STUDIES ON CEYLON SOILS

XIII. SOME FOREST AND OTHER CHARACTERISTIC SOIL TYPES OF THE WET AND DRY ZONES

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IN paper VI. of the Studies on Ceylon Soils (1), the analytical and profile characteristics of some forest soils of the wet low-country were dealt with. In a subsequent communication to this journal (2), de Rosayro described in greater detail the morphological and profile characteristics of seven groups of forest soils of the Matara, Galle, and Kalutara Districts. No analytical data in respect of these soils were furnished by him. At his request, however, analyses of the soils of four typical forest profiles within the same climatic zone were made in this laboratory. As the samples supplied were insufficient for a complete soil examination, only partial analyses were undertaken ; but as they are representative of the soils of the districts specified, the results are included in this paper. The authors are indebted to Mr. de Rosayro for descriptions of the profile characteristics and other features of interest in regard to the soils. In contrast to these wet zone forest soils, are the soils of the dry zone jungle. Four such soils have been studied recently. They consist of (1) a typical dry zone red loam carrying high jungle from Sigiriya, (2) two alluvial sandy loams from areas adjoining the Mahaweli-ganga at Minipe and Manampitiya, and (3) a sandy soil from Kottukachchiya near Puttalam. Included in these studies are three vegetation or topographic soil types of the wet zone low-country, *viz.*, a *bata* (S.) jungle soil, so designated because the *bata* bamboo (*Ochlandra stridula*) is a characteristic feature of the vegetation, and the soils of *deniya* (S.) and *owita* (S.) lands. The word *deniya* is very frequently used for low-lying, marshy ground which, when drained, is capable of growing yams and other annual crops. It is in this sense that the word is used in this paper and not in that indicated in the " Ceylon Glossary of Native, Foreign, and Anglicized words " (3) viz., " a stretch of moderately flat

high ground, as distinguished from low or marshy ground". *Owita* lands, on the other hand, are defined in this publication as "low lands which may be used for the cultivation of paddy without irrigation and also of yams and fine grain". This definition corresponds to that of "*deniya*" land as popularly understood. In this paper the word *owita* refers to a fairly flat, comparatively low-lying, well-drained land, adjacent to, but on a higher level than the paddy field.

In addition to the analytical determinations carried out in previous investigations, the base exchange capacity was determined in certain samples by the method of Olson and Bray (4).

The Wet Zone Forest Soils

The descriptions of the four soil profiles studied are furnished below, and their analytical data presented in Table I. As these soils have a number of features in common as regards their analytical composition they will be considered together.

KELANI VALLEY P. RESERVE

Location ..	Madawala, to the north-east of Kelani Valley P. R. a short distance south of Kitulgala
Elevation and topography	700–800 ft. ; fairly flat
Vegetation ..	*Beraliya* (*Doona cordifolia*), *Dun* (*Doona zeylanica*) *Katuboda* (*Cullenia excelsa*), *Kirihembiliya* (*Palaquium grande*).

Profile

A 1	0–9 in. ..	Surface root matting and leaf litter ; very loose light-brown sandy loam ; nutty ; gravel absent ; roots frequent
A 2	9 in.–2 ft. 2 in. ..	Yellowish-brown gravelly loam ; granular with small gravel and occasional layer of concretions and fragments af decomposing rock ; roots fair.
C 1	2 ft. 2 in.–3 ft. 3 in.	Reddish brown gravelly loam somewhat clayey in pockets, with prolific fragments of decomposing rock-forming concretions ; roots fair to few
C 2	3 ft. 3 in.–4 ft. ..	Slightly heavier dark reddish loam ; roots scarce

BAMBARABOTUWA P. RESERVE

Location ..	Gerandiella in Bambarabotuwa Reserve
Elevation and topography	1800 ft. ; fairly steep
Vegetation ..	*Katuboda* (*Cullenia excelsa*), *Tiniya* (*Doona congestifolia*, *Diyana* (*Mesua thwaitesii*), *Dun* (*Doona zeylanica*)

Profile

A 1	0–13 in. ..	Greyish-black light loam with occasional decomposing rock fragments ; no ironstone gravel ; roots prolific
A 2	13 in.–2 ft. 8 in.	Greyish-brown loam with gravel and decomposing rock fragments ; small lead shot gravel increasing with depth ; roots fair
C	2 ft. 8 in.–4 ft. ..	Brownish-red loam interspersed with decomposing rock fragments ; more clayey with depth ; roots scarce

GILIMALE P. RESERVE

Location	..	Gilimale P. R. in Ratgama block
Elevation and topography		800 ft. gradual slope
Vegetation	..	*Katuboda* (*Cullenia excelsa*), *Kina* (*Calophyllum tomentosum*), *Yakahalu* (*Doona trapezifolia*) *Welipanne* (*Anisophyllea cinnamomoides*)

Profile

A 1	0–10 in.	..	Brown loam ; little gravel or quartz accumulation ; irregular clod ; roots good
A 2	10–18 in.	..	Light-brown gravelly loam with high proportion of ironstone concentrations ; roots fair
C	18 in.–4 ft.	..	Yellowish-brown gravelly loam ; gravel characteristically shot-like in appearance ; occasional layer of concretions increasing with depth ; roots fair

BAMBARABOTUWA P. RESERVE

Location	..	Owala Mahabage in the western corner of the proposed reserve
Elevation and topography		600 ft. ; fairly steep slope
Vegetation	..	*Aridda*, (*Campnosperma zeylanicum*), *Welipanne* (*Anisophyllea cinnamomoides*)

Profile

A	0–20 in.	..	Dark-brown sandy loam, with thick root matting on surface ; cloddy ; no gravel ; occasional fragments of decomposing boulders ; root growth good
C	20 in.–4 ft.	..	Yellowish loam with occasional large ironstone concretions ; root growth good up to 24 in., poor below that.

It will be noted that in no instance has a typical B horizon been observed in the soil profiles, unless, of course, the ferruginous gravelly horizons (A2 or C1) be considered so. The gravelly subsoil is a characteristic feature of these wet zone soil profiles (1). It governs, to a large degree, the drainage of and root development in these soils. Generally speaking the soils are well drained and carry good stands of forest, the dominant heights varying from 80 to 120 ft. The A 1 horizons of these soils vary in texture from light to medium loams. The C horizons are gravelly, but the soil matrix is generally more clayey in nature. All the soils have fairly high organic matter and nitrogen contents in the A 1 horizons, the former varying from 1·65 to 2·28 per cent. and the latter from 0·08 to 0·1 per cent. These constituents decrease with increasing soil depth and are very low in the C horizons. The carbon-nitrogen ratios vary from 10·3 to 16·8 in the A horizon. As would be expected, owing to the intense leaching, the soils are very poor in replaceable bases and strongly acid in reaction. The pH varies from 4·7 to 5·2, and the total base contents from 0·42 to 1·02 mgm. equivalent per cent. In the foregoing respects, these results agree very closely with what was found previously (1). An examination of the fundamental nature

of the soils was not possible owing to the insufficiency of soil material, but there is little doubt that all the samples are lateritic or laterite in type. They will make only poor agricultural soils and are not normally recommended for the cultivation of annual crops, *e.g.*, grains. They are suitable for the production of such permanent crops as rubber, tea, cinnamon, and to a lesser degree, coconut.

The Dry Zone Soils

The analytical characteristics of these soils are indicated in Table II. These and the profile characteristics of each soil will be considered in three separate groups.

DRY ZONE RED LATERITIC LOAM.

Location	..	Sigiriya
Elevation	..	800 ft.
Climate	..	Rainfall : 76 in. ; temperature : 82°F.
Geological origin	..	Bintenne gneiss
Mode of formation	..	Residual
Topographic position	..	Very slightly undulating
Drainage	..	Good
Vegetation	..	Low jungle

Profile

A	0–10 in.	..	Dark-brown loam ; small accumulation of " mull " layer on the surface ; compact but friable ; root growth very good
B	10–42 in.	..	Reddish gravelly loam ; hard compact gravel with plenty of ironstone nodules—angular in shape ; yellow markings ; root growth good
C	Below 42 in.	..	Reddish heavy loam ; free from gravel ; compact ; minute particles of shining mica present ; root growth good

The Sigiriya red lateritic soil is a gravelly loam of about a foot depth, well supplied with organic matter and nitrogen if allowance for the gravel content is made, overlying an even more gravelly loam. This latter may be considered a typical B horizon in which hydrated iron and aluminium oxides from the C horizon below have been deposited. The two lower soil horizons are low in nitrogen and organic matter. The total replaceable base contents of the soils are high (10–15·3 mgm. equiv.) in all three horizons, and the soils are accordingly neutral or slightly alkaline in reaction. The readily available phosphoric acid is low in all three soil layers. In nature, the soil is lateritic, with a silica/alumina ratio of 1·72. This soil profile bears a resemblance, as would be expected, to the Habarana reddish brown loam described in paper X of this series (5). The latter soil discloses, however, the marked influence of limestone on its composition. These dry zone soils are well suited for annual crops, such as chillies, cotton, and dry grains, but manuring, particularly with nitrogenous manures, will have to be resorted to if continued good yields are to be secured.

MANAMPITIYA SANDY LOAM

Location	..	Galela, near Manampitiya
Elevation	..	About sea level
Climate	..	Rainfall probably about 70 in. ; temperature 82°F
Geological origin	..	Recent
Mode of formation	..	Sedimentary, alluvial
Topographic position	..	Flat
Drainage	..	Good
Vegetation	..	Jungle and tobacco

Profile

A 1 0–5 in.	..	Brown sandy loam ; loose and friable
A 2 Below 5 in.	..	Light-brown sand ; single grain structure ; loose

THE MINIPE SANDY LOAM

Location	..	Minipe
Elevation	..	370 ft.
Climate	..	Rainfall about 90 in. ; temperature 82°F
Geological origin	..	Recent
Mode of formation	..	Sedimentary, alluvial
Topographic position	..	Flat
Drainage	..	Good
Vegetation	..	Jungle

Profile

A 0–4 ft.	..	Brownish-yellow sandy loam ; compact but friable ; uniform ; granular to nut ; root growth good

The Manampitiya soil sample was taken from land immediately adjoining the Mahaweli-ganga while the Minipe sample was taken at some distance inland. Both are deep sandy loams containing very high proportions of fine sand, *viz.*, 67 and 69 per cent. respectively. The Manampitiya top soil is of a darker colour and contains more organic matter, nitrogen, available phosphate, and replaceable bases than the Minipe sample. It is slightly alkaline, while the Minipe soil is somewhat acid in reaction. The base exchange capacities of the two soils are also very different, the Minipe soil being only about half as reactive as the Manampitiya soil in this respect. This may be explained partly by the higher organic matter and partly by the lower degree of maturity of the latter soil (7). Both soils are lateritic in nature. This is only to be expected considering their common origin. The Manampitiya soil is of higher fertility than the Minipe soil as it is enriched each year with deposits of silty material from the highlands during the monsoonic rains. The soil is mainly cultivated with cigar tobacco, but sugarcane and food crops could also be grown, The Minipe soil, because of its freedom from inundation will, in addition, be suitable for fruit. These soils are somewhat similar to the Kiliveddi sandy loams described in an earlier article (6).

KOTTUKACHCHIYA SAND

Location	..	Kottukachchiya near Puttalam
Elevation	..	Sea level
Climate	..	Rainfall about 40 in. ; temperature 82°F
Geological origin	..	Pleistocene or recent

Mode of formation	..	Aeolian or alluvial
Topographic position	..	Flat
Drainage	..	Good
Vegetation	..	High jungle

Profile

A 1	0–72 ft.	..	Light sandy loam ; loose and friable ; horizon boundary indistinct

This is a light-brown sand, containing as much as 62 per cent. of fine sand. The top 5 inches of soil are well-supplied with organic matter (3·9 per cent.) and nitrogen (0·14 per cent.). The sub-soil has much lower percentages of these constituents. In reaction the soil and sub-soil are mildly alkaline and acid respectively. Despite its sandy nature, the soil carries a stand of good jungle. This is a good illustration of the fact that high jungle is not necessarily associated with soils containing large reserves of mineral and organic plant food. What is more important for its development is soil depth, good drainage and other favourable physical conditions. This soil is suited for a variety of crops, *e.g.*, fruit, tobacco, and food crops, but irrigation will be required for some of them.

The Wet Zone Vegetation and Topographical Soil Types

The analytical data of the three soils included under this heading, *viz.*, the *bata* jungle, *deniya*, and *owita* soils, are presented in Table III.

BATA JUNGLE SANDY LOAM

Location	..	Experiment Station, Horana
Elevation	..	100 ft.
Climate	..	Rainfall 96·8 in. ; temperature 80°F
Geological origin	..	Charnokite
Mode of formation	..	Residual
Topographic position	..	Hilly—samples taken on hill slope
Drainage	..	Good
Vegetation	..	*Batá* (*Ochlandra stridula*), *Weraniya* (*Hedyotis fructicosa*), *Peratambala* (*Gaertnera koenigii*), *Godapara* (*Dillenia retusa*), *Goraka* (*Garcinia cambogia*), *Hedawaka* (*Chaetocarpus coriaceus*)

Profile

A 1	0–7 in.	..	Dark-brown loam ; loose and friable ; horizon boundary indistinct ; root growth good
A 2	7–13 in.	..	Light-brown loam ; loose and friable ; small boulders of rock ; root growth good
C	Below 13 in.	..	Yellow brown to yellow loam, above decomposing rock ; loose and friable ; root growth good

This type of vegetation is a feature of the low-country wet zone, *e.g.*, the Ratnapura and Kalutara districts, and is the ecological succession to high forest or *mukalana* cut down for *chena* cultivation. It derives its name from the fact that *bata* bamboo (*Ochlandra stridula*) is the characteristic vegetation species. The soils of these areas are fairly deep, well-drained

sandy loams, which have been protected from erosion by the natural vegetation which is speedily established under the heavy rainfall and high temperature conditions prevalent. The A1 horizon has fair contents of organic matter and nitrogen; the lower horizons have lower percentages of these constituents. The soils are acid in reaction, the acidity increasing with depth. Their replaceable base contents are very low and they are also deficient in available phosphoric acid. The base exchange capacity of the surface soil is not high. This is only to be expected considering that, on the basis of the silica/alumina ratio of the clay fraction, it is of a laterite type. These soils are best suited for permanent crops such as rubber and cinnamon, but with cultivation, liming, and manuring, annual crops can be grown fairly successfully.

THE DENIYA SOILS

Location	..	Near Ambalangoda
Elevation	..	Sea level
Climate	..	Rainfall 73 in.; temperature 80°F
Geological origin	..	Recent
Mode of formation	..	Alluvial; cumulose
Topography	..	Flat
Drainage	..	Bad; water at about one foot from surface
Vegetation	..	Grass; ferns, &c.

Profile

A 1 0–10 in.	..	Dark grey humic sand; compact but loose and friable; root growth poor; water at one foot
A 2 10–15 in.	..	White sand
>3 ft.	..	White clay; kaolinitic in nature

The *deniya* soils are low-lying, ill-drained, dark-grey sands of shallow depth. The subsoil is bleached sand, which in turn overlies a kaolinitic clay. The soil is fairly well supplied with organic matter and nitrogen, but its replaceable base and phosphoric acid contents are low. As would be expected, the soil is very acid in reaction and of low base exchange capacity. On the basis of its silica/alumina ratio, it is lateritic. This is due, in some measure, to the leaching out of the iron and aluminium hydrated oxides by the organic acids formed under the water-logged conditions. The low iron oxide content of the clay fraction is striking. These soils with drainage and occasional liming will be suitable for vegetables, yams and other shallow-rooted crops.

THE OWITA HEAVY CLAY LOAM

Location	..	Nagoda, Galle district
Elevation	..	Above sea level
Climate	..	Rainfall 73 in.; temperature 80°F
Geological origin	..	Recent
Mode of formation	..	Sedimentary, alluvial
Topography	..	Flat
Drainage	..	Good
Vegetation	..	Sugarcane, rubber, coconut and yams

Profile

A	0–8 ft.	.. Deep, uniform, yellow-brown heavy clay loam; crumb structure; loose and friable; root growth good

The sample of *owita* soil examined was taken from an area bordering a river and was, in consequence, regularly subjected to floods. It can therefore be considered a typical *alluvial silt* in respect of its origin and an *owita* soil in respect of its topographical position. It is a deep, heavy clay loam, which, in spite of its very high clay content (54 per cent.), is very well drained. This is due to the nature of the clay. Its organic matter and nitrogen contents are high, but it is low in available bases and phosphoric acid. In reaction it is acid, but not markedly so. Its base exchange capacity, considering its clay content, is low. This, again, is accounted for by the nature of the clay fraction, which, on the basis of the silica/alumina ratio, is of the laterite type.

SUMMARY

In this paper the morphological and analytical characteristics of eleven soil profiles, consisting of four wet zone forest soils, four dry zone jungle soils, and three vegetation and topographical soil types of the wet zone, are described. The data obtained in regard to the wet zone forest soils confirm what has been previously found (1). Apart from textural differences, these soils differ from the dry zone jungle soils in being markedly acid in reaction and having much lower exchangeable base contents. A comparison of the *bata*, *deniya*, and *owita* soils indicate that while they vary markedly in texture and, to a lesser degree, in their contents of organic matter and nitrogen, they are, in common with all wet zone soils, acid in reaction, of low available base content and capacity and lateritic or laterite in nature. The available phosphoric acid contents of all the soils examined except the Manampitiya sandy loam are low.

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TABLE I.

Forest Soils

	Madawala				Gerandiella			Gilimale			Owala	Mahabage
	A1 Per cent.	A2 Per cent.	C1 Per cent.	C2 Per cent.	A1 Per cent.	A2 Per cent.	C1 Per cent.	A1 Per cent.	A2 Per cent.	C1 Per cent.	A Per cent.	C Per cent
Mechanical Analysis												
Gravel and stones	3·1	26·6	23·6	15.6	12·7	37·4	8·8	9·6	66·3	60·9	3·2	22·6
Coarse sand	65·6	59·8	52·7	47·2	41·5	35·0	35·7	29·5	27·6	24·3	36·5	35·2
Fine sand	13·0	13·7	13·7	15·2	37·2	36·3	33·4	34·7	30·9	26·6	33·9	31·6
Silt	5·0	8·1	6·1	7·3	4·9	4·7	5·6	5·5	7·2	8·9	6·6	6·8
Clay	13·1	15·2	24·2	27·1	13·5	20·7	22·4	23·8	29·6	35·3	18·2	22·5
Undetermined	1·9	1·6	1·2	1·3	1·3	1·6	1·5	3·2	1·6	1·3	2·4	1·6
Moisture	1·4	1·6	2·1	1·9	1·6	1·7	1·4	3·3	3·1	3·6	2·4	2·3
Texture index number	12·4	14·3	22·3	25·0	12·5	19·6	20·6	22·4	27·9	33·5	17·1	21·1
Soil type	Light loam	Gravelly light loam	Gravelly loam	Gravelly loam	Light loam	Gravelly loam	Loam	Loam	Gravelly loam	Gravelly loam	Light loam	Gravelly loam
Chemical Analysis												
Loss on ignition	6·98	11·0	11·14	11·65	7·24	7·98	11·40	11·36	11·16	12·08	8·13	7·33
Combined water	4·70	9·54	9·88	10·53	5·59	7·35	10·91	8·88	9·80	11·30	6·41	6·20
Organic matter	2·28	1·46	1·26	1·12	1·65	0·63	0·49	2·48	1·36	0·78	1·72	1·13
Carbon	1·35	0·85	0·75	0·66	0·96	0·36	0·29	1·44	0·79	0·45	0·99	0·66
Nitrogen	0·080	0·048	0·032	0·031	0·093	0·047	0·038	0·099	0·082	0·068	0·089	0·074
Carbon/nitrogen ratio	16·8	17·6	23·5	21·1	10·3	7·7	7·5	14·5	9·6	6·7	11·2	8·9
Total replaceable bases (m.e. per 100 gm.)	0·71	0·62	0·67	0·70	0·82	0.61	0·46	1·02	0·78	0.48	0·81	0·78
Replaceable Calcium	0·56	0·49	0·52	0·54	0·71	0·56	0·39	0·86	0·67	0.39	0·72	0·69
Reaction (pH)	4·7	5·1	4·9	5·0	4·7	5·3	5·1	4·7	5·1	5.2	4·8	5·3

TABLE II.

Mechanical Analysis

	Sigiriya.			Minipe.	Manampitiya.		Kottukachchiya.	
	A Per cent.	B Per cent.	C Per cent.	A Per cent.	A Per cent.	C Per cent.	A Per cent.	C Per cent.
Stones and gravel	20·2	67·3	8·5	Nil	Nil	Nil	3·7	1·4
Coarse sand	23·0	30·0	24·2	4·5	3·6	7·1	24·7	27·2
Fine sand	31·1	19·3	26·5	66·5	69·3	75·4	61·6	59·9
Silt	3·1	3·9	15·5	5·4	7·5	4·8	1·9	2·2
Clay	24·2	41·1	28·9	17·2	15·1	10·3	9·7	9·2
Loss by solution	5·9	1·5	0·6	4·2	0·7	0·6	0·3	0·2
Moisture	2·7	3·8	4·3	2·2	3·8	1·8	1·8	1·3
Texture index number	22·4	37·4	27·7	16·5	14·9	10·1	9·4	8·9
Soil type	Gravelly loam	Gravelly clay loam	Heavy loam	Sandy loam	Sandy loam	Sand	Sand	Sand

Chemical Analysis

Loss on ignition	6·92	7·01	7·08	3·72	6·01	3·66	5·33	1·82
Organic matter	3·41	0·75	0·56	1·61	2·89	1·72	3·91	1·59
Combined water	3·51	6·25	6·52	2·11	3·12	1·94	1·42	0·23
Carbon	1·97	0·44	0·323	0·93	1·68	1·09	2·26	0·92
Nitrogen	0·159	0·048	0·031	0·087	0·108	0·060	0·141	0·067
Carbon/nitrogen ratio	12·4	9·1	10·5	10·8	15·6	18·1	16·1	13·7
Reaction (pH)	7·1	6·9	7·2	6·3	7·3	7·1	7·2	6·8
Base exchange capacity (m.e. per 100 gm.)	—	—	—	6·11	13·05	—	—	—
Total replaceable bases (m.e. per 100 gm.)	14·57	9·97	15·28	5·36	12·55	8·08	—	—
Replaceable calcium (m.e. per 100 gm.)	11·74	8·11	10·63	4·20	0·62	6·62	—	—
Readily available phosphoric acid (mgm. per 100 gm.)	0·74	1·11	1·46	—	—	—	—	—

Clay Analysis

Loss on ignition	20·33	—	—	21·35	29·29	—	—	—
Silica (SiO_2)	42·14	—	—	43·76	41·68	—	—	—
Sesquioxides (R_2O_3)	53·57	—	—	51·02	54·85	—	—	—
Alumina (Al_2O_3)	41·62	—	—	39·06	38·43	—	—	—
Iron oxides (Fe_2O_3)	11·95	—	—	11·94	16·42	—	—	—
SiO_2/Al_2O_3 (molecular)	1·72	—	—	1·89	1·84	—	—	—
SiO_2/Fe_2O_3 (molecular)	1·45	—	—	1·58	1·45	—	—	—
Soil type	Lateritic	—	—	Lateritic	Lateritic	—	—	—

TABLE III.

Mechanical Analysis

	Bata Jungle Sandy Loam.			Deniya Sand.		Owita Heavy Clay Loam.
	A1 Per cent.	A2 Per cent.	C1 Per cent.	A1 Per cent.	A2 Per cent.	A Per cent.
Stones and gravel	3·1	8·4	19·8	Nil	Nil	Nil
Coarse sand	52·7	53·3	52·8	58·6	60·7	1·8
Fine sand	25·2	23·2	23·1	30·5	30·8	12·5
Silt	2·9	4·2	4·1	2·5	2·6	20·7
Clay	16·1	17·1	18·2	6·4	4·9	53·9
Loss by solution	1·2	0·6	0·3	1·2	0·7	5·5
Moisture	1·9	1·6	1·5	0·8	0·3	5·6
Texture index number	15·1	16·0	16·8	6·2	5·0	50·5
Soil type	Sandy loam	Sandy loam	Sandy loam	Sand	Sand	Heavy clay loam

Chemical Analysis

Loss on ignition	5·15	4·61	4·43	3·39	0·90	11·68
Organic matter	2·37	1·19	0·94	1·90	0·87	2·73
Combined water	2·78	3·42	3·49	1·49	0·03	8·95
Carbon	1·37	0·694	0·544	1·10	0·502	1·58
Nitrogen	0·104	0·071	0·061	0·076	0·046	0·123
Carbon/nitrogen ratio	13·1	9·7	9·0	14·5	10·9	12·8
Reaction (pH)	6·2	5·7	4·9	5·6	5·1	6·3
Base exchange capacity (m.e. per 100 gm.)	5·57	—	—	4·51	—	7·47
Total replaceable bases (m.e. per 100 gm.)	0·84	0·68	0·55	0·91	0·81	1·03
Replaceable calcium (m.e. per 100 gm.)	0·76	0·49	0·46	0·81	0·53	0·91
Readily available phosphoric acid (mgm. per 100 gm.)	1·06	1·03	0·94	1·08	0·83	1·01

Clay Analysis

Loss on ignition	42·07	—	—	53·15	—	24·36
Silica (SiO_2)	33·02	—	—	46·32	—	38·14
Sesquioxides (R_2O_3)	66·55	—	—	53·20	—	61·35
Alumina (Al_2O_3)	47·85	—	—	47·89	—	43·99
Iron oxides (Fe_2O_3)	18·70	—	—	5·31	—	17·36
SiO_2/Al_2O_3 (molecular)	0·84	—	—	1·47	—	1·05
SiO_2/Fe_2O_3 (molecular)	0·71	—	—	1·35	—	0·89
Soil type	Laterite	—	—	Lateritic	—	Laterite