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Soil- Site Relationship in Old Teak Plantations

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ကျွန်းစိုက်ခင်းဒေသများ၏ မြေအမျိုးအစားနှင့် ပေါက်ရောက်မှု အတန်းအစား ဆက်စပ်မှုလေ့လာခြင်း

စိန်သက်
ရေမြေသားဌာန်နှင့်သစ်တောသယံဇာတဌာနခွဲ
သစ်တောသုတေသနဗိမာန်

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံတွင် ပြည်တွင်းလိုအပ်ချက်များ ဖြည့်တင်းရန်နှင့် ပြည်ပသို့ကျွန်းသစ်များတင်ပို့ရန် ကျွန်းစိုက်ခင်းဧရိယာ အများအပြား တိုးချဲ့စိုက်ပျိုးလျက်ရှိပါသည်။ ဤကဲ့သို့ စိုက်ပျိုးရာတွင် အတန်းအစားကောင်း ကျွန်းသစ်များ ရရှိရေးအတွက်၊ မြေအမျိုးအစား ရွေးချယ်ရာတွင် အထောက်အကူပြု စေရန်အတွက် စိုက်ပျိုးခဲ့ပြီးသော ကျွန်းစိုက်ခင်းများဖြစ်သော ပဲခူးရိုးမအရှေ့နှင့်အနောက်ဒေသများ၏ သစ်တောမြေများကို လေ့လာခဲ့ပါသည်။ ဤစာတမ်းတွင် ဒေသအလိုက် ကျွန်းစိုက်ခင်းများ၏ ပေါက်ရောက်မှု အတန်းအစားနှင့် သစ်တောမြေဂုဏ်သတ္တိတို့ ဆက်စပ်မှုများကို လေ့လာတင်ပြထားပါသည်။

Soil- Site Relationship in Old Teak Plantations

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Abstract

Burma has been growing teak plantations intensively for export and local used. Since the growth and quality of teak plantations depends on site quality, this study attempts to evaluate some of the soil and environmental parameters which relate to site quality of old teak plantations in east and west Pegu Yoma. This paper describes some soil properties which relate to the growth of teak trees in those areas.

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1. Introduction

Teak is one of the most important commercial species in the tropic and a number of tropical countries such as India, Thailand, Laos, Indonesia, Nigeria and Burma are now establishing teak plantations. In Burma teak is in great demand both for local and international markets. In order to increase the potential of the forests, Burma is launching a large scale planting scheme especially in the Pegu Yoma.

Burma possesses wide variations in climatic and geologic conditions thus resulting in soils with tremendous variation in forest productivity. Within uniform climatic and physiographic regions, site differences in productivity based on soil variables and the growth and the quality of teak plantation depends on site quality. Soil-site requirements of Teak have been studied to some extent and various scientists have written on the subject (1,2,4,6,7); but there is little general agreement among them. Available information indicated that Burma possesses a large group of soils derived from Tertiary sandstones and limestones, well suited for the production of Teak and other commercially valuable species.

A study undertaken in the existing plantations view to obtain a correlation of the existing qualities of teak with soil conditions will provide some informations to assess site quality for teak plantation establishment and management.

2. Materials and Methods

It was aimed to carry out soil study both in the East and West Pegu Yoma; which included nine forest divisions namely, Yamethin, Pyinmana, North Taungoo, South Taungoo, North Pegu, South Pegu of East and Tharrawaddy, Zigon, Prome of West Pegu Yoma. Assuming that the plantation would have proper silvicultural treatments and the age between 15 and 20 years could be assessed for site quality; 1964 plantation was selected for the study, because only this year, teak plantation was well distributed within these nine forest divisions, during the period 1962-1967.

By using predetermined sampling pattern, eight points were selected at every plantation site. At each point, measurements of tree height and girth at breast height of the nearest tree and bulk density core, forest litter, soil core samples at 0-10 cm, 20-30 cm, 40-50 cm, 60-70 cm, 80-90 cm, 100-110 cm were collected. Core samples were air- dried and ground to pass through a 2 mm seive prior to analysis.

The bulk density (B.D) was expressed in grams per cubic centimeter of over-dried soil.

Total Porosity was calculated by the formula with the corresponding bulk density.
The Munsell (USDA Mis. Pub.425) book of soil colour chips was used and Munsell notations were applied to determine the colour of soil.

Particle size distribution of soil samples were carried out with the mechanical analysis by the hydrometer method.

Organic matter was determined by loss - on - Ignition method.

Soil reaction (p^H) readings were taken on soil/distilled water suspension (1:2.5) by using a Corning -EEL p^H meter 12 equipped with calomel glass electrodes.

Electrical Conductivity (E.C) were assessed on soil/ distilled water suspension (1:1) by using YSI Model 31 conductivity Bridge.

Cation Exchange Capacity (C.E.C) was determined by using Ammonium acetate method which was mentioned as m.e/100 gm of soil.

Total Nitrogen levels were assessed by Kjeldahl method by using labconco Kjeldahl, digestion and distillation unit.

Available phosphorous levels were assessed with Double-acid extracting solution and phosphomolybdenium-blue complex method by using Perkin-Elmer 55 E, Spectrophotometer set at 600 μm wave length.

Available Potassium and other trace elements such as Calcium, Sodium, Magnesium and Iron levels were assessed with double-acid extracting solution, by using Perkin-Elmer Atomic Absorption Spectrophotometer.

The basic statistics, mean, variance, and correlation for tree growth (height and girth) and soil properties were computed and significant difference of soil properties between the plots were analysed by students't test.

3. Results and Discussions

General description of study sites are shown in Table 1. Soil profile descriptions for four different sites are presented in Appendix I, and soil profile and tree growth condition are shown in Plate 1 to 4. Physical and chemical properties of soils along with depth for all plots are presented in Appendices II to IV.

Table 1. General Description of Study Sites

Plot No.	Location	Area (ac.)	Slope aspect position steepness %	Growth Ht.gbh(ft.)	Site quality
1.	Yamethin F.D. Pozaung daung R, Compt.31	41	NW Middle 11	54' 2'-5"	III
2.	Pyinmana F.D. Yonpin R, Compt.29	30	SE Middle 28	73' 2'-7"	$^{I}/_{II}$
3.	North Taungoo F.D. Saingya R, Compt. 93	25	S Middle 15	58' 2'-5"	III
4.	South Taungoo F.D. Bondaung R, Compt. 21	50	E Middle 39	53' 2'-0"	$^{III}/_{IV}$
5.	North Pegu F.D. Penwegon sample plot	2	SW Bottom 9	52' 2'-9"	$^{III}/_{IV}$
6.	South Pegu F.D, South Zamani R, Compt. 1	17	SE Bottom 4	56' 2'-5"	III
7.	Tharrawaddy F.D, Minhla R, Compt. 16	30	NW Middle 21	53' 1'-9"	$^{III}/_{IV}$
8.	Zigon F.D, Myodwin R, Compt.2	18	NW Bottom 5	53' 2'-11"	$^{III}/_{IV}$
9.	Prome F.D, South Nawin R, Compt. 51	50	NE Top 48	44' 2'-0"	IV

Relationship of selected surface soil (0-30 cm) properties to site quality (height) at age 18 for old teak plantation soils of Pegu Yoma are shown in Table 2.

Within the study area, site quality ranges from I/II to IV (Table 1). It was found that East Pegu Yoma sites were superior to West Pegu Yoma sites. Better site quality plantations were found on well drained flat and lower portion of the slope, while on the top of the ridge the plantation was inclined to be inferior. Gravelly soil as South Nawin site was the most inferior within the study area. Within the study area, out of fifteen properties of surface soil tested, only four properties namely Potassium, Phosphorous, Sodium and Iron levels were significantly different between sites.

Soil properties which were positively correlated to the site quality (height) were found to be sand percent, potassium level and sodium level while negatively correlated to the site quality were organic matter content, silt percent, clay percent and soluble salt content (Electrical conductivity).

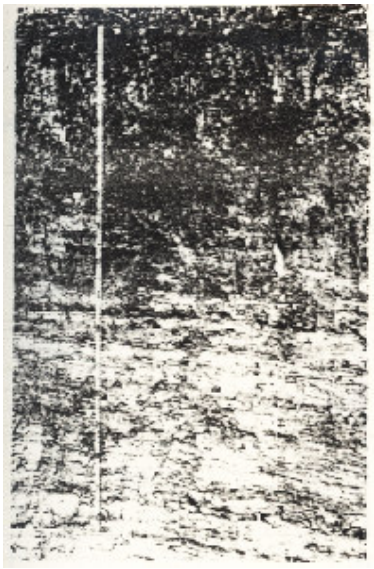

Plate 1.a Yonpin Soil Profile (Shale-origin, Yellowish Brown Forest Soil)

Plate 1.b Eightten Years Old Site I/II Plantation (Yonpin Reserve Forest, Compartment No.27)

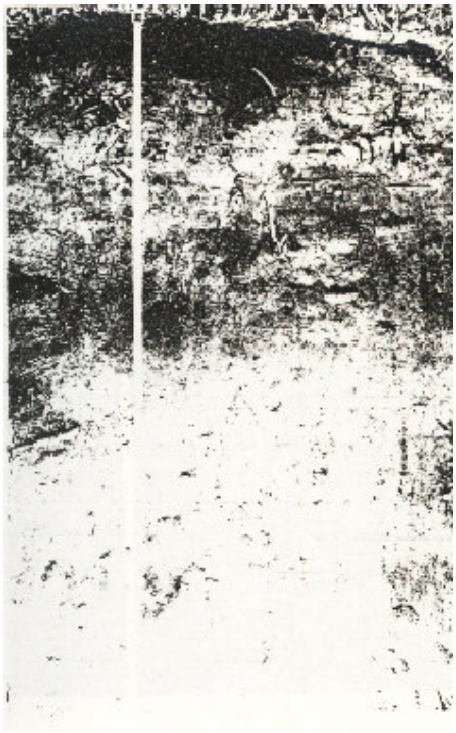

Plate 2.a Pozaung Daung Soil Profile (Sand Stone - origin, Yellowish Brown Forest Soil)

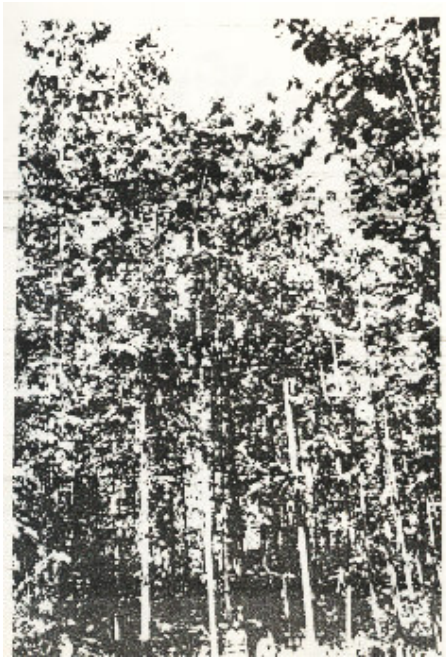

Plate 2.b Eighteen Years Old Site III Plantation. (Pozaung Daung reserve Forest, Compartment No.31)

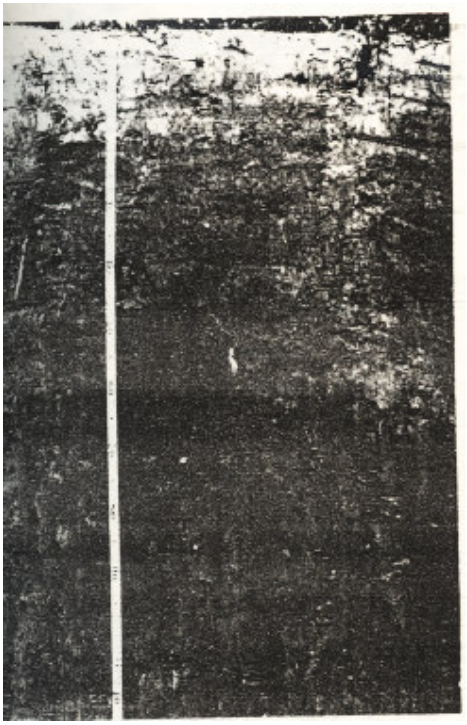

Plate 3.a Penwegon Soil Profile (Sand Stone-origin, Yellowlish Brown Forest Soil)

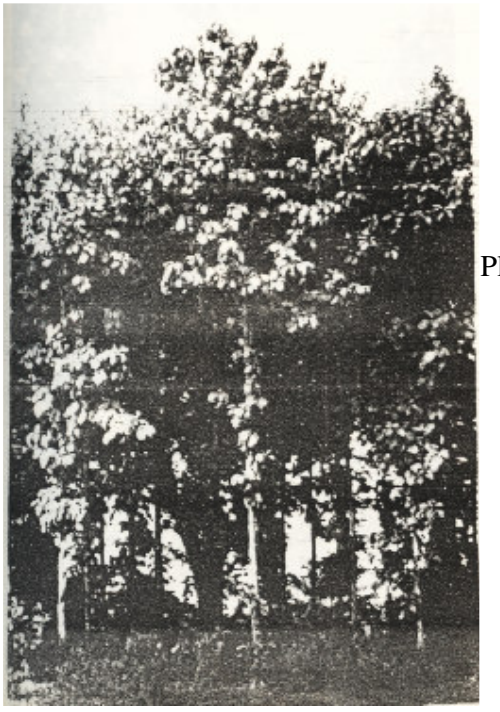

Plate 3.b Eighteen Years Old Site III/IV Plantation. (Penwegon Sample Plot, Tokan Range)

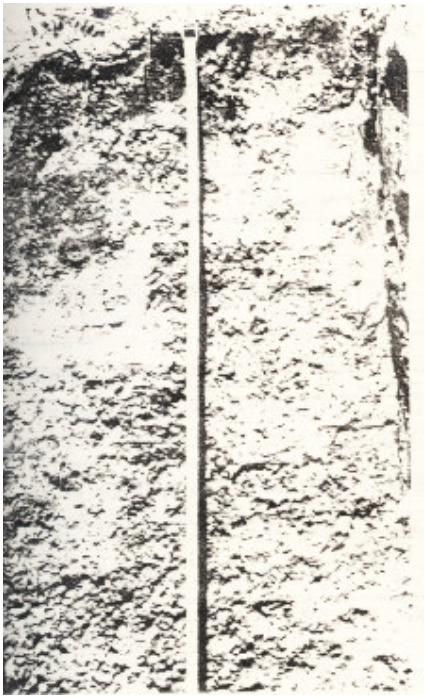

Plate 4.a Very Gravelly South Nawin Profile (Sand Stone-origin, Yellowish Brown Forest Soil)

Plate 4.b Eighteen Years Old Site IV Plantation. (South Nawin Reserve Forest, Compartment No.51)

Table 2. Relationship of selected surface soil (0-30cm) properties to site quality (height) at age 18 for Old Teak PLantation Soils of Pegu Yoma

Soil	Pozaung daung	Yonpin	Saingya	Bon daung	Penwe gon	South Zamani	Minhla	Myo dwin	South Nawin
O.M% Mean	4.2	4.2	4.5	6.2	4.9	6.5	4.9	5.0	5.1
r. value	-.5674	-.5435	-.3089	-.3976	-.3500	-.2999	-.6786	-.0059	-.7625
p^H Mean	6.2	6.1	5.4	5.7	5.9	5.7	5.8	5.9	6.3
r. value	-.1543	-.3571	-.0426	-.3898	-.0170	-.4903	-.3530	-.3063	-.3182
Sand% Mean	73.8	67.3	68.0	51.2	67.6	61.5	58.0	45.1	57.1
r. value	.1244	-.2429	.0953	.7168	.8341	-.2103	.7858	.4088	.6486
Silt % Mean	10.8	16.3	16.2	16.5	19.6	18.0	19.0	34.0	20.0
r-value	-.3143	.1659	-.0234	-.5189	-.6247	-.6003	-.6481	-.1305	.-5876
Clay % Mean	11.5	13.5	12.8	25.4	9.7	12.9	21.4	18.9	22.2
r-value	-.4985	-.1449	-.1168	-.5873	-.8640	.2367	-.7970	-.6134	-.6811
E.C Mean	4.74	7.57	3.76	2.77	4.65	9.11	4.94	6.60	13.59
r-value	-.1149	-.5639	0.0491	-.0042	.3266	.9644	-.7258	-.6706	-.3683
C.E.C Mean	20.39	20.58	16.22	25.06	24.52	17.38	21.36	23.94	22.56
r-value	.0663	.0646	-.1938	-.5285	-.6620	.1310	-.1488	-.0659	-.7320
Total N_2 % Mean	0.0913	0.0908	0.0668	0.0981	0.0806	0.0780	0.0863	0.1442	0.0934
r-value	-.5052	-.5627	.2053	-.7168	.2758	-.3959	-.5506	.4018	-.1876
Ava.P% Mean	0.0009	0.0003	0.0001	0.0000	0.0154	0.0002	0.0001	0.0016	0.0008
r-value	.3478	-.5940	-.1805	.0000	.4408	-.2416	-.5545	-.0567	.5359
Ava. K% Mean	0.0056	0.0047	0.0039	0.0071	0.0047	0.0075	0.0031	0.0060	0.0020
r-value	.3268	.5462	.1286	.2319	.2652	-.0388	-.5695	-.5026	.1929

Soil	Pozaung daung	Yonpin	Saingya	Bon daung	Penwe gon	South Zamani	Minhla	Myo dwin	South Nawin
Ava. Ca% Mean	0.0420	0.0468	0.0110	0.0120	0.0240	0.0244	0.0097	0.0372	0.0340
r-value	-.1091	.0207	.0978	.5317	.3303	-.2684	-.5674	-.1538	-.2479
Ava.Na % Mean	.00030	.0004	0.0011	0.0008	0.0003	0.0007	0.0008	0.0008	0.0027
r-value	-.1305	-.2744	.4168	.8358	-.1991	.2910	.5143	.4133	.6575
Ava.Mg% Mean	0.0190	0.0291	0.0138	0.0225	0.0177	0.0244	0.0395	0.0382	0.0309
r-value	-.0461	.2020	-.0502	-.2063	-.6769	-.0215	-.2289	.0513	0.1655
Ava.Fe% Mean	0.0036	0.0031	0.0018	0.0030	0.0084	0.0054	0.0079	0.0322	0.0015
r-value	-.2394	-.2488	.4441	.1434	.0095	-.4786	-.7246	-.0567	-.7552

4. Conclusion

This study evaluates some of the soil parameters which were related to site quality of old teak plantations. Within the study area of Pegu Yoma, site quality ranges from $^{I}/_{II}$ to IV. For better site quality plantations, site selection should be made on well drained sandy loam soils situated on the lower portion of the slope. It is wise to avoid gravelly soil, specially on top of the ridge.

Appendix I

Soil Profile Descriptions for Different Sites

Profile No.1

Soil Type	Yellowish Brown Forest Soil
Date of examination	24 October 1982
Location	South Nawin Reserved Forest, Compartment 51, about 1 mile from Prome – Paukkaung –Taungoo Road (17 miles from Paukkaung)
Map Reference	Indian survey map 85 $^{N}/_{9}$
Terrain	Very steep
Landform	On steep convex slope, at the $^{4}/_{5}$ of the ridge with steeply dissected surrounding and drainage normally flow North East to South West.
Slope	Steep. 48% (26°)
Aspect	South West (205°)
Elevation	1000' a.s.l
Drainage	Well drained
Forest Type	Moist Upper Mixed Deciduous
Parent Material	Apparently Derived " in situ" from sandstone
Landuse	Reserved Forest
Profile:-	

A 0-20 cm Very dark grayish brown (10 YR. $^{3}/_{2}$) moist and pale brown (10 YR. $^{6}/_{3}$) dry, clay loam developed fine granular structure, hard when dry, firm when moist, sticky, some roots, mostly small plant roots and distinct boundary to.

B 20-110 cm Very dark grayish brown (2.5 Y $^{3}/_{2}$) moist and dark grayish brown (2.5 Y $^{4}/_{2}$) dry, clay loam, weakly developed fine crumb structure, very hard when dry, very firm when moist, very gravelly, and diffuse boundary to

C 110 cm + Very dark gray (5 Y $^{3}/_{1}$) moist and dark gray (5 Y $^{4}/_{1}$) dry, silt loam, weakly developed fine crumb structure, very hard when dry, very firm when moist, very gravelly and without roots.

Profile No.2

Soil Type	Yellowish Brown Forest Soil
Date of examination	29 October 1982
Location	North Pegu Forest Division, Tonkan Range office campus, about $^{1}/_{4}$ miles from Penwegon Station.
Map Reference	Indian survey map 94 $^{B}/_{12}$
Terrain	Flat
Landform	Flat
Slope	Flat
Aspect	South West (210°)
Elevation	100' a.s.l

Drainage	Well drained
Forest Type	Original cultivated land
Parent Material	Apparently Derived " in situ" from sandstone
Landuse	Sample plot
Profile:-	
A 0-50 cm	Very dark grayish brown (10 YR. $^{3}/_{2}$) moist and pale brown (10 YR. $^{6}/_{3}$) dry, loamy sand, fine granular structure, hard when dry, firm when moist, some roots, mostly grass roots and diffuse boundary to.
B 50- 100 cm	Dark brown (10 YR. $^{3}/_{3}$) moist and yellowish brown (10 YR $^{5}/_{4}$) dry, loamy sand, fine granular structure, firm when moist and, diffuse boundary to
C 100 cm +	Dark yellowish brown (10 YR $^{4}/_{4}$) moist and light yellowish brown (10 YR $^{6}/_{4}$) dry, loamy sand, fine granular structure, firm when moist and without roots.

Profile No.3

Soil Type	Yellowish Brown Forest Soil
Date of examination	11 November 1982
Location	Yonpin Reserved Forest compartment 29, about 2 miles from Pyinmana - Taungdwingyi Railways Road (2 miles from Wintegu Station).
Map Reference	Indian survey map 85 $^{M}/_{14}$
Terrain	Hilly
Landform	On steep convex slope, at the $^{1}/_{3}$ of the ridge with steeply dissected surrounding and drainage normally flow North West to South East.
Slope	Hilly. 28% (16°)
Aspect	South East (130°)
Elevation	500' a.s.l
Drainage	Well drained
Forest Type	Moist Upper Mixed Deciduous
Parent Material	Apparently derived " in situ" from shales
Landuse	Reserved Forest
Profile:-	
A 0-15 cm	Black (10 YR. $^{2}/_{1}$) moist and brown (10 YR. $^{5}/_{3}$) dry, sandy loam, fine granular structure, hard when dry, firm when moist, sticky, some roots and sharp boundary to.
B 15 - 70 cm	Olive brown (2.5 Y $^{4}/_{4}$) moist and brown (10 YR $^{4}/_{3}$) dry, sandy loam, fine granular structure, hard when dry, firm when moist, sticky and diffuse boundary to
C 70 cm +	Olive (5 Y $^{4}/_{4}$) moist and dark grayish brown (2.5 Y $^{4}/_{2}$) dry, hard when dry, firm when moist and sticky

Profile No.4

Soil Type	Yellowish Brown Forest Soil
Date of examination	14 November 1982
Location	Pozaungdaung Reserved Forest, Compartment 31, about 5 miles from Pyinmana – Moeswe Road (19 miles from Pyinmana)
Map Reference	Indian survey map 94 $^{A}/_{1}$
Terrain	Rolling
Landform	On flant and drainage normally flow North West to South East.
Slope	Rolling 11% (6°)
Aspect	South East (125°)
Elevation	650' a.s.l
Drainage	Well drained
Forest Type	Moist Upper Mixed Deciduous
Parent Material	Apparently Derived " in situ" from sandstone
Landuse	Reserved Forest
Profile:-	
A 0-10 cm	Black (2.5 Y $^{N}/_{2}$) moist and dark brown (10 YR. $^{3}/_{3}$) dry, loamy sand, fine granular structure, firm when moist, some bamboo and small plant roots, many termite and ant holes, distinct boundary to.
B 10- 70 cm	Very dark brown (10 YR $^{2}/_{2}$) moist and dark brown (10 YR $^{4}/_{3}$) dry, loamy sand, fine granular structure, firm when moist, trace of some gravel between 60-70cm within the horizon, some roots, many termite and ant holes, diffuse boundary to
C 70 cm +	Dark yellowish brown (10 YR $^{3}/_{6}$) moist and yellowish brown (10 YR $^{5}/_{4}$) dry, sand structure less, loose, gravelly between 120-130 cm within the horizon, non sticky, some termite and ant holes.

Appendix II

Physical properties of soil study sites

Plot No.	Depth (cm)	Colour	Forest Litter kg/m^2	B.D gm/cc	Total porosity %	Partical size distribution %		
						Sand	Silt	Clay
1	0-10	dark brown 10 YR $^3/_3$	0.30	1.2	34.9	78.8	11.0	10.4
	20-30	dark grayish brown10 YR $^4/_2$				72.7	10.0	12.6
	40-50	brown10 YR $^4/_3$				89.7	10.0	9.6
	60-70	brown10 YR $^4/_3$				69.8	11.0	9.6
	80-90	brown10 YR $^4/_3$				70.4	10.0	9.6
	100-110	yellowish brown10 YR $^5/_4$				72.1	9.0	8.6
2	0-10	brown10 YR $^4/_3$	0.34	1.2	49.8	68.5	15.0	12.0
	20-30	brown10 YR $^4/_3$				65.9	17.0	14.0
	40-50	brown10 YR $^4/_3$				58.3	17.0	13.6
	60-70	yellowish brown10 YR $^5/_4$				56.2	15.0	15.6
	80-90	yellowish brown10 YR $^5/_4$				58.0	14.0	15.6
	100-110	yellowish brown10 YR $^5/_4$				58.4	15.0	15.6
3	0-10	grayish brown 10 YR $^5/_2$	0.38	1.3	40.6	67.7	16.0	11.0
	20-30	light yellowish brown10 YR $^6/_4$				68.3	16.0	13.0
	40-50	light yellowish brown10 YR $^6/_4$				69.6	13.0	15.0
	60-70	light yellowish brown10 YR $^6/_4$				68.7	14.0	14.0
	80-90	verypale brown 10 YR $^7/_4$				68.3	14.0	16.0
	100-110	very pale brown10 YR $^7/_4$				71.3	13.0	13.0
4	0-10	yellowish brown10 YR $^5/_4$	0.21	1.3	32.4	56.5	16.0	22.0
	20-30	yellowish brown10 YR $^5/_4$				45.8	16.0	28.0
	40-50	brownish yellow10YR $^6/_6$				48.5	17.0	29.0
	60-70	brownish yellow10YR $^6/_4$				53.8	15.0	27.0
	80-90	brownish yellow10YR $^6/_4$				50.7	17.0	26.0
	100-110	brownish yellow10YR $^6/_4$				57.8	18.0	26.0

Plot No.	Depth (cm)	Colour	Forest Litter kg/m^2	B.D gm/cc	Total porosity %	Partical size distribution %		
						Sand	Silt	Clay
5	0-10	brownish yellow10YR $^6/_4$	0.18	1.4	31.7	76.0	16.0	4.6
	20-30	brownish yellow10YR $^6/_4$				59.2	22.9	14.8
	40-50	yellowish brown10 YR $^5/_4$				58.3	23.0	15.1
	60-70	yellowish brown10 YR $^5/_4$				55.1	23.0	17.4
	80-90	brownish yellow10YR $^6/_4$				53.7	22.0	19.0
	100-110	brownish yellow10YR $^6/_4$				54.8	21.0	21.5
6	0-10	yellowish brown10 YR $^5/_4$	0.20	1.3	35.2	69.5	14.0	8.0
	20-30	yellowish brown10 YR $^5/_4$				53.5	21.0	17.0
	40-50	brownish yellow10YR $^6/_4$				46.2	21.0	22.0
	60-70	brownish yellow10YR $^6/_4$				41.1	25.0	26.0
	80-90	brownish yellow10YR $^6/_4$				39.9	26.0	27.0
	100-110	yellowish brown10 YR $^5/_4$				43.2	24.0	26.0

7	0-10	yellowish brown10 YR $^{5}/_{4}$	0.20	1.0	44.5	67.2	16.0	14.0
	20-30	yellowish brown10 YR $^{5}/_{4}$				48.9	22.0	27.0
	40-50	light yellowish brown2.5 Y $^{6}/_{4}$				42.9	22.0	33.0
	60-70	light yellowish brown10YR $^{6}/_{4}$				34.1	23.0	28.0
	80-90	brownish yellow10YR $^{6}/_{6}$				28.1	46.0	29.0
	100-110	brownish yellow10YR $^{6}/_{6}$				27.9	42.0	28.0
8	0-10	yellowish brown10 YR $^{5}/_{4}$	0.21	0.9	45.2	45.5	35.3	15.5
	20-30	light yellowish brown2.5 Y $^{6}/_{4}$				44.7	32.6	22.3
	40-50	light yellowish brown2.5 Y $^{6}/_{4}$				40.3	32.8	24.3
	60-70	light yellowish brown2.5 Y $^{6}/_{4}$				39.3	31.0	28.2
	80-90	light yellowish brown2.5 Y $^{6}/_{4}$				38.9	31.7	27.3
	100-110	light yellowish brown2.5 Y $^{6}/_{4}$				34.2	32.7	29.7
9	0-10	yellowish brown10 YR $^{5}/_{4}$	0.15	1.0	42.4	56.4	20.0	19.0
	20-30	yellowish brown10 YR $^{5}/_{4}$				54.1	19.0	24.0
	40-50	light yellowish brown10 YR $^{6}/_{4}$				48.8	24.0	24.0
	60-70	brownish yellow10YR $^{6}/_{6}$				47.4	26.0	25.0
	80-90	light yellowish brown10 YR $^{6}/_{4}$				44.0	28.0	25.0
	100-110	light yellowish brown10 YR $^{6}/_{4}$				48.6	25.0	25.0

Appendix III

Chemical properties of soil for study sites

Plot No.	Depth (cm)	p^H	O M %	E C (µm hos/cm)	C E C (m.e/100 gm)
1.	0-10	6.2	4.12	5.07	20.38
	20-30	6.3	4.20	4.39	30.18
	40-50	6.4	3.47	3.75	
	60-70	6.0	3.13	3.63	
	80-90	5.9	3.12	3.00	
	100-110	6.0	2.67	2.75	
2.	0-10	6.2	4.31	11.76	20.58
	20-30	6.0	4.16	3.37	28.18
	40-50	6.2	3.60	2.75	
	60-70	6.0	3.72	1.87	
	80-90	6.1	3.25	1.84	
	100-110	6.2	3.25	1.65	
3.	0-10	5.4	4.18	3.47	16.21
	20-30	5.4	4.77	4.05	24.30
	40-50	5.4	3.96	2.91	
	60-70	5.4	3.21	2.37	
	80-90	5.5	3.16	2.70	
	100-110	5.6	3.49	2.78	
4.	0-10	5.8	5.89	3.36	25.06
	20-30	5.7	6.60	2.18	25.38
	40-50	5.7	5.10	1.85	
	60-70	5.9	5.26	1.55	
	80-90	5.8	6.87	1.63	
	100-110	6.0	6.36	1.60	
5.	0-10	6.0	4.30	5.43	24.52
	20-30	5.8	5.45	3.86	24.54
	40-50	5.8	6.47	3.07	
	60-70	5.8	6.52	3.99	
	80-90	5.9	7.28	5.20	
	100-110	6.0	7.03	3.97	
6.	0-10	5.9	5.86	3.92	16.13
	20-30	5.6	5.82	14.31	25.38
	40-50	5.6	7.34	14.84	
	60-70	5.4	5.32	14.75	
	80-90	5.4	6.70	26.88	
	100-110	5.7	7.25	3.13	
7.	0-10	5.8	4.99	5.18	21.36
	20-30	5.8	5.06	4.72	26.72
	40-50	5.7	5.19	4.92	
	60-70	5.7	5.21	10.66	
	80-90	5.9	5.04	11.66	
	100-110	5.9	4.41	17.05	

Plot No.	Depth (cm)	p^H	O M %	E C (µm hos/cm)	C E C (m.e/100 gm)
8.	0-10	6.0	5.44	9.51	23.93
	20-30	5.8	4.48	3.69	26.51
	40-50	5.8	4.41	3.63	
	60-70	5.7	4.19	3.24	
	80-90	5.7	4.16	3.38	
	100-110	5.7	4.57	3.18	
9.	0-10	6.3	5.18	18.63	
	20-30	6.2	5.00	10.40	29.74
	40-50	6.3	4.43	13.90	
	60-70	6.4	4.64	15.27	
	80-90	6.4	4.84	22.76	
	100-110	6.5	4.46	32.47	

Appendix IV

Soil nutrients levels of study sites

Plot No.	Depth (cm)	Primary Nutrients Levels %			Secondary Nutrients Levels %			
		N	P	K	Ca	Na	Mg	Fe
1.	0-10	0.2605	0.0015	0.0059	0.0457	0.0003	0.0198	0.0034
	20-30	0.0829	0.0003	0.0052	0.0381	0.0002	0.0180	0.0037
	40-50	0.0624	0.0001	0.0073	0.0356	0.0003	0.0170	0.0043
	60-70	0.0502	0.00001	0.0030	0.0302	0.0004	0.0211	0.0039
	80-90	0.0489	trace	0.0039	0.0247	0.0003	0.0204	0.0036
	100-110	0.0454	0.00003	0.0036	0.0195	0.0004	0.0165	0.0051
2.	0-10	0.0901	0.0005	0.0050	0.0537	0.0003	0.0295	0.0030
	20-30	0.0913	0.0005	0.0043	0.0401	0.0004	0.0287	0.0032
	40-50	0.0674	0.00004	0.0047	0.0532	0.0003	0.0329	0.0031
	60-70	0.0641	trace	0.0045	0.0516	0.0003	0.0338	0.0031
	80-90	0.0565	trace	0.0035	0.0327	0.0005	0.0273	0.0036
	100-110	0.0481	0.001	0.0033	0.0362	0.0006	0.0302	0.0031
3.	0-10	0.0796	0.00006	0.0039	0.0105	0.0012	0.0136	0.0019
	20-30	0.0674	0.00008	0.0038	0.0111	0.0014	0.0139	0.0016
	40-50	0.0608	0.00007	0.0040	0.0072	0.0011	0.0154	0.0015
	60-70	0.0485	0.00006	0.0024	0.0100	0.0010	0.0152	0.0018
	80-90	0.0417	0.00005	0.0036	0.0070	0.0021	0.0144	0.0014
	100-110	0.0316	0.00005	0.0028	0.0055	0.0018	0.0147	0.0018
4.	0-10	0.0970	trace	0.0075	0.0143	0.0007	0.0225	0.0021
	20-30	0.0990	trace	0.0067	0.0096	0.0008	0.0224	0.0021
	40-50	0.0889	trace	0.0056	0.0112	0.0008	0.0238	0.0021
	60-70	0.0653	trace	0.0051	0.0151	0.0010	0.0261	0.0025
	80-90	0.0774	trace	0.0048	0.0183	0.0009	0.0281	0.0028
	100-110	0.599	trace	0.0045	0.0179	0.0012	0.0286	0.0017
5.	0-10	0.0861	0.02110	0.0044	0.0226	0.0003	0.0123	0.0053
	20-30	0.0725	0.00929	0.0049	0.025	0.0003	0.0229	0.0055
	40-50	0.0745	0.00748	0.0050	0.0200	0.0002	0.0284	0.0054
	60-70	0.0783	0.00199	0.0078	0.0173	0.0003	0.0319	0.0051
	80-90	0.0549	0.00134	0.0071	0.0139	0.0004	0.0296	0.0049
	100-110	0.0549	0.00070	0.0061	0.0138	0.0007	0.0355	0.0048
6.	0-10	0.0747	0.00039	0.0077	0.0026	0.0006	0.0195	0.0051
	20-30	0.0813	0.00009	0.0073	0.0226	0.0006	0.0291	0.0049
	40-50	0.0822	0.00005	0.0081	0.0305	0.0008	0.041	0.0042
	60-70	0.0803	0.00006	0.0083	0.0645	0.0009	0.0426	0.0042
	80-90	0.0874	0.00004	0.0073	0.0318	0.0009	0.042	0.0045
	100-110	0.0801	0.00004	0.0067	0.0293	0.0010	0.0425	0.0053
7.	0-10	0.0880	0.00001	0.0030	0.0096	0.0006	0.0361	0.0065
	20-30	0.0845	0.00008	0.0029	0.0097	0.0010	0.0427	0.0092
	40-50	0.0775	0.00049	0.0036	0.0104	0.0012	0.0428	0.0105
	60-70	0.0655	0.00050	0.0027	0.0257	0.0019	0.0451	0.0114
	80-90	0.0564	0.00057	0.0034	0.0262	0.0034	0.0496	0.0113
	100-110	0.0512	0.00047	0.0034	0.0262	0.0065	0.0478	0.0093

Plot No.	Depth (cm)	Primary Nutrients Levels %			Secondary Nutrients Levels %			
		N	P	K	Ca	Na	Mg	Fe
8.	0-10	0.1596	0.00168	0.0069	0.0430	0.0007	0.0330	0.0340
	20-30	0.1042	0.00157	0.0049	0.0313	0.038	0.0342	0.0304
	40-50	0.0866	0.00113	0.0043	0.0276	0.0017	0.0508	0.0261
	60-70	0.0814	0.00121	0.0040	0.0221	0.0010	0.0490	0.0307
	80-90	0.0819	0.00120	0.0046	0.0234	0.0012	0.0548	0.0250
	100-110	0.0888	0.00099	0.0047	0.0222	0.0009	0.0597	0.0275
9.	0-10	0.1058	0.00052	0.0024	0.0308	0.0021	0.0329	0.0016
	20-30	0.0865	0.00073	0.0015	0.0371	0.0032	0.0288	0.0011
	40-50	0.0837	0.00126	0.0016	0.0448	0.0028	0.0340	0.0010
	60-70	0.0863	0.0008	0.0017	0.0465	0.0027	0.0376	0.0016
	80-90	0.0830	0.0010	0.0016	0.0459	0.0025	0.0335	0.0014
	100-110	0.0816	0.00936	0.0016	0.0748	0.0026	0.0332	0.0016

References

1. Bhatia, K.K (1955). Factors in the distribution of teak in Madhya Pradesh. J. Indian Bot. Soc. 34 (4) pp 459-90.
2. Boonkind, S, Dawson, M.D. and Stone, E.L., (1960). A perliminary study on Teak Soils and Sites in Lampang province, Thailand. Nat. Res. Coun. Thailand, Bangkok 1(1) pp 27-75.
3. Kermode, C.W.D (1964). Some aspects of Silviculture in Burma. Central Press, Rangoon.
4. Pritchett, W.L (1979). Properties and management of Forest Soils. John Wiley & Sons, New York.
5. Sein Thet, and Pritchett,W.L (1981) Soil properties and the growth of some Burmese tree species. Technical Document No.7/81-82, FRI, Burma.
6. Tin Tin Ohn, and Sein Thet (1982). Some chemical and physical properties of East Pegu Yoma Forest Soils. Research Leaflet No.15, FRI, Burma.
7. Yadav, J.S.P.(1969). Soil study of site suitability appraisal of forest plantation in North Bihar. Indian For. 95 (3) pp 139 - 48.