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Physico-chemical and microbiological properties of forest litter soil

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ABSTRACT

The present study was carried out in search of correlation between the physico-chemical and biological properties of forest and normal soil. Variation in physicochemical and biological properties were noticed in forest soil accumulated with litter than normal soil (control soil) includes soil pH (4.6 – 5.7) WHC (0.63 – 0.36ml/gram of soil), EC (0.18 – 0.072 Mhos/cm,) Phosphorus (3 – 7kg/h), Potassium (93 – 103) Kg/h in litter and normal soils respectively. The biological properties such as bacterial and fungal population was enumerated and expressed in terms of CFU/g of soil. Nearly threefold higher bacterial and fungal population was observed in litter soil than control.

KEYWORDS

Forest litter soil;
Physico-chemical;
Microbiological properties.

INTRODUCTION

Forests represent approximately 27 percentage of worlds land area and wood is the main commercial product from the forest[1]. The forest trees / litter help improving soil fertility through biological nitrogen fixation, phosphorus solubilization and decomposition of organic matter in their rhizosphere and non rhizosphere zone. These processes play an important role in plant nutrition and maintaining soil fertility[2]. The forest ecosystem contributes a lot of organic matter to the soil in the form of leaves, twigs, branches, reproductive parts, fruits etc., which after decomposition results in the formation of organic matter and release of nutrients. Plant residues added to the soil are transformed into Co_2, microbial material and relatively stable humus components[3]. Decomposition of leaf litter includes leaching, breakup by soil fauna, and transformation of organic matter by microorganisms and transfer of organic and mineral compounds. Microorganisms in soil influence on cycling of inorganic and organic materials through the ecological niches of decomposers and affect on plant growth and soil fertility[4]. Decomposition of plant residues is influenced by substrate quality, decomposer community and environmental factors[5-7]. Plant vegetation plays an important role in soil formation[8]. The fertility of soil improves under the tree cover which checks soil erosion, adds soil organic matter, available nutrients and replenishes the nutrients through effective recycling mechanisms[9]. Plant tissues are the main sources of organic matter which influences physicochemical characteristics of soil such as pH, WHC, texture and nutrient availability[10]. Physico- chemical characteristics of forest soils vary in space and time due to variations in topography, climate, physical weathering, processes, vegetation cover, microbial activities and sev-

eral other biotic and abiotic variables[11]. The main aim of the present study is to determine influence of forest litter on soil physico-chemical and microbiological properties.

MATERIALS AND METHODS

Collection of soil samples

The Soil sample composited with forest litter/tree wastes was collected from Nallamala Forest area of Kurnool Dt A.P. India. The soil sample collected from adjacent site served as control. It was air dried and mixed thoroughly to increase homogeneity and shifted to < 2mm. sieves for determination of soil texture.

Analytical methods for physico-chemical characterization of soil samples

The texture of soil samples such as sand, silt, clay contents were analyzed with the use of different sizes of sieves by following method[12]. Cent percent water holding capacity of soil samples were measured by the method[13]. Soil pH was measured in ELICO digital pH meter with Calomel glass electrode assembly. Electrical conductivity of soil samples were determined by the conductivity bridge quantified by the method[14]. Soluble phosphorus and potassium contents were determined by the Standard method[15].

Enumeration of micro flora in forest and normal soils

Enumeration of bacteria

The bacterial populations present in the collected soils were enumerated by serial dilution method. For this method one gram of soil was transferred to 10ml of distilled water in test tubes and dilutions were made up to 10^{-9}. 0.1ml of soil suspension was spread on to the sterilized medium by using spread plate method. The bacterial population was grown on nutrient agar medium with following composition. (g/1). Peptone – 5.0, NaCl – 5.0, Yeast extract – 30, Agar – 20. The pH of the medium was adjusted to 7.0 and autoclaved. After sterilization of medium, 20ml of sterile medium was transferred to sterile Petri plates and allowed for solidification. After solidification of the medium 0.1 ml of soil suspension was spreaded with the help of spreader and incubated at 37^0C. After the incubation of petriplates the bacterial colonies formed on the medium was counted by Quebec colony counter.

Enumeration of fungi

The fungal populations present in the soil were enumerated by serial dilution technique. For this method one gram of soil was transferred to 10ml of distilled water in test tubes. Dilutions were made up to 10^{-6} and 0.1ml of soil suspension was spreaded on to the sterilized medium by using spread plate method. The fungal population was cultivated on Czapek-Dox agar medium with following composition (g/l); sucrose – 30, $NaNo_3$ – 2, K_2HPO_4 - 1, Mg SO_4 – 0.05, KCl – 0.5, $FeSO_4$ – 0.01, Agar - 20. P^H of the medium was adjusted to 5.6. After preparation of medium 20ml of sterile medium was transferred to sterile petri plate and allowed for solidification. After solidification of the medium 0.1 ml of soil suspension was spreaded by the help of spreader and incubated at 37°C for 7days. After the incubation of petri plates the fungal colonies formed on the medium was counted by Quebec colony counter.

RESULTS AND DISCUSSIONS

Physico-chemical properties of forest litter and normal soils

Soil fertility mediated by microorganisms is dependent on maintenance of physico-chemical properties in soil. Therefore the soil samples were analyzed for physico-chemical characteristics and results were represented in TABLE 1. Analysis of soil samples revealed that forest litter soil (test) underwent changes in all the measured parameters in comparison to control. Soil composed with forest litter exhibited texture different from that of corresponding control. Soil texture in terms of percentage of sand, silt and clay were 80.2, 12.6 and 7.2 in the test; 86. 9.3 and 4.3 in control soil was observed and shown (TABLE 1). The above results indicated that test sample had lower sand and higher silt and clay content in comparison to the control. The results of the present study seems to be in agreement with an earlier study, Shishir and Jaysah[11]. as per his reports the forest soils of Shorea robusta and mixed Shorea robusta exhibited sandy loam texture. The pine and oak oriented forest soils were found tobe loamy sand in texture[16]. Soil pH is one of the most indicative

measurements of soil because it is an important factor for the survival of microorganisms[17]. The effect of soil pH is profound on solubility of minerals and nutrients. Most minerals and nutrients are more soluble in acidic soils than in neutral or slightly alkaline soils[18]. In the present study, the pH of litter sample was decreased to 4.6from 5.7. This change in pH may be due to the deposition of plant residues in the soil. Similar reports were made by Oseni *et al.*,[19] that pH of the natural forest soil was acidic, as acidity was observed to increase with increase in soil depth. The pH of soil ranged about 4.03 to 4.24 in Pinus densiflora forest soils and 4.38 to 4.65 in Quercus mongolica forest soils[20]. Similarly, Zende *et al.*,[21] reported that discharge of cane sugar residues from sugarcane industry reduced the soil pH. For instance an acidic pH of 5.25and 5.35 was recorded in oak and pine oriented forests[16]. Water holding capacity (WHC) and electrical conductivity (EC) of 0.63 ml/g and 0.33 μ Mhos/Cm was recorded in test soil where as 0.18 ml/g and 0.072 μMhos/Cm was recorded in control. Similar reports were made Narasimha *et al*,[22] and Nagaraju *et* al,[23].Discharge of effluents from cotton ginning mill dairy mills improved the soil water holding capacity and electrical conductivity. The Water holding capacity of the soil under different tree cover was significantly superior to open field[24]. This improvement in EC and WHC in the test soil may be due to the long term deposition of organic manure in the form of plant residues. Phosphorous and potassium content in the test soil is 7 kg/h and 109 kg/h as against control 3 kg/h and 93 kg/h respectively (TAVLE-1). Similarly higher levels of total organic carbon, total nitrogen and soluble phosphorous were found in organic soils[25-27].. The leaf litter of Alder and Khasimandarin with high concentration of N, P and K enhanced fertility by adding high quality of litter to the soil system[9]. High content of available phosphorous (11.2 mg/kg) was observed in pine oriented than oak oriented forest areas (6.3 mg/kg),. Concentrations of C, N and potassium increased significantly with increasing application rates of organic amendments[28]. Amendment of sewage sludge to the soil improved total N and P contents[29].

Microbiological properties

Microorganisms are widely distributed in different types of environments like soil, water and air. In soil these organisms play an important role in maintaining soil fertility by recycling of nutrients through their biochemical processes. Amendment of sewage sludge (litter) to the soil generally raises microbial activity by increasing the soil organic matter. Because of importance of soil microbial biomass in break down of organic matter in soil and decomposition in soil by proteolytic fungi and bacteria, microflora of both soil samples were enumerated and listed in TABLE 2. Higher bacterial and fungal populations were observed in the test soil than the control (TABLE 2). The fungal populations were relatively higher in litter decomposed soil by nearly two folds than in control soil. For instance the fungal population in the test soil was $10x10^4$ CFU/g of soil where as $3x10^4$ CFU/g of soil in control (TABLE 2). Two folds higher bacterial population with $354x10^4$ CFU/g in test soil was recorded than in control soil with $126x10^4$ CFU/g. Increase in size of fungal and bacterial population observed in the litter soil may be attributed to deposition of organic manure (mostly lignocellulosic wastes) and lower pH favorable for fungal organisms. These findings corroborate with observation of Oseni *et al.*,[19]. The natural forest at 0-10 Cm depth has the greatest number of both fungi and bacteria count. Similarly, Narasimha *et al.*,[22]. and Nagaraj *et al.*, [23]. reported that organic waste released from agro based industries improved the microbial populations. Higher microbial activity[30] .and microbial biomass[30, 31] .were found in organic soils. The higher microbial activities in rhizosphere soil in oak oriented forest soil might be due to increased

TABLE 1 : Physico-chemical characteristics of forest and normal soils

Properties	Forest soil	Normal soil
Color	Reddish brown	Light grey
Odor	Light pungent	Normal
pH	4.6	5.7
Water Holding Capacity (ml/g of soil)	0.63	0.36
Electrical conductivity (μ Mhos/cm)	0.18	0.072
Texture		
Sand (%)	80.2	86.4
Silt (%)	12.6	9.3
Clay (%)	7.2	4.3
Phosphorous (kg/h)	7	3
Potassium (kg/h)	109	93

TABLE 2 : Microbial populations* in forest and normal soils

Parameter	Forest soil	Normal soil
Bacteria	354×10^4	126×10^4
Fungi	10×10^4	3×10^4

***Microbial populations measured in terms of colony forming units (CFU/g soil)**

supply of carbon and nutrients from dead root cells and rhizodeposition[32,33] and less forest floor removal[34].

CONCLUSIONS

The present study clearly indicates that the soil composed with forest litter alters the physico-chemical properties and improved the soil microbiological properties including bacterial and fungal populations. Soil microorganis and enzymes are sensitive indicators for soil fertility. The forest litter could be useful for improvement of soil fertility.

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