IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Studies The Effect of Physicochemical Properties of Soils in the Forest Area of Tarai West, Uttarakhand, India.

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Abstract

Soil represents one of the most active and complex natural system on earth where most of Physico-Chemical reaction occurs. Therefore, the study was aimed to find out the difference in the physical and chemical properties of the soil under three different horizons.Physico-chemical properties of soil is done to do physical analysis of Soil sample to do analysis of soil sample of Tarai West forest. Soil sample were analyzed and collected from three different horizons and three different seasons like rainy, winter and summer. Soil sample were brought to laboratory, air-dried and packed in polythene bags for physical chemical analysis. Physical Characteristics of collected sample like Soil Color, Soil Texture, Soil moisture, Water holding capacity were investigated. The forest soils had significantly higher water holding capacity, Cation exchange capacity, Organic Carbon, nitrogen and potassium contents.

Key words- Physicochemical- soil, Tarai west.

INTRODUCTION

Soil represent one of the most active and complex natural system on the earth surface and being made up of six constituents namely inorganic matter, organic matter, soil organism, soil moisture, soil solution and soil air.

Development of soil layers and humus accumulation take place in natural ecosystems. A part of annual increments of minerals from substrate weathering and atmospheric inputs including N-fixation are immobilized by colloids and biota. This leads to available nutrient element build up in the soil pool which increases the soil fertility. For assessing the soil fertility status and in nutrient cycling studies, the determination of the amount of nutrients in the forest soil is important. In high altitude, the process of solification forms the soils. Soil on the slope above 30°C angle are generally shallow, due to erosion and mass wasting processes usually have very thin surface horizons such as skeletal soils have medium to coarse texture depending on the materials from which they have been derived. The inter dependence of soil, plant and animal has penetrated deeply into the life of the mankind. Braun-Blanquet (1934) has pointed out the close relationship between the natural evaluation of the vegetation and the development of the soil. Various studies with regard to soil and their correlation with plant growth have been carried out in the deciduous forests of the country (Singhal *et al.,* 1980). The present study was therefore undertaken to analyze the physical and chemical properties of the soil along a disturbance gradient in forest area of Tarai in Ramnagar.

MATERIAL AND METHODS

Study Area

Uttarakhand occupying area 53,483 sqkm. In which this Research study was done in forest area of Tarai of Ramnagar.

Sampling and Analysis

Collection of soil Sample

The physical and chemical properties of soils were analyzed by collecting random samples from three different horizons i.e. horizon A (0-5 cm), horizon B (10-15 cm) and horizon C (20-30 cm) in different seasons (rainy, winter and summer).

Physicochemical Analysis of Soil Sample

The Collected soil sample were air-dried, ground into fine powder using pestle and mortar and were passed through a 2 mm sieve. The processed soil sample were used for determine the pH, electrical conductivity, available nitrogen, organic carbon(%OC) by Walkley Black method (7), organic matter (OM), texture, water holding capacity (WHC) and cation exchange capacity (CEC) in thee replicates.

Soil colour

Soil colour was directly read off with the help of Munsell's soil colour chart. Soil sample is spread uniformly over a cardboard sheet. The soil particles are matched with chips of different colours in the Munsell's soil colour chart. The chip with which the soil colour matches is taken out and the notation indicated on the chart is noted which gives the colour characteristic of that soil.

Soil texture

Three size fractions of soil viz., sand, silt and clay were determined by using sieves of different sizes.

Soil moisture

For estimation of moisture content of the soil, the soil samples from three depths were collected in polythene bags, closed rapidly and tightly. About 100 gms of soil from each depth was oven-dried at 105°C till constant weight and dry weight was recorded after cooling the samples using the following formula (Misra, 1968):

$$\text{Soil moisture} = \frac{\text{Loss in weight after drying}}{\text{Dry weight of soil}} \times 100$$

Water holding capacity

The water holding capacity was determined by the method adopted by Misra (1968).

CHEMICAL CHARACTERISTICS

a) Soil pH

Soil pH estimation was carried out by a digital pH meter using 1:5 soil-water suspensions after wetting the soil overnight.

b) Organic carbon (OC)

The organic carbon per centage of the soil was determined by Walkey and Black's rapid titration method (Walkley and Black, 1934)

c) Estimation of phosphorus

For the determination of available phosphorus 2 gm soil was transferred to a conical flask of 100 ml capacity. 20 ml baryate solution was added and the flask was shaken for few minutes. The content was filtered in a beaker using filter paper. Five ml of filtrate was transferred to a 25 ml volumetric flask and 5 ml ammonium molybdate solution was added to it. Ten ml distilled water was added into the flask followed by an addition of 1 ml stannous chloride (1 ml stock solution + 65 ml distilled water). The contents in the flask were diluted to make up 25 ml and per cent transmission was measured at 660 nm in Colorimeter. The amount of phosphorus was calculated using regression equation (Jackson, 1958).

d) Estimation of potassium

The exchangeable potassium was estimated by flame photometer. The aliquot was taken to measure potassium emission in a flame photometer and the amount was calculated by regression equation (Jackson, 1958).

e) Estimation of nitrogen

The total nitrogen of soil was determined by Micro-kjeldahl method (Piper, 1944).

RESULT AND DISCUSSION

The soil texture, colour and other properties represent wide range of variations, depending upon geology, climate, vegetation and biological and chemical interactions.

The soil colour of the study area indicates many fold features. Many types of minerals and chemicals present in it reflect the colour of the soil. Any change in soil colour at two different places indicates a difference in their mineral origin or in soil development. Difference in colour is due to the presence of organic matter, mineral and moisture content of the soil.

The soil at the depth of 0-5 cm comprised 21.27 per cent sand, 8.18 per cent silt and 70.55 per cent clay. Soil at the depth of 10-15 cm have 19.85 per cent sand, 14.27 per cent silt and 65.88 per cent clay and 17.17 per cent sand, 24.33 per cent silt and 58.50 per cent clay at the depth of 20-30 cm in highly disturbed (HD) site of outer region.

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Edaphic factors are the factors, which are related to soil in which the vegetation grows. A close relationship between soil and geomorphology of the hills has been widely recognized. Any change in geomorphic processes affects the pedogenic processes (Gerrad, 1981; Hall, 1983). Now it is well understood that the factors responsible for evolution of geomorphology are also responsible for the soil formation. This has led to assume that soil formed in a single geomorphic position may have almost similar pedogenic properties (Pandey and Pofali, 1982).

Soil texture is among the most important of soil physical properties. Soil moisture relations, erosion characteristics, bulk density, nutrient content and availability are influenced by soil particle size distribution (Toy and Shay, 1987). The soil of study sites was dominated with clay soil. Here the clay content decreased with the increase in depth.

Clay holds maximum moisture per unit volume and provides moisture for tree growth, while sandy soil holds less moisture per unit volume but permits more rapid percolation of precipitation water than clay. Clay content decreased with decrease in precipitation. Small differences between soil layers with regard to texture are indicative of the immaturity of soil (Hanawalt and Whittaker, 1976).

During start of summer in May, the insolation period increased with increase in the atmospheric and soil temperature and decrease in rainfall. The increasing temperature influenced soil temperature adversely and equilibrium was attained only after the monsoon showered during the period June to August. The movement of soil moisture upto the depth of 6 ft under crop plants was studied by Nijhawan (1946). In the present study both sites showed higher moisture content in rainy season while lower value was recorded in summer season. Carbery and Chaklodar (1936) studied soil moisture conditions *in situ* during the dry season in Dacca farm. They found that in the first three inches the loss of soil moisture was the highest and most rapid, it gradually decreased upto a depth of 18 inches, below which there was an equilibrium moisture zone, where the moisture content was about 23 per cent.

The water holding capacity of the study site was determined by a number of factors. Most impotent among these were soil texture or size of particles, porosity and the amount of expansible organic matter and colloidal clay. In the present study the per cent of soil moisture and WHC showed same uniform trend with increasing rainfall and both decreased with increasing depth. The soil colour in present study sites varied from reddish brown at horizon C (20-30 cm) where the organic content was low while dark brown in horizon A (0-5 cm) where organic content was high due to accumulation of litter fall. Thus the soil forming processes were reflected in the colour of the surface soil.

In soils of temperate regions the pH value varies inversely with the increase in organic matter both in Mull and Mor types of humus. In some soils of Bashahar Himalayas, Mohan *et al.* (1957) found that the pH value of the soil was related to the soil moisture, organic matter content ratio. In the present study, the pH ranged from 6.23 to 7.00 on both sites. Soil pH of these regions was slightly acidic to neutral except a few. Similar values of pH were also recorded by Singh and Singh (1987) and Bhandari (1995, 2000) etc. Acidity of the soil is exhibited due to the presence of different acids.

With only a few exceptions a greater concentration of nutrients occurred in the surface soil reflecting the massive input of nutrients to the soil through litter fall. This pattern of nutrient distribution is in agreement with the reports made elsewhere on forest soil (e.g. Thompson *et al.,* 1954; Cunningham, 1962, Pandeya and Kurvilla, 1968; Kawahara and Tsutsum, 1972; Singh, 1979; Pandey, 1980).

The soil being storehouse for organic and inorganic plant nutrients is subjected to continuous and simultaneous depletion and addition of soil resources. Litter fall is the major route through which nutrients are returned from autotrophs to the soil pool after decomposition. Some earlier studies indicate that an interaction of several factors determines the rate of decomposition. Temperature, moisture, C:N ratio and lignin interact in a complex way to cause the differences in the decomposition rate of Banj Oak leaf litter at different elevations (Singh and Singh, 1987).

The organic matter was maximum at surface horizon A and it decreased with increase in depth without a definite trend. Decrease in the ionic concentration of nutrient in the soil with depth is related to high root biomass, turnover rate, weathering of soil material near the surface and activity of microorganism (Monk and Day, 1985). Nutrient input through rainfall, output through overland flow and sediment movement in the forest of Kumaun Himalaya have been assessed by Pathak *et al.* (1984). They reported that among the nutrients, K and C were lost through sediment output but more N and P through overland flow. The C:N ratio roughly reflects the release of N in the soil by organic matter decomposition and therefore, indicate the degree of decomposition of organic matter in soil (Kononova, 1966; Ulrich, 1971).

Pandit and Thampan (1988) reported that during monsoon nitrogen showed higher concentration, because the atmospheric nitrogen comes to the soil with rainfall. This mineralization rate of organic N depends upon factors like temperature, soil moisture and texture of soil. Because of shallow coarse soil, poor mineral status and deficient water availability, the forest showed poor growth and shrub vegetation showed prominence. Dhar (1936-37) suggested that in tropical soils, especially under aerobic conditions, photosynthesis and photocatalysis play important part in nitrogen fixation.

Bawa (1992) concluded in his study on phosphorus as an indicator of pedogenesis of soils that the relative magnitude of pre-distribution within the profile is a function of the degree of soil development and that it can support the lower layer (horizon C) to contain more phosphorus than upper layer (horizon A), because the new layer is recently formed layer. In discussing the role of phosphate in soil productivity, Deewan (1953) reported that since phosphate status of soils decreases as a result of continued cultivation under Indian conditions "phosphorus is going to be a serious bottle neck in increased crop production in India". Potassium ranks amongst the "big three" of plant nutrients (N, P and K). The micaceous soils have a high K-fixing capacity but organic matter content reduces its amount (Raychaudhary, 1963). High values in silt soils are presumed to be due to the presence of primary micas in these soils. Champion and Seth (1968) reported that potassium plays an important role in enzyme activity of plants.

. Plants and soils are the subsystem of this dynamic system and serve as storage compartment, while the atmosphere can be considered as an open reservoir, fluxes of nutrients from plants occur to soil via litter formation (Karunaichamy and Paliwal, 1995).

Differences in topography, rainfall and other environmental factors interact with the parent material to create micro-differences in the soil (Golley *et al.,* 1975).

Seasonal chemical characteristics of forest soils in the outer region

Site	Depth (cm)	pH	Organic carbon (%)	Nitrogen (%)	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
		RAINY SEASON				
HD	0-5	6.70±0.25	1.74±0.54	0.150±0.03	27.49±0.88	108.4±2.7
	10-15	7.06±0.56	1.01±0.26	0.155±0.02	9.43±0.11	144.3±2.9
	20-30	7.03±0.25	0.89±0.28	0.158±0.04	4.50±0.80	151.5±3.6
MD	0-5	7.00±0.44	1.78±0.27	0.148±0.33	49.83±2.91	108.0±4.3
	10-15	7.03±0.30	0.89±0.25	0.155±0.04	27.11±1.18	131.9±1.17
	20-30	6.90±0.22	1.25±0.14	0.160±0.02	18.57±0.80	171.3±1.62
		WINTER SEASON				
HD	0-5	6.86±0.30	1.83±0.28	0.152±0.06	31.50±1.53	86.3±3.2
	10-15	6.63±0.28	1.61±0.62	0.155±0.08	18.78±0.88	157.9±2.7
	20-30	6.43±0.26	1.79±0.24	0.176±0.02	9.47±0.11	166.2±3.0
MD	0-5	6.46±0.25	1.62±0.46	0.148±0.08	45.62±1.51	95.2±0.71
	10-15	6.70±0.40	1.44±0.22	0.148±0.03	36.83±1.85	99.7±0.81
	20-30	6.70±0.30	1.51±0.33	0.152±0.05	18.49±0.80	108.5±0.86
		SUMMER SEASON				
HD	0-5	6.40±0.54	1.75±0.05	0.162±0.04	22.50±1.45	135.3±0.27
	10-15	6.36±0.28	0.85±0.29	0.166±0.04	18.46±0.11	144.7±4.2
	20-30	6.38±0.32	1.63±0.02	0.168±0.07	4.50±0.80	157.3±3.6
MD	0-5	6.53±0.34	1.38±0.46	0.155±0.03	49.22±0.79	86.4±1.2
	10-15	6.46±0.32	1.29±0.64	0.146±0.03	31.50±0.18	135.3±1.5
	20-30	6.23±0.11	1.08±0.12	0.162±0.08	4.50±0.80	194.2±3.0

CONCLUSION

The study indicates that the physicochemical properties of soil such as water holding capacity, percent organic carbon, cation exchange capacity, available nitrogen and available potassium are negatively affected in cultivated systems as compared to the non-cultivated due to frequent tillage practices. Normally The forest area and selected six villages had a hot summer, cold winter season and high humidity in rainy season. Normally the soil was slightly acidic in nature with pH values ranging from 6.23±0.11 to 7.06±0.56. The soil moisture and water holding capacity was maximum at upper horizon and both decreased with increasing depth. The mean nitrogen content varied from 0.140±0.06 to 0.176±0.02 in the forest area and the mean phosphorus. This is the first study of this type from Uttarakhand which can be helpful to establish a relation among the different land systems used by farmers and in identifying and planning necessary measures required for sustainable environment.

ACKNOWLEDGMENT

The Author are very grateful to L.M.S.G.P.G College , Rishikesh Uttarakhand under HNB UNIVERSITY SRINAGAR for providing necessary laboratory facilities.

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