**Int. J. Forest, Soil and Erosion, 2020 10 (3)**
**ISSN 2251-6387**

***Research Paper***

# Analyzing physico-chemical properties of soil along the altitudinal gradients in Thalamalai range of Sathyamangalam Tiger, Tamil Nadu, India.

Bhuvanesh.P, Baranidharan.K* and Vijayabhama.M

Forest College and Research Institute, Mettupalayam 641301, TNAU, Tamil Nadu

*Corresponding author Email- baranidharan.k@tnau.ac.in

**Abstract:**

Sathyamangalam Tiger Reserve is the second largest reserve in Tamil Nadu having 1.45 lakh ha of forest area, out of which 524 sq.km area of lower plains and mountain slopes. Thalamalai range is the newly formed range in Sathyamangalam Tiger reserve, Tamil Nadu. The total forest area of Thalamalai range is 11476.92 ha. And the elevation ranges from 800 MSL to 1400 MSL. The study area has 3 different forest type Southern Tropical Dry Deciduous Forest (5A/C3), Southern Tropical Moist Deciduous Forest (3B/C2) and Southern Tropical Semi-Evergreen Forest (2A/C2). Healthy soil is an important component of the forest ecosystem. It is a strong foundation for trees and plants to grow on, a habitat for numerous insects, fungi, algae and a lab where old organic matter is recycled back into the ecosystem. Soil plays an important role in forestry. Rain water run off gets trapped in the soil like a sponge where it is retained for trees and plants as a water source. This also serves to limit water run-off into streams and filters various minerals and impurities from the water before it hits streams and rivers. Plant life including trees is essential for maintaining the integrity of the soil. The present study deals with the analyzing physico-chemical properties of the soil along the different altitudinal gradients in Thalamalai range of Sathyamangalam tiger reserve. Representative soil samples were collected from 60 sample plots on different altitudinal interval. The soil samples were collected from each sample plots at the depths of 15 – 30 cm (sub surface) by standard sampling procedure. The result showed that in altitudinal interval of 1000-1200 MSL the acidic pH value registered. The electrical conductivity, soil organic carbon, available soil nitrogen and available soil potassium was higher in 1000-1200 MSL and available soil phosphorus was higher in 1200-1400 MSL. In case of soil organic carbon and soil nitrogen content it was very high in these region because of the high floral composition which resulted in the proper nutrient recycling in this area.

**Keywords:** Thalamalai Range, Tiger Reserve, Organic Carbon, Electrical Conductivity

## INTRODUCTION:

India, known for its rich heritage of biological diversity, occupies tenth in the world and fourth in Asia for its plant diversity so far documented over 91,200 species of animals and

45,500 species of plants in its ten bio-geographic regions, which hosts four global biodiversity hot spots (Eastern Himalaya, Indo-Burma, Sundaland and Western Ghats). Of these 12.6 per cent of mammals, 4.5 per cent of birds, 45.8 per cent of reptiles, 55.8 per cent of amphibians and 33 per cent of Indian plants are endemic, being found nowhere else in the world. Soil is "a natural surface layer containing living matter and it supports various tissues". Soil, is also the foundation of infinite life and is the most vital and expensive natural resource, and not renewable in short time. Soil is composed of different sized inorganic particulars, reactive and stable forms of organic matter, a myriad of living organism, water and gases (Sannappa *et al.*, 2013). The total forest cover in India is estimated to be 24.01 per cent of the total geographical area and in Tamil Nadu it is estimated to be 18.33 percent (FSI, 2015). It is highly essential that these forest soils have to be conserved from different losses and also the quality of the forest soils also should be maintained. The forest soils vary in physico-chemical changes with time resulting in variation among topography, climate, weathering processes, vegetation cover and microbial activities and also biotic and abiotic factors (Paudel and Sha, 2013). The soil and vegetation have a complex interrelation because they develop together over a long period of time. The vegetation influences the chemical properties of soil to a great extent. The selective absorption of nutrient elements by different tree species and their capacity to return them to the soil brings about changes in soil properties. The presence of essential nutrients in soil would give good information towards the knowledge of nutrient cycling and bio-chemical cycle in the soil plant ecosystem (Gairola *et al*., 2012). In view of this, Tamil Nadu state consists of 4 tiger reserves which are rich in biodiversity. Among them the recently declared Tiger reserve is Sathyamangalam Tiger Reserve. Sathyamangalam Forest Division was first declared as Sathyamangalam Wildlife sanctuary in the year 2008, in the month of November. In March 2013 Sathyamangalam Wildlife sanctuary was declared as Sathyamangalam Tiger Reserve. Sathyamangalam Tiger Reserve encompasses large contiguous Reserve Forests extending over 1455 sq.km with diversity of vegetation types from dry thorn shrub to patches of semi-evergreen forests in the upper regions. Sathyamangalam forest area has two unique bio geographic entities, i.e., the Eastern and the Western Ghats in peninsular South India and constitutes a large contiguous natural forest ecosystem. It comprises a large chunk of rain shadow forest area, with lower average annual rainfall. On the other hand it is bestowed with perennial sources of water, such as the Moyar River.

## MATERIALS AND METHODS:

### Geographical details of the study area

Thalamalai range is the newly formed range in Sathyamangalam Tiger reserve. Vegetation study was carried out in Thalamalai range of Sathyamangalam Tiger Reserve, Erode district, Tamil Nadu. The total forest area of Thalamalai range is 11476.92 ha. And the elevation ranges from 800 MSL to 1400 MSL. This range is surrounded by Thalavadi range in the north, Bhavanisagar range in the south, Germalam range in the east and Nilgiri North Division on the west (Plate 1).

### Geology, rock and soil

The soil derived from a parent rock varies considerably with climatic conditions, the parent rock influence on the properties of the desired soil considerably. The rock types of the Thalamalai range mainly belong to the great gneissic series of pre-Cambrian age. Metamorphic igneous rock types such as biotic gneiss, Charnockite and granite gneiss also widely present. The common soil types of the range are red soils, laterite soils, black cotton soils, and alluvial soils. The physical properties of soils often acquire greater importance than the chemical properties. In majority of the cases the fertility may be adequate but the growth of trees differs widely in accordance with the physical nature of the soil.

**Climatic condition of study area**

**Temperature and rainfall**

The climate of the Thalamalai range is moderate. The mean minimum and mean maximum temperature of the plateau region of study area are; 21.54$^{o}$ C and 27.02$^{o}$ C and the mean minimum and mean temperatures in plains of study area are 26.24$^{0}$C and 32.84$^{o}$C. The mean annual rainfall is 824 mm, north east monsoon contributed to 70 per cent of the total rainfall in this region.

**Forest types in Thalamalai range**

The study area is rich in floral diversity and vegetative pattern. This is apportioned into three forest types located in three different altitudinal interval (Table 1 and Plate 2)

**Table 1. Forest Types in the study area (Champion and Seth, 1968)**

| S.No. | Forest Type | Altitudinal Interval | Beat | Area in Hectares |
|---|---|---|---|---|
| 1. | Southern Tropical Dry Deciduous Forest (5A/C3) | 800-1000 MSL | Thalamalai | 3670.4275 |
| 2. | Southern Tropical Moist Deciduous Forest (3B/C2) | 1000-1200 MSL | Bejalahatti | 3386.2615 |
| 3. | Southern Tropical Semi-Evergreen Forest (2A/C2) | 1200-1400 MSL | Honnathittu | 4420.2312 |

(Source: Management Plan Sathyamangalam Wild Life Sanctuary, 2011).

**Collection of soil samples**

At the beginning, a general visual field survey of the area was carried out to have a general view of the variations in the study area. Representative soil samples were collected from 60 sample plots on different altitudinal interval. The soil samples were collected for analyzing soil chemical properties from each sample plots at the depths of 15 – 30 cm (sub surface) by following standard sampling procedure. During collection of samples; dead plants, furrow, old manures, wet spots, areas near trees and compost pits were excluded. This was done to minimize

differences, which may arise because of the dilution of soil organic matter by other external factors. The soil samples were collected from sample plots then air-dried, mixed well and passed through a 2 mm sieve for the analysis of selected soil chemical properties. Global Positioning System (GPS) were used to identify the geographical locations of the sampling sites, respectively.

**Soil physico-chemical and chemical properties**

Soil reaction (pH) was determined using 1:2.5 ratio soil water suspension with glass electrode (Jackson, 1973). Electrical Conductivity (EC) was determined using soil water suspension of 1:2.5 ratios was used for measuring electrical conductivity. It is measured with Conductivity Bridge and expressed in $dSm^{-1}$ (Jackson, 1973).Soil organic carbon was determined through Chromic acid wet digestion method (Walkley and Black, 1934). The amount of soil available nitrogen in soil sample was determined by alkaline permanganate method (Subbiah and Asija, 1956).The amount of available phosphorus from soil was extracted with Bray I extractant (0.025 N HCl + 0.03 N NH4F). Blue colour was developed using ascorbic acid as reductant and the colour intensity measured at 660 nm with photoelectric colorimeter. (Bray and Kurtz, 1945). Neutral normal ammonium acetate (N NH4OAc) is used to extract the available potassium in the soil. The soil available potassium concentration was read in flame photometer (Standford and English, 1949).

**RESULT AND DISCUSSION:**

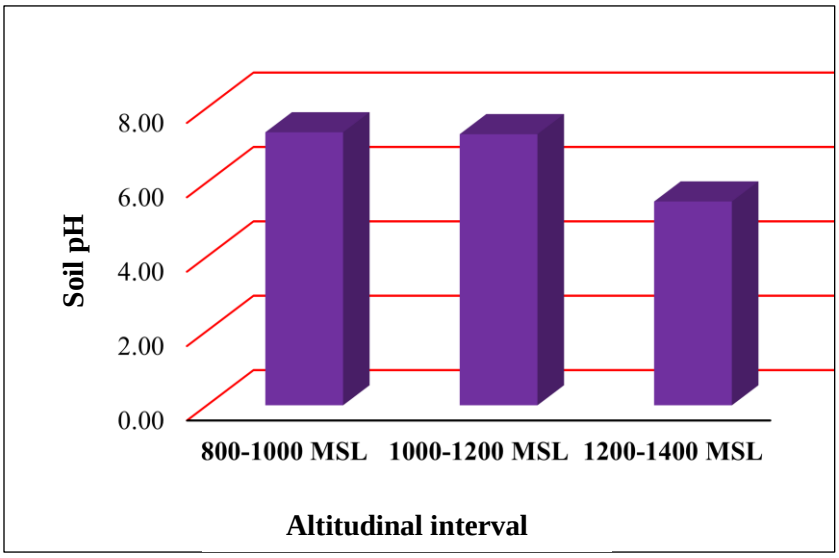
**Soil physico-chemical and chemical properties in different altitudinal interval of Thalamalai range**

**Soil physico-chemical properties**

**Soil reaction (pH)**

The soil pH of the samples ranged from 5.48 to 7.34. Among the soil samples analyzed, soils of 800-1000 MSL registered higher pH of (7.34) followed by 1000-1200 MSL soils (7.29). The lower mean value of pH (5.48) was observed in the 1200-1400 MSL (Table 2). Among the soil samples analyzed, the acidic pH (5.48) was observed in the 1200-1400 MSL of semi evergreen forest (Fig.1). This may be due to the higher altitudinal influence over the soil with high precipitation rate, resulting in leaching of mineral salts from the soil resulting in lower pH. This was in close agreement with the results of Venkatachalam *et al.* (2007) who has reported that shola forest and grassland soil pH on Nilgiri hills were 5.44 and 4.04.

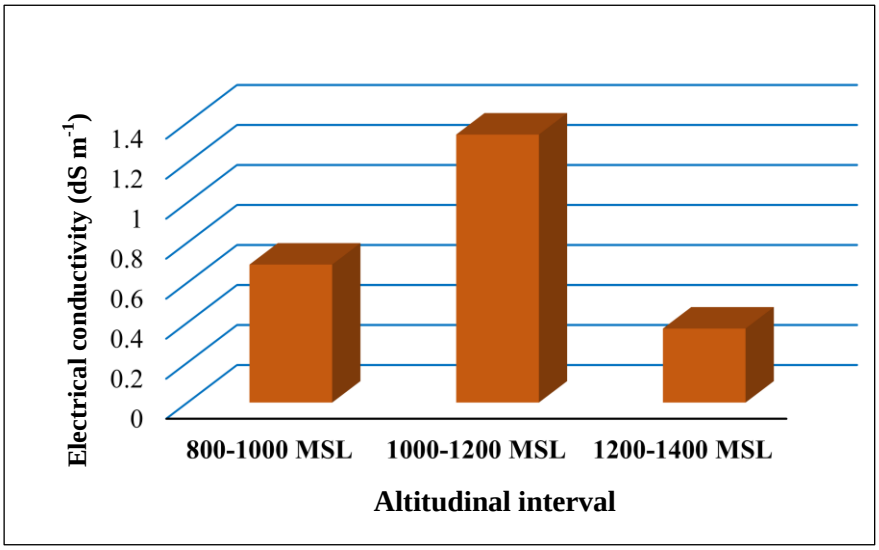
**Figure 1. Soil pH in different altitudinal interval of Thalamalai range**




## Electrical Conductivity (EC)

The electrical conductivity values ranged from 0.37 to 1.34 $dSm^{-1}$. The comparison of mean values of all the samples showed (Table 2) that the soils of 1000-1200 MSL registered higher value (1.34 $dSm^{-1}$) of electrical conductivity followed by 800-1000 MSL (0.69 $dSm^{-1}$) and 1200-1400 MSL (0.37 $dSm^{-1}$). Among the soil samples analyzed, the lowest EC (0.37) was observed in the 1200-1400 MSL of semi evergreen forest (Fig.2). In this altitudinal interval, presence of grassland patches might be the reason for low EC value. These findings corroborated with that of Saravanakumar and Kaviyarasan (2010) in their study on electrical conductivity values at shola forest in Nilgiris. Similarly Sonaimuthu (2016) observed 0.06 $dSm^{-1}$ in shola forest and grassland of Udhagai range, Nilgiri, South forest division.

**Figure 2. Soil EC in different altitudinal interval of Thalamalai range**

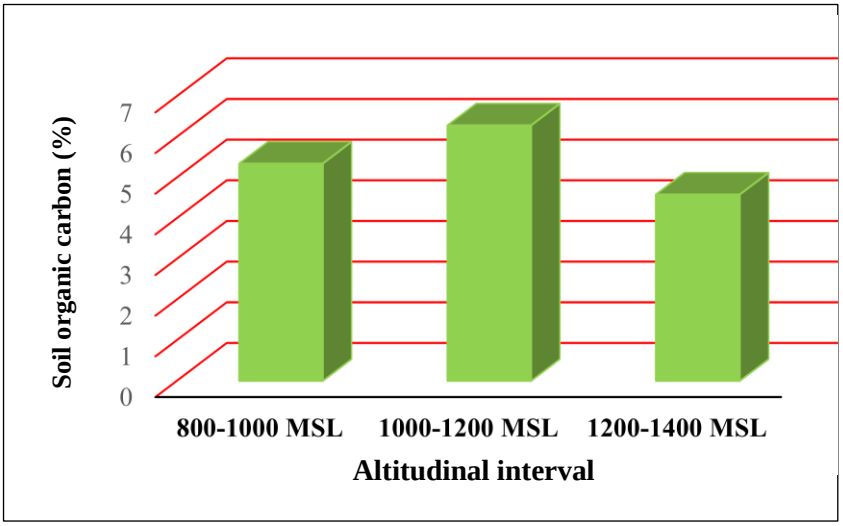


## Soil chemical properties

### Soil Organic Carbon

The organic carbon content of samples ranged from 4.58 to 6.28 % The overall mean values of all the samples showed that the soils of 1000-1200 MSL recorded higher value of organic carbon content (6.28%) followed by 800-1000 MSL (5.34 %).The soils of 1200-1400 MSL observed the lowest mean value for organic carbon (4.58 %) (Table 2). The samples showed that the soils of 1000-1200 MSL of moist deciduous forest recorded higher value of organic carbon content of 6.28 percent (Fig.2). This might be due to the presence of high floral species diversity and richness in this area. The high floral diversity contributes organic matter to the soil in the form of leaf litter which directly influences the organic carbon content of the soil. The higher accumulation of soil organic matter in the forest soils than the other land use soils may be due to the continuous accumulation of undecayed and partially decomposed plant and animal residues in the surface soils as reported by Lechisa Takele *et al.* (2014). Similarly Sonaimuthu (2016) has also observed 9.45 percent of organic carbon in shola forest of Udhagai range, Nilgiri, South forest division.

**Figure 3. Soil organic carbon (%) in different altitudinal interval of Thalamalai range**




### Soil available nitrogen

The available nitrogen content of samples ranged from 203 to 327 kg ha-1.A comparison of mean values of all the soil samples analyzed for available nitrogen showed that the 1000-1200 MSL recorded higher value (327 kg $ha^{-1}$), followed by the soils of 800-1000 MSL (238 kg $ha^{-1}$).The 1200-1400 MSL soil recorded the lowest mean value (203 kg $ha^{-1}$) of available nitrogen (Table 2). The soil samples analyzed for available nitrogen showed that the 1000-1200 MSL of moist deciduous forest has recorded highest value of 327 kg $ha^{-1}$ (Fig.4). Regular addition of plant residues on the soil and decomposition, might be the reason for the higher nitrogen content

in this area. Similarly Sonaimuthu (2016) also observed higher nitrogen upto 583.4 kg $ha^{-1}$ in shola forest of Udhagai range, Nilgiri, South forest division. The present investigation also finds support with the work of Venkatachalam *et al.* (2007) who has reported that high amount of nitrogen in shola forest (306.91 kg $ha^{-1}$).

**Soil available phosphorus**

The available phosphorus content of the samples collected from different altitudinal interval ranged from 44 kg $ha^{-1}$to 50 kg $ha^{-1}$. Among the mean values of available phosphorus content of all the samples, the soils of 1200-1400 MSL recorded higher value (50 kg $ha^{-1}$) followed by 1000-1200 MSL (47 kg $ha^{-1}$). The 800-1000 MSL soil recorded the lower value of 44 kg $ha^{-1}$ available phosphorus (Table 2). Among the mean values of available P content of all the samples, the soils of 1200-1400 MSL of semi evergreen forest recorded higher value of 50 kg $ha^{-1}$ (Fig.4). The phosphorus is the ore based mineral which has no influence by plant communities in that area and this might be the reason for higher phosphorus content in that area. Similar results were also reported by Mani *et al*. (2006) that the highest available phosphorus content was recorded in sholas and minimum was found in moist deciduous forest.

**Soil available potassium**

The soil analysis on available potassium content of all the altitudinal interval the values ranged from 139 kg ha-1 to 165 kg $ha^{-1}$. Among the mean values of available potassium content of all the samples, the soils of 1000-1200 MSL recorded higher value (165 kg $ha^{-1}$), followed by 800-1000 MSL (148 kg $ha^{-1}$). The 1200-1400 MSL registered the lower value (139 kg $ha^{-1}$) for available potassium content (Table 2). The available potassium content of all the samples, the soils of 1000-1200 MSL of moist deciduous forest recorded higher value of 165 kg $ha^{-1}$ (Fig.4). The floral species diversity was very high in this area and this might be the reason for the higher potassium content in the soil. The values of available potassium in the present study are similar to those recorded by Venkatachalam *et al.* (2007) who has reported it in some parts of the Nilgiris, Tamil Nadu, but in general varied considerably.

**Figure 4. Soil available nitrogen, phosphorus and potassium in different altitudinal interval of Thalamalai range**

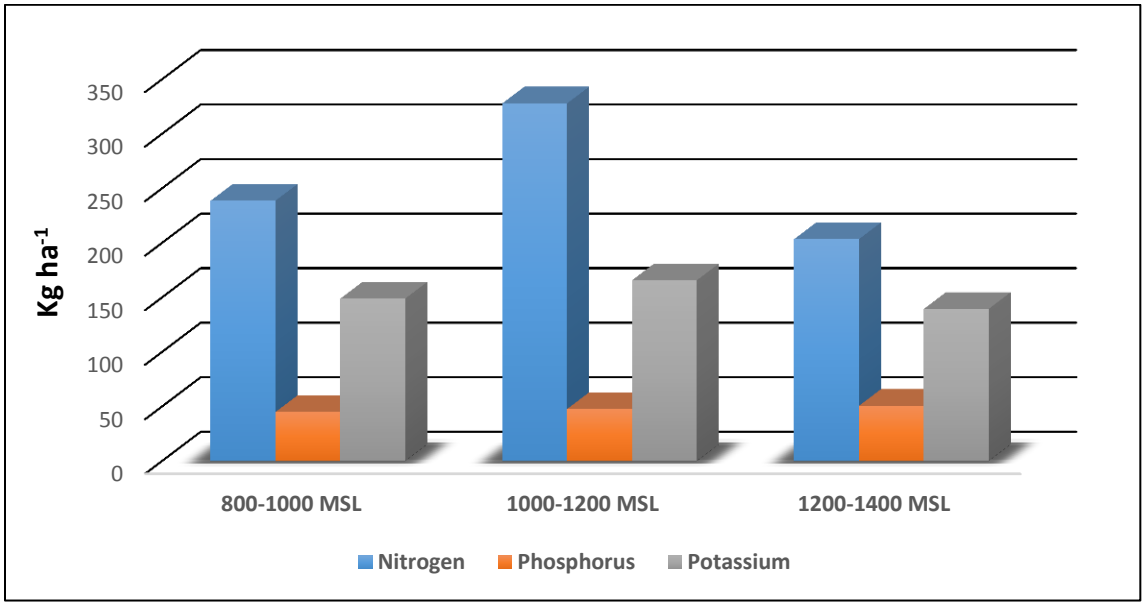



**Table 2: Soil physico-chemical and chemical properties in different altitudinal interval of Thalamalai range**

| S.No. | Altitudinal interval | pH | EC | Soil organic carbon (%) | Soil available Nitrogen (kg ha$^{-1}$) | Soil available Phosphorus (kg ha$^{-1}$) | Soil available Potassium (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| 1. | 800-1000 MSL | 7.34 | 0.69 | 5.34 | 238 | 44 | 148 |
| 2. | 1000-1200 MSL | 7.29 | 1.34 | 6.28 | 327 | 47 | 165 |
| 3. | 1200-1400 MSL | 5.48 | 0.37 | 4.58 | 203 | 50 | 139 |

## CONCLUSION

In altitudinal interval of 1000-1200 MSL the acidic pH value was registered. The electrical conductivity, soil organic carbon, available soil nitrogen and available soil potassium was higher in 1000-1200 MSL and available soil phosphorus was higher in 1200-1400 MSL. This range acts as transition zone for both Sathyamangalam forest division and Hasanur forest division with varying altitude from 800 MSL to 1400 MSL. Presence of three different forest type located in this area results in the high floral diversity. In turn floral diversity directly contributed to the soil properties. In case of soil organic carbon and soil nitrogen content it was very high in these region because of the high floral composition which resulted in the proper nutrient recycling in this area. The present study pictured about the soil properties of Thalamalai

range in Sathyamangalam tiger reserve according to various altitudinal gradient. This will serve as data base for soil properties of the study area and which can be further used for the soil management and soil conservation works in this area in the future, pertaining to habit improvement programs and future management and conservation activities in this area.

**REFERNCES:**

Bray, R.H. and L.T. Kurtz. 1945. Determination of total, organic and available forms of phosphrous in soils. **Soil Sci.** 59: 39-45

Forest survey of India .2015. **India state of forest report**.

Gairola Sumeet, C.M. Sharma, S.K. Ghildiyal and Sarvesh Suyal. 2012. Chemical properties of soils in relation to forest composition in moist temperate valley slopes of Garhwal Himalaya, India. Environmentalist.

Jackson, M.L. 1973. Soil chemical analysis. Prentice Hall of India (P) Ltd., New Delhi. 260 p.

Lechisa Takele, Achalu Chimdi and Alemayehu Abebaw. 2014. Dynamics of Soil Fertility as Influenced by Different Land Use Systems and Soil Depth in West Showa Zone, Gindeberet District, Ethiopia. **Agriculture, Forestry and Fisheries.** Vol. 3, No. 6, pp. 489-494.

Management Plan Sathyamangalam wild life sanctuary, 2011. Sathyamangalam forest division.

Mani, A.K., S. Manivasakan and R. Santhi. 2006. Impact of forest types on soil properties. **International Forestry and Environment Symposium.** Forest College and Research Institute, Tamil Nadu Agricultural University, India.

Paudel, S. and J.P. Sha. 2013. Physio-chemical characteristics of soil in tropical sal (Shorea robusta Gaertn.) forest in eastern Nepal. **Himalayan J. Sci., 1**(2): 107-110.

Sannappa, B. and K.G. Manjunath. 2013. Fertility Status of Soils in the Selected Regions of the Western Ghats of Karnataka, **India. Sch. Acad. J. Biosci., 1**(5):200-208.

Saravanakumar, K. and V. Kaviyarasan. 2010. Seasonal distribution of soil fungi and chemical properties of montane wet temperate forest types of Tamil Nadu. **African Journal of Plant Science, 4**(6): 190-196.

Sonaimuthu, M. 2016. Studies on Soil Quality Status as Influenced by Different Land Uses in Udhagai Range, Nilgiri South Forest Division, Tamil Nadu, **M.Sc. Thesis,** Forest College and Research Institute, Mettupalayam.

Stanford, S. and L. English. 1949. Use of flame photometer in rapid soil tests of K and Ca. Agron. J. 4: 446-447.

Subbiah, B.V. and G.L. Asija. 1956. A rapid method for estimation of available N in soil. **Current Science, 25**: 259-260.

Venkatachalam, S., T. Kalaiselvi, Neelakantan and S. Gunasekaran. 2007. "A Comparative Study on Soil Microflora and Nutrient Status of Sholas and Adjoining Vegetation," **Indian Journal of Forestry**, Vol. 30, pp. 135-140.

Walkley, A and T.A. Black. 1934. An examination of the wet acid method for determining soil organic matter and proposed modification of the chromic acid titration method. Soil Sci., 37: 29-38.