Comparative study on soil nutrient status (N, P and K) in relation to the forest types of southern Western Ghats region, Kerala

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Abstract- This study deals with the nutrient status of soil profiles collected from different forest types of the southern Western Ghats falling within the north-eastern part of the Idukki district. Ten locations were selected for the present study; altitude of the region varies from 150 to 2000 m above mean sea level. The vegetation pattern of the area is composed of evergreen, semi evergreen, hill top evergreen, dry deciduous, moist deciduous, sandal wood, shola (tropical montane forest) and grasslands. Shola forests register higher nutrient (especially N and K) status while dry deciduous forest records lower values. The N, P, K status of the forest soils varies from 0 to 1.09%, 0.04 to 0.92% and 0.56 to 3.81% respectively. N and P shows decreasing trend with increasing soil depth and K shows more or less same values throughout the entire depth of the 1 m length profiles.

Index Terms- southern Western Ghats, Forest soil, Nutrients, Soil profile,

I. Introduction

The Western Ghats, an orographic feature extending from Kanyakumari in the south to Tapti in the north and aligned parallel to the western coast of Peninsular India, host a rich source of diversified flora and fauna. Mountain ecosystems are considered as a centre of biological diversity because of its distinct climate zone which varies with altitudinal changes. Thick forests flourish the slopes of the mountain ranges but the forest types and composition varies with altitudinal and climatic variations. The topmost portions of the mountains are covered with rocks or by a thin soil cover with grasslands. The major forest types present in this region includes evergreen, semi-evergreen, moist deciduous, dry deciduous, grassland, shola (Tropical montaneforest), sandalwood and plantations like tea, sugarcane, coffee and cardamom. The properties of the soils are varying according to the vegetation pattern and climate. Organic matter is an important factor to determine quality of soil and serves as source of nutrients for improving physical and biological properties of soils in addition to productivity. The forest soils vary in physico-chemical changes with time and space resulting in variation among topography, climate, weathering process, vegetation cover and microbial activities and also biotic and abiotic factors.The present paper addresses the organic carbon, nitrogen (N), phosphorous (P) and potassium (K) contents in the southern Western Ghats soil profiles, covering almost all forest types

II. MATERIALS AND METHODS

North eastern part of the Idukki district(Fig. 1), Kerala was chosen for studying the effects of forest types on soil nutrient status. Ten locations were selected based on vegetation pattern for collecting 1m depth soil samples. Monsoon controls the climate of this region (both south-west and north-east monsoon). Analyses were carried out by using standard procedures. Organic carbon was determined by wet digestion method (Walkley and Black, 1934), Nitrogen by Kjeldahl digestion method (Maiti, 2003), Phosphorous by X-ray fluorescence spectrometry afterignition for 2 hours at 900°C and Potassium by using flame photometer.

Major soil types encountered in the area are forest loam, lateritic soil, brown hydromorphic soil and alluvial soil. About 60% of the area is covered with forest soil, which is the product of weathering of rock under forest cover. They are generally acidic in nature and are characterized by rich organic matter and nitrogen contents and poor in bases, due to heavy leaching. They are dark brown to yellowish red in colour with sandy clay to sandy clay loam texture. In denuded areas leaching and deposition of humus in lower layers are common. The lateritic soils are seen in Eravikulam National Park – Grassland areas and are dark red in colour. The organic matter content and plant nutrients in this soil are very low. The brown hydromorphic soil quiet extensively occurs in valley bottoms and is formed by the activity of transportation and deposition of materials from the surrounding hill slopes. The colour of the soil is deep brown and the texture varies from sandy loam to clay. The alluvial soil is seen as narrow strips along the banks of rivers and the texture of the soil ranges from sandy loam to clay and are fertile (Soman, 2002).

ISSN 2250-3153

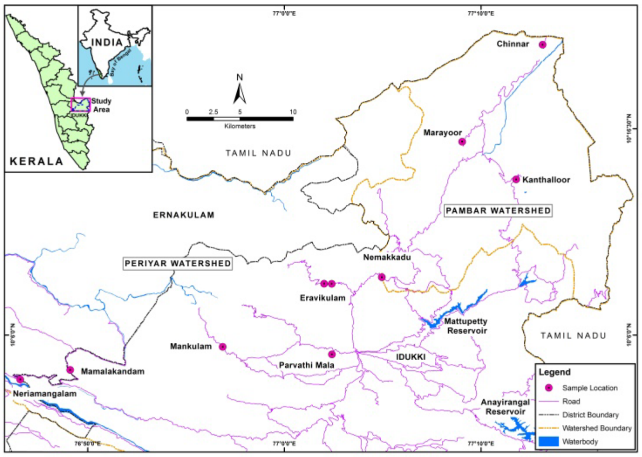

Fig. 1 Study area map showing 1 m soil profile sampling locations.

General features of forest types seen in sampling areas

Soil samples were collected from different locations having different forest categories. The general features of forest pattern seen in this area are

Evergreen

In general, these forests occur on the windward side (western slopes) of the Western Ghats in at an altitude of 200-1500 m (above msl) and it receives 2500-5000 mm rainfall. More than 50% of the tree species in these forests are highly endemic. Most of the evergreen trees have tall hardwoods with broad leaves. They grow very close to each other and the canopy cover is very thick, and always looks green. In this forest system, the trees are composed of three distinct layers, the shrubs covers the ground surface followed by short structured trees and then tall trees. Various varieties of orchids and ferns are present in the trunk of tress. The most common tall trees in this forest types are rosewood, ebony, mahagony, palm and jackfruit. Due to dense foliage the light that reaches the under story is very less.

Dry deciduous forests

Dry deciduous forests occur in the leeward (eastern slope) side of the Western Ghats at an elevation of 300-900 m msl. These forests are characterized by the predominance of hardwood tree species. The canopy cover is less and normally does not exceed 25 m. The most common trees in this forest pattern are sal, acacia and bamboo. These forests are highly variable due to anthropogenic activities like fire and grazing. The rainfall pattern of the forest ranges from 1000 to 1500mm.

Moist deciduous forests

Moist deciduous forests are found at altitude of 500-900 m msl and it occupies the largest area within the Western Ghats. The forests receive 2500-3000 mm rainfall and have no dense canopy cover. In monsoon time, the canopy of the moist deciduous forests looks similar to that of semi evergreen due to the presence of broad leaved trees. In summer season, the trees shed their leaves. The dominated trees in this forest type are sal, teak and bamboo.

Shola forest (Tropical montane forest) and grasslands

In Kerala shola forests are seen on the crest of Western Ghats, where the altitude is beyond 1800 m and receives 2500-5000 mm rainfall. The shola forests are interspersed with a vast expanse of grasslands. The grasslands are generally found above 1500 mm elevation and are also called shrub-savanna. In colder months, the minimum temperature goes to below 0°C and the heights of the grasslands are less than 1m.

Sandalwood forest

Sandalwood (Santalum album Linn.) is a small evergreen hemi-parasite tree famous for its fragrance heartwood. These are indigenous to Peninsular India and have high economic value. It is commonly known as ‘Chandan’ (Sundaraj and Sharma, 2010). It grows naturally and extensively in Western Ghats region at an altitude of 700-1200 m msl. These are mostly found in dry deciduous and scrub jungles either along with other species as an associate. The reduction/depletion of sandalwood trees are mainly due to disease, illicit felling or smuggling (Rocha et al., 2015).

III. RESULTS AND DISCUSSION

Table 1depicts the sampling location and vegetation pattern of the area. Nitrogen is the most critical element for plant growth. It materializes in soils from nitrogen fixation, microbial activity and addition through manures and fertilizers. It increases protein content, improves quality and produces rapid growth of plants (Survase et al., 2011). The nitrogen concentration in soil differs significantly with respect to forest types. The nitrogen value varies from 0 (Stn 10) to 1.09% (Stn 6). Organic matter degradation helps to improve the status of nitrogen contents in soil. The organic carbon content of the soils are varies from 0.13 (Stn 10) to 13.89% (Stn 6). Shola forests records higher nitrogen values while dry deciduous forest records lower nitrogen values. Nitrogen values shows decreasing trend with increasing altitude and surface layers have higher nitrogen percentages than lower layers (Fig.2).

Table 1: Sampling location details.

Station No., Name and Altitude (in m)	**Forest type**
Stn 1: Neriamangalam (158)	Evergreen
Stn 2: Mamalakandam (455)	Moist deciduous
Stn 3: Mankulam (972)	Evergreen
Stn 4: Parvathy mala (1643)	Low elevation Shola
Stn 5: Eravikulam National Park (1906)	Grassland
Stn 6: Eravikulam National Park (1915)	Shola
Stn 7: Nemacaud (1874)	Hill top evergreen
Stn 8: Kandallur (1384)	Dry deciduous
Stn 9: Marayoor (970)	Sandal wood forest
Stn 10: Chinnar (481)	Dry deciduous

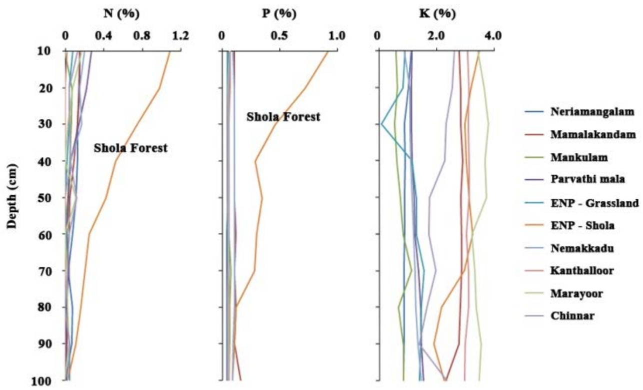

Fig. 2. Depth wise variation of nutrient (N, P, K) status of all 1 m length profile samples.

Phosphorous plays an important role in energy transformations and metabolic processes of plants and is closely related to the cell division and development (Shukla et al., 2010; Wang et al., 2006). It helps the root development and growth, gives rapid and vigorous start to plant, strengthen straw and decreases loading tendency and improves the quality or crops. It is produced in soils by organic matter decomposition and phosphate fixation (Survase et al., 2011). Soil organic matter contains between 2% and 3% phosphorous, but it is available to plants after mineralization. Many factors that contribute to mineralization are soil temperature, moisture, pH and presence of micro-organisms. Phosphorous does not readily leach out of the root zone; potential for P-loss is mainly associated with erosion and runoff. Among the ten trench samples studied, values of total phosphorous vary from 0.04% (Stn 1) to 0.92% (Stn 6) with an average of 0.10% for the bulk soil. Depth-wise variations of phosphorous within the profile for different vegetation are shown in Fig 2. The highest value for phosphorous was observed in the shola forest and the values progressively decreases with increasing depth. Most of the P-compounds are available to the plants between pH values of 6-7.5. Availability is governed by P fixation rate and solubility. Fixed P is not lost; it becomes slowly available to plants over several years depending on soil structure and P-compound type.

Potassium also plays an important role in the maintenance of cellular organization and keeping the protoplasm in a proper degree of hydration (De and Sarkar, 1993). It also helps to disease resistance to plant, regulate cell's water condition, helps protein and chlorophyll formation, increase plumpness of grains and seeds and counteracts to excess nitrogen (Survase et al., 2011). Among the ten profile samples studied, the total potassium content varies from 0.56% (Stn 3) to 3.81% (Stn 9) with an average of 1.96% for the bulk soil. Potassium content shows a strong positive correlation with sand content (r = 0.60) and negatively correlated with mud (silt and clay) fractions (r = -0.47) (Fig. 3). Most of the total potassium in soils is in the mineral form, mainly as K bearing primary minerals such as muscovite, biotite, and feldspar in the sand fractions (Spark, 1987). All the samples show moderate values in Potassium content. The total K content may be quite low in tropical soils because of the origin of the soils, high rainfall and temperatures (Yawson et al., 2011). All the samples in the study area, the K contents were more or less same throughout the entire layers in 1m depth samples (Fig.2).

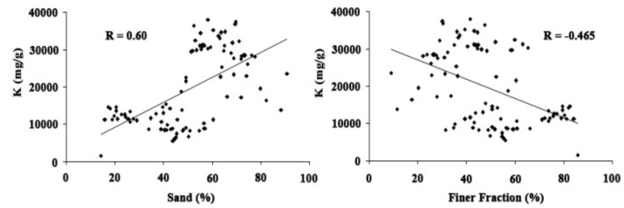

Fig. 3. Inter- relationship existing between potassium (K) with sand content and finer fractions (<63μ).

ACKNOWLEDGEMENT

We thank the Director, National Centre for Earth Science studies, Thiruvananthapuram for facilities and support. The financial assistance from Kerala State Council for Science, Technology and Environment (KSCSTE), Government of Kerala to one of the author(Divya V.) is gratefully acknowledged.

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