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RESPONSE OF SOIL MICROORGANISM ON SOIL HEALTH, ORGANIC MATTER DECOMPOSITION AND NUTRIENT MINERALIZATION

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Abstract: *Soil microorganisms which are so small that these can be seen only after magnification using a microscope. Soil microorganisms are two type (1) Micro flora e.g. bacteria, actinomycetes, fungi and algae etc. (2) Micro fauna e.g. protozoa, nematodes, rotifers, mites, acari and collembolan etc. These organisms thrive in soils, which serves as a source of energy for them. Soil organisms being largely saprophytic in nature derive carbon and energy from the organic matter and multiply. Upon death and decomposition, they release plant nutrient elements hooked with organic matter. Soil organic matter is central to soil quality assessments as it influences several soil properties for e.g. biological activity, aggregate stability, bulk density and cation exchange capacity etc. Physical and chemical properties of soil are shaped by its biological activity. A large, diverse and active population of soil organisms may be the most important indicator of a healthy soil.*

Introduction: Microorganisms possess the ability to give an integrated measure of soil health, an aspect that cannot be obtained with physical/chemical measures and/or analyses of diversity of higher organisms. Microorganisms respond quickly to changes, hence they rapidly adapt to environmental conditions. The microorganisms that are best adapted will be the ones that flourish. This adaptation potentially allows microbial analyses to be discriminating in soil health assessment, and changes in microbial populations and activities may therefore function as an excellent indicator of change in soil health [1,2]. Microorganisms also respond quickly to environmental stress compared to higher organisms, as they have intimate relations with their surroundings due to their high surface to volume ratio. In some instances, changes in microbial populations or activity can precede detectable changes in soil physical and chemical properties, thereby providing an early sign of soil improvement or an early warning of soil degradation [2]. An example is the turnover rate of the microbial biomass. This is much faster, e.g. 1-5 years, than the turnover of total soil organic matter [3]. Observations in the Dutch Soil Monitoring Programme have shown that most microbial indicators indeed have discriminating power relative to different soil treatments [4]. This has also been shown for microbial biomass and basal respiration at a regional scale in the USA [5]. Soil is dominated by a solid phase (mineral matter and organic matter) consisting of particles of different size surrounded by water and gases, the amount and composition of which fluctuate markedly in time and space. Water is normally discontinuous, except when the soil is water saturated. The pore space without water is filled with air and other gases and volatiles [6]. There is continual interchange of molecules and ions between solid, liquid and gaseous phases which are mediated by physical, chemical and biological processes. These processes represent a unique balance between physical, chemical and biological components [7]. Maintaining this balance is of great importance to soil health. Soil carbon improves the physical properties of soil. It increases the cation exchange capacity (CEC) and water-holding capacity of sandy soil and it contributes to the structural stability of clay soils by helping to bind particles into aggregates. Soil organic matter, of which carbon is a major part, holds a great proportion of nutrients, cations and trace elements that are of importance to plant growth. It prevents nutrient leaching and is integral to the organic acids that make minerals available to plants. It also buffers soil from strong changes in pH. It is widely accepted that the carbon content of soil is a major factor in its overall health.

Soil Microorganisms: Soils are alive because a variety of soil organisms live in it. These include bacteria, fungi, microarthropods, nematodes, earthworms and insects. These organisms live on soil organic matter or other soil organisms and perform a number of vital processes in soil. Other organisms are involved in transformation of inorganic molecules. Very few soil organisms are pests.

The role of soil organisms in soil fertility may involve the following:

- Helping soil to form from original parent rock material,
- Contributing to the aggregation of soil particles,
- Enhancing cycling of nutrients,
- Transforming nutrients from one form to another,
- Assisting plants to obtain nutrients from soil,
- Degrading toxic substances in soil,
- Causing disease in plants,
- Minimizing disease in plants,
- Assisting or hindering water penetration into soil.

Microorganisms are small organism that can not be seen with naked eye. It is seen with help of microscope. These microorganisms are microscope dimensions.

(Microorganisms or microbes, mikros = small. Organism or bios = living or life)

Classification of Microorganisms

Soil Microorganisms

Micro flora
e.g. Bacteria, Actinomycetes, Fungi and Algae etc.

Micro fauna
e.g. Protozoe, Nematodes, Rotifers, Mites, Acari and Collembola etc.

Role of Microorganism

Bacteria

1. Bacteria participate in organic matter transformation.
2. Bacteria carry out enzymatic transformation.
3. They oxidises or reductes sustain chemical reaction in soil e.g.-Nitrification, Dentrification, sulphur oxidation and Nitrogen fixation.

Fungi

1. One of the primary function of filamentous fungi in soil degrade organic matter and health in soil degradation.
2. Some of the fungi, capable of forming ectotrophic associations on the root system of forest trees such as pine belonging to the genera bolter and lacterious, help in mobilization of soil phosphorus and nitrogen in soil.
3. The saprophytic fungi are active decomposers of plant residues and can be decompose all component at plant material.
4. The fungus basidiomycetes attack on lignin, cellulose and other related compounds.

Actinomcetes: Recently actinomycetes have attractive and world wide attention after it was discover. They produce a number of beneficial antibiotic. About 500 antibiotics. have been so for isolated of which a most important are straptomycen, teramycen and auromycene. Neomucin and Actinomucetes helps in decomposition of soil organic matter and liveration of its nutrient. Resistant compounds such as cellulose, chitin and phospholipid are reduced into their simpler form. Actinomycetes can decompose different green manure, hedge, sludge, silage, compost and animal manure at high temperature.

Algae: Algae are generally aquatic, both unicelluler and multicelluler type. The cells of algae filamentous 4-10 μm, Algae are photoautotrophs. i.e. they are able to photosynthesis and therefore tend to be concentrated near the soil surface. Soil surface may become green.

Virus: Soil viruses are ultra microscope always required a living host of their multiplication. The virses soil are known as paracityze bacteria and specifically known as bacteriophase. They destroy a bacterium of agricultural importance like rhizobium. They attain economic importance clay, organic matter in soil adsorb bacteriophase and they cause their relaintion and sprayed.

Protozoe: Protozoe are unicellular, aquatic, contain nucleous and other membrane bound organales. Protoze are mobile and more in soil pores where rich sufficient thickness of water.

Nematode: Next to protozoe nematodes are abundent soil microfauna in soil. They are also called eclwarm, threadwarm or roundworm. Most nematode feed on bacteria and fungi. Some nematodes which can infest on plant root are called hetrodera.

Soil health: Soil health have been proposed during the last decades. Historically, the term *soil quality* described the status of soil as related to agricultural productivity or fertility [8]. In the 1990s, it was proposed that soil quality was not limited to soil productivity but instead expanded to encompass interactions with the surrounding environment, including the implications for human and animal health. In this regard, several examples of definitions of soil quality have been suggested [7]. In the mid-1990s, the term *soil health* was introduced. For example, a programme to assess and monitor soil health in Canada used the terms *quality* and *health* synonymously to describe the ability of soil to support crop growth without becoming degraded or otherwise harming the environment [9]. Others broadened the definition of soil health to capture the ecological attributes of soil, and went beyond its capacity to simply produce particular crops. These attributes are chiefly associated with biodiversity, food web structure, and functional measures [10, 7] proposed the following definition of soil health: "The continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments, and maintain."

Aspects of soil health: The term soil health is used to assess the ability of a soil to:

- Sustain plant and animal productivity and diversity;
- Maintain or enhance water and air quality;
- Support human health and habitation

The underlying principle in the use of the term "soil health" is that soil is not just a growing medium, rather it is a living, dynamic and ever-so-subtly changing environment. We can use the human health analogy and categories a healthy soil as one:

- In a state of composite well-being in terms of biological, chemical and physical properties;
- Not diseased or infirmed (ie. not degraded, nor degrading), nor causing negative off-site impacts;
- With each of its qualities cooperatively functioning such that the soil reaches its full potential and resists degradation;
- Providing a full range of functions (especially nutrient, carbon and water cycling) and in such a way that it maintains this capacity into the future.

Conceptualisation of soil health: Soil health is the condition of the soil in a defined space and at a defined scale relative to a described benchmark. The definition of soil health may vary between users of the term as alternative users may place differing priorities upon the multiple functions of a soil. Therefore, the term soil health can only be understood within the context of the user of the term, and their aspirations of a soil, as well as by the boundary definition of the soil at issue.

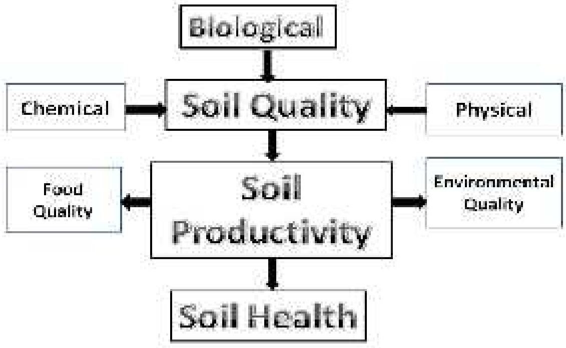

Fig. Component of soil quality

Microorganisms as Indicators of Soil Health: The bioavailability of chemicals, e.g. heavy metals or pesticides, is also an important issue of soil health because of its connection with microbial activities. The impact of such chemicals on soil health is dependent on microbial activities. For example, the concentration of heavy metals in soil will not change over small time periods, but their bioavailability may. It has thus been shown that the bioavailability of poly-aromatic hydrocarbons was lower in autumn compared to early spring due to a higher microbial activity after the growing season. Therefore, the total content of chemicals in soil is not a reliable indicator of its bioavailability [11] and thereby soil health. Instead, bioavailability has to be measured in relation to bioassays and specific microbial processes. In context of this, microbial responses also integrate the effect of chemical mixtures, an information not obtained by studying the chemical mixtures themselves.

Microorganisms have Key Functions in Soil: The biological activity in soil is largely concentrated in the topsoil, the depth of which may vary from a few to 30 cm. In topsoil, the biological components occupy a tiny fraction (<0.5%) of the total soil volume and make up less than 10% of the total organic matter in soil. These biological components consist mainly of soil organisms, especially microorganisms. Despite their small volume in soil, microorganisms are key players in the cycling of nitrogen, sulphur, and phosphorus, and the decomposition of organic residues. Thereby they affect nutrient and carbon cycling on a global scale [10]. That is, the energy input into the soil ecosystems is derived from the microbial decomposition of dead plant and animal organic matter. The organic residues are in this way, converted to biomass or mineralised to CO_2, H_2O, mineral nitrogen, phosphorus, and other nutrients. Mineral nutrients immobilised in microbial biomass are subsequently released when microbes are grazed by microbivores such as protozoa and nematodes [12]. Microorganisms are further associated with the transformation and degradation of waste materials and synthetic organic compounds [13].

In addition to the effect on nutrient cycling, microorganisms also affect the physical properties of soil. Production of extra-cellular polysaccharides and other cellular debris by microorganisms help in maintaining soil structure, as these materials function as cementing agents that stabilise soil aggregates. Thereby, they also affect water holding capacity, infiltration rate, crusting, erodibility and susceptibility to compaction [14].

Organic Matter Decomposition: Residues play a significant biological and physical role in soils and represent a principal means by which soil organic matter (SOM) can be managed. Studies of the factors controlling microbial decay of litter provide the basis for the understanding of how residue quality influences SOM dynamics. Litter quality is equated with the rate at, or ease with, which organic substrates are, decomposed [15]. Litters are mostly abundant in unmanaged or minimally managed systems, such as in forest soils. The physical activity of litter- and plant derived carbohydrates is important. Surface litter also provides protection against erosion. Disturbance in microbial activity will result in a change of the organic matter (OM) decomposition rate and hence the availability. Metabolic quotient and cycling of the most important organic bound nutrients within the ecosystem, such as carbon, nitrogen, sulphur and phosphorus. Knowledge about rates of OM decomposition is thus a prerequisite for understanding the availability and recycling of all these nutrients. Field incubation of different types of plant litter or more standardised pieces such as cotton strips and wood sticks are the most commonly used methods for studying OM decomposition rates. Decomposition of plant litter can be measured by placing the litter in so-called litterbags in the field. Litterbags are made of inert nylon with a defined mesh size allowing a free exchange of air, water and nutrients and access for organisms. The mesh size defines the groups of organisms that can contribute to the decomposition within the litterbag. The decomposition rate of the litter is determined as weight loss per time interval [16]. The advantage of using plant litter for studying decomposition rates is the natural origin of the litter, which provides a direct correlation to naturally occurring processes within the soil ecosystem. The disadvantage of the method is the difficulties in obtaining uniform litter from year to year. Changes in cellulolytic and ligninolytic enzyme activities in litterbags have recently been shown to explain changes in litter decomposition upon nitrogen deposition [17].

Conclusion: Soil microorganisms are key players in the cycling of plant nutrient in form of macro nutrient like nitrogen, phosphorus, potassium and sulphur and also micro nutrient. The most important role of soil microorganisms are decomposition of organic residues as a result overall improve soil health. In addition to the effect on nutrient cycling, microorganisms also affect the physical properties of soil. Production of extra-cellular polysaccharides and other cellular debris by microorganisms help in maintaining soil structure, as these materials function as cementing agents that stabilise soil aggregates. Thereby, they also affect water holding capacity, infiltration rate, crusting, erodibility and susceptibility to compaction.

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