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Role of Soil Flora in Agriculture

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ABSTRACT

The soil is considered to be a living system because it contains a dynamic population of organisms/microorganisms; hence, it is important to add good quality compost to keep the bacterial and fungal population up to appreciable limit. Cultivated soil has relatively more population of microorganisms than the fallow land, and the soil is rich in organic matter and contains much more population than sandy and eroded soils. Microbes in the soil are important to Agriculture in maintaining soil fertility. productivity, cycling of nutrient elements in the biosphere and sources of industrial products such as enzymes, antibiotics, vitamins, hormones, organic acids, among others. Among the organisms found in the soil, the bacteria and fungi carry out the decomposition of plant residues, breaking them down and holding the nutrients in their bodies, glued and bound to soil particles. This prevents the nutrients leaching out into the soil. At this point the nutrients are not available to the plants. Bacteria and fungi hold onto these nutrients until protozoa, nematodes, small micro arthropods, and earthworms consume individuals of bacteria and fungi and release nutrients in plant available forms. The nutrients are released to the plants in the right amount and form according to the requirements by the growing plants. The plants protect the root system from pathogen and pest attack by excrete foods for bacteria and fungi which are a food source for the beneficial species. This paper thus concluded that it is important to keep adding these products to the soil to build up bacteria and fungi numbers.
Keywords: Fungi, Bacteria, Microorganism, Soil, Agriculture

INTRODUCTION

Soil organisms constitute the likes of plants and animals which comprise important components of soil. The pioneering investigations of a number of early microbiologists showed for the first time that the soil was not an inert static material but a medium pulsating with life. The soil is now believed to be a dynamic or rather than a living system, containing a dynamic population of organisms/microorganisms [1]. Cultivated soil has relatively more population of microorganisms than the fallow land, and the soil is rich in organic matter and contains much more population than sandy and eroded soils. Microbes in the soil are important to Agriculture in maintaining soil fertility. productivity, cycling of nutrient elements in the biosphere and sources of industrial products such as enzymes, antibiotics, vitamins, hormones, organic acids etc. At the same time certain soil microbes are the causal agents of human and plant diseases.

Categorization of Soil Flora

Soil flora belongs to plant kingdom. They are classified in to two broad categories.

a) Microflora: this include: Bacteria, Fungi, Molds, Yeast, Mushroom, Actinomycetes, Stretomyces, Algae (eg. BGA, Yellow Green Algae, Golden Brown Algae.).

Bacteria is again classified into:

i. Heterotrophic eg. symbiotic & non -symbiotic N_2 fixers, Ammonifier, Cellulose Decomposers, Denitrifiers

ii. Autrotrophic eg. Nitrosomonas, Nitrobacter, Sulphur oxidizers, etc.

b) Macroflora: Roots of higher plants

Overview of Chemical activity of micro-organisms present in soil for decomposition and disintegration of inorganic to organic mass:

The bacteria and fungi carry out the decomposition of plant residues, breaking them down and holding the nutrients in their bodies, glued and bound to soil particles, this prevents the nutrients leaching out into the soil (2). At this point the nutrients are not available to the plants. Bacteria and fungi hold onto these nutrients until protozoa, nematodes, small micro arthropods, and earthworms consume individuals of bacteria and fungi and release nutrients in plant available forms. The nutrients are released to the plants in the right amount and form according to the requirements by the growing plants. The plants protect the own root system from pathogen and pest attack by excrete foods for bacteria and fungi which are a food source for the beneficial species (3).

Bacterial membranes, in comparison, are phospholipids, which are energy-rich. Bacteria degrade easily and quickly. They also function as a food source for a wide range of microorganisms. The different proportions of C and nitrogen (N) (i.e. different C: N ratios) of bacteria and fungi might also play a role in the mineralization and immobilization processes of nutrients in the soil. Due to their structure, fungi need a greater amount of carbon to grow and reproduce and will, therefore, 'collect' the required amount of carbon available for this from the soil organic matter. Bacteria, however, have a higher nitrogen requirement and, therefore, a lower C: N ratio and take more nitrogen from the soil for their own requirements (4). To feed up the numbers of fungi which remain present in the fertile soil, it is needed to add fungal foods such as dead leaf material, woody material, fish hydrolysate (also a bacterial food), and N and other micronutrients. Wood, sawdust, bark, paper and cardboard can be used as well, but diversity is the key (4).

Soil bacteria:Amongst the different microorganisms inhabiting in the soil, bacteria are the most abundant and predominant organisms. These are primitive, prokaryotic, microscopic and unicellular microorganisms without chlorophyll. Morphologically, soil bacteria are divided into three groups viz. Cocci (round/spherical), (rod-shaped) and Spirilla I Spirllum (cells with long wavy chains). Bacilli are most numerous followed by Cocci and Spirilla in soil. The most common method used for isolation of soil bacteria is the "dilution plate count" method which allows the enumeration of only viable/living cells in the soil. The size of soil bacteria varies from 0.5 to 1.0 micron in diameter and 1.0 to 10.0 microns in length. They are motile with locomotory organs flagella. Bacterial population is one-half of the total microbial biomass in the soil ranging from 1,00000 to several hundred millions per gram of soil, depending upon the physical, chemical and biological conditions of the soil. (5), on the basis of ecological characteristics classified soil microorganisms in general and bacteria in particular into two broad categories i.e. Autochnotus (Indigenous species) and the Zymogenous (fermentative). Autochnotus bacterial population is uniform and constant in soil, since their nutrition is derived from native soil organic matter (eg. Arthrobacter and Nocardia whereas Zymogenous bacterial population in soil is low, as they require an external source of energy, eg. Pseudomonas & Bacillus. The population of Zymogenous bacteria increases gradually when a specific substrate is added to the soil. To this category belong the cellulose decomposers, nitrogen utilizing bacteria and ammonifiers. As per the system proposed in the Bergey's Manual of Systematic Bacteriology, most of the bacteria which are predominantly encountered in soil are taxonomically included in the three orders, Pseudomonadales, Eubacteriales and Actinomycetales of the class Schizomycetes. The most common soil bacteria belong to the genera Pseudomonas, Arthrobacter, Clostridium Achromobacter, Sarcina, Enterobacter etc. Another group of bacteria common in soils is the Myxobacteria belonging to the genera Micrococcus, Chondrococcus, Archangium, Polyangium, Cyptophaga.

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 i.e. a) Autotrophs and b) Heterotrophs

1. Autotrophic bacteria are capable of 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 eg.Nitrobacter, Nitrosomonas, Thiaobacillus).
2. Majority of soil bacteria are heterotrophic in nature and derive their carbon and energy from complex organic substances/organic matter, decaying roots and plant residues. They obtain their nitrogen from nitrates and ammonia compounds (proteins) present in soil and other nutrients from soil or

from the decomposing organic matter. Certain bacteria also require amino acids, B-Vitamins, and other growth promoting substances also.

Functions / Role 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: decomposition of cellulose and other carbohydrates, ammonification (proteins ammonia), nitrification (ammonia-nitrites-nitrates), denitrification (release of free elemental nitrogen), biological fixation of atmospheric nitrogen (symbiotic and non-symbiotic) oxidation and reduction of sulphur and iron compounds. All these processes play a significant role in plant nutrition.

Table 1: Process/reaction

Process/reaction		Bacterial genera
Cellulose decomposition (celluloytic bacteria) most cellulose decomposers are mesophilic	a.	b. Aerobic: Angiococcus, Cytophaga, Polyangium, Sporocytophyga, Bacillus, Achromobacter, Cellulomonas c. anaerobic: Clostridium Methanosarcina, Methanococcus
Ammonification (Ammonifiers)		Bacillus, Pseudomonas
Nitrification (Nitrifying bacteria)		Nitrosomonas, Nilrobacter Nitrosococcus
Denitrification (Denitrifies)		Achromobacter, Pseudomonas, Bacillus, Micrococcus
Nitrogen fixing bacteria		a. Symbiotic-Rhizobium, Bradyrrhizobium b. Non-symbiotic: aerobic – Azotobacter Beijerinckia (acidic soils), anaerobic-Clostridium

Table 2: Bacteria capable of degrading various plant residues in soil are:

Cellulose	Hemicelluloses	Lignin	Pectin	Proteins
Pseudomonas	Bacillus	Pseudomonas	Erwinia	Clostridium
Cytophaya	Vibrio	Micrococcus		Proteus
Spirillum	Pseudomonas	Flavobacteriumm		Pseudomonas
Actinomycetes	Erwinia	Xanthomonas		Bacillus
Cellulomonas		Streptomyces		

Soil Actinomycetes

These are the organisms with characteristics common to both bacteria and fungi yet possessing distinctive features to delimit them into a distinct category. In the strict taxonomic sense, actinomycetes are clubbed with bacteria the same 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). 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. Certain actinomycetes whose hyphae undergo segmentation resemble bacteria, both morphologically and physiologically. Actinomycetes are numerous and widely distributed in soil and are next to bacteria in abundance. They are widely distributed in the soil, compost etc. 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 waterlogged soil conditions. The population of actinomycetes increases with depth of soil even up to horizon 'C' of a soil profiler They are heterotrophic, aerobic and mesophilic (25-30 ^c) organisms and some species are commonly present in compost and manures are thermophilic growing at 55-65° c temperature (eg. Thermoatinomycetes, Streptomyces). Actinomycetes belonging to the order of Actinomycetales are grouped under four families viz Mycobacteriaceae, Actinomycetaceae, Streptomycetaceae and Actinoplanaceae. Actinomycetous genera which are agriculturally and industrially important are present in only two families of Actinomycetaceae and Strepotmycetaceae. 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/Role 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 odor /smell of freshly ploughed soils.
6. Many genera species and strains (eg. 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.

Soil Fungi: Fungi in soil are present as mycelial bits, rhizomorph or as different spores. Their number varies from a few thousand to a few -million per gram of soil. Soil fungi possess filamentous mycelium composed of individual hyphae. The fungal hyphae may be aseptate /coenocytic (Mastigomycotina and Zygomycotina) or septate (Ascomycotina, Basidiomycotina & Deuteromycotina). As observed by (6), 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. Most of these fungal genera belong to the subdivision Deuteromycotina / Fungi imperfeacta which lacks sexual mode of reproduction. As 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 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 / Role 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 eg. 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 eg. Glomus, Gigaspora, Aculospora, (Endomycorrhiza) and Amanita, Boletus, Entoloma, Lactarius(Ectomycorrhiza).

Soil 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 do not posses flagella and do not reproduce sexually. 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, eg Anabaena-Azolla association fix nitrogen symbiotically in rice fields.

Functions / Role 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.

CONCLUSION

It is important to add good quality compost or keep soil inoculated to keep the bacterial and fungal population up to appreciable limit. All composts contain a good range of bacteria, fungi and microorganisms. So it's important to keep adding these products to the soil to build up bacteria and fungi numbers (7, 8). Losses incurred at post-harvest are quite common and enormous leading to valuable food loss. At every stage of post-harvest practice, agricultural products are deprived from quality due to physical, chemical, biological and mechanical factors. The soil quality also proves to be an important factor in this aspect (9).

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