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PHYSICO-CHEMICAL ATTRIBUTE OF SOIL UNDER DIFFERENT NATURAL FOREST STANDS IN ACHANAKMAR -AMARKANTAK BIOSPHERE RESERVE OF INDIA

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ABSTRACT

A study of soil attributes at three sites under different natural forest stand in Lamni range of Achnakmar-Amarkantak Biosphere Reserve, Chhattisgarh, India reveals that there is a considerable difference in the soil properties due to species composition of perennial vegetation. All three sites soil *viz.* - Sal forest, Mix Forest and Bamboo Forest are acidic in nature and degree of acidity decreases with depth. Organic C%, CEC, and mineral contributed to acidity of soil and it was more in Bamboo stand as compare to Sal and mixed stand. Parameter like AWC, organic C, CEC, texture and bulk density are major attributes which contribute to differential recycling of elements under different species. The presence of roots, the quantity of roots per horizon indicates availability of nutrient in the soil.

Keywords **:** Soil attributes, vegetation and Achnakmar-Amarkantak Biosphere Reserve.

Introduction

The knowledge of the soil as regards its origin and development, its nature and composition, and the part its plays an important role in the plant nutrition. The past and present status and its optimum utilization are very essential for production of forest produces. The soil may be looked upon as a store house of plant nutrients. It contains a large number of compounds of both organic and inorganic. Some of these compounds are soluble in water and utilized by the plant. The composition of forest vegetation, distribution, density and plant health reflects the soil condition of the area.

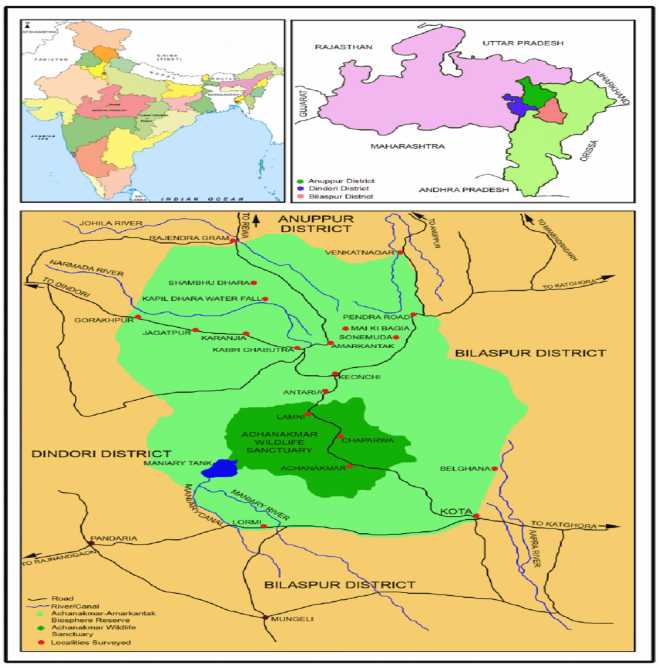
Living organisms such as vegetation also have an important role in a number of processes involved in soil formation including organic matter accumulation, profile formation and biogeochemical nutrient cycling. Through litter fall and the process of vegetation decomposition, plants add humus and nutrients to the soil which influences soil structure and fertility NRCS (2007). Soil biological, chemical and physical properties are modified by plants by means of root exudation, uptake of nutrients, contaminants and root growth Marcet *et al*. (2006). In fact, under equilibrium conditions, vegetation and soil are closely linked with each other that different vegetation type exhibit different physical properties Wilson and Sellers (1985). Studies have also showed that vegetation, production of organic matter, quality of forest floor and availability of nutrient elements, are strongly combined with the local precipitations, the physical properties of the soil as well as the history of land use Wezel *et al*. (2000); Epstein *et al*. (1998); Burke *et al*. (1997)

Influence of vegetation on soil properties has been a subject of great interest in forestry. The available literature Nath *et al*. (1988); Banedee *et al.* (1989); Das *et al.* (1989) suggests that vegetation has pronounced effect on many soil properties.

In natural forest and man-made protected plantation, cycling of nutrient is important aspect as litter fall brings about important change in physico- chemical attributes of the soil under different forest vegetation. Present study is focused on the comparison of soil physico-chemical profiling of three different forest Sal forest, Mixed forest and Bamboo forest of Lamni range of Achnakmar-Amarkantak Biosphere Reserve, Chhattisgarh.

Material & Methods

The study area is located between 22º33′ 0″ to 22º33′45″ N latitude and 81º45′ 0″ to 81º52′ 0″ E longitude, falling under Lamni range of Achnakmar-Amarkantak Biosphere Reserve, Chhattisgarh .The study area received temperature ranges from 13.4 to 39.3ºC. In natural Sal forest the species viz. *Shorea robuta, Terminalia tomentosa, Pterocarpus marsupium, Anogeissus latifolia* are common. In mixed forest *Mytrigyna parviflora, Lagerstromia parviflora, Boswellia serrata* are common and Bamboo forest *Diospyros meanoxylon, Tactona grandis, Mangifera indica, Gmelina arborea*, are rarely found. Soil sample were taken from four depth 0-30, 30-60, 60-90 and 90-120cm.



Map: Achanakmar-Amarkantak Biosphere Reserve showing explored localities and its location within India, Madhya Pradesh and Chhattisgarh

The samples were analyzed for separates (international pipette method), AWC (available water capacity) is determined by pressure plate apparatus, Bulk density is calculated by Clod Method Black(1965), pH is calculated by pH meter Jackson(1967), Organic C% is estimated by Walkey and Black rapid titration method Jackson (1958), CEC (Ammonia acetate), Exchangeable cations as per standards procedure Pipers(1956), Exchangeable Calcium and Magnesium was determined by inductive Plasma Methods Pipers(1956),Exchangeable Sodium and Potassium were determined by Flame Emission Spectrophotometer Jackson(1958), available Phosphorus and Potassium is analyzed by inductive Plasma Method Jackson(1953).

Result and Discussion

The soil was found sandy loam in all three sites, pH of all three sites are acidic and decreases regularly down the depth. This is attributed to die formation of organic acids through litter decomposition. The surface soil under Mixed forest has low pH as compare to surface soil under Sal forest and Bamboo forest.

The general trend of percentage of organic carbon with increasing depth there is sharp fall for all the three sites. The percentage of organic carbon was found maximum on Bamboo forest. The % of organic carbon of surface soil of Sal Forest and Mixed forest varies with approximately 0.4% to 1.86% sharp declining in percentage of organic carbon regularly with depth can be attributed to the fact that the litter fall from the vegetation accumulates on the surface soil where the microbial activity is the greatest hence ensuring continuous composting process releases nutrient and thereby elevating the level of organic carbon in soil. The observation analysis concluded that upper depths (0-10 cm) of all the forest have close correlation in compared to other depths. It is a very important soil property influencing soil structure, stability, nutrient availability, soil pH and soil's reaction toward fertilizers and other amendments Hazelton and Murphy (2007). On the basis of above observation we concluded that mixed forest like banj-oak should promote for better soil health, which is good for germination of seeds because of high moisture content and water holding capacity.

The available nutrient status of the soil under natural forest varies from 4.60 to 14.22 ppm for phosphorus and 21 to 142 ppm for potassium. Available phosphorus is maximum in Mixed forest and minimum in Sal forest. It is occurred due to different vegetation. The available K shows the same trend as available P but the quantity is high in all three sites. It acts as internal buffer or catalyst essential to many physiological functions. It is rapidly cycled in established forest stand. It was found that very little K appears to leached below the rooting zone.

The Cat ion Exchange Capacity of the soil varies from 6.25 to 19.13Me/g. In all three study sites Ca^{++} is the preponderant cat ions followed by Mg^{++} much lower and Na+ in very small quantities. The CEC is to be high under Bamboo Forest 10.07 to 19.13me/g. This may be correlated with the presence of organic carbon are important integrative properties of soils. Exchangeable calcium and Magnesium are more under Teak cover partly due to the incorporation and decomposition of Calcium and Magnesium rich leaf litter of Teak in soil Upadhayay *et al.* (1955).

Exchangeable Potassium and Calcium do not show any definite trend of distribution under different species, however, in surface layer the content are comparatively higher in natural forest which may be due to the release of these cat ions after decomposition of litter of various species.

Bulk density increased regularly with depth in all three sites. This is due to the fact that surface soil contains more humus than sub soil plant roots present in the surface soil bind the soil particle is form soil aggregates and therefore reduce the bulk density of the surface soil. The percentages of pore space decrease with depth, so the infiltration rate is comparatively less due to the lower organic matter and higher bulk density.

Available water holding capacity gradually increases with depth in Sal forest and Bamboo forest but AWC gradually decrease regularly down to depth in Mixed forest. This may be due to increase in sand % in soil separates better aggregation under natural stand may also be responsible to higher infiltration rate under the soil . The vegetation influences the physico-chemical properties of the soil to a great extent. It improves the soil structure, infiltration rate and Water Holding Capacity and aeration Ilorkar and Totey (2001); Kumar *et al.* (2004); Champan and Reiss (1992). AWC is high in Sal forest, Sal exists in low valleys and plains therefore, at higher elevation. Sal forest converted in to mixed type. Bamboo forest has low AWC than Sal and Mixed forest. So Bamboo can exist in dry condition. Estimation of root biomass of different stand in different depth highlights the active portion of root biomass in soil. The root biomass is negative correlated with the soil depth. The average biomass is higher in Bamboo forest (3.1) followed by Mixed forest and Sal forest (2.074, 0.278) respectively. Soil root biomass indicates the living portion of soil organic matter and is mainly responsible for the conversion of complex into available form of nutrients. From the above result it is quite evident that different stand has different impact on physical, physiochemical and nutritional status of the soil.

Table 1 : PHYSICAL AND CHEMICAL PROPERTIES OF SITE-1 -SAL FOREST

Depth in cm	pH 1:2 H_2O	pH 1:2 KCL	soil seprate %			Organic C%	Exchangeable cation (Meg/100g)				C.E.C. (Meg/ 100g)	Clay C.E.C. (%)	Available nutrients (ppm)		Bulk density gm/ml	Pore space %	AWC
			T Sand	T Silt	T Clay		Ca^{++}	Mg^{++}	Na^{++}	K^{++}			P	K			
0-30	5.18	4.06	61.7	16.6	21.64	0.82	2.22	1.12	0.08	0.2	9.35	42	4.62	79	1.12	55	17.92
30-60	5.34	4.12	61.46	17.64	20.89	0.74	3.56	0.75	0.14	0.18	8.3	40	7.15	43	1.18	53	17.46
60-90	5.52	4.4	61.43	17.8	20.7	0.5	3.74	0.76	0.12	0.13	6.24	30	7.27	40	1.19	54	17
90-120	5.94	4.78	62.04	17.44	20.54	0.57	4.4	0.8	0.16	0.08	9.56	42	5.8	38	1.2	52	17.18
120-150	5.52	4.6	60.86	18.2	20.98	0.52	4.88	0.93	0.18	0.09	7.72	38	4.64	39	1.22	50	18.32

TABLE 2 : PHYSICAL AND CHEMICAL PROPERTIES OF SITE-2 MIXED FOREST

Depth in cm	pH 1:2 H_2O	pH 1:2 KCL	soil seprate %			Organic C%	Exchangeable cation (Meg/100g)				C.E.C. (Meg/ 100g)	Clay C.E.C. (%)	Available nutrients (ppm)		Bulk density gm/ml	Pore space %	AWC
			T Sand	T Silt	T Clay		Ca^{++}	Mg^{++}	Na^{++}	K^{++}			P	K			
0-30	4.92	4.02	74.77	12.12	13.05	1.52	3.74	1.35	0.16	0.04	10.2	76	14.2	144	1.18	56	18.06
30-60	5.03	4.14	74.59	13.18	12.2	1.1	2.7	1.12	0.12	0.04	7.28	60	8.94	22	1.2	53	14.08
60-90	5.36	4.1	76.15	9.61	13.42	1.06	2.64	1.1	0.1	0.03	10.16	74	4.99	121	1.25	52	12.22
90-120	5.41	3.95	78.6	9.42	12.3	0.89	2.16	0.89	0.09	0.02	6.84	56	6.74	66	1.97	43	8.42
120-150	5.58	3.86	77.5	9.1	13.35	0.65	2.24	1.7	0.09	0.04	8.46	64	6.64	24	1.32	48	9.1

TABLE 3 : PHYSICAL AND CHEMICAL PROPERTIES OF SITE-1II BAMBOO FOREST

Depth in cm	pH 1:2 H_2O	pH 1:2 KCL	soil seprate %			Organic C%	Exchangeable cation (Meg/100g)				C.E.C. (Meg/ 100g)	Clay C.E.C. (%)	Available nutrients (ppm)		Bulk density gm/ml	Pore space %	AWC
			T Sand	T Silt	T Clay		Ca^{++}	Mg^{++}	Na^{++}	K^{++}			P	K			
0-30	5.74	4.6	63.76	12.85	23.37	1.85	9.04	3.84	0.16	0.4	19.14	82	8.5	82	1.1	60	11.08
30-60	6.06	4.94	62.75	13.63	23.62	0.97	8.47	3.56	0.14	0.06	15.46	64	9.82	48	1.12	54	13.26
60-90	6.04	4.72	63.67	14.27	22.07	0.56	9.7	4.02	0.2	0.04	14.76	66	6.8	34	1.14	59	14.13
90-120	6.44	4.95	67.75	13.06	19.2	0.46	6.76	2.8	0.21	0.06	10.06	53	3.38	32	1.12	56	8.56
120-150	6.62	4.97	66.74	55.08	18.14	0.43	8.24	3.52	0.16	0.02	12.24	68	6.16	22	1.15	58	14.15

TABLE 4 : ROOT BIOMASS OF DIFFERENT FOREST STAND

Depth in cm	Sal Forest			Mixed Forest			Bamboo Forest		
	No. of Roots	No. of Lat. Roots	Biomass (gm)	No. of roots	No. of Lat. Roots	Biomass (gm)	No. of roots	No. of Lat. Roots	Biomass (gm)
0-30	15.8		0.74	23.2		2.65	38.6		4.23
30-60	13.8		0.27	17.2		2.44	21.4		3.39
60-90	13.6	2	0.28	10.8	3	2.21	17.8	5	2.98
90-120	8.4		0.06	5.6		2.03	7.46		2.49
120-150	5.4		0.04	5.4		1.04	2		2.42
Average	9.4		0.278	12.44		2.074	18.28		3.1

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