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SOIL VARIABILITY IN A TROPICAL MOIST DECIDUOUS FOREST OF KERALA, INDIA

M.P. Sujatha & T. P. Thomas

Soil Science Division, Kerala Forest Research Institute, Peechi, Thrissur 680 653, India

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SUJATHA, M.P. & THOMAS, T.P. 1997. Soil variability in a tropical moist deciduous forest of Kerala, India. This study examines the extent of interplot (10 x 10 m) variation in soil properties in a tropical moist deciduous forest of Kerala. Soil properties in their ascending order of variation are pH < sand+ silt + clay content < exchangeable bases < organic carbon < gravel content < exchange acidity. The variations in all properties except pH and sand + silt + clay content are found to be statistically significant. Percentile distribution of all properties except exchange acidity is higher at the medium range and starts decreasing towards the extremities.

Key words: Soil variability - tropical moist deciduous forest - percentile distribution

SUJATHA, M.P. & THOMAS, T.P. 1997. Perubahan tanah di hutan daun luruh lembab tropika di Kerala, India. Kajian ini menguji takat perubahan interplot (10 x 10 m) bagi ciri-ciri suatu hutan daun luruh lembap tropika di Kerala. Ciri-ciri tanah dalam susunan menaik ialah pH < kandungan pasir + kelodak + tanah liat < kandungan bes boleh tukar < kandungan karbon organik < kandungan kerikil < kandungan keasidan tukaran. Perubahan dalam semua ciri kecuali pH dan kandungan pasir + kelodak + tanah liat didapati ketara secara statistik. Peratus taburan semua ciri, kecuali keasidan tukaran, didapati lebih tinggi pada julat pertengahan dan mula menurun ke arah bahagian hujung.

Introduction

Heterogeneity of soil is always a problem encountered in field experiments. In order to minimise the errors in field experimental results, quantification of soil variability seems to be essential. Moreover, the measure of heterogeneity in soil variables stands as an added property in basic soil studies. Variability in different soil morphological and physico-chemical properties has been summarised by Beckett and Webster (1971). It is assumed that forest ecosystem with its diversified flora, fauna and abundant litter layer aggravates the variability of soil. A wide array of investigations on spatial variability of different soil parameters have been reported elsewhere (Mausbach *et al.* 1980, David & Wang 1989, Di & Kemp 1989, Stolt *et al.* 1993), very few in India (Prasad & Gupta 1990, Baraugh *et al.* 1992) and none in Kerala, especially in forest ecosystems. Hence the present study attempts to display the extent of interplot variation in soil properties in a tropical moist deciduous forest of Kerala.

Materials and methods

Study area

The study area (10°30' N, 76°22' E) situated in the Peechi Range of Thrissur Forest Division, Kerala is located at an elevation of about 180 m a.s.l. It has been receiving a mean annual rainfall of 2793 mm for the past 10 years with minimum and maximum temperatures of 18.9 °C and 39.4 °C respectively. The site is characterised by a gentle slope facing southeast. A closed canopy, recurrent fires and the presence of a large number of big boulders are the remarkable features of the study plot.

Sampling and chemical analysis

An area of 2 ha was divided into 100 m^2 subplots. The 200 subplots thus demarcated were utilised for the present study. Surface soil samples (0-20cm) were taken from the centre of each plot, air dried and sieved through 2 mm sieve. Gravel content (2- 75mm) was determined and the 2 mm sieved soil was subjected to the following analyses: organic carbon (dichromate oxidation), pH (20:40 soil water suspension), exchange acidity (0.5 N barium acetate extraction) and exchangeable bases (0.1 N hydrochloric acid extraction).

Statistical analysis

Descriptive statistics of the data were calculated following Snedecor and Cochran (1975). To study the percentile distribution, the 200 values in the ascending order of each property were divided into five groups, the minimum and maximum values of each group were used to form the range of each property in each group. The percentile distribution of each property was then computed.

Results and discussion

The mean, minimum and maximum values of the soil properties are given in Table 1. Among the properties studied, exchange acidity showed the highest coefficient of variation (48.5%) and pH the least (3.4%). The coefficients of variation for other properties, viz. gravel content (G), sand + silt + clay content (S+Si+C), organic carbon (OC), and exchangeable bases (EB), are 32.3%, 9.3%, 22.3% and 18.4% respectively. Soil properties in their ascending order of variation are pH <S+Si+C <EB <OC <G <EA. The variations in all properties except pH and sand + silt + clay content are found to be statistically significant since their coefficients of variation fall above 10%. Correlations existing between the properties studied are shown in Table 2.

Relatively low natural spatial variation of pH in different situations has already been established by various workers (Haines & Cleveland 1981, Prasad & Gupta 1990). The present study also records the same trend for pH. As expected, a significant negative correlation is observed between pH and exchange acidity. The soil separates which follow pH immediately in the ascending order are also found to keep the spatial homogeneity in a better way.

Table 1. Descriptive statistics of surface soil properties

Soil property	Mean	n-1	CV (%)	Minimum	Maximum
G (g kg^{-1})	223	72	32.3	69	405
S+Si+C (g kg^{-1})	777	72	9.3	595	931
OC (g kg^{-1})	21	4.7	22.3	9	35
pH	5.8	0.2	3.4	5.3	6.3
EA (mg kg^{-1})	33	16	48.5	7	78
EB (mg kg^{-1})	163	30	18.4	79	245

n = 200

CV = coefficient of variation; G = gravel content; S+Si+C = sand+silt+clay content; OC = organic carbon; EA = exchange acidity; EB = exchangeable bases.

Table 2. Correlation matrix of surface soil properties

Soil property	G	S+Si+C	OC	pH	EA	EB
S+Si+C	- 0.999					
OC	- 0.499	0.499				
pH	- 0.173	- 0.174	0.115			
EA	- 0.272	0.273	0.039	- 0.628		
EB	- 0.454	0.454	0.628	0.360	- 0.023	

n = 200

Table 3. Range of soil properties in each group formed to study the percentile distribution

Soil property	Range				
	I	II	III	IV	V
G (g kg^{-1})	69 - 157	157 - 219	219 - 281	281 - 343	343 - 405
S+Si+C (g kg^{-1})	595 - 657	657 - 719	719 - 781	781 - 843	843 - 931
OC (g kg^{-1})	9 - 14	14 - 19	19 - 24	24 - 29	29 - 35
pH	5.3 - 5.5	5.5 - 5.7	5.7 - 5.9	5.9 - 6.1	6.1 - 6.3
EA (mg kg^{-1})	7 - 20	20 - 34	34 - 47	47 - 61	61 - 78
EB (mg kg^{-1})	79 - 112	112 - 145	145 - 178	178 - 211	211 - 245

n = 200

Table 4. Percentile distribution of surface soil properties

Soil property	Percentile distribution				
	I	II	III	IV	V
G	19	35	24	16	6
S+Si+C	6	17	23	36	18
OC	7	28	33	27	5
pH	1	15	54	18	12
EA	35	22	24	15	4
EB	4	17	50	21	8

n = 200

Unlike the above two properties, exchangeable bases and organic carbon show significant interplot variation and there exists a significant positive correlation between these properties. In the ascending order, gravel comes next to organic carbon with coefficient of variation of 32.3 %. The exchange acidity, occupying the final position of ascending order, shows the highest variation (48.5%).

The study area enjoys a mean annual rainfall of about 2793 mm and this allows most of the bases to move downward resulting in a homogenous acid condition irrespective of the floral and faunal variations. The gentle slope of the plot reduces loss of fine soil separates through erosion and this prevents the irregular distribution of these particles among the subplots.

The significant variation shown by organic carbon and exchange properties is explained by the highly diversified vegetation occurring in each subplot (Swarupanandan & Sasidharan 1992) as well as the associated variations in soil biology and mineralisation process. It is assumed that the large number of big granitic boulders present in some of the subplots might account for the highly significant variation in the coarser particles, termed gravel.

Analysis of the percentile distribution (Table 3) also provides some interesting information on the distribution of soil properties in the study area. Gravel and exchange acidity are maximum (35) in the ranges 157- 219 g kg^{-1} and 7-20 mg kg^{-1} respectively. The highest distribution (36) of sand + silt + clay lies in the range 781-843 g kg^{-1}. Nearly half of the area falls in the ranges 5.7 - 5.9 and 145 -178 mg kg^{-1} in the case of pH and exchangeable bases respectively. Organic carbon shows the highest distribution (33) in the 19-24 g kg^{-1} range. However, it is found that percentile distribution of all properties except exchange acidity is higher at the medium range and decreases towards the extremities.

Conclusion

On the basis of the above study, soil heterogeneity does occur in the present study site and the soil properties in their ascending order of variation are pH<S+Si+C <EB<OC <G <EA . The variations in all the properties except pH and sand+silt+clay content are found to be significant statistically. Percentile distribution

of soil variables except exchange acidity is higher at the medium range and shows a tendency to decrease towards both ends.

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