumulate as they face less competition from other organisms. The role of actinomycetes in the synthesis of humus is well known. They are reported to produce a number of colour pigments contributing dark colour to soil humus. Actinomycetes population is also much larger in compost pits as they can withstand high temperatures. Some of them are pathogens causing plant diseases such as potato scab, etc.

Fungi

Saprophytic fungi perform a very important function in the decomposition of organic matter, particularly plant residues.

Some fungi form a symbiotic association with roots of higher plants facilitating uptake of plant nutrients, particularty of those which are less mobile. This association is known as “mycorrhizal association”. There are two types of mycorrhizh association.

(i) **Ectotrophic mycorrhizae** – where the fungus forms a mantle or sheath around the root surface (called Hartig net) and where the mycelium develop intercellulary.

(ii) **Endomycorrhizae** – where the fungus develops intracellular in the root without forming Hartig net. In this association, the penetration of roots cells is characterized by the formation of terminal spherical structure called vesicles which contain oil droplets and phosphorus. This type of mycorrhiza is called ‘vescicular arbuscular mycorrhizae’ (VAM) and is of agricultural significance particularly in P-deficient soils.

The beneficial effect of these fungi on nutrient uptake has been attributed to three factors:

(i) Increased absorption of available nutrients from soil as the fungus changes root morphology which results in the larger root surface available for nutrient absorption. Fungal filaments also act as absorption surface.

(ii) Increasing the nutrient availability by solubilizing insoluble nutrients like P which thus become available to plant, and

(iii) Increasing the nutrient mobility due to faster intracellular nutrient mobility and visited by the root system but traversed by the mycorrhizal hyphae.

Algae

Soil algae are chlorophyll containing organisms. They are autotrophic, therefore their development is not restricted by organic carbon supply. They are unicellular, filamentous or form colonies from single cells.

Soil algae are classified on the basis of the colour (pigments) as: (i) Cyanophyta (blue green), (ii) Chlorophyta (grass green), (iii) Xanthophyta (yellow green), and Bacilliriophyta (golden brown), Blue green algae, also known as ‘Cyanobacteria’, are most important from agricultural point of view because they fix atmospheric nitrogen and contribute towards the nitrogen economy of soils, particularly in rice cultures of tropics.

Blue green algae have been reported to fix about 20 kg N per ha. Some of the important genera dominant in rice fields are Anabaena, Nostoc, and Tolypothrix.