Review On Soil Microbial Benefits To Crops, Rhizosphere Activities And Impact On Soil Health

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Abstract: Soil microorganisms play a crucial role in maintaining soil health, plant growth, and ecosystem functioning. This review highlights the benefits of soil microbes in plant growth promotion, carbon sequestration, soil biodiversity enhancement, and disease control. Microbes also improve soil structure, increase nutrient availability, and produce metabolites that stimulate plant growth. The rhizosphere, a critical region of soil directly influenced by plant roots, is home to diverse microbial populations that enhance soil-plant nutrition and health. Inoculating crops with beneficial rhizospheric microorganisms significantly boosts plant productivity. The application of microbial fertilizers increases soil microorganism richness, maintains soil ecological balance, and improves the soil environment. Understanding the mechanisms of soil microbes is essential for promoting sustainable agricultural practices and enhancing soil health.

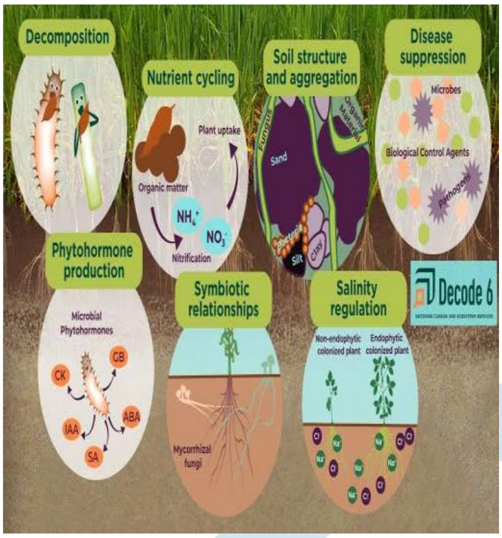
INTRODUCTION

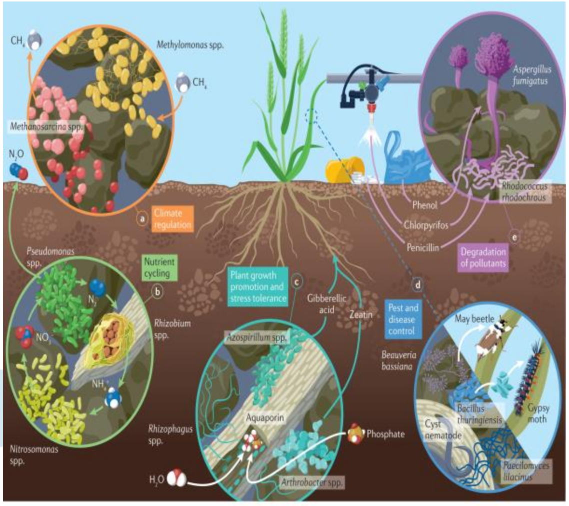
Soil microbes also known as microorganism, are tiny living organism that inhabits the soil, They are incredibly diverse and include Bacteria, Fungi, Nematodes, Arthropodes , Viruses, Archae, Actinomyces, Microalgae and Yeast. They play a vital role in boosting soil activities and plant growth, these include the following:

Plant Growth Promotion, Plant growth is improved by beneficial microbes through at least two modes of action (MOAs).Increasing nutrient availability is one; this is achieved by converting unavailable nutrients into plant-available form in exchange for energy from their hosts. Secondly they stimulate plant growth without actually increasing nutrient availability to plants. Certain beneficial bacteria and fungi stimulate plant growth through the production of metabolites or by their physical interactions with host plants. (wwwBioworks,2010). They help in carbon sequestration: Soil microbes play a critical role in the decomposition and storage of organic carbon in soil; they help in Soil biodiversity enhancement, which is essential for maintaining ecosystem services and resilience (Jayne, 2012). Beneficial microbes help to control plant diseases by the following mechanisms: Predation and Hyperparasitism that is feeding on pathogens; Antagonism, competitive exclusion and microbiostasis that is competing for nutrients or space by producing metabolites that kill pathogens or inhibit their growth and movement; Rhizospere competency, which involve blocking pathogen access to plant roots; Induced systemic resistance and systemic acquired resistance, that is stimulating or priming the plant's own natural defense system. (www.Bioworks 2010). Other roles performed by microbes include, converting atmospheric nitrogen to ammonium, making it available to plants, increasing the available plant root area for nutrient uptake; binding soil particles into aggregates, helping with soil structure and water dynamics; Association with Arbuscular Mycorrhizal Fungi (AMF) can enhance growth and protect plants from environmental stressors while they share products of photosynthesis with the resident fungi. Ellouze et al. 2014 observed that Soil health is benefited by extensive mycelia networks of AMF with the glomalin secretion leading to the improvement of structural stability and quality of soil (Jayne, 2012). Soil microbes have a significant impact on soil health, through nutrient cycling and decomposition: Microbes play a crucial role in breaking down organic matter, releasing nutrients for plants, and improving soil fertility; another impact of soil microbes on soil health is their ability to improve Soil structure, by formation of soil aggregates, enhancing soil porosity, aeration, and water-holding capacity.

Gupta *et al*., 2016, in their review of microbes as potential tools in remediation of heavy metals in soils reported that ''the use of microbes to reclaim polluted soils is one of the safer, cleaner, cost operative and environmental friendly technology for decontaminating sites which are contaminated with extensive range of pollutants", the result is the restoration of soil health for agricultural production.

The rhizosphere is a critical region of soil directly influenced by plant roots, exhibiting high microbial diversity and dynamic activity. Research has consistently shown that microbial populations are significantly higher in the rhizosphere than in bulk soil (Brimecombe *et al.*, 2001; Bahadur *et al.*, 2017; Verma *et al.*, 2017; Kumar *et al.*, 2017). The rhizosphere microorganisms play a vital role in agriculture, enhancing soil-plant nutrition and health, and improving soil quality (Lugtenberg, 2015). This complex ecosystem is a "melting pot" of components and processes that impact plant growth, development, and ecosystem functioning. The rhizosphere's unique properties make it a crucial area of study for understanding soil-plant interactions and promoting sustainable agricultural practices. Venant *et al*.,(2011) reported that the vicinity of the area around the root region of crop known as rhizosphere is inhabited by some specific microbes that were attracted by the root exudates secreted by the roots and they are referred to as plant growth promoting rhizobacteria, and that they "fulfiled important functions for plant growth and health by various manner neither from improved nutrient acquisition and/or from hormonal stimulation". Jamal *et al*., 2018 conducted an experiment to verify the impact of the bacteria strain "*amyloliquefaciens* Y1 on Soil Properties, Pepper Seedling Growth, among others the outcome of their findings indicated an increased in chlorophyll content of pepper in addition to increases in assimilation of NPK, they conclude that the "bacterial strain has a positive effects on soil properties and can be suggested as a bio-fertilizer to minimize fertilizer application in modern agriculture". Huehi and Lie(2017) study the effect of beneficial soil microorganism on the growth of kiwifruit and conclude that the microorganism contributed to the development of kiwi fruits and that it can be use in the cultivation of the fruits. Scientists have consistently found that biological nitrogen fixation is the primary source of nitrogen in agricultural soils (Alves *et al*., 2004; Govindarajan et al., 2008; Ikeda *et al*., 2013). Inoculating crops with beneficial rhizospheric microorganisms (PBRMs) like Rhizobium, Azotobacter, Azospirillum, Burkholderia, Pantoea, Bacillus, and Klebsiella significantly boosts plant productivity. For instance, inoculating Rhizobium in legumes like groundnut, pigeon pea, and soybean can provide 19-22 kg/ha of nitrogen, leading to a 17-33% increase in production. Similarly, using non-symbiotic bacteria in various crops can supply 20-30 kg N/ha and enhance yields by 10-30%. Eman *et al*., (2008) noted that some selective varieties of yeast promote plant growth by means of pathogen suppression, phytohormone production,phosphate solubilization, N and S oxidation,siderophore production, and stimulation of mycorrhizal root colonization. Elayouty *et al*., (2012) observed that Cyanobacteria, as inoculants in rice production, have enhanced soil fertility and improved soil structure, besides enhancing crop yields. Also in another report some strain of bacillus bacteria has been observed to improved soil quality and health as well as the growth and yield of crop (Ortiz and Sansinenea., 2021) Some of the bacterial strain are said to secret different types of hormones which affect crop growth (Sorokin *et al*., 2021). According to Wei *et al.*, (2024), soil microorganisms play a vital role in maintaining the structure and function of soil ecosystems. Their research demonstrated that the application of microbial fertilizers significantly increases soil microorganism richness, maintains soil ecological balance, and improves the soil environment. Additionally, they found that microbial fertilizers recruit specific fungal microorganisms, which are attracted to the secondary metabolites, proteins, and mucilage secreted by plant roots. These microorganisms bind soil particles with their extracellular polysaccharides, stabilizing soil aggregates, improving soil structure, and alleviating soil compaction.





Graphic representation of some beneficial soil Microbes,(Adapted from google image,2024)

CONCLUSION

Soil microorganisms are vital components of soil ecosystems, and their benefits to crops, rhizosphere activities, and soil health are numerous. By understanding the mechanisms of soil microbes, we can harness their potential to enhance soil fertility, plant growth, and ecosystem functioning. The use of microbial fertilizers and inoculation of beneficial microorganisms can improve soil health, reduce chemical fertilizer use, and promote sustainable agriculture. Further research is necessary to explore the vast diversity of soil microbes and their applications in agriculture, environmental sustainability, and human well-being.

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