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The Significance of Microbes in Agriculture

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Microbes are an integral part of agriculture, and certain beneficial microbes, such as bacteria, actinomycetes, fungi, and protozoa, can be found in various aspects of it. Although the majority of microorganisms found in compost are bacteria, soil contains a more diverse group of microbes, including Arthrobacter, Bacillus, Clostridium, and Micrococcus. Fungi such as molds and yeast also play a crucial role in aiding bacteria in breaking down complex compounds such as lignin in woody materials.

Protozoa, which consume bacteria, fungus, and other microscopic organic particles, are abundant in the top layers of well-cultivated, aerated, and predominantly acidic soils. These microbes work to enhance soil quality and create favorable conditions for plant growth. As biochemical agents, soil microbes transform complex organic compounds into simpler inorganic compounds or their component elements. This transformation of organic substances into inorganic substances serves as plant nutrition, resulting in increased yields and improved quality of agricultural goods and services.

Importance of Microorganism

Microorganisms play a crucial role in the decomposition of organic matter, contributing to the production of humus and greatly influencing the quality and structure of soil. They help preserve biological equilibrium, facilitate the recycling of nutrients between the soil and roots, and aid in the transformation of nutrients. Furthermore, they assist in reducing erosion losses by promoting surface blooming. Microbes help maintain soil pH and mineral and nutrient balance, increasing soil fertility.

Rhizobium, a type of microbe, forms root nodules and symbiotic relationships with plants, contributing to their growth and development. These organisms assist in fixing atmospheric nitrogen in the soil, which becomes available for plant use. Overall, microorganisms are essential for maintaining a healthy soil environment and ensuring optimal plant growth and crop yields.

Microbes as Biofertilizers

Biofertilizers are a group of specialized microorganisms, including bacteria, fungi, and algae, that can fix atmospheric nitrogen and convert insoluble phosphate in the soil into a form that plants can utilize. They play a crucial role in enhancing soil fertility and increasing agricultural yields. Biofertilizers are microbial inoculants that can fix nitrogen, solubilize phosphate, and break down organic materials more rapidly. Plant Growth Promoting Rhizobacteria (PGPR) and Vesicular Arbuscular Mycorrhizae (VAM) are among the most important microbes in biofertilizers, as they help to improve soil fertility and boost crop productivity. PGPRs can enhance plant growth by producing growth-promoting substances and by facilitating the uptake of essential nutrients. VAMs, on the other hand, form a

symbiotic relationship with plant roots, enhancing nutrient uptake and providing protection against various stresses. Overall, the use of biofertilizers is an effective and sustainable method to improve soil fertility and increase agricultural yields.

Rhizobium: Rhizobium is one of the most effective and widely used nitrogen-fixing bacteria. It is commonly found in the root nodules of leguminous plants and plays a vital role in promoting plant growth by adding nitrogen to the soil. The legume-rhizobium symbiotic relationship results in the formation of root nodules that fix atmospheric nitrogen, which is then delivered to the plant for growth. Rhizobium was the first microbial fertilizer to be widely utilized due to its effectiveness. Each type of bean has its unique Rhizobium strain, and using effective strains during inoculation can increase nitrogen uptake and improve crop yields. Therefore, it is crucial to use the appropriate Rhizobium strains to ensure optimal growth and yield of leguminous crops.

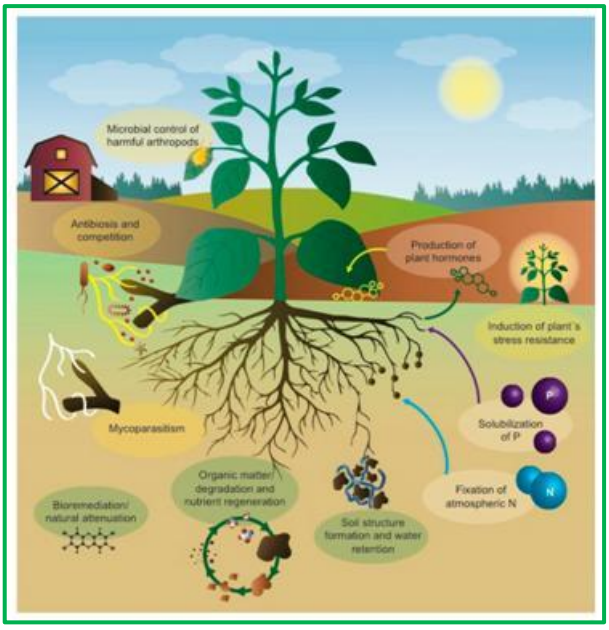

Fig.1 Functions of Microbes in soil

Azospirillum: Azospirillum is a group of bacteria that can form a close symbiotic relationship with higher plants by colonizing their roots and fixing atmospheric nitrogen. This process involves the production of photohormones, especially indole-3-acetic acid, which is known to improve a plant's resistance to biotic and abiotic stress. Azospirillum is commonly associated with fodder grasses and cereals such as sorghum, maize, finger millet, pearl millet, and other minor millets. When these bacteria colonize plant roots, they do not only remain on the surface of the root but also penetrate into the root tissues and coexist hormonally with the plant. This association promotes plant growth and increases nutrient availability, thereby improving crop yields.

Azotobacter: Azotobacter is a common soil bacterium that plays an important role in enhancing seed germination and improving soil fertility. This bacterium helps to increase nutrient availability in the soil, which can lead to better crop yields. The proliferation of Azotobacter in the soil is greatly influenced by the concentration of organic matter. Inadequate levels of organic matter can limit the growth and nitrogen-fixing ability of Azotobacter in the soil. Therefore, it is essential to maintain healthy levels of organic matter in the soil to support the growth and activity of this beneficial bacterium. By doing so, farmers can improve soil fertility and promote sustainable agricultural practices.

Blue Green Algae (BGA): Blue-green algae are commonly known as "rice creatures" due to their frequent occurrence in rice fields. These microorganisms are photoautotrophic and free-living. Most of the nitrogen-fixing blue-green algae are filamentous, composed of a series of vegetative cells, including specialized cells called heterocysts that function as small nodules for nitrogen fixation and synthesis. In addition, blue-green algae and the water fern Azolla have a mutually beneficial relationship and can coexist symbiotically.

Nitrogen fixing Bacteria: Nitrogen is a crucial element for promoting vegetative growth in plants. It is an essential component of many compounds, including hormones, enzymes, amino acids, proteins, and vitamins. Nitrogen-fixing organisms, whether free-living or in symbiosis with plants, provide plants with nitrogen nutrients. Free-living nitrogen fixers

include blue-green algae and bacteria like Azotobacter. Associative symbiotic relationships between grass roots and root symbionts also exist. The water fern Azolla forms a cooperative relationship with the blue-green alga Anabaena azollae, which fixes atmospheric nitrogen in the rice habitat.

Phosphorus Solubilisation: Phosphorus is an essential nutrient for root growth and development, as well as for energy storage and transfer in plants. Microorganisms that can solubilize phosphorus play a crucial role in making this nutrient available to plants. Some of the microorganisms known to solubilize phosphorus include Bacillus megaterium, B. circullans, B. subtitis, and various fungi. These microorganisms secrete different organic and inorganic acids, which act on insoluble phosphates in the soil, converting them into soluble phosphates that plants can absorb. The addition of organic manures can increase the solubilizing power of these microorganisms. However, the process of phosphorus solubilization can also lower the pH of the soil due to the production of organic acids by the microorganisms.

Potash mobilisation: Potassium is an important nutrient for plant growth and development as it helps in the production of chlorophyll and regulates various physiological processes. It also plays a vital role in reducing transpiration and increasing photosynthetic activity in plants. Microbes play a crucial role in mobilizing potassium by transforming unavailable potassium into a form that is easily accessible to plants. They aid in the conversion of ammonium ions into monoacids and proteins, which are then absorbed by plant roots from the soil. The use of microbial-based fertilizers decreases the reliance on chemical fertilizers with a potash basis. Microbes also promote water retention and enhance the flavour, colour, texture, yield, and disease resistance of crops.

Vesicular Arbuscular Mycorrhizae (VAM): Vesicular Arbuscular Mycorrhizae (VAM) are endophytic fungi that form a beneficial relationship with plant roots, enhancing the availability of phosphorus. This interaction is more active in legumes when they are inoculated. Mycorrhiza is a common feature in the majority of crops grown in temperate and tropical regions. It is a symbiotic relationship between the roots of the plant and the fungal mycelia. Although they can be found in diverse biological settings, from aquatic to desert, they cannot be grown on nutrient media.

Plant Growth Promoting Rhizobacteria (PGPR) Plant Growth Promoting Rhizobacteria (PGPR) are beneficial bacteria that can promote root and shoot growth in plants. These bacteria are found in the rhizosphere, the soil region surrounding plant roots, and belong to several genera including Arthobacter, Azotobacter, Bacillus, Xanthomonas, Streptomyces, and Pseudomonas. PGPR not only enhance plant growth but also help plants to resist various biotic and abiotic stressors, including diseases. They can promote root hair development, which in turn improves nutrient and water uptake by plants. These bacteria are thus valuable tools for sustainable agriculture, as they can reduce the need for synthetic fertilizers and pesticides.

Conclusion

Soil microbes are vital for maintaining the structure and biological balance of soil. Without them, there can be a negative impact on plants due to nitrogen loss, soil fertility, and water-holding capacity. Microbes play a crucial role in breaking down organic materials, and they can also provide defense against some soil-borne diseases and drought. In eco-friendly agriculture, microbes can enhance productivity, soil health, and plant growth. Beneficial microorganisms that are found in the root zone of plants are involved in nutrient transformation, which is essential for producing high yields. This highlights the importance of microorganisms in agriculture.

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