Studies on some Forest Soils of Kerala*

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Forests cover 26.2 per cent of the total land area *in* Kerala and contribute substantitally to the wealth of the State. The heavy rainfall and hot humid climate of this region provide very congenial conditions for the luxuriant growth of forests. It is well recognised that the composition, growth and distribution of forests is strongly influenced by edaphic conditions. Hence, precise information on the physical and chemical characteristics of forest soils is absolutely essential for a thorough understanding of the soil-vegetation complex and is a pre-requisite for any project of afforestation.

Numerous investigations have been carried out on the agricultural soils of Kerala but the forest soils have received very littJe attention so far. Barring the studies of Davis (1940) and Griffith and Gupta (1947) on the teak-growing soils of Nilambur, hardly any work of a systematic nature seems to have been done on forest soils of the State. Consequently, the information now available regarding these soils is very meagre. In view of the paramount importance of forests in the economy of the State, the systematic study of forest soils is an urgent necessity. The present work is a preliminary study of some typical soil profiles under different types of forests jn Kerala with special reference to their morphological features, physico-chemical characteristics and fertility status. The results are reported in this paper.

Climate:

Kerala lies in the tropical belt and the climate, in general, is characterised by heavy rainfall and high atmospheric humidity. The annual rainfall varies from about 2000 mm in the south to over 4000 mm in the north. The temperature seldom falls below 70°F and rarely rises above 95°F. The topography of the land is undulating. The highland region of the State which is hilly and mountainous also receives abundant rainfall and is covered with forests and plantations. The temperature here is much lower (60°F to 80°F) and where the altitude exceeds 1500 m the climate is sub-tropical.

Geology:

Climatic conditions in Kerala are very conducive to laterite formation and laterization is the major soil-forming process in the State. Consequently, the greater part of Kerala is covered with laterite forma-

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tions but the degree of laterization varies in different regions. All the forest soils included in the present study overlie laterite and have been formed *in situ* by the disintegration of granite and mainly gneissic rocks.

Field Study

The material for this study consisted of five typical profiles of forest soils of Kerala. These profiles were located in widely distributed forest regions which differ in altitude, topography and rainfall and are under three major types of forests, viz., tropical evergreen, moist deciduous and 'shola' forests. Tropical evergreen forests represent the most luxuriant type of forest vegetation. They occur in areas with an annual rainfall of over 2500 mm and an elevation ranging from 250 to 1050 m. Forests of this type support trees which grow to lofty heights and [illegible] an unbroken, dense canopy. Moist deciduous forests are found in areas with lesser rainfall. The 'sholas' are moist evergreen forests of close canopy which occur above an altitude of 1500 m and with climatic conditions more like [illegible] in temperate humid regions. The soil profiles were examined *in situ* and the morphological features recorded are given below:

Profile I

Location :—Mangayam, Palode Range, Trivandrum Division.

Elevation :—240 to 300 m.

Topography :—Rolling and hilly.

Mean annual rainfall: —2004 m. m.

Forest type :—Moist deciduous forest.

Vegetation :—Mainly under *Xylia xylocarpa* and *Dalbergia Latifolia* (Rosewood). Surface covered with herbaceous fleshy annuals and perennials.

Depth (cm.) Morphological features.

0—25—Very dark brown (10 YR 2/2) sandy clay loam with about 25 per cent gravel up to 2 cm size; coarse granular; friable; acid reaction; abundant roots; few earth worms; clear wavy boundary.

25—56—Dark brown (7.5 YR 4/4) sandy clay loam; gravel present but in much lesser amount and of smaller size; granular; friable; acid reaction; few roots; red mottling common; clear wavy boundary,

56—150—Strong brown (7.5 YR 5/6) sandy clay loam with few pebbles; sub-angular blocky; acid reaction; very few roots: crumbly laterite merging into laterite bed below.

Profile II

Location :—Bavali, Begur Range, Wynad Division.

Elevation :—960 to 1050 m.

Topography :—Hilly.

Mean annual rainfall :—1715 m. m.

Forest type :—Moist deciduous forest.

Vegetation :—Mainly under *Tectona grandis* (Teak), *Terminalia tomentosa* and *Grewia tiliaefolia*. Surface covered with *Eupatorium sp.* and grasses.

Depth (cm.) Morphological features.

0—60—Dark reddish brown (5 YR 3/2) sandy loam with about 20 per cent gravel of varying size ; quartz grains present; coarse granular; friable; acid reaction; abundant roots: no earth worms; clear well defined boundary.

60—97—Dark red (2.5 YR 3/6) sandy clay with about 30 per cent gravel; granular; friable; acid reaction; very few roots; prominent yellow mottling with slight red and black admixture; diffuse boundary.

97–120—Red (2,5 YR 4/6) sandy clay loam with few pebbles; sub-angular blocky; firm consistence; acid reaction; roots absent; red, yellow and black mottling: very hard layer.

Below:—Parent rock.

Profile III

Location :— Thulapally, Ranni Division,

Elevation :— 300 to 350 m.

Topography:— Rolling and hilly.

Mean annual **rainfall :—** 4005 m. m.

Forest **type :—** Tropical Evergreen forest.

Vegetation ; —**Mainly** under ***Hopea parviflora***, ***Dysoxylum malabaricum*** and *Artocarpus* ***hirsuta.*** Surface covered with herbs and shrubs.

Depth (cm) Morphological features

0—48—Dark reddish brown (5 YR 3/4) sandy clay loam with about 30 per cent gravel up to 2 cm size; quartz grains present; granular; friable; acid reaction; yellow and red mottling; abundant roots; no earthworms; clear wavy boundary.

48—75—Yellowish red (5 YR 4/6) sandy clay loam with about 20 per cent gravel; quartz grains present; granular; friable; acid reaction; occasional yellow mottling; few roots; clear wavy boundary.

75—150—Red (2.5 YR 4/8) sandy loam; crumbly laterite; **vermicular;** acid reaction; red and **yellow** mottling; roots absent; merges with hard laterite layer unsuitable for quarrying due to high content of quartz grains,

Profile IV

Location :—Parambikulam, Parambikulam Division.

Elevation **:—750** to 900 m.

Topography :—Hilly.

Mean annual **rainfall :—2325** m. m.

Forest type :—Tropical Evergreen forest.

Vegetation :—Mainly under ***Myristica sp.***, *Artocarpus sp.* and ***Calophyllum elatum.*** Surface covered with herbs and small shrubs.

Depth (cm) Morphological features

0—65—Dark brown (10 R 3/3) sandy loam; pebbles practically absent; coarse granular; friable: acid reaction; red and yellow mottling; abundant roots; earthworms in plenty; wavy diffuse boundary.

65—95—Dark reddish brown (2.5 YR 3/4) sandy clay with few pebbles; granular; friable; acid reaction; slight red and yellow mottling; very few roots; few earthworms; diffuse boundary.

95—150—Dark red (2.5 YR 3/6) sandy clay loam; sub-angular blocky; friable; acid reaction; dark red and yellow mottling; mica flakes present; roots absent; diffuse boundary.

Profile V

Location :—Devikulam, Munnar Division

Elevation **:—1620** m.

Topography —Hilly and mountainous,

Mean annual rainfall **:—2900** m. m.

Forest type **:—Shola** forest.

Vegetation **:—Mainly** under ***Actinodaphne hookeri***, ***Bauhinia racemosa*** and ***Cinnamomum sulphuratum.*** Surface covered with ***lantana*** and fleshy herbs.

Depth (cm) Morphological features

0—34—Dark reddish brown (5 YR 2/2) sandy loam with about 20 per cent gravel of varying size; coarse granular; friable; acid reaction; red, yellow and black mottling; abundant roots; few earthworms; clear wavy boundary.

34—75—Strong brown (7.5 YR 5/8) sandy loam with very few pebbles; granular; friable; acid reaction; yellow and black **mottling**; wavy diffuse boundary,

75—150—Red (2.5 YR 4/8) sandy loam; sub-angular blocky; friable; acid reaction; roots absent; weathered rock fragments and quartz grains present; wavy diffuse boundary.

Experimental

Representative soil samples were collected from the different horizons of the profiles for laboratory studies. The samples were air-dried and passed through a 2 mm. sieve. Mechanical analysis was carried out by the International Pipette method. Single value constants, viz., water-holding capacity, volume expansion, porespace, apparent specific gravity and true specific gravity were calculated from Keen-Raczkowski Box experiments. Organic carbon was estimated by Walkley and Black's method (1934) and organic matter calculated from this figure. Total nitrogen was determined by the Kjeldhal method as described by Wright (1939). The HC1 extracts were prepared by the A. E. A. method and analysed for various constituents by standard procedures as outlined by Piper (1950). Available phosphorus was extracted with Bray's reagent and available potassium with Morgan's reagent and estimated using a Klett-Summerson photoelectric colorimeter. The cation exchange capacity was determined by the neutral ammonium acetate method (Piper, 1950). The pH was determined in 1:2,5 soil water suspension using a photovolt pH meter, model 115.

Results and Discussion

Morphological characteristics

All the soils studied have well developed profiles as a result of intensive leaching. Except in profile IV, appreciable amounts of gravel are found in the soil mass which is indicative of good internal drainage The accumulation of humus in the top soil gives it a dark reddish brown to dark br own colour which changes to red in the subsoil due to dehydration of sesquioxides eluviated from the surface horizon. In all the profiles the surface soil has a granular structure which favours good root development and ensures satisfactory air-moisture relations. In profiles I and III, hard laterite is found at depths ranging from 56 to 150 cm while in the other profiles laterite occurs at much lower depths as inferred from the examination of adjoining road cuts. All the soils are non-calcareous in character and acidic in reaction throughout the profile.

Mechanical composition and physical characteristics

The mechanical analysis of the soils is given in Table I.

The data show that, in general, the sand fractions exceed the fine fractions at all depths in the different profiles. The clay content varies from 2.0 to 40,0 per cent and the soils range in texture from sandy loam to sandy clay. Profile V from the Shola forest records the lowest values for clay at **all** depths (2.0 to 8.0 per cent) which points to lesser weathering. Except in this profile, the translocation of clay from the surface soil and its deposition in the lower layers, mainly in the intermediate horizon, is well marked. In all the profiles the content of silt falls in the subsoil but shows an increase in the third horizon. There is but little variation in the texture of the soils with depth.

In Table II data are presented on the single value constants of the soils studied.

The water holding capacity ranges from 28.8 to 48.9 per cent. Soiis of profile V

TABLE I

Mechanical composition of forest soils of Kerala

Profile No.	Locality	Depth cm.	Coarse sand percent	Fine sand percent	Silt percent	Clay percent	Textural class
I.	Palode	0- 25	37.1	24.9	12.0	26.0	Sandy clay loam
		25- 56	31.3	22.7	12.0	34.0	Sandy clay loam
		56-150	30.2	23.5	14.1	32.2	Sandy clay loam
II.	Wynad	0- 60	29.4	46.6	14.0	14.0	Sandy loam
		60- 97	26.5	33.5	6.0	40.0	Sandy clay
		97-120	25.6	34.2	12.0	28.2	Sandy clay loam
III.	Ranni	0- 48	28.7	29.3	20.0	22.0	Sandy clay loam
		48- 75	37.5	26.5	9.0	27.0	Sandy clay loam
		75-150	49.3	22.6	11.1	17.3	Sandy loam
IV.	Parambikulam	0- 65	31.2	29.8	19.0	20.0	Sandy loam
		65- 95	24.3	23.7	14.0	38.0	Sandy clay
		95-150	23.4	26.4	18.1	32.1	Sandy clay loam
V.	Devikulam	0- 34	38.6	29.4	24.0	8.0	Sandy loam
		34- 75	37.5	40.5	20.0	2.0	Sandy loam
		75-150	33,9	37.8	26.3	2.0	Sandy loam

TABLE II

Single value constants of forest soils of Kerala.

Profile No.	Locality	Depth cm.	Water holding capacity per cent	Volume expansion. per cent	Pore-space per cent	Apparent sp. gravity.	True sp. gravity.
I.	Palode	0- 25	40.8	3.75	52.2	1.46	2.35
		25- 56	41.9	5.02	51.9	1.18	2.40
		56-150	400	5.43	51.1	121	2.30
II.	Wynad	0- 60	28.8	3.88	44.7	1.48	2.52
		60- 97	35.7	7.10	50,4	1.31	2.34
		97-120	342	5.40	49.1	1.34	2.40
III.	Ranni	0- 48	38.7	6.50	52.2	1.32	2.52
		48- 75	31.6	2.07	45.6	1.41	2,45
		75-150	28 8	2.60	42.6	1.46	2.47
IV.	Parambikulam	0- 65	34.6	6.28	39.4	1.38	2.25
		65- 95	39.5	4.04	43.8	1.27	2.25
		95-150	42.1	2.98	45.3	1.20	2.21
V.	Devikulam	0- 34	48.9	8.48	47.6	1.11	2.02
		34- 75	40.3	2.04	49.2	1.23	2.37
		75-150	47.2	3.30	54.3	1.17	220

TABLE III

Organic carbon, organic **matter,** total nitrogen and C/N ratio of forest **soils** of Kerala

Profile No.	Locality	Depth cm.	Organic carbon percent	Organic matter percent	Total nitrogen percent	C/N ratio
I.	Palode	0- 25	2.44	4.20	0.24	10.2
		25- 56	1.82	3.13	0.09	20.2
		56-1:0	1.15	1.98	0.12	9.6
II.	Wynad	0- 60	1.16	2.00	0.16	7.2
		60- 97	0.56	0 96	0.10	5.6
		97-120	0.42	0.72	0.15	2.8
III.	Ranni	0- 48	3.77	6.48	0.31	12.2
		48- 75	0.97	1.66	0.13	7.5
		75-150	0.53	0.91	0.05	10.6
IV.	Parambikulam	0- 65	1.57	2.70	0.19	8.3
		65- 95	0.44	0.76	0.11	4.0
		95-150	0.41	0·71	0.10	4.1
V.	Devikulam	0- 34	5.56	9.56	0.46	12.1
		34- 75	0.49	0.84	0.05	9.8
		75-150	0.14	0.24	0.04	36

TABLE IV

Chemical composition of forest soils of Kerala

Profile No.	Locality	Depth cm.	pH	HC1 insolubles	Al_2O_3 FeA	Total %	Avail. %	Total %	Avail. K_2O %	CaO %	MgO %	C.E.C. m.e./100 g soil
I.	Palode	0- 25	4,2	64.7	26.1	0.09	0.0026	0.18	0.019	0.13	0.11	8.3
		25- 56	4.3	59.2	31.4	0,16	0.0002	0.18	0.012	0.08	0.18	6.5
		56-150	4.2	57.9	32.6	0.11	0.0002	0.14	0.017	0.03	0.16	5.7
II.	Wynad	0- 60	5,2	81.3	14.1	0.09	0.0016	0 24	0.021	0.35	0.34	8.9
		60- 97	5.2	62.1	30.0	0.17	0.0063	0.34	0.016	0.36	0.41	12.7
		97-120	5.3	67.1	26.8	0.05	0.0051	0.32	0.019	0.30	0.25	9.9
III.	Ranni	0- 48	5.3	53.1	38.3	0.14	0.0014	3.37	0.015	0.27	0.04	10.0
		48- 75	5.0	54.5	39.3	0.16	trace	0.39	0.007	0.19	0.21	3.2
		75-150	5.1	62.0	36.4	0.10	trace	0.25	0.055	0.22	0.10	2.1
IV.	Parambikulam	0- 65	6.4	72.6	21.2	0.05	0.0007	0.12	0.023	0,22	0.10	9.3
		65- 95	6.4	61.0	53.5	0.15	trace	0.11	0.018	0.17	0.13	6.2
		95-150	6.4	57.2	32.2	0.17	trace	0.09	0.012	0.14	0.11	6.5
V.	Devikulam	0- 34	5.5	49.5	31.0	0.32	0.0011	0.06	0.027	0.28	0.13	16.4
		34 75	4.5	45.9	40.2	0.35	0.0005	0.11	0.016	0.05	0.10	3.1
		75-150	4.8	31.3	52.4	0.25	trace	0.12	0.006	0.12	0.12	1.1

from the shola forest of Devikulam register the maximum values (40.3 to 48 9 per cent). No significant difference is observed in the moisture retaining power of soils under moist deciduous and tropical evergreen forests. The variation in the water holding capacity with depth is irregular in the different profiles. The porespacc which was determined in the soil in its disturbed condition varies from 39.4 to 54.3 per cent and the values show a rough correlation with the day + silt content of the soils.

The volume expansion figures are low and of the order of 2.04 to 8.48 per cent. The specific gravity of the different soils varies within narrow limits suggesting that their mineralogical make up is similar. It may be noted that the results reported in Table II are in good agreement with the values given by Sen and Deb (1941) for various physical constants of Indian laterite and red soils,

characteristics

Data regarding organic carbon, organic matter, nitrogen and C/N ratio are shown in Table HI.

It will be observed that there is heavy accumulation of organic matter in the surface horizon of all the profiles. This is a distinguishing feature of forest soils and is due to the large quantity of vegetable debris that falls on the surface. The maximum amount of organic matter (9.56 per cent) is found in profile V from the Shola forest. This can only be attributed to the cooler climate in this region which reduces microbiological activity considerably resulting in the accumulation of raw humus on the surface. Organic matter decreases progressively and substantially with depth in all the profiles. Leaching of this constituent in noticed in most of the profiles and is particularly high in profile I, The nitrogen content of the soils varies from 0.04 to 0.46 per cent. The surface layers are rich in nitrogen and register the maximum values. Nitrogen decreases sharply in the subsoil and the minimum amount occurs in the subsoil of profile V from Shofa forest.

The C/N ratio of the surface soils ranges between 7.2 and 12.2 which indicates a satisfactory rate of decomposition of organic matter. The values show a general trend to narrow down with increase in depth. The very low C/N ratios recorded for the lower horizons of profiles II and IV may be attributed mainly to the low content of organic carbon of these layers.

Analytical data pertaining to other important chemical characteristics of the profiles examined are assembled in Table IV.

It may be noted that all the soils are distinctly acid in reaction. The pH ranges from 4.2 to 6.4 with the majority of the values falling between 4.2 and 5.3. Serious loss of calcium and other bases brought about by prolonged leaching under heavy rainfall conditions obviously accounts for the strong acidity of these soils. In profile V from the Shola forest the surface soil is found to be much less acid than the subsoil. It would be interesting to find out whether the leaves of trees growing in this type of forest have a high content of bases. In all the other profiles, the pH is more or less uniform at all depths. No relationship seems to exist between acidity and altitude in the soils studied here.

The HCt insoluble material, which consists mainly of silica, varies from 31.3 to 81.3 per cent. In general, it is maximum at the surface and decreases with depth. The content of sesquioxides is high and is more than 30.0 per cent in most cases. In all the profiles there is considerable deposition of iron and aluminium in the lower layers as a result of leaching. This accumulation is more marked in profiles from higher elevations. The difference in the mobility of sesquioxides in the various profiles appears to be due to the differences in the amount and nature of the complcxing agents in the leaching medium as explained by Bloomfield (1955).

The amount of total P_2O_5 shows considerable variation ranging from 0.05 to 0,35 per cent. The majority of the values, however, lie'above 0.10 per cent indicating a fairly good reserve of P_2O_5 in these forest soils unlike in most agricultural soils in Kerala. Soils of profile V from the Shola forest which are under a sub-tropical climate are the richest in this constituent and record the maximum values for all the horizons (0·25 to 0.35 per cent). This is in accord with the observation of Yadav and Pathak (1963) that forest soils of temperate hilly regions contain the maximum amount of total phosphorus. The total P_2O_5 content of soils ofmoist deciduous and tropical evergreen forests seems to be of the same order. In normal cultivated soils the general tendency is for phosphorus to be concentrated in the surface horizon. But in all the soils examined it is seen that there is mobilisation of P_2O_5 in the subsoil. The fairly large amount of clay and silt and the high content of sesquioxides may chiefly account for the greater retention of phosphorus in this horizon as suggested by Raychaudhuri and Landtey (1960) and Yadav and Pathak (1963).

The available P_2O_5 content which is of much greater consequence from the point of view of plant growth is very low in all the soils. It varies from a mere trace to 0.0063 per cent, and even the highest value works out to less than 4.0 per cent of the total P_2O_5. It is quite evident that the major portion of the phosphorus in the soils studied is in an unavailable form. Immobilisation of phosphorus as iron and aluminium phosphates seems to be mainly responsible for the extremely low rate of release of this nutrient. The high accumulation of organic matter in these soils at the top may also contribute to poor phosphorus availability as shown by Shrikhande and Yadav (1954) and Yadav and Pathak (1963). Available P_2O_5 decreases sharply with depth except in profile II.

The level of total K_2O ranges from 0.06 to 0.39 per cent with a mean value of 0.20 percent. The potassium status of these forest soils is higher than that of most agricultural soils Kerala but is low compared to average Indian soils. Soils of profile V under Shola forest are the poorest in potassium which is in keeping with the low clay content of these soils. The reserve of K_2O in soils supporting moist deciduous and tropical evergreen forests is fairly good and more or less of the same order. In some of the soils studied there are indications of downward movement of potassium. The amount of available K_2O varies from 0.006 to 0 055 per cent, with only two soils giving values below 0.01 per cent. This is a satisfactory position and signifies the presence of easily weatherable potassium bearing minerals in these soils.

The CaO content lies between 0.03 and 0.36 per cent with most of the values falling below 0.20 per cent· The calcium status of these soils is low because of the non-calcareous character of their parent rocks and the severe acid leaching they are subject to. Maximum amount of CaO (0.30 to 0.36 per cent) occurs in profile II from Wynad where the rainfall is lower than in other localities. In all the profiles there is surface concentration of CaO which has presumably been derived from forest litter. This observation is in line with the finding of Alway (1933) that many hardwoods favour the accumulation of calcium in the surface soil due to relatively high content of this element in their litter. CaO content decreases down the profile but the variation with depth is erratic.

The amount of MgO varies from 0.04 to 0.41 per cent. Like calcium, maximum amount of magnesium (0.25 to 0.41 per cent) is found is profile II from Wynad. Except in profile V from the Shola forest, MgO content is highest in the intermediate horizon. This is in conformity with the observation of Lutz and Chandler (1957) that magnesium accumulates in the B horizon of forest soils.

The cation exchange capacity of the soils studied ranges between 1.1 and 16.4 m. e. per 100 *g* soil. With one exception, the surface horizons register the maximum *values* evidently because of accumulation of organic matter. In general, the cation exchange capacity decreases with depth. The very low values recorded even where the clay content is relatively high strongly suggest that kaolinite is the predominant clay mineral in these soils. This inference is supported by the fact that the soils are laterite in nature and have been formed from acid rocks of low inherent base status under conditions of prolonged and severe leaching. There is also the possibility of an admixture of illite as the parent rocks contain fair amounts of mica.

The critical examination of the results presented here reveals a close resemblance between the soils under moist deciduous and tropical evergreen forests in many physical and chemical characteristics. They are medium in texture, moderately deep, non-calcareous in nature and acid in reaction throughout the profile. There is high accumulation of organic matter in these soils. They are well supplied with nitrogen and contain fairly good reserves of phosphorus and potassium. These soils are very deficient in available P_2O_5 and their calcium and magnesium status is also poor. Their cation exchange capacity is very low and kaolinite seems to be the predominant clay mineral present. Though similar in many respects, there are certain differences between these soils which deserve to be taken note of. Soils supporting moist deciduous forests tend to be more acid and have slightly higher reserves of magnesium, whereas soils under tropical evergreen forests are richer in organic matter and nitrogen. These differences seem to be a consequence of site features, mainly relief and vegetation.

The influence of site features is more marked in soils of Shola forests which are situated at much higher altitude and are under a cooler climate. In these soils there is much heavier accumulation of organic matter than in soils supporting moist deciduous and tropical evergreen forests. They are also lighter in texture but possess higher water-holding capacity. Further, soils of Shola forests are considerably richer in nitrogen and phosphorus but seem to be poorer in bases, particularly potassium. As these observations are based on data relating to only a few profiles, further studies are necessary before difinite conclusions can be arrived at on the influence of site features, especially different forest communities, on soil properties and profile development.

It may be pointed out that all the forest soils included in the present study are sedentary formations. They have developed under climatic conditions very conducive to laterization and the laterite nature of these soils is clearly reflected in their morphological, physical and chemical characteristics. Soils under Shola forests in Devikulam where the climate is sub-tropical appear to have undergone less laterizalion than soils supporting moist deciduous and tropical evergreen forests. It was beyond the scope of the present study to determine the extent of laterization in each case but this point merits investigation.

Summary and Conclusions

A preliminary study was made of the morphological features, physico-chemical characteristics and fertility status of five typical soil profiles under three major type of forests in Kerala, viz., moist deciduous, tropical evergreen and 'shola' forests. These soils are derived from gneissic rocks and are the product of prolonged and severe leaching. They have well developed profiles and are characterised by heavy accumulation of organic matter in the surface horizon. They are medium in texture, moderately deep, acidic in reaction and laterite in nature. The soils are well supplied with nitrogen and have fairly good reserves of phosphorus and potassium. They are, however, very deficient in available phosphorus and their calcium and magnesium status is poor.

The data also reveal that soils supporting moist deciduous forests tend to be more acid and have slightly higher reserve of magnesium than soils under tropical evergreen forests, whereas the latter are richer in organic matter and nitrogen. Soils of shola forests which are under a cooler climate are found to be lighter in texture but have greater amount of organic matter and higher water-holding capacity than soils supporting other types of forests. They are also much richer in nitrogen and phosphorus but seem to be poorer in bases. These soils appear to have undergone less laterization than soils under moist deciduous and tropical evergreen forests. The influence of site features on soil properties is discussed to account for these differences.

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