SOIL PROPERTIES IN TEAK, BOMBAX AND EUCALYPT PLANTATIONS OF TRICHUR FOREST DIVISION, KERALA

M. Balagopalan, T.P. Thomas, M.V. Mary, S. Sankar & T.G. Alexander

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

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Key words: Soil properties - teak - bombax - eucalypt - uncoppiced - coppiced plantations

BALAGOPALAN, M., THOMAS, T.P., MARY, M.V., SANKAR, S. & ALEXANDER, T.G. 1992. Sifat tanah di ladang-ladang jati,bombax dan eucalypt di Bahagian Hutan Trichur, Kerala. Kertas kerja ini menerangkan sifat dan keadaan tanah dalam ladang-ladang monokultur jati, eucalypt (kopis dan tidak kopis), dan dirian campuran jati dan bombax. Diantara sifat-sifat tanah yang di selidiki ialah ketumpatan pukal, saiz zarah terasing, pH tanah, karbon organik,pertukaran basa dan pertukaran keasaman. Sifat kimia di ladang-ladang ini berbeza berbanding dengan sifat fizikal. Nilai yang agak rendah untuk pH, karbon organik pertukaran bes , pertukaran asiditi dalam ladang jati dan eucalypt (kopis dan tidak kopis) berbanding dengan ladang jati dan bombax, memerlukan tindakan positif bagi ladang jati dan eucalypt untuk memelihara dan meninggikan kesuburan tanah.

Introduction

Scientific forestry demands a thorough knowledge of the nature and properties of soils just as those in agriculture. All the vital properties of soils more or less influence the nature of the vegetation, both natural and man-made and *vice versa* (Aweto 1981, Verma *et al.* 1982, Hornung 1985, Kadeba & Advayi 1985, Lescure & Boulet 1985).

With few exceptions, in Kerala large scale conversion of various types of natural forests to intensively managed tree monocultures for timber and industrial raw material in wood pulp industries is a rather recent development. Taking the pattern in the distribution of the vegetational components and the soil characteristics together, it is possible to see that alteration in the canopy brings about changes in soil properties. Following canopy closure and up to the time of final felling, the tree crop and its ecological characteristics exert a dominant influence on soil and nutrient dynamics along with the management practices such as thinning and rotation of species (Turner & Kelly 1977). Although a number of studies on

plantation soils of different species in a composite area have been conducted (Evans 1976, Chijioke 1980, Singh 1985, Allen 1986, Aborisade & Aweto 1990), very few attempts have so far been made under Kerala conditions (Alexander *et al.* 1981a,b). This study was undertaken to evaluate the physical and chemical properties of soils in plantations of teak, bombax and eucalypt in the Trichur Forest Division, Kerala.

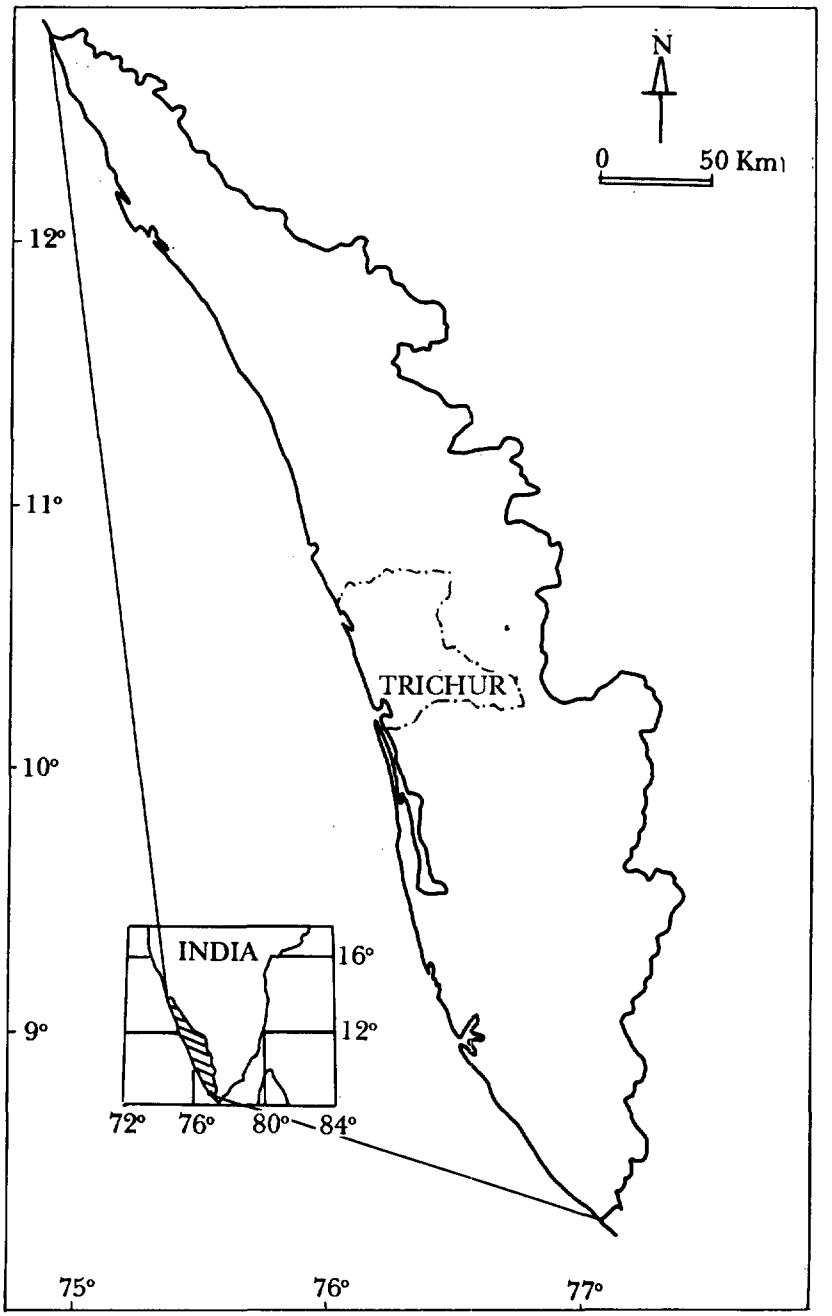

Figure 1. Location of study area in Kerala, India

Materials and methods

The study area, Trichur Forest Division, located in the central part of Kerala State in southwest India has a warm humid climate (Figure 1). The main sources of atmospheric precipitation are the southwest and northeast monsoons. The annual rainfall for the last ten years (1978-1987) was between 2397 and 3600 *mm* with the average value being 2793 *mm* (Balagopalan 1991).

The temperature extremes recorded for the past few years are 18.9 and 39.4°*C*. Relative humidity is also greater than 55 and attains 100% during the rainy days. Generally, June to October are wet months and November to May are dry. The predominant parent material seen is of metamorphic rocks of the gneiss series.

Teak (*Tectona grandis*), teak and bombax (*Bombax ceiba*) and eucalypt (*Eucalyptus tereticornis*) plantations dominate in Trichur Forest Division and they have been planted mostly during the middle and latter half of this century. Some of the eucalypt plantations after ten years have been harvested and they are now under second rotation (coppiced). Study sites were selected randomly in teak, teak and bombax, eucalypt (uncoppiced and coppiced) plantations in proportion to their total area. For this a survey was carried out in these four plantations, having maximum stocking. Fifteen teak, 14 eucalypt (uncoppiced), five each for teak and bombax and eucalypt (coppiced) plantations were selected. The year of establishment, elevation and other details of plantations are presented in Table 1. In each plantation, an area having dominant trees was demarcated and one 20×20 *m* plot was laid out randomly. The study plots in the four plantations were widely scattered and are depicted in Figure 2. One soil pit was taken from each plot and samples were collected from 0 to 20, 20 to 40 and 40 to 60 *cm* layers of soil pits. One sample each was also taken from 0 to 20 *cm* layer for bulk density determination. Soil samples were air-dried, passed through 2 *mm* sieve and the following analyses were carried out on the < 2 *mm* portion based on the procedures in ASA Monograph (1965): sand, silt and clay by hydrometer; soil pH in 20:40 soil-water suspension; organic carbon by potassium dichromate-sulphuric acid wet digestion; exchangeable bases by 0.1 *N* hydrochloric acid; and exchange acidity by 0.5 *N* barium acetate.

Mean values of bulk density ($g\ cm^{-3}$), gravel (2-75 *mm*), sand, silt, clay, organic carbon, all in percent, soil pH, and exchangeable bases and exchange acidity, both in *meq* % in different plantations are presented in Table 2.

The soils in the teak plantations were well drained and severely eroded especially in younger plantations, while in teak and bombax, they were well drained and slightly eroded. In the case of the eucalypt (uncoppiced and coppiced) plantations, the soils were well drained with slight to severe erosion in most of the plantations in the former and in all plantations in the latter.

Correlation coefficients were also computed for measuring the extent of linear association among different soil properties in each plantation in the 0 to 60 *cm* layer.

For comparing properties in teak, teak and bombax, eucalypt (uncoppiced and coppiced) plantations, soils in the 0 to 60 *cm* layer were considered.

Table 1. Description of plantations

Locales of plantations	Year of establishment	Elevation (*m*, asl)
Teak:		
Vazhani	1959	80
Enkakkad	1949	50
Kakkinikkad	1944	"
Kundukkad	1954	"
Kattilapoovam	1974	"
Chittanda	1954	25
Pooduruthi	1950	50
Akamala	1954	"
Potta	1964	25
Pottankod	1954	80
Thalamuriankulamb	1920	"
Cherukunnu	1944	50
Payampillymoola	1934	80
Alpara	1944	25
Pothuchadi	1975	50
Teak + Bombax:		
Machad	1954	25
Vennor	1962	80
Vallikkayam	1968	"
Vanchikkadam	"	"
Adukkilappara	1973	120
Eucalypt (uncoppiced):		
Kurancheri	1976	80
Chittanda	1977	"
Mayannoor	1980	"
Kondazhi	1979	100
Kayampoovam	1980	80
Elanad	1983	80
Killimangalam	1978	100
Pulakkod	1980	90
Mannamangalam	1978	50
Chittakunnu	1976	130
Chempamkandam	1977	100
Vallikkayam	1973	50
Chennaippara	1977	100
Marroticha1	"	150
Eucalypt (coppiced):		
Pazhoori	1977	80
Kuzhipot	"	"
Cheenagund	"	"
Veetikkunu	1978	"
Thonnoorkara	1983	"

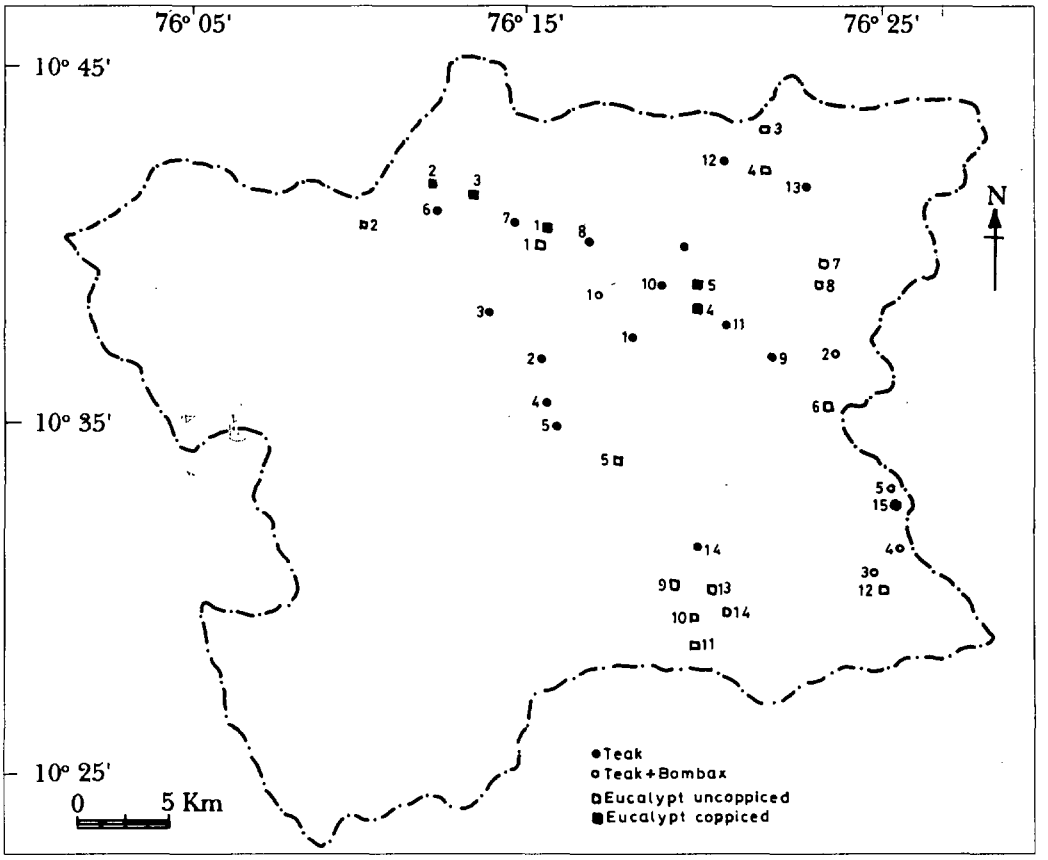

Figure 2. Study plots in the four plantations

Results and discussion

In the teak plantation, gravel, silt, clay and soil pH increased while sand, organic carbon and exchange acidity decreased with depth. There was no trend for exchangeable bases in the three layers. The soil was loam and slightly acidic in all the three layers.

In the teak and bombax plantation, gravel, clay and soil pH increased whereas sand, organic carbon and exchange acidity declined with depth. For silt, the values remained the same while there was no trend for exchangeable bases in the three layers. The soil was loamy sand in the surface and loam in deeper layers. It was slightly acidic in all the layers.

Mean values of sand, silt, organic carbon and exchange acidity diminished while clay and soil pH went up with depth in eucalypt (uncoppiced) plantations. Gravel and exchangeable bases showed no general trend in the three layers. The soil was sandy loam in the surface and loam in deeper layers. It was medium acidic in the surface and 40 to 60 *cm* layers while slightly acidic in the 20 to 40 *cm* layer.

Table 2. Mean values of soil properties in different layers in the four plantations

Properties	Plantations/Layers (*cm*)															
	Teak				Teak + Bombax				Eucalypt (uncoppiced)				Eucalypt (coppiced)			
	0-20	20-40	40-60	0-60	0-20	20-40	40-60	0-60	0-20	20-40	40-60	0-60	0-20	20-40	40-60	0-60
Bulk density ($g\ cm^{-3}$)	1.32	-	-	-	1.27	-	-	-	1.33	-	-	-	1.37	-	-	-
Gravel%	30	32	33	31 (±7.54)	27	41	45	37 (±12.54)	27	30	28	28 (±8.45)	30	37	39	35 (±12.61)
Sand %	74	71	70	71 (±7.12)	74	73	73	75 (± 4.97)	78	76	75	76 (±4.19)	77	73	74	70 (± 3.40)
Silt %	10	11	11	11 (±1.89)	11	11	11	11 (± 2.14)	10	9	9	10 (±1.73)	9	10	11	15 (± 3.92)
Clay %	16	18	19	18 (±4.76)	15	16	16	14 (± 4.03)	12	15	16	14 (±3.33)	14	17	15	15 (±15.07)
Soil pH	6.0	6.2	6.2	6.2 (±0.21)	6.1	6.3	6.4	6.3 (± 0.06)	6.0	6.1	6.1	6.1 (±0.23)	5.9	6.0	6.1	6.0 (± 0.22)
Organic carbon %	1.30	0.76	0.63	0.87 (±0.35)	1.97	1.35	1.07	1.57 (± 0.47)	1.25	0.81	0.67	0.91 (±0.46)	0.96	0.61	0.51	0.70 (± 0.23)
Exchangeable bases *meq* 100 g^{-1}	9.3	10.3	9.2	9.6 (±2.68)	13.1	14.2	13.6	13.6 (± 3.49)	12.7	11.8	12.5	12.3 (±2.94)	8.6	10.5	10.5	10.6 (± 2.73)
Exchange acidity *meq* 100 g^{-1}	5.8	5.2	4.4	5.1 (±1.34)	6.3	5.8	5.4	5.8 (± 0.46)	5.8	4.8	4.2	4.9 (±1.44)	4.9	4.4	3.9	4.5 (± 1.11)

Standard deviation in parentheses

In the eucalypt (coppiced) plantations, gravel, silt, soil pH and exchangeable bases increased while organic carbon and exchange acidity declined with depth. For sand and clay, there was no general trend in the three layers. The soil was sandy loam in the surface and loam in the lower layers. It was medium acidic in the upper two layers while slightly acidic in the 40 to 60 *cm* layer.

Soil properties in different plantations - a comparative study

The soils in the four plantations belong to the group of red soils or oxisols or red ferralitic soils. The colour of these soils is red, of different intensities and hues depending on the content of Fe_2O_3, Al_2O_3 and SiO_2 (Sankar *et al.* 1987).

It could be seen that in the 0 to 60 *cm* layer, the variations in soil physical properties were negligible. Soils in the teak plantation were loam while those in the plantation of teak and bombax and eucalypt, both uncoppiced and coppiced, were sandy loam. Exchangeable bases content was lowest in the teak plantation followed by the eucalypt (coppiced and uncoppiced) plantations. In the case of soils in teak and bombax plantations, pH and exchange acidity values were higher than in the other three plantations. The same trend was followed for organic carbon and exchangeable bases contents. The gravel content was lowest in the eucalypt (uncoppiced) plantations. Soils in the eucalypt (coppiced) plantations had relatively lower pH and exchange acidity values and organic carbon contents. It could be seen that pH, organic carbon, exchangeable bases and exchange acidity differed in these plantations. Soils in the teak, teak and bombax and eucalypt (uncoppiced) plantations were slightly acidic while those in eucalypt (coppiced) plantation were medium acidic. Soils in the teak and bombax plantation had higher organic carbon and exchangeable bases contents and exchange acidity values than those in the eucalypt (coppiced) plantation. As the plantations were in an elevation ranging from 25 to 150 *m*, the effect of elevation on soil characteristics could not be taken into account. The contents of organic carbon and exchangeable bases together reflect the fertility status of the soils. The organic matter is the main storehouse of plant nutrients and is the result of the rhythm in forest growth and development and the rates of constant exchange of matter and energy between plants and soils. The general nature of the deciduous trees to add more bases to the surface soil (Pritchett 1976) supports the relatively high values for soil pH and exchangeable bases in teak and bombax and teak in comparison to eucalypt plantations. The soils in the eucalypt plantation with the oblong conical canopy were more subjected to the action of environmental factors leading to enhanced leaching of bases. This might have led to relatively higher acidity of soils in eucalypt plantations. The low contents of organic carbon observed in eucalypt plantations could be due to slower decomposition of eucalypt litter (Mary & Sankaran 1991).

It was also observed by the presence of iron concretions in most of the soil pits that the content of crystallized forms of iron compounds was higher in soils of eucalypt (coppiced) plantations. These concretions indicated both the onset of the initial stages and various forms of laterisation.

The coefficients of variation for pH, organic carbon, exchangeable bases and exchange acidity values were relatively higher in teak, eucalypt (uncoppiced) and eucalypt (coppiced) plantations. Even though comparison was made only between the four plantation soils, it could be seen that due to disturbances and subsequent plantation activities, soils exhibited wide variability in their properties within each plantation. This might lead to serious nutrient management problems in future. Intercorrelation among soil properties revealed that no property was correlated with others in the four plantations in common. They followed a different pattern. The results indicated relatively high values for pH, organic carbon, exchangeable bases and exchange acidity in teak and bombax plantations.

Conclusion

Studies in teak, teak and bombax, and eucalypt (uncoppiced and coppiced) plantations showed that the nature and properties of soils differed. In general, pH, organic carbon, exchangeable bases and exchange acidity values differed appreciably while variations in soil physical properties were negligible. Soil pH, organic carbon and exchange acidity values decreased in the order: teak + bombax, teak, eucalypt (uncoppiced) and eucalypt (coppiced) plantations. The relatively low values for these soil properties in teak and eucalypt (uncoppiced and coppiced) in relation to teak + bombax plantations warrant positive measures in the former plantations to preserve and enhance the fertility of the land.

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