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RELATIONSHIP BETWEEN SOIL BACTERIAL POPULATION AND CHEMICAL PROPERTIES UNDER POPLAR AND EUCALYPTUS PLANTATION AT HARYANA

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Abstract: Relatively less information is available on the relationship between soil properties and microbial communities in plantation areas that are characteristically different from other terrestrial ecosystems. A Study was initiated to assess soil chemical attributes under poplar and eucalyptus plantations and to study Colony forming units (CFU) of bacteria and fungi in soil under poplar and Eucalyptus plantations. Study revealed that soil pH have a negative correlation with soil fungus (r = -0.108) and bacteria (r = -0.043) under Eucalyptus plantation whereas positive correlation with soil fungus (r = 0.037) and bacteria (r = 0.299) under poplar plantation. Under eucalyptus plantation positive correlation was found between soil bacteria and organic carbon (r= 0.521) and between soil fungus and organic carbon (r=0.666). Under Eucalyptus plantation correlation between available Nitrogen and soil bacteria was highly significant (r=0.665**), under poplar plantation also soil N and Soil bacteria positively correlated. Soil fungus positively correlated with soil nitrogen in both eucalyptus and poplar plantation. Available phosphorus positively correlated with soil fungus and soil bacteria under eucalyptus (r=0.243) and (r=0.216) and poplar plantations(r=0.198) and (r=0.223) respectively. A negative correlation was found between bacteria and fungus in both Eucalyptus(r= -0.214) and poplar soils (r=-0.091).

Keywords: Chemical properties, Haryana, Bacteria, Fungus, Poplar, Eucalyptus.

INTRODUCTION

The diversity of plants and animals in forests and agro-ecosystems receives a great deal of scientific attention, whereas, the diversity of microorganisms is often ignored of this soil bacteria are one of the important biotic components that influence decomposition and nutrient mineralization in the terrestrial ecosystems (Bardgett 2005). Evaluating soil physico-chemical characteristics provided useful information on soil microbial activity. It is necessary to study the interrelationship between the physical, chemical properties of soil in order to see the microbial activities Meliani *et al.* 2012. However, the activity and species composition of microbes are generally influenced by many environmental factors including edaphic properties of soil, some of these factors are called modulators, in contrast to resources that the microbial community needs for growth and survival. The variation between modulators and

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resources is that organisms actively compete for resources (e.g. Carbon, nitrogen), while they cannot compete for modulators. Examples of modulators are temperature, pH, water potential and salinity Balser *et al* 2001.

Haryana is a landlocked state in northern India, surrounded by Punjab and Himachal Pradesh to the north and Rajasthan to the west and south. Its eastern border touches Uttaranchal and Uttar Pradesh which is defined by river Yamuna. It is primarily an agriculture state with almost 80% of its land under cultivation. The rest extends as tree cover in village common lands, community lands, institutional lands and agriculture farms, making the area under forest and tree cover to 6.80%. The indirect impact of intensive management on soil quality is due to the effects of accelerated stand growth on organic matter accumulation and nutrient cycling. There are frequent questions about the impact of eucalyptus trees on the soil whether they exhaust soil fertility or cause erosion. Soil fertility is a key issue that has been getting attention from professionals involved with eucalypt plantations in tropical areas. In contrast to other trees commonly used, such as *Leucaena* and *Acacia*, *Eucalyptus* species do not fix nitrogen from the atmosphere as the leguminous species do. Fast growing non-legume trees like *Eucalyptus* are therefore not recommended for intercropping with annual crops. Poplar is very prominent taxonomical group of tree species in plantation forestry in India. Poplars have demonstrated a wide tolerance for pH conditions (from 4.0 to 8.0). Soil pH above 7.0 may limit the availability of specific nutrients such as magnesium, calcium, and Sulphur; however, these conditions occur primarily east of the Cascades. Soil organic matter contents up to 12% improve growth on plantations west of the Cascades. The soil range for adequate nitrogen avail-ability is believed to be between 70 and 160 parts per million (70 to 160 mg/kg).

Relatively less information is available on the relationship between soil properties and microbial communities in plantation areas that are characteristically different from other terrestrial ecosystems. Therefore, much more needs to be done to understand the role of microorganisms and inventory of their diversity and to find ways to exploit them beneficially. Keeping in view the importance of these aspects, the above study was initiated to assess soil chemical attributes under poplar and eucalyptus plantations and to study Colony forming units (CFU) of bacteria and fungi in soil under poplar and Eucalyptus plantations

METHODS

Study area- Sites were selected after surveying the area in Ambala from Kurali, Khuda, Narayangarh, Saha, Shazadpur and Mulana Ambala Barada Boh Jansui under Poplar and

Eucalyptus plantation area. Adequate number of sampling points was determined at the site, on the basis of variations in the selected area. It was ensured that sampling points typically represent the study area. Stratified sampling design was followed for soil sample collection. Samples were collected from 0-30 depth under poplar and eucalyptus plantation as well as in agriculture field in Ambala district of Haryana. Soil parameters studied were (Soil pH, Organic carbon, available Nitrogen, Phosphorus and Potassium. Soil pH was determined by using calomel electrode by 1:2.5 soil water ratios. Soil organic carbon (SOC) was determined by (Walkley and Black Method, 1934). Soil available nitrogen was analysed by Subbiah and Asija (1956). Potassium by (Hanway and Heidel, 1952), Determination of available phosphorus is by the Olsen method (Olsen, *et al.*, 1954).Soil bacteria and fungi were typically assessed using viable plate count method for counting colony form bacteria and fungi propagules. For the isolation of bacteria, serial dilution method given by Johnson and Curl 1972 was followed using Nutrient Agar medium, one gram of air dried soil was placed in 99 ml sterile physiological saline and shaken for 30 min. After settling, soil suspension was serially diluted from each diluted sample; three petri plates for bacteria were inoculated with 1 ml of the suspension. It was determined that dilutions of 10^{-5}, 10^{-6} and 10^{-7} were the most appropriate for bacterial counts, For isolating Fungi, the PDA media was added with 50 g/ml tetracycline to suppress bacterial growth then three petri plates were inoculated with 1 ml of the each serially diluted sample after 4 days of incubation fungal colony started appearing on PDA medium on petri plates it was found that 10^{-2} and 10^{-3} were most appropriate for fungi. The number of bacterial and fungal colonies was counted and the Colony Forming Unit (CFU) was calculated based on dry weight basis.

$$\text{CFU g}^{-1}\text{ dry weight} = \frac{\text{Number of colonies x dilution factor x inoculums}}{\text{Dry weight of Soil }(\text{g})}$$

Statistical analysis:

Data were summarized as mean ± SD (standard deviation).Pearson correlation analysis was done to assess associations between the variables. A two tailed values less than ($p<0.01$) was considered statistically significant.

Results and discussion:

Chemical properties of soil are depicted in the Table: 1.Soil pH ranged from (7.7 ±0.4) to (8.4. ±0.30) under eucalyptus plantation and it was toward basic range whereas in Poplar plantation soil pH ranged from (5.9±0.8) to (7.9±0.2). Organic carbon% under eucalyptus plantations ranged from (0.21±0.07) to (1.22±0.59) in poplar plantation it ranged from

(0.3±0.05) to (1.9±0.15). Gupta and Pandey (2008) worked on soil organic carbon (SOC) pool in Uttarakhand and Haryana under the plantation of eucalyptus and poplar also with shisham and Teak. He found soil under eucalyptus; shisham and teak plantation were better enriched by soil organic carbon in Uttarakhand as compared to Haryana. They indicated that soils under eucalyptus, shisham and teak plantation were better enriched by soil organic carbon in Uttarakhand as compared to Haryana. High temperature and good aeration in these soils increased the rate of oxidation of organic matter resulting in the reduction of soil organic carbon content (Meena *et al*. 2006; Singh *et al.* 2007; Kumar *et al.* 2009). This also reflected on the poor available N status of soils. Available nitrogen ranged from (255.4±29.61) to (441.6±13.6) under eucalyptus plantation and under poplar plantation available N ranged from (370.1±103.7) to (581.1±26.5). Available potassium (Kg/ha) ranged from (62.3±5.12) to (87.1±10.3) under Eucalyptus and (94.4±6.6) to (109.4±12.4) under poplar plantation.

Table:-1 Chemical properties of soil under eucalyptus and poplar plantation

	Khuda	Kurali	Mulana	Narayangarh	Saha	Shazadpur	Ambala	Barada	Boh	Jansui
Eucalyptus										
pH	8.3-8.9 (8.4. ±0.30)	7.7-7.9 (7.8±0.1)	8.1-8.4 (8.2 ±0.15)	7.5-8.2 (7.8 ± 0.35)	7.2-8.4 (7.9 ±0.6)	7.2-8.1 (7.7 ±0.4)	7.4-8.6 (8.1 ±0.6)	7.4-8.1 (7.8±0.3)	7.8-8.4 (8.1±0.3)	7.9-8.5 (8.2 ±0.3)
OC%	0.26-1.26 (0.65 ±0.5)	0.28-0.88 (0.59 ±0.3)	0.42-1.08 (0.66 ±0.36)	0.76-0.98 (0.86± 0.11)	0.42-0.94 (0.72±0.2)	0.78-0.88 (0.84±0.05)	0.14-0.28 (0.21±0.07)	0.32-0.66 (0.47 ±0.17)	0.14-0.44 (0.3±0.15)	0.78-1.9 (1.22±0.59)
%OM	0.44-2.17 (1.12±0.91)	0.48-1.51 (1.02±0.51)	0.72-3.41 (1.6 ±1.5)	1.31-2.82 (1.87±0.8)	0.72-3.52 (1.8 ±1.4)	1.34-4.28 (2.37±1.6)	0.24-0.67 (0.43 ±0.21)	0.55- 1.13 (0.82±0.29)	0.24-1.28 (0.69±0.53)	1.34-3.28 (2.63±1.1
Av K(Kg/ha)	73.42-92.23 (82.2 ±9.4)	83.5-87.91 (85.33±2.2)	58.82-78.11 (66.05±10.51)	61.87-87.63 (77.4 ±13.6)	68.45-89.01 (79.1±10.3)	70- 87.23 (76.59±9.2)	56.7 -66.8 (62.3±5.12)	80.1 -98.9 (87.1±10.3)	78.46-82.24 (79.91±2.0)	81.2-89.2 (85.5±4.0)
Av N(Kg/ha)	301.1-480.1 (411±26.2)	300.4-439.7 (347.8±29.6)	301.1-476.7 (366.2±16.16)	200.7-339 (280.2±21.43)	313.6-427.3 (380.4±29.4)	401.4-502.5 (441.6±13.6)	227.2-382.7 (282.6±16.8)	249-377 (305±25.5)	187.8-439.4 (317.4±22.7)	187.8-326.9 (255.4±29.61)
Av P(Kg/ha)	19.21-23.67 (21.57±2.2)	11.54-27.31 (19.27±7.8)	17.81-30.17 (23.2±6.3)	19.73-22.81 (20.91±1.6)	10.79-18.42 (14.55±3.8)	17.85-23.17 (19.91±2.8)	8.58-20.76 (15.35±6.2)	11.36-21.13 (17.16±5.1)	16.53-25.02 (19.82±4.5)	13.22-19.86 (17.14±3.4)
Poplar										
pH	6.8-8.3 (7.6± 0.7)	6.7-8.5 (7.6±0.9)	7.7-8.2 (7.9±0.2)	7.5-8 (7.7±0.2)	6.7-7.8 (7.3±0.5)	5-6.6 (5.9±0.8)	6.7-8.5 (7.3±1.0)	6.8-7.7 (7.3±0.4)	7.3-8.2 (7.6±0.4)	6.5-7.3 (6.8±0.4)
% O. Carbon	0.84-1.34 (1.0±0.2)	0.78-0.88 (0.8±0.05)	0.84-0.96 (0.8±0.06)	0.26-0.37 (0.3±0.05)	0.77-0.96 (0.84±0.10)	0.69-0.83 (0.7±0.07)	0.96-1.56 (1.3±0.31)	0.84-1.63 (1.13±0.43)	1.78-2.08 (1.9±0.15)	0.66-0.9 (0.8±0.13)
% O. Matter	1.4- 2.3 (1.8±0.4)	1.3- 1.5 (1.4±0.08)	1.4- 1.6 (1.5±0.11)	0.44- 0.63 (0.52±0.10)	1.3- 1.6 (1.4±0.17)	1.1 -1.4 (1.2±0.1)	1.6- 2.6 (2.2±0.5)	1.4- 2.8 (1.9±0.7)	3.1- 4.8 (3.8±0.8)	1.1- 1.5 (1.4±0.2)
Av K(Kg/ha)	91.28-114.2 (99. 9±12.4)	100.2-123.5 (109.4±12.4)	83.6-104.9 (95.84±10.99)	96.88-105.7 (100.1±4.8)	89.12-102.5 (95.1±6.7)	78.96-120.2 (95.6±21.7)	86.8-98.7 (94.4±6.6)	84.4- 116.6 (96.9±17.1)	88.8-114.5 (97.6±14.5)	94.4- 117.2 (103.8±11.8)
Av N(Kg/ha)	486.1-539.4 (509.2± 27.3)	376.3-450.2 (409.3±37.5)	439-515 (481.5±38.75)	363.8-426.7 (390.22±22.1)	480.2-589.9 (538.8±59.8)	551.2-602.1 (581.1±26.5)	414-640.4 (544.4±117.1)	375.3-498.2 (446.3±63.66)	250.9-439.4 (370.1±103.7)	351.2-614.7 515.6±143.4
Av P(Kg/ha)	12.21-19.07 (16.08±3.5)	16.5 -22.7 (19.6±3.0	14.52-18.58 (16.4 ±2.0)	13.66-20.12 (17.5±3.4)	14.4 -20.6 (17.8± 3.1)	15.63-19.18 (17.3±1.7)	15.6 -22.9 (18.7±3.7)	17.9 -22.04 (19.4±2.2	18.4 -22.1 (20.2±1.8)	16.5 -21.6 (18.6± 2.6

Available Phosphorus under Eucalyptus plantation ranged from (14.55±3.8) to (23.2±6.3) and (16.08±3.5) to (20.2±1.8) under poplar plantation. The lower status of P in the soil is attributed to intensive cropping systems resulting in absorption of plant nutrients in higher amounts (Pandey *et al*. 2000).

Correlation studies

Table 2 and 3 depicts the correlation coefficient (r) values of bacterial CFU and the various chemical properties. Pearson's correlation revealed that different soil variables were significantly correlated with each other. A diverse range of correlation was recorded among different variable and is presented in the Table (2 & 3). Soil pH have a negative correlation with soil fungus (r= -0.108) and bacteria (r= -0.043) under Eucalyptus plantation whereas positive correlation with soil fungus(r=0.037) and bacteria(r= 0.299) under poplar plantation. Under eucalyptus plantation positive correlation was found between soil bacteria and organic carbon (r= 0.521) and between soil fungus and organic carbon (r=0.666). Soil organic matter serves as a good source of energy for soil microbes, positively affecting microbial growth and hence influences their distribution (Wang *et al*., 2016). Under Eucalyptus plantation correlation between available Nitrogen and soil bacteria was highly significant ($r=0.665^{**}$), under poplar plantation also soil N and Soil bacteria positively correlated. Soil fungus positively correlated with soil nitrogen in both eucalyptus and poplar plantation.

Available phosphorus positively correlated with soil fungus and soil bacteria under eucalyptus (r=0.243) and (r=0.216) and poplar plantations (r=0.198) and (r=0.223) respectively. A number of soil bacteria and fungi are capable to dissolve soil phosphate continuously. Their activity increase phosphate availability through several mechanisms, i.e.: mineralization of organic phosphate by phosphatase enzyme (Jana 2007) to an organic phosphate which can be used by the plants, competition of adsorption site, and changes of soil reaction. A negative correlation was found between bacteria and fungus in both Eucalyptus (r= -0.214) and poplar soils (r=-0.091). Laldinthar and Dkhar 2015 significant positive correlation with organic carbon and total nitrogen in both the two forest stands indicating that these two constitute the major driving factors of bacterial communities in the broad leaved forest stand of Meghalaya.

Table: 2 Correlation Coefficient (r) Values of Bacterial and fungal CFU and the various chemical Properties of soil under poplar plantation in Haryana

Parameters	pH	OC	OM	K	N	P	Fungus
OC	0.349						
OM	0.355	0.796**					
K	0.261	0.307	0.248				
N	0.184	0.261	0.308	0.196			
P	0.154	-.0058	-0.040	0.031	0.017		
Fungus	-0.108	0.521	0.332	0.203	0.269	0.243	
Bacteria	-0.043	0.666	0.230	-0.214	0.665**	0.216	-0.214
** Correlation is significant at the *P*< 0.01 level (2-tailed).							

Table:-3 Correlation Coefficient (r) Values of Bacterial and fungal CFU and the various chemical Properties of soil under poplar plantation in Haryana

Parameters	pH	OC	OM	K	N	P	Fungus
OC	0.228						
OM	0.184	0.944**					
K	0.218	-0.149	-0.175				
N	0.053	0.389	-0.257	-0.046			
P	-0.012	0.276	0.275	-0.233	0.109		
Fungus	0.037	0.606	0.419	-0.117	0.407	0.198	
Bacteria	0.299	0.680	0.427	0.235	0.484	0.223	-0.091
**Correlation is significant at the *P*<0.01 level (2-tailed).							

CONCLUSION

Bacterial population positively correlated with organic carbon and total nitrogen and it can be concluded that these two constitute the major driving factors of bacterial population in both the two from the study; it may conclude that the biochemical as well as microbial properties of soil is significantly affected by plantation type.

REFERENCES

[1] Andrews, S.S., Carroll, C.R., 2001. Designing a soil quality assessment tool for sustainable agro ecosystem management.*Ecological Applications* 11, pp1573–1585.

[2] Arshad, M.A. and Martin, S., 2002.Identifying critical limits for soil quality indicators in agro- ecosystems. *Agriculture, Ecosystems and Environment* 88, pp153–160.

[3] Balser TC, Kinzig AP, Firestone MK. 2001. Linking soil microbial communities and ecosystem functioning. The functional consequences of biodiversity: empirical progress and theoretical extensions Princeton University press. Princeton and Oxford: Princeton university press.

[4] Bardgett R, D. 2005 The Biology of Soil: A community and ecosystem approach. Oxford. B.B. Jana, Distribution pattern and role of phosphate solubilizing bacteria in the enhancement of fertilizer value of rock phosphate in aquaculture ponds: 2007, State-of-the-art, in: First International Meeting on Microbial Phosphate Solubilization, Springer, pp. 229-23.

[5] Bill Schuette. 2009. Presite Assessment for Short Rotation, Intensively Cultured Poplar Plantations, pp1-3.

[6] Godbold DL, Hoosbeek MR, Lukac M, Cotrufo MF, Janssens IA, CeulemansR,Polle A, Velthorst EJ, Scarascia-Mugnozza G, De Angelis P, Miglietta F,Peressotti A, 2006.

[7] Mycorrhizalhyphal turnover as a dominant process for carbon input into soil organic matter.Plant Soil 281, pp15-21.

[8] Johnson, Leander F., and Elroy A. Curl. 1972. Methods for Research on the Ecology of Soil-Borne Plant Pathogens. 426 So. Sixth St., Minneapolis Burgess Publishing Company.

[9] Hanway, J.J. and Heidel, H. 1952. Soil analysis methods as used in Iowa state college soil testing laboratory. *Iowa Agric*., 57: 1-31.

[10] Kumar, M., Singh, S.K. and Sharma, B.K. 2009. Characterization, classification and evaluation of soils of Churu district. *Journal of the Indian Society of Soil Science* **57**, 253-226.

[11] Laldinthar, R and Dkhar M S. 2015 Relationship between Soil Bacterial Population and Various Physico- Chemical Properties at Two Broadleaved Forest Stands of Meghalaya Differing in Altitudes Transcriptomics, 3:2 http://dx.doi.org/10.4172/2329-8936.1000125

[12] Meliani A, Bensoltane A, Mederbel K 2012 Microbial diversity abundance in soil: related to plant and soil type. *American Journal of Plant Nutrition and Fertilization Technology* 2: 10-18.

[13] Meena, H.B., Sharma, R.P. and Rawat, U.S. 2006 Status of macro- and micronutrients in some soils of Tonk district of Rajasthan. *Journal of the Indian Society of Soil Science* **54**, 508-512.

[14] Pandey, S.P., Singh, R.S. and Misra, K. 2000. Availability of phosphorus and sulphur in Inceptisols of central Uttar Pradesh. *Journal of the Indian Society of Soil Science* **48**, 118-123.

[15] Singh, S.K., Mahesh Kumar, Sharma, B.K. and Tarafdar, J.C. 2007 Depletion of organic carbon, phosphorus and potassium under pearl millet based cropping system in the arid region of India. *Arid Land Research and Management* **21**, 119-131

[16] Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Curr. Sci*., 25: 259-260.

[17] Wang, Z., Chen, Q., Liu, L., Wen, X., Liao, Y. 2016. Responses of soil fungi to 5-year conservation tillage treatments in the drylands of northern China. *Appl. Soil Ecol*. 101, 132-140.

[18] Walkley, A. and Black, I.A. (1934). An Examination of Degtjareff Method for Determining Soil Organic Matter and a Proposed Modification of the Chromic Acid Titration Method. *Soil Sci.* 37: 29-37