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Studies of Soil Microbial Diversity and Physiochemical Properties of Tropical Humid Plantation in Western Chhattisgarh

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Abstract: Studies were conducted under *Peltophorum ferrugineum, Dalbergia sissoo and Eucalyptus globules* plantation to measure the diversity of culturable bacterial and fungal communities with physico-chemical properties. Organic carbon was found 57mg ha^{-1},48mg ha^{-1} and 39mg ha^{-1}, respectively for *Peltophorum ferrugineum*, *Dalbergia sissoo* and *Eucalyptus globulus*. N content of *Peltophorum ferrugineum* contained 370.8 mg ha^{-1} of N and the remaining two species (*Dalbergia sissoo* and *Eucalyptus globulus*) had low N content i.e.,230.7mg ha^{-1} and 215.5mg ha^{-1}, respectively. The phosphorus content in *Eucalyptus globulus* were high (15.1mg ha^{-1}) but *Peltophorum ferrugineum* showed higher content of K (445.6 mg ha^{-1}). *Eucalyptus globulus* showed the maximum number of bacterial colonies (5.38 x 10^{-2}), whereas sample of *Peltophorum ferrugineum* has least number of colonies (7.5 X 10^{-2}). Fungal colonies *Dalbergia sissoo* had greater number 7.3 x 10^{-2} growing in each dilution as compared to *Peltophorum ferrugineum* and *Eucalyptus globulus* 2.3 X 10^{-2}, 2.9 x 10^{-2}, respectively.

Key Words: Fungi, Microflora types, Soil bacteria, Soil enrichment, Top soil

Soil is a big biological laboratory had varied population of living organisms (bacteria, fungi, actinomycetes, algae, and protozoans) inconceivable in number. The number of bacteria in 1 gram of soil may range from 100,000 to several billion depending on soil conditions. Soil micro-organisms constitute the basic consumer tropic level of the decomposer subsystem. As such, they control the breakdown of organic matter and hence the release of nutrients and their availability to other organisms to maintaining long-term agricultural sustainability of the agro ecosystem (Jenkinson,1988; Robertson *et al.*, 1994).

Large quantities of readily decomposable organic matter are added to soils every year as crop residues or animals waste and have a significant outcome on soil microbial communities. The plant species growing on the soil also equally influence the population and species composition of the soil fungi (Hackl *et al.*,2000). Fungi and bacteria play a focal role in nutrient cycling by regulating soil biological activity (Arunchalam *et al.*,1997). However, the rate at which organic matter is decomposed by the microbes is interrelated to the chemical composition of the substrate as well as environmental condition. Therefore, a study was conducted to assess the life in soil under plantations.

The study was conducted during 2014 January to 2015 January in plantations raised in Bilaspur, Chhattisgarh. The area is located at 81°45' to 82°15' E longitude and 21°45' to 22°8' N latitude. Physiographically, the area comes under Satpura and Maikal mountain ranges. The climate being sub- humid to humid tropical monsoonal, with distinct winter (Nov.-Feb.), summer (March- mid June) and June-Sep rainy (late). But, due to the presence of lush green vegetation in area a favourable microclimate is maintained. Average annual rainfall varies from 1220–1600mm. Mean monthly minimum temperature ranges from 10.9 – 25.6°C and mean monthly maximum temperature from 25-44°C.

The soil of area is deep, red and laterite with good content of organic matter, which affects various properties of soil PH (6.4-7.5). Water holding capacity is good, cation exchange capacity is high, soil profile is well developed, soil is loamy to sandy loan in texture, natural clodal structure are developed which have granular or crumby structure. The soil is rich in nutrients and biological properties. The compactness and consistency of soil varies from place to place, soil aeration and soil water are affected by the texture and organic matter content. The vegetation of the area is composed of both artificial as well as natural vegetation and the most common species are *Eucalyptus globulus, Butea monosperma, Delonix regia, Peltophorum ferrugineum, Dalbergia sissoo, Acacia nilotica, Pongamia pinnata, Jatropha curcus, Albizia procera, etc.*

Soil sample were collected randomly from 10-15 places for each site (15cm depth) plantation of three species namely *Dalbergia sissoo, Peltophorum ferrugineum* and *Eucalyptus globulus*. Samples were mixed thoroughly, sieved(<2mm) and separated in to parts; one part was air dried while the other was kept in sterilized polythene bags in field moist condition. Organic carbon was determined by Walkley and Black's rapid titration method. Total N by using Kjeldahl digestion method and total P was estimated after $HClO_4$ digestion method (Jackson,1958). Available N was

Table 1. Physio-chemical prosperities of soil under tree plantations

Plantation	Ph	Organic carbon mg kg^{-1}	Total N mg ha^{-1}	Total P mg ha^{-1}	Av. N mg ha^{-1}	Av. P mg ha^{-1}	Av. K mg ha^{-1}
Dalbergia sissoo	6.96	48	1698	570	230.7	14.3	267.7
Peltophorum ferrugineum	7.27	57	2020	620	370.8	12.3	445.6
Eucalyptus globules	5.23	39	1174	510	215.5	15.1	280.7

Table 2. Biological properties of soils under tree plantation

Plantation	Bacteria*		
	Dilution No.	Dilution factor	Colony forming units
Dalbergia sissoo	10^{-2}	10^{-2}	$8.5x10^{-3}$ ($7x10^{-2}$)
	10^{-3}	10^{-3}	$1.7x10^{-3}$ ($3x10^{-3}$)
	10^{-4}	10^{-4}	$6.4x10^{4}$
	10^{-5}	10^{-5}	$2x10^{-6}$
Peltophorum ferrugineum	10^{-2}	10^{2}	$7.5x10^{2}$ ($2x10^{-2}$)
	10^{-3}	10^{3}	$4.2x10^{3}$ ($1x10^{-3}$)
	10^{-4}	10^{4}	$5.6x10^{4}$
	10^{-5}	10^{5}	$1.8x10^{5}$
Eucalyptus globulus	10^{-2}	10^{2}	$5.38x10^{-2}$ ($2x10^{-2}$)
	10^{-3}	10^{3}	$4.3x10^{-3}$ ($1x10^{-3}$)
	10^{-4}	10^{4}	$5.1x10^{4}$
	10^{-5}	10^{5}	$5.0x10^{-5}$

*Fungi colony forming units in parentheses

determined by steam distillation using devendra alloy and available P by ammonium molybdate-stannous chloride method. Available potassium in soils by flame photometer. Soil microbiological studies, isolation and enumeration of bacteria and fungi from soil was done by the serial dilution-agar plating method. Fungal colonies were developed on Czapek-Dox agar medium. The numbers of colonies were calculated from each plate through ocular estimation.

The population count of bacteria and fungi in the soils of plantation were influenced by vegetation. However, the macro and micro climate conditions, seasonality and soil nutrient status also has a significant effect on it. It is also understood that the quality of plant residues accumulating in these plantation are furthermore important and may play a vital role in soil nutrient management within the system through microbial decomposition. Comparing the samples from the rhizospheric area of three different plant species *Dalbergia sissoo*, *Peltophorum ferrugineum* and *Eucalyptus globulus* showed that pH of *Dalbergia sissoo* was slightly acidic and of *Eucalyptus globulus* was strongly acidic whereas *Peltophourm ferrugineum* was normally saline nature. Organic carbon was found to be 57 mg ha^{-1} for *Peltophorum ferrugineum* whereas, *Dalbergia sissoo* and *Eucalyptus globulus* showed low level of organic carbon 48mg ha^{-1} and 39mg ha^{-1}, respectively.

The N content also followed the same trend to the organic carbon that *Peltophorum ferrugineum* contained high (370 .8mg ha^{-1}) N, which is supposed to be of medium level and the remaining two species (*Dalbergia sissoo* and *Eucalyptus globulus*) had low N content *i.e.* 230.7 and 215.5mg ha^{-1}, respectively. The phosphorus content in *Eucalyptus globulus* was high level (15.1mg ha^{-1}), whereas, *Peltophorum ferrugineum* had low content of phosphorus (12.3mg ha^{-1}), but higher content of K (445.6mg ha^{-1}) and the other two species *Dalbergia sissoo* (267.7mg ha^{-1}) and *Eucalyptus globulus* (280.7mg ha^{-1}) had relatively low values.

Dalbergia sissoo had greater number of bacterial and fungal colonies. In Bacterial colonies, dilution number 10^{-2} of *Eucalyptus globulus* showed the maximum number of bacterial colonies (5.38×10^{-2}), whereas *Peltophorum ferrugineum* has least number of colonies (7.5×10^{-2}). It was noted that plantation type significantly influenced species diversity of cuiturable microbial communities. While *Dalbergia sissoo had greater number of fungal colonies* 7.3×10^{-2} growing in each dilution in comparison to *Peltophorum ferrugineum and Eucalyptus globulus* (2.3×10^{-2}, 2.9×10^{-2}, respectively). This study will provide an insight to the microbial population not only for basic scientific research in forestry but to understand species composition and nutrient recycling for regeneration, preservation and stabilization of degraded land.

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