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Geography

IMPACT OF ALTITUDE ON SOIL PHYSICAL AND CHEMICAL PROPERTIES IN YERCAUD HILLS, EASTERN GHATS, TAMIL NADU, SOUTHERN INDIA

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ABSTRACT The objective of this study was to investigate the changes in soil physical and chemical properties across four different elevation of an area. Soil samples were collected from four different locations is pointed. The results obtained that the soil physico-chemical properties of collected soil samples show significant correlation with the elevation gradient. Organic matter content of soil was positively correlated to the altitude it decreases. The soil carbon amount increased with increase in altitude at correlation coefficient 0.334. Soil pH shows minor changes with the elevation gradient. EC were minimum at 0.32 and maximum at 0.48. While the micro-macro nutrients of soil samples also show significant results towards altitude gradient. The percentage of available phosphorus, iron and copper content in the soil increased with increasing altitude with the rate of correlation coefficient 0.959, 0.170 and 0.807 respectively. While the percentage of available manganese, boron and sulphate show some different pattern it increased at between the elevations. All the physical parameters and macro-micro nutrients showed significant ($P< 0.001$) while some chemical parameters were significant at ($P < 0.05$. $P< 0.01$ and $P< 0.001$).The future trend of this study will play an important role in understanding the changes in soil properties and its impact on plants genetic diversity and phytochemical variations with altitude gradient.

KEYWORDS : Altitude, soil, physical-chemical, impact

INTRODUCTION

The term soil is usually defined as a complex mixture of eroded rock, mineral nutrients' decaying organic matter, water, air, and living organisms, most of them are microscopic decomposers (Miller, 2007). The altitudinal gradient of hill is characterized by variable temperature and precipitation records. Variable temperature and moisture differences generated from elevation and aspect gradients may have the same effect on organic matter decomposition (Griffiths *et al*., 2009). There were considerable changes in horizon composition, including dramatic differences in soil texture, horizon depth and temperature. There were correlation between soil chemistry and elevation (Bromley, 1995). Soil pH may also control biotic factors such as the activity and biomass composition. The change in altitudinal gradients influences soil organic matter by controlling soil water balance, soil erosion, geologic deposition processes, species and biomass production of the native vegetation and cultivated plants (Tan *et al*., 2004). Change in other soil properties have been found to be more variable, perhaps due to differences in climate, crop rotation, soil type or length of time and soil has been under organic management (Lockeretz, *et al*., 1981). In the present study reported that the relationship between soil micro-macro chemical compositions. This result showed that an increase in the humidity increases the percentage of organic carbon, nitrogen and other soil nutrients. The result indicated that the physical and chemical compositions of soils are directly related to elevation and climatic conditions of study area.

MATERIALS AND METHODS

Collection site

The Yercaud hills is one of the major hill ranges on the southwest of the Eastern Ghats, in Salem district of Tamil Nadu. It is located between 11°46' to 11°77'N latitudes and 78°12' to 78°20'E longitudes. It covers an area of 470 km^2. The elevation ranges from 400 - 1600 m above mean sea level, it rich in archaean chamokites with a few belts of granite gneiss (Krishnan, 1956). The soil is red, loamy, lateritic, brown calcareous type. The forest receives both southwest (June - September) and northeast (October - December) monsoon rains, but the latter brings copious rain. The mean annual rainfall is 1500 – 2000 mm.

Collection of soil samples

Four sites were selected with different elevations. From the selective sites, soil samples were collected (1000 g) in the depth of 15 cm. from the surface of land, which were taken in polythene bags. The soil samples were collected in the month of December 2014 from the four different selective elevation sites. These samples were brought to the laboratory for further analysis. The physico-chemical analysis of soil samples were carried out by the standard procedure recommended by Trivedi and Goel (1989). The soil samples were dried in oven to 105°C about 24 hours and grinded more finely. This powder was passed through 2 mm sieve and stored in polythene bag. The pH and electrical conductivity of soil can be measured. Total Chloride was determined by titrating it with $AgNO_3$. Total alkalinity was determined by titrating it with N/50 HCl using phenolphthalein and methyl orange as indicator. Sulphate was determined by gravimetric method. Organic matter was determined by titrating with ferrous ammonium sulphate. Na and K in the soil samples are determined by using the digital flame photometer.

Statistical Analysis

Data were statistically analyzed. An analysis of variance was used to test differences in soil physical and chemical properties across the different elevation sites of an area. Data analyses were done using a statistical software (Statistix 10) package. To seek the relationship between elevations. Correlation and regression analyses were performed. Correlations between soil variables were also performed with the software Graphpad Prism 5.0.

RESULTS AND DISCUSSION

The soil pH low at 6.46 in 800m of elevation, while maximum 7.32 in 1200m of elevation (Table 1). Soil EC was minimum at 400m (0.32) and maximum at 800m (0.48). Correlation significant differences in EC. These findings indicate that no major difference in cumulative salt accumulation along the altitude. However, decreasing trend of pH and TDS from lower altitude (10000-11000 ft amsl) to higher altitude shows that at lower altitude sites have more cumulative salt accumulation rather than higher altitude sites. This may be due to the higher accumulation of base forming cations like Ca^{+2}, Mg^{+2}, K^{+} and higher accumulation of $CaCO_3$ (Northcott *et al*., 2009). The total minerals in the soil are decreasing with the increase in altitude (Table 1). That may be due to temperature because temperature decreases as altitude increases and the amount of organic material decreases because it becomes more difficult for plants to survive at higher altitudes (Bromley, 1995). The soil organic carbon amount was increases as altitude increases (Fig. 1) similar results were observed by Sevgi (2003). Nitrogen amount was increases as elevation increases (Fig. 4).

Calcium shows negative correlation it decreased with the increase in altitude with the rate of correlation (Table 1) Maximum value 58.04% at 400 m and minimum 38.76% at 1600m elevation (Table 1). Panthi (2000) reported which was might be due to change in temperature. As the temperature influence the calcium equilibrium directly. Elevation gain also seems to affect the soil texture and more correlation between soil chemistry and elevation. The previous work and present study suggested the organic matter decreased with increase in altitude reported by Bromley, 1995; Panthi, 2010. Results of micro-macro nutrients revealed significant correlation with the altitude gradient that the percentage of available copper and phosphorus content in the soil is increasing with the increase of altitude (Table 1). And the rate of correlation coefficient is 0.807 and 0.959 respectively at $P<0.001$ significance. Available phosphorus content were maximum at 1600m same were the results (Panthi, 2010) at elevation 2216m show the maximum range which shows the elevation range with the our site

elevation range. Manganese, iron and show some different pattern it increased at between the elevations (Table 1). Zinc and boron show different pattern in the various elevations (Fig 12). Level of rainfall, snowfall, and temperature variation affects organic matter decomposition that affects accumulation of organic matter with elevation (Walker *et al*., 2000).

The similarity coefficient values minimum (83.55%) between 400m and 1600m range of elevation, and Maximum (95.40%) between 800m and 1200m elevation (Table 2). The physico-chemical characters are both positively and negatively correlated this pattern formation to influence the different characteristics of soil (Figs. 1-12). The soil chemical properties are similar in elevation of 400m to 1200m. But chemical nature of soil is clear negatively correlated. Results of micro and macro nutrients revealed significant correlation with the altitude gradient that the percentage of available ferrous, boron, sulphate content in the soil is increasing with the increase in altitude (Table 1).

Level of rainfall, snowfall, and temperature variation affects organic matter decomposition that affects accumulation of organic matter with elevation (Walker *et al*., 2000). These changes in microenvironment may affect physico-chemical characteristics of soil in this region hence there is need to study the physico-chemical characteristics of soil in this area. Many soil fertility characteristics such as organic matter content, pH, cation exchange capacity, phosphate sorption, and phosphorus availability show significant altitudinal variations (Jobbagy and Jackson, 2000).

Soil properties generally reflected the climatic conditions, in particularly higher moisture and cooler temperatures experienced at the higher altitudes. This produced a general decrease in nutrients and pH with increased altitude (Fig. 2). In contrast, soil moisture, organic matter content increased with increasing altitude. These trends are consistent with other studies and suggest that leaching of nutrients caused by higher moisture levels at the higher altitudes is highly probable and that the buildup of organic matter may reflect low microbial turnover rates due to cooler, wetter conditions. However further seasonal fluctuation experimentation is required to test this hypothesis.

Table - 1 Altitudinal variation in physical and chemical properties across different elevations in Yercaud hills

Analysis	Elevation (in meter)			
	400	800	1200	1600
pH	7.36	6.46	7.32	6.91
EC	0.32	0.48	0.35	0.36
Carbon	1.31	1.46	1.61	1.93
Nitrogen	9.52	9.86	10.35	11.48
Phosphorus	1.26	1.23	1.38	1.36
Calcium	58.04	53.43	54.74	38.76
Megnesium	15.97	18.19	15.62	16.04
Sodium	9.89	9.82	9.35	10.68
Ferrous	1.21	1.32	1.39	1.59
Manganese	0.87	0.64	0.6	0.71
Copper	0.12	0.13	0.12	0.13
Zinc	0.12	0.17	0.17	0.15
Boron	0.05	0.05	0.07	0.09
Sulphate	1.27	1.45	1.61	1.79
Total minerals	16.84	19.77	25.35	31.07

Table - 2 Similarity coefficient of chemical properties of soil with different elevation

Similarity co-relation		**Elevations**		
	400	**800**	**1200**	**1600**
400	*	95.32	93.79	83.55
800	*	*	95.40	86.30
1200	*	*	*	89.30
1600	*	*	*	*

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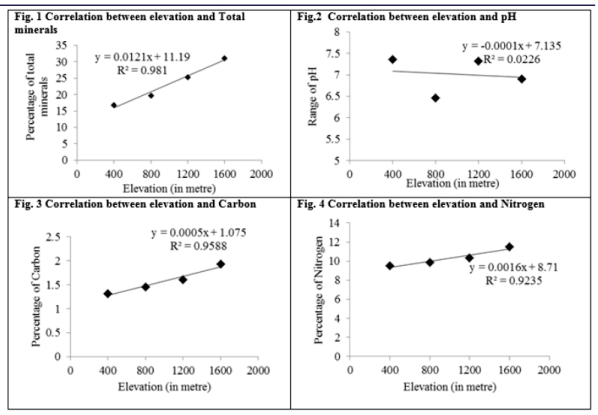

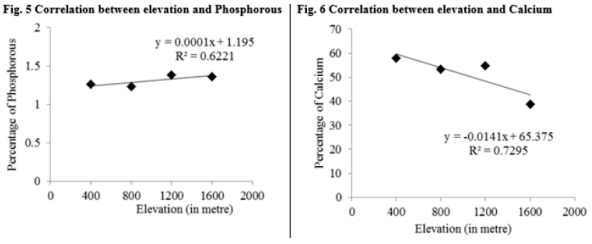

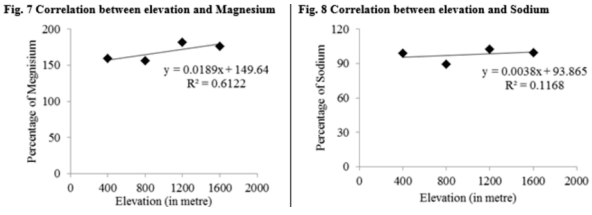

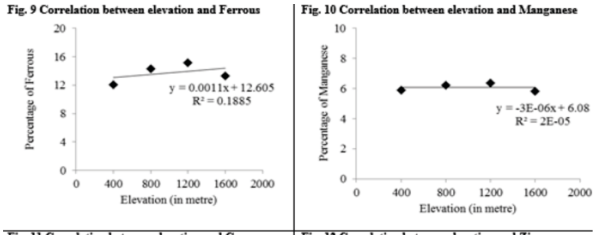

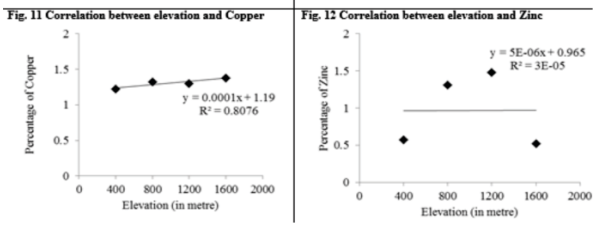

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