Soil Microbial diversity and soil health in NE India :

Abstract

Soil health is the capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health. Soil microbial community act as primary driving agents of nutrient cycling, regulating the dynamics of soil organic matter, soil carbon sequestration and green house gas emissions; modifying soil structure and water regimes; enhancing the amount of nutrient acquisition by vegetation; conferring stress tolerance, resisting pathogens and improving plant and soil health. With the advent of a molecular techniques, the incredible diversity of soil microorganisms is finally being unraveled. This review is an attempt at bringing in such studies conducted in North East India and its seeking an analysis of its impact on the soil health of the region .

Introduction

Soil microorganisms represent a crucial element in the reaction of changing climates on agriculture through their various nutrient cycles and the sequestration of soil carbon. Microorganisms in soil are important because they affect soil structure and fertility and can be classified as bacteria, actinomycetes, fungi, algae and protozoa. Soil is a dynamic, biological system that is an essential part of the terrestrial ecosystem. The functions of soil biota are central to decomposition processes and nutrient cycling. Soil microorganisms play an important role in soil processes that determine plant productivity. Soil microbial biomass comprises about 2–3% of total organic carbon in the soil and has been recognized as an important source of nutrients to plants because of its fast turnover (Jenkinson and Ladd, 1981). Soil fungi make a very important part of the ecosystem along with other microbes in turnover of the biomass (James & Hyde1998). There is an urgent need to conserve biodiversity at global level to preserve the endemic and endangered species, both microscopic and macroscopic which plays vital role for the maintenance of sustainable environment, agriculture and forestry (Jha et al. 2002). Soil microorganisms are the major organisms responsible for controlling the amount of nutrient cycling and for controlling the amount of nutrient available to plants (Hernot & Robertson 1994; Singh & Rai 2004; Jain et al. 2005). The soil microbes decompose the plant and animal residues entering the soil and convert them into soil organic matter, which influences on soil physical, chemical and biological properties and on creating a complimentary medium for biological reactions and life support in the soil .

Healthy soils , on the other hand are critical to the health of ecosystems, economies, and human populations. Thus, it is widely acknowledged that soil health is important to quantify, both for assessment and as a tool to help guide management strategies.

The North-East India (21° 34′ N latitude and 97°52′ E longitude) is a genetic treasure house of plant, animal and microbial resources. This region falls in a distinctive part of the Indo-Burma mega biodiversity hotspot (Myers et al. 2000) and being considered as

prime one amongst the two identified in Indian sub-continent.

North East India has a wide variability of soil microbes have been reported and can be called the niche area for microbial growth and diversity . Extensive studies have been carried out here in North East India and from the studies , the microbial population diversity has been correlated to different physico- chemical parameters and studies have been made regarding soil health and its sustainability .

Soil Microbes and functioning of soil ecosystem

Soil organic matter (SOM) can be seen as a mixture of biogenic components that include, in variable proportions and evolutionary stages, microorganisms and non-decomposed plant materials (1–10%). SOM has a new significance for it correlates well with physical, chemical, and microbiological properties of soil and the status of healthy soil . High significance for organic matter decomposition depend on soil microbial diversity .

With hundreds of thousands of taxa per gram of soil, microbial diversity dominates soil biodiversity. While numerous studies have established that microbial communities respond rapidly to environmental changes, the relationship between microbial diversity and soil functioning remains controversial. Using well-controlled laboratory approach and empirical evidence microbial diversity and its role in soil health maintenance has been tried to be studied .

Biological indicators used for determining soil ecosystem wellbeing includes :

Microbial biomass ,Microbial activity , Bacterial DNA synthesis , Bacterial protein synthesis , CO_2 production , Carbon cycling , soil respiration ,Decomposition of organic matter ,N-mineralization Nitrification , Denitrification , N-fixation ,Plasmid-containing bacteria and Antibiotic-resistant bacteria .

There are a number of key indicators related to microbial activity and the diversity in soil , and some can be used to estimate both biomass and activity (e.g. soil respiration and the microbial quotient).

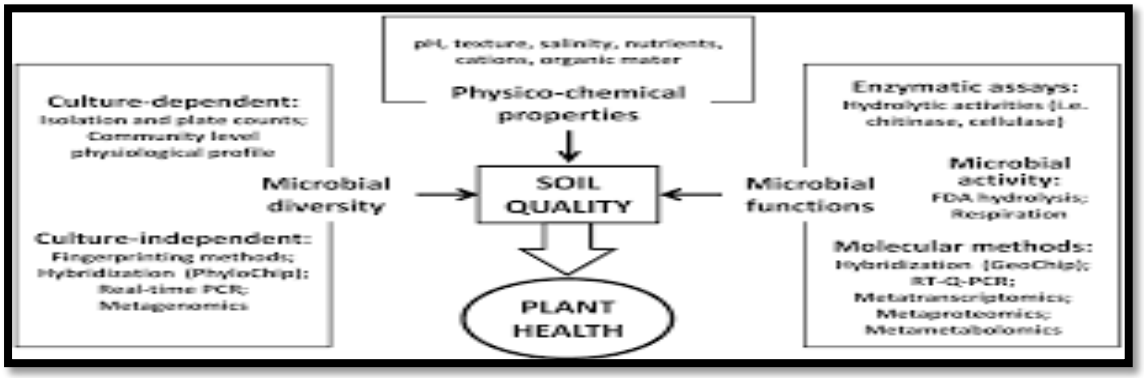

Fig : Inter-relationship between microbial diversity and soil health

Soil microbial diversity and soil health with reference to studies conducted in North East India :

The Northeastern region in India is one of the most important biodiversity hot spots of the world. The microbial resources of this area have tremendous potentiality for sustainable human development and livelihood management .

In Assam , the highest microbial counts were recorded in the top soil (0-10 cm) layer except during the summer season when the population was greater in the subsurface (10-20 cm) layer. Aspergillus and Penicillium were the abundant genera in all sites studied.Parameters viz. water holding capacity, soil moisture content, pH,organic C, total N and available P had correlated with the microbial colony forming units (cfu). (Das *et al* ,2013) .

The rate at which organic matter is decomposed by the microbes is interrelated to the chemical composition of the substrate as well as environmental conditions. Substantial works for conservation of diversity and preservation of their genetic resources have done but works on microbial dynamics is very meager in this region . Microbial Population Dynamics revealed that the bacterial and fungal counts were greater in the surface (0-10 cm) layer of the soil as compared to others. The maximum bacterial and fungal population was recorded in spring season in all the sites and minimum during winter. During rainy season, maximum microbial count was, however, recorded in the subsoil (10-20 cm) layer. Quantitatively, bacterial counts were always high as compared to fungal population in all the sites.

Devi *et al* , 2005 from mixed-oak forest ecosystem of Manipur , reported that microbial biomass C and P showed a positive significant correlation with abiotic variables, i.e.soil moisture, soil temperature, rainfall, mean air temperature and relative humidity . From the study it was concluded that , In forest stand , microbial C contributed 1.7–2.7% of the total soil organic C, the maximum being contributed during rainy season and the minimum during winter season. The percentage contribution of microbial biomass N and P to total N and total P ranged from 1.6 to 1.8 and 4.8 to 7.6, respectively. Maximum microbial biomass N and P was contributed during winter season and minimum during summer season .

Laxminarayana , 2010 working with integrated farming system in meghalaya reported Microbial biomass carbon (C) had a significant relationship with organic C, microbial biomass N, and biomass P, indicating that the living part of soil organic matter is involved in the transformation of nutrients into the labile pool and governs their availability to the plants .

Soil organic C showed a significant relationship with biomass C and biomass N, indicating that increased C substrate helped in increased microbial activity.

In Mizoram,in tropical and sub tropical forest, the population of fungi and actinomycetes was related to rainfall .(Singh *et al*,2020) Marked seasonal variations were observed in the groups of microbial population counts (Table 2). Diversity of fungi (F) was maximum in the sites . This study shows that seasonal changes in microbial populations (fungi and actinomycetes) are more strongly influenced by fluctuations in the rainfall, temperature and their associated variables. However, the above abiotic variables were able only regulate the variability in the population of actimycetes in TF. It is suggested that more frequent data on seasonal abiotic

variables (at least monthly) would required to understand the role of abiotic variables on soil microbial population .

Najar et al , 2018 reported that the most abundant bacteria as isolated and identified were Gram-positive genus Geobacillus and Anoxybacillus. The genus Geobacillus has been reported for the first time in North-Eastern states of India.

Discussion :

The population of bacteria and fungi in the are influenced by vegetation, physico-chemical properties and species composition. However, the role of macro and microclimatic seasonality and soil nutrient status cannot be completely ruled out. It is also understood that the quality of plant residues accumulating in these sampling sites are furthermore important and may play a vital role in soil nutrient management within the system through microbial decomposition .

The microbial C, N and P was significantly found to be higher during the rainy season and lower in winter season with the exception of microbial N exhibiting lowest value in summer season This may be due to higher immobilization of nutrients by the microbes from the decomposing litters as decomposition rate of litters and microbial activities are at peak during this period. The low value of microbial C, N and P in winter season may be due to low activities of microorganisms and slow rate of decomposition of litter in dry and cool period. Diaz-Ravina et al. (1995) reported that lack of water seemed to limit the microbial biomass more than temperature since lower microbial biomass content .

From a plant nutrition point of view, soil microbial biomass C, N, and P are the most important parameters in assessing the biological activity of soils. These parameters were significantly influenced by application of manures and other organic sources, and their role might have helped in nutrient transformations. Microbial biomass had positive relations with available nutrients, and it had a direct impact on nutrient transformations as well as nutrient availability. Improvement in microbial biomass will not only enhance the soil quality but also increase sustainable crop production .

Conclusion :

The importance of soil microorganisms for sustenance of all other life forms needs no emphasis. Microbes are the basis of the biosphere . 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 and thus improve soil quality and in the long run the soil health . Therefore it is high time to find ways to conserve soil microbial diversity by taking up different management practices to improve soil quality and maintain soil health .

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