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Physico-Chemical Characteristics of Soil in Mixed Oak Forest of Manipur, North-East India

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ABSTRACT

Physico-chemical characteristics of soil was analysed in the mixed Oak forest of Senapati District, Manipur. Soil samples were collected from different soil depth i.e. 0-10 cm, 10-20 cm and 20-30 cm and analysed for texture, soil moisture, temperature, bulk density, pH, organic carbon, total nitrogen, available phosphorus and potassium. The soil was clayey loam in texture (sand 35%, silt 24% and clay 41%).The soil temperature ranged from 13.12°C to 25°C,soil moisture ranged from 19.63% to 30.72%.The soil pH ranged from 4.6 - 5.0, bulk density (0.92 g cm^{-3} - 1.54 g cm^{-3}),organic carbon (1.214% - 1.435%), total nitrogen (0.121% - 0.233%), available phosphorus (5.19 kg/ha - 42.02 kg/ha) and potassium (134.96 kg/ha - 303.52 kg/ha).The amount of organic carbon, N, P and K decreased with increased of soil depth. The C/N ratio was recorded to be 6.99.

Introduction

Soil as a component of the terrestrial ecosystem fulfils many functions including those that are essential for sustaining plant growth (Nwachokor *et al*., 2009).Vegetation distribution and development are largely depends on the soil conditions (Kardol *et al.,*2006).Soil fertility depends on the concentration of N,P,K, organic and inorganic materials, micronutrients and water. Physico-chemical characteristics of forest soils vary in space and time because of variation in topography, climate, weathering processes, vegetation cover, microbial activities and several other biotic and abiotic factors (Paudel and

Sah,2003).The physico-chemical characteristics of soil was studied by several workers in different forests of the world (Paudel and Sah,2003;Joshi and Negi,2015;Jamil *et.al*.,2017;Vishnu *et.al*.,2017)).The present study was carried out to analyse the physico-chemical characteristics of soil in subtropical mixed Oak forest.

Materials and methods

The study site is situated in Senapati District at a distance of 25 km from Imphal city which falls at 93° 55' E longitude and 24° 54' N latitude at an altitude of 941 m from mean sea level. The climate of the area is monsoonic with warm moist summer, a distinct rainy season and cool dry winter. The average annual rainfall of the study site is 1131.8 mm.The forest is dominated by *Castanopsis indica, Lithocarpus dealbata, L.fenestrata, Quercus polystachya,Quercus serrata and Schima wallichii.*The soil samples were collected by using a soil corer from different depths of 0-10 cm, 10-20 cm and 20-30 cm soil layer and placed in polythene bags separately. The soil samples were air-dried, sieved through a 2 mm mesh sieve and stored for physico-chemical analysis. All analyses were performed by using three replicates. Soil texture was determined by Bouyoucos Hydrometer. The soil moisture was estimated by gravimetric method (oven dry at 80° C till constant weight).A soil thermometer was used to determine soil temperature. The pH of the soil was measured by pH meter (systronic) in 1:2.5 water suspension. Soil organic carbon by Walkley-Black method, total nitrogen by Kjeldahl method, available phosphorus by Bray and Kurtz (1945) and available potassium by using Systronics Flame photometer.

Results

The soil is clayey loam in texture (sand 35%, silt 24% and clay 41%). The soil temperature varied from 13.26°C to 25.2°C in 0-10 cm, 12.91°C to 25°C in 10-20 cm and 13.2°C to 24.8°C in 20-30 cm. The percentage of soil moisture content ranged from 18.57 % to 33.33 % in 0-10 cm layer, 19.04 % to 30.07 % in 10-20 cm layer and 20.44% to 29.86 % in 20-30 cm. The bulk density varied from 0.87 g cm^{-3} to 1.54 g cm^{-3} in 0-10 cm depth, 0.91 g cm^{-3} to 1.56 g cm^{-3} in 10-20 cm depth and 0.97 g cm^{-3} to 1.62 g cm^{-3} in 20-30 cm depth. The soil pH ranged from 4.48 to 4.71 in the 0-10 cm depth, 4.56 to 4.89 in 10-20 cm depth and 4.6 to 5.4 in 20-30 cm depth. Soil organic carbon ranged from 1.683 % to 2.206 % in 0-10 cm depth, 0.927% to 1.395 % in 10-20 cm depth and 0.692 % to 0.894 % in 20-30 cm depth. The organic carbon percentage was found highest in the upper soil layer (0-10 cm) and decreased with increased of soil depth. Total nitrogen ranged from 0.168 % to 0.378 % in 0-10 cm layer, 0.112 % to 0.21 % in 10-20 cm layer and 0.085 % to 0.168 % in 20-30 cm layer. The concentration of total nitrogen was found maximum in the upper soil layer and decreased with increased of soil depth.

The available phosphorus ranged from 32.53 kg/ha to 42.02 kg/ha in 0-10 cm soil layer, 10.38 kg/ha to 21.95 kg/ha in 10-20 cm soil layer and 5.19 kg/ha to 18.88 kg/ha in 20-30 cm soil layer. The amount of soil available phosphorus decreased with increasing soil depth. The potassium varied from 243.6 kg/ha to 303.52 kg/ha in 0-10 cm soil layer, 198.8 kg/ha to 239.68 kg/ha in 10-20 cm soil layer and 134.96 kg/ha to 197.4 kg/ha in 20-30 cm soil layer. The amount of potassium decreased with increasing of soil depth. Annual mean carbon to nitrogen ratio was recorded to be 6.99.

Table 1. Physico-chemical characteristics of soil in depthwise

Depth (cm)	Moisture (%)	Bulk density (g cm^{-3})	pH	Organic carbon (%)	Nitrogen (%)	Phosphorus (kg/ha)	Potassium (kg/ha)
0-10	18.57-33.33	0.87-1.54	4.48-4.71	1.683-2.206	0.168-0.378	32.53-42.02	243.6-303.52
10-20	19.04-30.07	0.91-1.56	4.56-4.89	0.927-1.395	0.112-0.21	10.38-21.95	198.8-239.68
20-30	20.44-29.86	0.97-1.62	4.6-5.4	0.692-0.894	0.085-0.168	5.19-18.88	134.96-197.4

Discussion

The soil temperature decreased with increase of soil depth. It may be due to solar radiation directly heating on the surface soil. Tiwari *et al.* (1989) reported that soil temperature was highest on the top layers of soil and decreased with increase of soil depth. Kaspar and Bland (1992) reported that temperature of the surface soil layer is influenced by the fluctuations in air temperature near the ground and decline in soil temperature with increasing soil depth depends to some extent on the metabolic activities of plant roots and microbes inhibiting this layer. The surface soil layer (0-10 cm) had higher moisture percentage during rainy season but subsurface soil layers (10-20 cm and 20-30 cm) had higher moisture percentage than surface layer during winter season. It may be due to the variation of temperature between the surface and sub-surface soil layers. Arunachalam (1996) reported similar trend in subtropical forest at Meghalaya.

The bulk density of surface soil is lower than subsoil layers which might be due to contains of more humus in surface soil than the subsoil layers. Maithani *et al.* (1998) also reported that bulk density

was lower in the surface soil layer than the subsoil layers. Aweto (1981) reported that low bulk density in the surface soil of forest ecosystem was enhanced by the contribution of roots which loosen the soil. The soil pH increased with increase in the depth of soil. The soil is acidic in nature. Nayak and Srivastava (1995) concluded that the reason for acidic condition in the soils of shifting cultivated lands of north-eastern India being due to intense leaching of bases and presence of exchangeable Al^{+3}.Bhattacharya *et.al* (1998) also reported base leaching due to higher rainfall in the region and presence of organic acids which tend towards acidic condition of soils at low and high hill slopes of Arunachal Pradesh. The soil organic carbon content was recorded to be maximum in the upper layer of 0-10 cm soil layer and it decreased with increase in soil depth may be due to the high organic matter content on the upper soil layer than the subsoil layers. Similar pattern of soil organic carbon was also reported by Singh *et al.,* (1987). The total nitrogen of soil was found to be higher in the upper layer of soil (0-10 cm) and it decreases with increase in soil depth which may be due to high organic carbon in the upper layer of soil. This pattern of decreasing total nitrogen with increase of soil depth was also reported by several workers (Sirajul *et al*, 1995).The available phosphorus was found higher in the upper soil layer and decreased with increase in soil depth. Arunachalam (1996) reported the high concentration of phosphorus in the upper soil layer and decreased in the lower soil layers in the subtropical forest of Meghalaya. The soil potassium also showed decreasing trend with increased of soil depth. The soil potassium was recorded maximum during rainy season and minimum during winter season. The present C/ N ratio was lower than that of Arunachalam *et al.* (1998) reported from subtropical forest of Meghalaya. The present study shows a declining nutrient concentration with increasing soil depth.

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