Studies on Soil and Microbial Properties in Different Soil Samples of Namakkal District, Tamilnadu

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Abstract: *Physico-chemical and microbial parameters of soil samples around Namakkal district, Tamilnadu, India were examined to determine the fertility status of the soil. Five representative villages were chosen and different number of surface soil samples (0-15 cm) collected and analysed for microbial and physico-chemical properties. The extent of the diversity of microorganisms in soil is seen to be critical to the maintenance of soil health and quality, as a wide range of microorganisms is involved in important soil functions. Results of the physico-chemical analysis showed that the highest bacterial and fungal population was observed in sample-5, followed by 1, 4, 3 and 2. The maximum bacterial population was observed at sample-1 followed by 5, 4, 3 and 1. However, microbial enumeration indicated that bacteria were most numerous followed by actinomycetes and fungi in the soil samples. The range of soil pH and organic carbon percent was 7.62 to 8.43 and 0.07 to 0.3% respectively. The EC values varied from 0.13 to 0.54 dS/m. In the Namakkal garden land, the available nitrogen, phosphorus and potash content ranged between 67.17 to 184 kg/ha, 2.56 and 47.50 kg/ha and 225 to 1012 kg/ha respectively.*

Keywords: soil, Physico-chemical and microbial parameters, pH, EC, Organic carbon, available nitrogen, phosphorus and potash.

1. INTRODUCTION

In the world, microorganisms are ubiquitous and form crucial components of all known ecosystems on earth. Their ubiquity is mainly due to the small size, metabolic versatility and versatility of using wide substrates as a source of nutrients, and the ability to thrive and multiply in different environments, including anaerobic and other extreme conditions.

The soil is a dynamic ecosystem, home to a large number of species. The majority of soil biomass is produced by bacteria, fungi, protozoa and algae, thus contributing to soil structure and soil stabilisation [1] and has also been suggested as organic soil carbon indicators [2]. Bacteria and fungi are highly versatile among soil microorganisms and can carry out almost all known biological reactions and are responsible for the vast majority of decomposition, and also make up the greater part of soil biomass [3].

By developing soil fertility, biocomposting, biodegradation, development of plant growth hormones, phosphate dissolution, nitrogen fixation, inhibition of plant pathogens through antibiotic production, siderophore release, antifungal and inducer metabolite synthesis, this organism could increase soil productivity [4,5]. Biofertilizers that minimise the unnecessary use of chemical fertilisers have been used as plant growth-promoting rhizobacteria (PGPR) [4, 6].

2. MATERIALS AND METHODS

Soil sample collection: Soil samples were taken from different places viz., sample-1 (Pottireddipatti Mitta,11.1848°N, 78.2715°E), sample-2 (Vadavatrhur, 11.1012°N, 78.1240°E), sample -3 (Chandrasegarapuram Agraharam, 11.4011°N, 78.3231°E), sample-4 (Vadugam Muniappampalayam, 11.4572°N, 78.2446°E) and sample-5 (Melappatti, 11.3756°N, 78.2292°E) of Namakkal district, Tamil Nadu, India at random by soil sampling auger from 4-5 places from each plot and mixed thoroughly to prepare one composite sample.

Preparation of samples for analysis: The plant material and other residue were collected from the sample by hand, the samples were dried in the shade and then ground with a wooden mortar and pestle. Samples collected in each location were divided into two parts, one part for physico-chemical analysis while the other for microbial analysis. Each sample meant for physico-chemical analysis was air dried for five days, and then sieved to ensure homogeneity using a 2mm size sieve.

Chemical analysis of the soil samples: The soil pH and EC were determined by soil saturation extract (l : 5 of soil water ratio) [7]. Organic carbon has been estimated using the Walkley and Black method [8, 9]. The available N (Alkaline permanganate method), the available P (Olsen method) and the available K (Flame photometer method) have been estimated by standard procedures [9, 10].

Enumeration of microorganisms from the soil samples: Ninety ml of sterile distilled water mixed with 10g of soil sample which suspended in a tube is shaken thoroughly to mix and distribute soil particles evenly, and further dilution of 10^{-1} to 10^{-6} is carried out by serial dilution techniques for bacterial, fungal and actinomycetes populations [11,12]. The 10^{-6} dilutions were plated on sterile Petri plates containing nutrient agar medium for the growth of bacterial colonies at 37°C for two days, 10^{-4} dilutions were plated on sterile Petri plates containing Sabouraud's Dextrose Agar for the growth of fungal colonies at 28 ± 1°C for 3-5 days and 10^{-5} dilutions were plated on sterile Petri plates containing Kenknight's agar medium (KKA) for the growth of actinomycetes colonies at 30±2°C for 7 to 11 days. The number of bacteria, fungi and actinomycetes colonies in each plate was counted.

3. RESULTS AND DISCUSSION

Marshal [13]observed that in general, site high in carbonaceous materials and humus has larger numbers of microorganisms than habitat poor in organic

matter. Bacteria's ability to survive in favourable ecosystem is due to their character to form spores which have thick strong sheathes to make it easier for them to survive in a savage environment. Bacteria can also stand extreme climate condition although temperature, humidity, pH, agriculture practice, fertilizers, pesticide and the addition of organic matter can influence their population [14]. Total bacterial population was high at soil sample whereas the fungus is one of the most important microbes in the soil ecosystem dynamics, because they function in the decomposition, mineralization and organize the migration of soil elements to plant root [15]. In the present studies, the number of fungi in the soil is fewer than those of bacteria. The highest bacterial and fungal population was observed in sample-5, followed by 1,4,3 and 2. Thus, although a fungi colony is microbes which is more resistant to soil acidity, their live hood still depends on the availability of organic materials and is much influenced by climate, especially soil moisture content [14]. Many of actinomycetes show a branched filamentous growth and generally form spores and some form sporangia and zoospores. It plays an important ecological role in recycling substances in the natural world [16]. Considering actinomycetes in the soil were quite plentiful and surprising that genus variety because of the presence of acid pH and low soil nutrient. The deeper the soil, the higher was the percentage of actinomycetes in the total microbial population [14]. The increase of the discomposed organic matter would also increase the number of actinomycetes. In the present studies, the maximum population was observed at sample-1 followed by 5, 4, 3 and 1 (Figure-1).

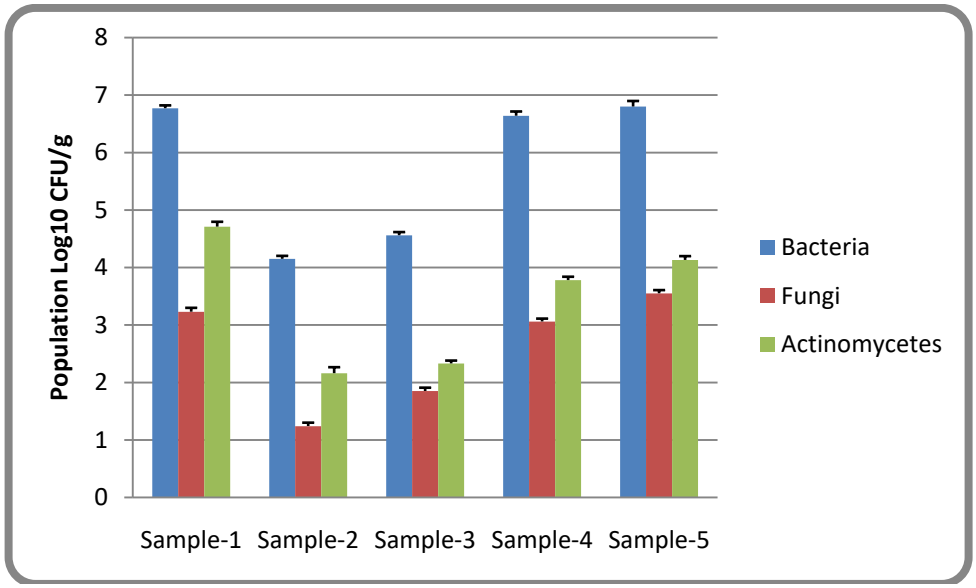

Figure-1 Microbial properties in different soil samples of Namakkal district

Physical chemical properties of soil samples was studied, the pH of soil is one of the most important physicochemical parameter. It affects mineral nutrient soil quality and much microorganism activity. The pH range of 6.8 to 8.0 has been recommended optimum for plants growth. The pH of soil samples shows variation

7.67 to 8.43, the above 7.5 value of pH shows basic nature. pH is an important parameter as it measures availability of nutrients like Fe, Mn, Zn and Cu which are more available in acidic soil than alkaline soil. Soil with pH 6.8 to 7.5 is considered to have most of the nutrients available for plants [17]. Soil pH is described as the "master soil variable" that influences myriads of soil biological, chemical, and physical properties and processes that affect plant growth and biomass yield [18, 19]. The highest pH value of 8.43 was recorded from sample - 2 followed by sample-2 (8.07). The percentage of organic carbon ranged from 0.07 to 0.3% in the study area, indicating low organic matter content in the soil.

Electrical conductivity, as the measure of current carrying capacity, gives a clear idea of the soluble salts present in the soil. It plays a major role in the salinity of soils. Lesser the EC value, low will be the salinity value of soil and vice versa. Even though, soil conductivity is influenced by many factors, high conductivities are usually associated with clay-rich soil and low conductivities are associated with sandy and gravelly soils. This is a result of the shape and physical properties of the particles which make up the soil [20]. In the garden land soil, the EC values varied from 0.13 to 0.54 dS/m, with a highest EC value of 0.54 dS/m in sample -4 and the lowest value of 0.13 dS/m in sample-3.

Table-1 Physico-chemical properties of soil samples in Namakkal district

S. No	Parameter	Mean ± SEM				
		Sample-1	Sample-2	Sample-3	Sample-4	Sample-5
1	pH	$7.70^{a,b}$±0.0882	8.40^{d}±0.0882	8.10^{c}±0.1453	$7.96^{b,c}$±0.0291	7.62^{a}±0.1222
2	EC (dS/m)	0.21^{a}±0.0208	0.22^{a}±0.0328	0.12^{a}±0.0120	0.54^{c}±0.0410	0.31^{b}±0.0208
3	Organic Carbon (%)	0.30^{c}±0.0145	0.07^{a}±0.0058	0.11^{a}±0.0153	0.25^{b}±0.0265	0.07^{a}±0.0116
4	Available Nitrogen (Kg/ha)	192.00^{d}±3.0551	67.17^{a}±1.4814	139.00^{b}±2.4037	168.00^{c}±1.4530	70.33^{a}±1.4530
5	Available Phosphorus (Kg/ha)	35.00^{b} ±0.2082	4.10^{a} ±1.7321	2.53^{a}±0.2028	47.50^{c}±1.4434	2.60^{a}±0.2082
6	Available Potassium (Kg/ha)	331.00^{b}±2.0817	563.00^{c}±2.5166	225.00^{a}±2.8868	1006.00^{e}±4.1633	700.67^{d}±2.9059

SEM – Standard Error Mean; Means followed by a common letter(s) in the same row are not significantly different at the 5% level by Duncan's Multiple Range Test (DMRT)

Soil organic carbon (SOC) affects the chemical and physical properties of the soil, such as water infiltration ability, moisture holding capacity, nutrient availability, and the biological activity of microorganisms [21]. Soil organic C and N is considered to be one of the major attributes of soil fertility and agricultural sustainability [22]. The percentage of organic carbon ranged from 0.07 to 0.3%.in the study area,

indicating variable organic matter content and decomposition rates. All soil samples appear to possess low percent organic carbon content and it is necessary to apply organic wastes as an important source of nutrient to these agricultural fields.

Plants take up nitrogen generally as nitrates under aerobic conditions and as ammonium ions during anaerobic conditions. Nitrogen is most often the limiting nutrient for the plant growth [20]. The nitrogen content is very low (< 184 Kg/ha) in all the soil samples in the study area. All the soil samples were having low available nitrogen content, ranging from 67.17 to 184 kg/ha and it is essential to apply organic wastes as an important source of nutrient to the agricultural fields.

Phosphorus is the second most important macronutrient available in the biological systems, which constitutes more than 1% of the dry organic weight. It is also a second most limiting factor often affecting plant growth, which exists in the soil in both organic and inorganic forms [20]. In the Namakkal garden land, the available phosphorus content ranged between 2.56 and 47.50 kg/ha (Fig. 3B) and sample -1 and 4 showed abundant quantity of available phosphorus while remaining soil sample exhibited less available phosphorus in the soil. Soils from Agricultural fields with low phosphorus content in the study area can be supplemented by applying phosphorous rich fertilizers as required by a specific crop.

The available Potash (K) values varied from 225 to 1012 kg/ha in the Namakkal garden land soil which had adequate supply of potassium. Soils from agricultural fields with high potash content in the study area can be solubilised by applying potash solubilising bacteria as required by a specific crop.

Soil microorganisms have played important roles in the cycling and storage of carbon and nutrients for plants use [23] and there study noted that soil organic matter decomposition involves principally different mechanisms, multiplication and growth of responsive microorganisms, induction and repression of degrading enzymes.

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