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Comparative assessment of soil microbial dynamics under two different plantation of Bilaspur(C.G.) in tropical ecosystem, India

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ABSTRACT

A present study was conducted to assess the microbial dynamics under two different multipurpose tree species plantations of Eucalyptus tereticornis and Pogamia pinnata in Bilaspur. The soil microbial dynamics can change productivity of plantation therefore ,changes in soil act as indicator for the microbial status of plantation productivity and management in tropical ecosystem. It was found that some of the soil properties and biological properties were significantly different ($p<0.05$). The soil organic carbon, available nitrogen, phosphorus and potassium including microbial population were comparatively higher in Pogamia pinnata plantation than the Eucalyptus tereticornis plantation . However, some of the micronutrients were higher in Eucalyptus tereticornis plantation. Microbial population i.e. both bacteria and fungi showed positive significant correlation with soil pH ($p<0.05$,0.001), phosphorus ($p<0.01$,0.001) and nitrogen ($p<0.05$, 0.01, 0.001) in both the plantations. Among the tree species Pogamia pinnata was found better for soil amelioration and the restoration of land.

KEYWORDS | Soil nutrients, plantation, microbial population, multipurpose tree

Plantation is one of the effective measures for the restoration of degraded land as the vast area of the land has lost its fertility and converted into degraded or unproductive land. Plantations of fast growing trees are assuming an increasingly significant role in site management and in the country economy in many tropical regions (Parrotta, 1999). Artificial planting techniques are used for rehabilitation of degraded land. Tropical plantations and mono specific rehabilitation plantation programs revolve around the use of exotic species and their effects on soil fertility and biodiversity.

Many soil properties control the availability of a specific nutrient to plant by controlling both mobility and nutrients contents in soil solution (Kabata-Pendias 2004). Examples of these properties include soil pH, mineral composition, claycontent, soil organic matter (SOM) and water –holding capacity. It is been observed that the studies on soil properties in the model generally improves the relationship between foliar and soil contents obtained with any extraction method (krishnamurti and Naidu 2002; Lombnaes and Singh 2003; Obrador et al. 2007). Microbial activities, which have a significant role in nutrient cycling process, have not been examined so far to observe the specific role and developed under particular tree species and their litter quality. Soil microorganism are responsible for organic matter decomposition, maintenance of soil struture and degradation of pollutant and thus have great role in long-term sustainability.(Duffkova and Macurova, 2011).

The present study deals with the effect of tree species on soil physiochemical and microbial poplution under the two different plantation under the two different plantations of Guru Ghasidas Central University (GGV) of Bilaspur , Chhattisgarh, India. Such studies are important particularly to assess the role of microbial dynamics and soil properties in growth of tree species and restoration of land.

Material and Method

The present experiment was conducted during August 2014 to December 2015 in the Department Of Foresty, Wildlife and Environmental Sciences, Guru Ghasidas Central University of Bilaspur , Chhattisgarh, India (22.09 N 82.15 E) with an elevation of 262m to observe the effect of microbial dynamics on the growth and nutrient content of different plantations in the University Campus. The University campus is rich in natural vegetation and artificial plantations include both indigenous and exotic tree species. The soil used for the study was of different plantation of ***Eucalyptus tereticornis*** and ***Pogamia pinnata.*** The climate of Bilaspur is pleasant and mild with minimum temperature 10°C and 45° C in very hot summers.

The soil sample were collected by random sampling under different stands of plantation of ***Eucalyptus tereticornis*** and ***Pogamia pinnata*** species. Soil sample were collected in the polythene bag in five replicates from depth of 0-30 cm at three different sites of plantation under study. Residues were removed before collection. Soil sample were dried in shade, grounded with pestle-mortar and passed through a 2mm sieve for subsequent analysis. Standard procedures were followed in soil analysis. The moisture content of fresh soil sample was determined by the methods of association of official analytical chemists (AOAC,2000) using absorption spectrometer. The macronutrients were determined by organic matter (Walkley-Black method), Nitrogen (Kjeldahl technique), phosphorous (Olsen method) and potassium (Jackson, 1973).

The soil microbial population were determined by counting the colony forming units samples were serially diluted method and plated on Nutrient agar (Hi-media) plates for bacteria and rose Bengal (Hi-media) for fungal population. After incubation of about 24hr for bacteria and 72 hr for the fungal population. Colony forming units of different plates were counted, calculated and expressed in CFU/g of the soil. The microbial population was correlated with soil physico-chemical analysis by using pearson correlation (two tailed) method in statistical software.

Results and discussion

The tree species play a crucial role in maintaining and reestablishing the sol fertility. The role of organic matter in the buildup of soil nutrient appears crucial in all ecosystems and depends on the foliage cover, rate of litter production and subsequent decomposition. The soil of the University campus is red and laterite in all sites and have loamy to sandy loan in texture. The table 1 shows the result of soil physico-chemical and biological properties of soil under plantation of ***Pongamia pinnata*** and ***Eucalyptus tereticornis***. The soil pH meas-

ure is an important parameter which helps in identification of chemical nature of soil (Shalini et al., 2003) and the pH of soil sample ranged from 5.23-6.8, indicating the soil existence is acidic to slightly neutral in nature. The analyses of soil showed that the soil pH was more acidic in ***Eucalyptus tereticornis*** plantation than in ***Pongamia pinnata*** plantation while organic matter including nitrogen and phosphorus was higher in ***Pongamia pinnata*** plantation as compared to ***Eucalyptus tereticornis*** plantation. Mulugeta and mats (2005) and Rahi et al.,(2012) have also observed that the ***Prosois Juliflora*** (leguminous) tree species has improved soil structure and nutrient availability more effectively as compared to Eucalyptus (non-leguminous) tree species. The nitrogen, phosphorus, potassium and the micronutrients which are also the limiting factors for plant growth. The soil organic carbon was similar in both the plantation. The increase of organic matter and nutrients under the plantation has enriched the soil fertility in the soil depending on biomass of species at different ages (Beeldini et al., 2010; Mishra et al., 2003; Cunningham et al., 2012).

The soil microorganism dynamics play an important role in nutrient dynamics and soil particles contribute to soil structure that provide habitat for soil microorganisms. Thus, the activities of microorganism can be measured to have a direct influence on soil. The soil microbial population showed significant variation with respect to tree species. The mixed plantation forests were appropriate for better availability of nutrients, decomposition of litter and microbial activities especially of bacteria and fungi that decompose organic matter and release nitrogen (Chaubey et al., 2004). The data also indicate that the microbial population in ***Eucalyptus tereticornis*** plantation were comparatively less from the indigenous species of ***Pongamia pinnata*** tree.

The table 2 and 3 shows the correlation coefficient among soil Physisco-chemical characterstics and microbial population in ***Pongamia pinnata*** plantation and ***Eucalyptus tereticornis*** plantations. The nutrient characteristics like soil pH, available nitrogen and available phosphrous shows positive correlation with both the microbial population of bacteria and fungi in both the plantations.

Table 1: Physco-chemical characterstics of soil in plantation forests of *Pogamia pinnata(linn) Pierre* and *Eucalyptus tereticornis*.(values are mean ± SE)

Parameter	Pogamia Plantation	Eucalyptus Plantation
pH	6.8 ± 0.034	6.5 ± 0.25
Moisture content (%)	32.8 ± 0.20	34 ± 1.03
OM	0.40 ± 0.006	0.33 ± 0.006
Organic carbon (%)	0.38 ± 0.008	0.37± 0.016
Available P (Kg/ha)	10.8 ± 0.90	8.97 ± 1.37
Available N (Kg/ha)	156.2 ±17.5	152.3 ± 14.83
Available K (Kg/ha)	259.8 ± 3.46	261.5 ± 26.48
Calcium (Kg/ha)	212 ± 3.74	248.4 ± 6.03
Cu (mg/kg)	6.51 ± 0.38	9.1 ± 0.11
Zn (mg/kg)	1.34 ± 0.04	1.65 ± 0.02
Fe (mg/kg)	4.03 ± 0.28	5.98 ± 0.03
Mn (mg/kg)	2.46 ± 0.10	3.76 ± 0.04

Table 2: Biological properties of soil in plantation forests of *Pogamia pinnata(linn) Pierre* and *Eucalyptus tereticornis*.(values are mean ± SE)

Microbial Population	Pogamia Plantation	Eucalyptus Plantation
Bacteria (CFU/g) x 10^{-6}	4.8 ± 0.32	4.5 ± 0.13
Fungi (CFU/g) x 10^{-3}	4.59 ± 0.18	3.6 ± 0.23

Table 3: Pearson Correlation (r) values among soil Physco-chemical characteristics and Microbial population in *Pogamia Pinnata* plantation

Soil properties	pH	OM	OC	MC	N	P	K
Bacteria	0.76***	0.98***	0.82***	0.53*	0.87***	0.93***	0.52*
Fungi	0.90***	0.87***	0.69*	0.82***	0.89***	0.61**	0.80***
pH		-0.71***	0	0.82***	0.80***	0.83***	0.63**
OM			-0.72***	0.87***	0.58*	0.92***	0
OC				0	-0.51*	0.76***	0
MC					0	-0.79***	-0.58*
N						0.73***	0.68**
P							0.52*

Note: MC= moisture content, OC= organic carbon, N= available nitrogen, P= available phosphorus, K= available potassium. Value marked with *,**,*** are significant at P≤0.05, P≤ 0.01 and P ≤ 0.001 and the non significant values are marked as '0'

Table 4: Pearson Correlation (r) values among soil Physco-chemical characteristics and Microbial population in *Eucalyptus tereticornis* plantation

Soil properties	pH	OM	OC	MC	N	P	K
Bacteria	0.87***	-0.50*	-0.75***	-0.60**	0.79***	0.63**	0
Fungi	0.52*	0.78**	0.61**	0.70**	0.56*	0.92***	0
pH		0.56*	-0.54*	-0.54*	0.67**	0.89***	-0.9***
OM			0	0.52*	0	0.59**	-0.55*
OC				0.77***	-0.53*	0.65**	0.79***
MC					-0.56*	0.75***	0.74***
N						0.54*	0
P							0

Note: MC= moisture content, OC= organic carbon, N= available nitrogen, P= available phosphorus, K= available potassium. Value marked with *,**,*** are significant at P≤0.05, P≤ 0.01 and P ≤ 0.001 and the non significant values are marked as '0'

Conclusion

In the present study we have analyzed the effect of soil microbial dynamics under the two different plantations of ***Eucalyptus tereticornis*** and ***Pongamia pinnata***. The plantations improve the physic-chemical and biological quality of soil. The nutrients and microbial population are significantly interrelated to one another. The study showed that the soils under ***Pongamia pinnata*** tree is respectively better enriched with nutrients and organic matter as compared to the soil under ***Eucalyptus tereticornis*** tree. Thus the plantation of multi-purpose tree species specially the leguminous tree species can play an important role in conservation of biological diversity, restoration of degraded land and stability of an ecosystem and also provides variety of medium to microorganisms for decomposition activities.

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