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Indispensable role of soil flora and fauna in maintaining soil quality: A thematic review for sustainable agriculture

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Abstract
Soil is the dynamic naturally occurring, unconsolidated mineral and organic material at the earth surface that provides an environment for living organism. Soil epitomizes one of the most important reservoirs of biodiversity and monitoring its fertility is an important objective in the sustainable development of agro-ecosystems. The soil is a complex ecosystem with a highly diverse community of organism, both micro flora (fungi, bacteria, algae and Actinomycetes) and micro-fauna (protozoa, nematodes, earthworms, moles, ants) that is vital to the cycle of life on earth. Soil microorganism perform wide range of function such as they decompose organic matter, release nutrient into plant available form and degrade toxic residue, they also form symbiotic association with plant root, act as antagonists to pathogen, influence the weathering and solubilization of mineral and contribute to soil structure and aggregation. The soil microorganism also serves as biological indicator of soil. Likewise, in soil they are essential to play prospective role in maintaining soil health and to ass's soil quality. The main intendment of this review paper to study the role of different soil microorganism in maintaining Soil quality. The objective of this review paper is to outline the indispensable role of soil microorganism in maintaining soil physical, chemical and biological properties and their potential importance as soil quality indicator for maintaining fertility of soil in sustainable agriculture.

Keywords: Soil microorganism (flora and fauna), role, soil quality, sustainable agriculture

Introduction

Soil is crucial to life on earth. Non-renewable resource, composed of mineral and organic solids, gases, liquids, and living organism which serve as medium for plant growth. Among all components, Soil biota are thought to harbor a large part of the world's biodiversity and to govern processes that are regarded as globally important components in the recycling of organic matter, energy and nutrients. Moreover, they are also key players in several supporting and regulating ecosystem services. Soil microorganisms play essential roles in the nutrient cycles that are fundamental to life on the planet. Every gram of a typical healthy soil is home to several thousand different species of microorganism. A microorganism or microbe is a microscopic organism which may be a single cell or multicellular organism. Soil is a habitat for large number of organisms and organisms in soil are classified as: 1. Soil Flora-Plant kingdom 2. Soil Fauna-Animal kingdom.

Soil microorganism play essential role in maintaining soil health and its fertility in sustainable agro-ecosystem. Collectively, soil microorganisms play an important role in decomposing organic matter, cycling nutrients and fertilizing the soil. Soil microbes are also important for the development of healthy soil structure. Soil microbes produce lots of gummy substances (polysaccharides and mucilage, for example) that help to cement soil aggregates. The majority of vascular plant associated with arbuscular mycorrhizal or ectomycorhizal fungi and benefit to increase capacity to extract phosphorous and other nutrient from soil. Soil microorganisms are both components and producers of soil organic carbon, a substance that locks carbon into the soil for long periods. Abundant soil organic carbon improves soil fertility and water-retaining capacity. Changes in microbial populations or activity can precede detectable changes in the soil's physical and chemical properties, thereby providing an early sign of soil improvement or an early warning of soil degradation (Pankhurst *et al*. 1995) [6]. A diverse group of soil micro flora was reported to be involved in solubilizing insoluble phosphorous complexes enabling plants to easily absorb phosphorous (Tripura *et al*. 2005) [7].

Microbes play a vital role as organic fertilizers in facilitating uptake of nutrients in a crop. Thus microorganism play key role in maintaining soil fertility and soil health. It is essential to study of different soil microorganism and there potential role in maintaining soil quality. Thus microbes in the soil is very important as it may give indications of the potential of the soil to support biochemical processes, which are essential for maintaining soil fertility as well as soil health. The purpose of this review paper is to explore the potential of soil microorganism in maintaining soil quality in sustainable agriculture.

Role of Soil Microorganism in Sustainable Agriculture

(a) Role of microbes in decomposition of organic matter

Microorganisms play an important role in the decomposition of organic matter. Different types of microbes are specialized to different types of organic matter, between them covering just about everything.

(b) Soil microbes recycle nutrients

Soil microbes play a crucial role in returning nutrients to their mineral forms, which plants can take up again. This process is known as mineralization.

(c) Role in humus formation

When the soil microbes have broken down all they can, what's left is called humus, a dark brown jelly-like substance that can remain unchanged in the soil for potentially millennia. Humus helps the soil retain moisture, and encourages the formation of soil structure. Humus molecules are covered in negatively charged sites that bind to positively charged ions (cations) of plant nutrients, thus forming an important component of a soil's cation exchange capacity. Humus is also suspected of suppressing plant diseases.

(d) Maintenance of soil structure

Some soil microbes secrete polysaccharides, gums and glycoproteins, which glue soil minerals together, forming the basis for soil structure. Fungal hyphae and plant roots further bind soil aggregates together. Soil structure is essential to good plant growth.

(e) Role in biological nitrogen fixation

Agriculture depends heavily on the ability of certain microbes (mainly bacteria) to convert atmospheric nitrogen (N_2 gas) to ammonia (NH_3). Some live freely in the soil, while others live in association with plant roots – the classic example is *Rhizobium* bacteria in the roots of legumes. The process of conversion is known as nitrogen fixation. Biological nitrogen fixation contributes about 60% of the nitrogen fixed on Earth. In contrast, manufactured fertilizers contribute 25%. As the cost of energy continues to rise, so too the cost of manufactured nitrogen fertilizers will rise, so biological nitrogen fixation is likely to have ever increasing importance in food production.

(f) Promote plant growth

Some soil microbes produce a variety of substances that promote plant growth, including auxins, gibberellins and antibiotics.

(g) Control pests and diseases

The best known example of the use of soil microbes in pest control is the commercial production of the soil bacterium *Bacillus thuringiensis* (*Bt*) to control caterpillar pests of crops. Some strains of *Bt* are used to control beetles and flies as well. Several strains of the fungal genus *Trichoderma*have been developed as biocontrol agents against fungal diseases of plants, mainly root diseases. Various other genera of fungi are used for the control of insect pests.

Conclusion

Intensive agriculture practices and continued use of land resources lead to low productivity of crop, decrease soil fertility, poor water holding capacity by forest cleaning, are not sustainable. Soil habitat comprising micro and macroscopic world generally not visible by unaided human eye are the integral and indispensable part of below ground as well as above ground ecosystem. Animal, particularly earthworms, ants, and termites mechanically incorporated residue into soil and leave open channels thought which water and air can flow. Various microbes carry out the transformation in soil that insures the availability of different nutrient element in requisite form for growth and development of plant. Therefore, understanding the Therefore, understanding of composition and functioning of soil microbial communities has a large potential of enhancing plant growth and restoration of soil quality in sustainable agriculture.

Future prospect

Soil is a key natural resource interacting with aboveground plant and animal communities and contributing to the success of sustainable agriculture (Pimentel *et al*. 1992; Smith, 1974) [2, 3]. Soil health is defined as the continued capacity of soil to function as a vital living system, by recognizing that it contains biological elements that are key to ecosystem function within land use boundaries (Karlen *et al.* 2001) [8]. Soil is a resource critical to the maintenance of any ecosystem that we need to manage effectively. Thus, soil quality is an issue that needs to be including in sustainability. Soil is a complex, interrelated community of soil organisms, which influence, yet are in part determined by the chemical and physical parameters of the soil. The science of soil microbiology is often inexact, with many of our assumptions gleaned from the information derived from aboveground ecology of plants and animal.

The major emphasis in soil quality investigations, until recently, has been on the use of chemical and physical attributes of soil to define soil quality (Arshad and Coen, 1992) [1], since the biological portion is so much more difficult to quantify. However, these two soil features are only part of what may impart to a soil its essence or characteristics. Investigations into microbial parameters involved in soil quality are increasing (Hatfield and Stewart, 1994) [4]; Turco *et al.* 1994) [5]. By considering all this situation, the study on role of different microorganism in maintaining soil health and quality for getting maximum crop productivity show brilliant prospect for successive studies for sustainability of soils and agriculture ultimately.

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