



ROLE OF MICROORGANISM FOR PLANT GROWTH AND EXECUTION OF ECOFRIENDLY ENVIRONMENT

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INTRODUCTION:

The earth's surface is naturally covered in soils, which are the interface of three different material states: liquids (water), gasses (air in soil pores), and solids (geological and dead biological components). The combination of geological parent material, glacial and geomorphological history, biota existence and activity, land use history, and disturbance regimes results in a distinct soil composition. All terrestrial ecosystems are built on soils, which are also home to a wide variety of plants, algae, bacteria, archaea, fungi, insects, annelids, and other invertebrates. The species that live both above and below ground are supported by the food or nutrients that these soil dwellers supply. Soils also play critical roles in buffering and filtering freshwater ecosystems. Consequently, soils are extremely important to human societies. We depend on soils for the basis on which we and our buildings stand, and for the production of food, building materials, and other resources; indeed, soils influence most ecosystem services on which we depend (Dominati *et al.*, 2010). Soil microbes, bacteria, archaea, and fungi play diverse and often critical roles in these ecosystem services. The vast metabolic diversity of soil microbes means their activities drive or contribute to the cycling of all major elements (e.g. C, N, P), and this cycling affects the structure and the functions of soil ecosystems as well as the ability of soils to provide services to people. The pressure on agricultural land to provide the need for food, fuel, and raw materials rises as a result of the rapid growth in human population. Farmers utilize chemical pesticides and fertilizers to meet requirements, but this deteriorates soil health and reduces soil biodiversity. Over the next 30 years, there will be a 70% increase in demand for agricultural produce. Similar to this, people are now realizing that sustainable agricultural methods are necessary to meet the world's agricultural needs in the future (Altieri, 2004). Soil physical and chemical properties depend on quantity and quality of soil organic matter, pH and conditions of redox potential. All of these significantly influence the structure and dynamics of the microscopic community as well as soil functions. Improvement in soil quality, plant nutrition and maintenance of plant

health is a fundamental role of soil microorganisms in agriculture. Generally, people think that microbes are disease-causing agents. The decomposition of organic matter will be done through the help of these microorganisms in the soil. Plants are sessile, multicellular organisms, which rely on developmental and metabolic changes for growth. At least three well defined parts can be recognized in the developing plant, the root, the below-ground part of the plant, which provides anchorage and plays an important role in water and nutrient uptake from the soil, the stem, which performs essential functions as a supporting structure for the leaves and as a conduit for water and nutrients moving from one part of the plant to another, and the shoot, which produces leaves, flowers and fruits that enables efficient light capture and provides a means for reproduction and seed dispersal. The anatomical configuration of the root, stem and shoot systems to build a plant is known as plant architecture. Plant architecture is a crucial factor in the agronomic success of crops and is a vital consideration for plant breeders (Ross *et al.*, 2005).

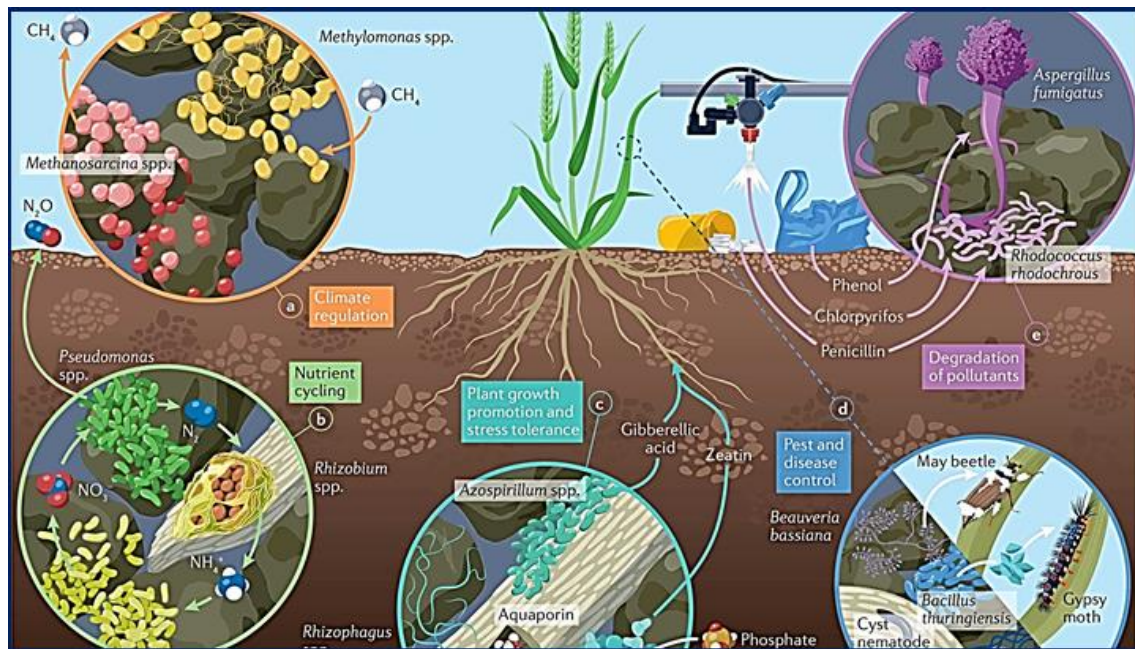
Table 1: Role of soil microbes in provisioning and regulating services provided by soil ecosystems (adapted from Dominati *et al.*, 2010)

Soil Service	Descriptor	Role of Soil Microbes
Physical support	Soils form the surface of the earth and represent the physical base on which animals, humans and infrastructures stand. Soils also provide support to animal species that benefit humans	Microbes contribute to soil formation through nutrient cycling and organic matter production.
Raw materials	Soils can be a source of raw materials (e.g. peat for fuel and clay for potting).	Soil microbes produce antimicrobial agents and enzymes used for biotechnological purposes.
Nutrient cycling	Soil is the site of the decomposition of organic materials and the mobilisation of nutrients in bedrock and soil aggregates.	The activities of soil bacteria, archaea and fungi drive nutrient cycling in soils and are involved in weathering minerals.
Filtering of contaminants	If pollutants (e.g. excess nutrients, exotic microbes, metals, organic compounds) are leached from soils, they can contaminate aquatic ecosystems and threaten human health. Soils absorb and retain solutes and pollutants, avoiding their release into water.	In concert with the clay and organic matter content of soils, microbial products contribute to both the hydrophobicity and wettability of soils, impacting on the ability of soils to filter contaminants.

TYPES OF SOIL MICROORGANISMS:**Bacteria:**

Bacteria are so basic in structure that they are sometimes referred to as bags of enzymes and/or fertilizer soluble bags. In crop processing, soil bacteria have a key role as they take part in the processes that provide soil nutrients, boosting plant growth, e.g. plant hormone development, regulating or inhibiting plant pathogens, improving the composition of the soil as well as bioaccumulation and inorganic microbial leaching. Ingham (2009) defines the four main functional groupings of soil bacteria as decomposers, mutualists, pathogens, and lithotrophs. Each functional bacteria category plays a role in recycling soil nutrients. microorganisms used to fix atmospheric N and increase the availability of nutrients, specifically nitrogen. In addition to its critical function in food production and plant growth (Pandey *et al.*, 2020), nitrogen is also needed for the creation of proteins, RNA, DNA, chlorophyll, and cellular enzymes. Bacteria commonly referred to as “Rhizobia” are believed to trigger the nodules at the roots of leguminous plants (and, rarely, stalks). The distinguished “bacteroid” types help in the fixation of nitrogen from the atmosphere within those nodules and subsequent ammonia is used as a fixed nitrogen supply. This symbiotic relationship is an exceptional niche for a bacterium and a specialized supply of nitrogen is obtained by the plants. Plant Growth-Promoting Rhizobacteria (PGPR) are natural rhizosphere-inhabiting bacteria, which belong to diverse genera such as *Pseudomonas* and *Bacillus* species. These microorganisms have been isolated from a wide variety of wild and cultivated plant species such as *Arabidopsis*, barley, rice, canola and bean. PGPR are used as inoculants for biofertilization, phytoestimulation and biocontrol. The general effect of PGPR is an increased growth and productivity of plants. Their contribution can be exerted through different mechanisms including root system architecture modulation and increased shoot growth by production of phytohormones such as auxins and cytokinins. Other indirect mechanisms include the effects of products such as antibiotics and hydrogen cyanide, which promote plant growth by inhibiting the growth of deleterious microorganisms in the rhizosphere. PGPR can induce defense programs such as systemic acquired resistance and induced systemic resistance, thus reducing phytotoxic microbial communities. They also can elicit induced systemic tolerance (IST) to abiotic stress (Mantelin *et al.*, 2004). *Pseudomonas* comprises a genus of ubiquitous Gram-negative bacteria that can live in several environmental niches such as the rhizosphere. Although a few *Pseudomonas* are studied for their roles as plant pathogens (i.e., *Pseudomonas syringae*), there are many species such as *P. fluorescens*, *P. putida*, *P. acaulescens* and *P. chloraphis*, which may act as plant beneficial bacteria by antagonizing plant pathogens and through the production of traits that directly influence plant disease resistance and growth (Yang *et al.*, 2009).

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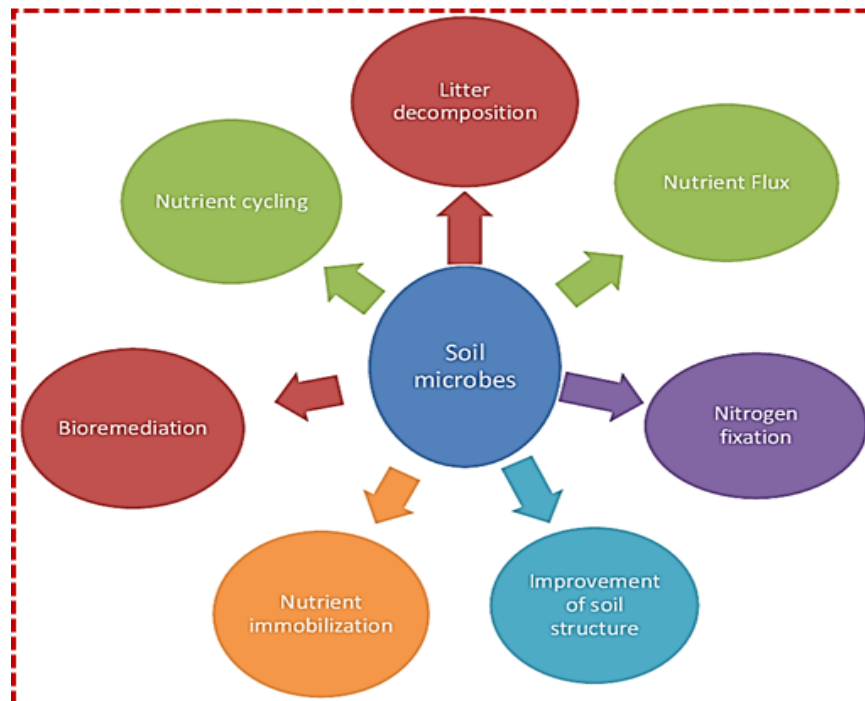
Actinomycetes:

Actinomycetes are gram-positive aerobic bacteria that belong to the order of Actinomycetes known by its substrate and aerial mycelium production. They form associations with some non-leguminous plants and fix N, which is then available to both the host and other plants in the near vicinity. Actinomycetes inhabit the rhizosphere of agricultural crops, where they increase soil fertility through recycling of organic matter and solubilizing phosphate.

Fungi:

Fungi are very productive inhabitants of soil, due to their high plasticity and ability to adopt different forms in response to adverse or unfavorable conditions. Fungi also perform an important part in the stabilization and decomposition of soil organic matter (Shah *et al.*, 2021). Dead organic matter is converted by fungi into biomass, organic acids, and carbon dioxide. By accumulating toxic metals in their fruiting bodies, such as lead, zinc, cadmium, copper, and mercury, many fungal species can serve as significant biosorbents. Fungi are highly adapted to preserve and replenish the soil, hence facilitating the growth and development of plants. Fungi have the advantage over bacterial inoculants in that they are generally more effective at spreading through the soil and rhizosphere. The mechanisms involved in plant growth promotion by fungi are competition with fungal pathogens, antibiotic production and elicitation of defense responses. In addition, many plant beneficial fungi are able to parasitize spores, sclerotia or hyphae of pathogenic fungi, resulting in biocontrol. Mycoparasitism is initiated by host sensing, which is generally followed by direct growth towards it, recognition, penetration and degradation.

Production of a number of degradative enzymes, including chitinases, proteases and glucanases is involved in the biocontrol process (Harman *et al.*, 2004).



Algae:

Algae are a very wide and varied group of simple, usually autotrophic organisms which can perform photosynthesis and capture energy from sunlight; they also play a significant role in the soil where they are used as biofertilizer and soil stabilizers. Like other species, algae contained in various types of soil can help the soil improve its characteristics such as carbon content, texture, and aeration. Growth-promoting chemicals like hormones, vitamins, amino acids, and organic acids are released by soil algae, and these molecules have a variety of effects on other organisms. Algae have a major role in maintaining soil fertility, especially in tropical soils where they raise the quantity of organic carbon and other organic matter in the soil, which supports soil health.

BENEFITS FROM SOIL MICROBES:

The ability of plants to withstand plant diseases is greatly influenced by soil microorganisms. By fostering plant systemic disease resistance and coating root surfaces to physically protect the plant from pathogen infection, they can stop pathogen infection. By increasing a plant's resistance to a severe illness, soil microbes can create new opportunities for the production of sustainably produced food. One well-known method for using soil microbes to control pests is the industrial cultivation of the bacterium *Bacillus thuringiensis* (Bt) in the soil for caterpillars and other pests. Numerous Bt strains are frequently employed to keep an eye on flies and beetles. Many strains of the fungus *Trichoderma* spp. have been

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developed as biocontrol agents for fungal plant diseases, mostly pertaining to root issues. Soil microbes may contribute greatly to enrich the soil with nutrients which helps in maintaining soil productivity. It has been proved that biological fertilization is an efficient method to supply plants with their necessary nutrient. Soil microorganisms help plants by converting atmospheric elemental dinitrogen (N_2) into ammonia and are capable of nitrogen-fixing (bacteria possessing nitrogenase enzyme). Nitrogen-fixing and nutrient mineralization processes performed by soil, the microorganism is important in plant nutrition in natural ecosystems because these reactions metabolize recalcitrant forms of N, P, and S to liberate their elements providing plant nutrition

CONCLUSION:

The microorganisms found in soil include nematodes, bacteria, actinomycetes, viruses, and protozoa. They generate metabolites and plant growth regulators, which have an impact on the development and growth of plants. Recycling soil nutrients and breaking down organic wastes depend on soil bacteria. They improve crop yields, soil health, and crop nutrition. Plant disease tolerance is largely influenced by soil microorganisms.

REFERENCES:

1. Altieri, M. A. (2004). Linking ecologists and traditional farmers in the search for sustainable agriculture. *Frontiers in Ecology and the Environment*, 2(1), 35-42.
2. Dominati, E., Patterson, M., & Mackay, A. (2010). A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological economics*, 69(9), 1858-1868.
3. Harman, G. E., Howell, C. R., Viterbo, A., Chet, I., & Lorito, M. (2004). Trichoderma species—opportunistic, avirulent plant symbionts. *Nature reviews microbiology*, 2(1), 43-56.
4. Ingham, E. R. (2009). Chapter 4-Soil biology primer: soil fungus. *Soil and Water Conservation*, 22-23.
5. Mantelin, S., & Touraine, B. (2004). Plant growth-promoting bacteria and nitrate availability: impacts on root development and nitrate uptake. *Journal of experimental Botany*, 55(394), 27-34.
6. Pandey, M., Shrestha, J., Subedi, S., & Shah, K. K. (2020). Role of nutrients in wheat: A review. *Tropical Agrobiodiversity*, 1(1), 18-23.
7. Ross, J. J., Reid, J. B., Weller, J. L., & Symons, G. M. (2018). Shoot architecture I: regulation of stem length. *Annual Plant Reviews online*, 57-91.

8. Shah, K. K., Tiwari, I., Modi, B., Pandey, H. P., Subedi, S., & Shrestha, J. (2021). Shisham (*Dalbergia sissoo*) decline by dieback disease, root pathogens and their management: a review. *Journal of Agriculture and Natural Resources*, 4(2), 255-272.
9. Yang, J., Kloepper, J. W., & Ryu, C. M. (2009). Rhizosphere bacteria help plants tolerate abiotic stress. *Trends in plant science*, 14(1), 1-4.