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Some Chemical and Physical Properties of East Pegu Yoma Forest Soils

by
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အရှေ့ပဲခူးရိုးမ သစ်တောမြေ၏အချို့သောဂုဏ်သတ္တိများ

ဒေါ်တင်တင်အုန်း၊ ဦးစိန်သက်
သစ်တောနှင့်ရေမြေသားဌာနထိန်းသိမ်းရေးဌာနစိတ်
သစ်တောသုတေသနဗဟိုဌာန်

စာတမ်းအကျဉ်းချုပ်

အရှေ့ပဲခူးရိုးမ စိုက်ခင်းစီမံကိန်းအရ၊ ကျွန်းနှင့် အခြားအဘိုးတန်သစ်မာများကို အရှေ့ပဲခူးရိုးမ ဒေသတွင် တိုးချဲ့စိုက်ပျိုးသွားရန် စီစဉ်ဆောင်ရွက်လျက်ရှိပါသည်။ စိုက်ခင်းတည်ထောင်ခြင်းနှင့် စီမံအုပ်ချုပ်ခြင်းတွင် ပိုမို၍ ထိရောက်အောင်မြင်မှု ရရှိစေရန်အတွက်၊ သစ်တောမြေများကို လေ့လာခဲ့ပါသည်။ ဤစာတမ်းတွင် အရှေ့ပဲခူးရိုးမဒေသရှိ သစ်တောအမျိုးအစားများတွင် ဖြစ်ပေါ်လျက်ရှိသော သစ်တောမြေ၏အချို့သောရူပနှင့် ဓါတုဂုဏ်သတ္တိများကို စူးစမ်းတင်ပြထားပါသည်။ သစ်တောစိုက်ခင်းတည်ထောင်ရန် မြေနေရာ ရွေးချယ်ရေးကို ဦးတည်လျက်၊ ကျွန်းနှင့် ပျဉ်းကတိုး တို့အတွက် လိုအပ်သော အဓိကအဟာရဓါတ်နှင့် မြေ၏ ဂုဏ်သတ္တိများကို ဆွေးနွေး တင်ပြထားပါသည်။

Some Chemical and Physical Properties of East Pegu Yoma Forests Soils

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Abstract

Burma Forestry II Project (East Pegu Yoma Plantation Project) is launching a large scale planting scheme in the East Pegu Yoma. Soil tests for these areas were carried out to provide some information for plantation establishment and management. This paper describes some physical and chemical properties of soils under differs forest types of East Pegu Yoma. Threshold levels for primary nutrient of soil and foliage of Teak and Pyinkado are also discussed with special reference to the selection of sites.

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Some Chemical and Physical Properties of East Pegu Yoma Forest Soils

1. Introduction

Teak, which is the most important timber species in Burma is in great demand both for local use and international markets. To increase potential of Burma forests, Burma Forestry II Project (East Pegu Yoma Plantation Project) is launching a large scale planting scheme in the East Pegu Yoma. According to the project almost 14580 hectares (36000 acres) of Teak and other high value commercial hardwood (Pyinkado, Padauk, etc.) plantations are to be established within a period of five years. Burma possesses wide variations in climatic and geologic conditions and resulting soils with tremendous variation in forest productivity. Burma's agricultural soils have been rather well mapped but forest soils have hardly been studied. So field studies and soil tests for East Pegu Yoma areas will provide some in formations for plantation establishment and management.

2. Literature Review

In Burma, forest soils productivity is related to climatic factors and man's indiscriminate cutting and burning. However, an important part is related to differences in chemical and physical properties, brought about by those agents active in soil formation. These factors are the force of water and of living organisms, midified by topography, acting over long period of time upon the parent rocks.

Three elements, nitrogen, phosphorous and potassium (N, P, K) are often called primary plant nutrients because they are used in relatively large quantities by plants, and are the elements most often deficient in soils. Three others, namely, calcium, magnesium and sulphur refered to as secondary plant nutrients are also used in fairly large quantities but are not so often deficient in soils. The remaining elements are termed micronutrients because they are needed in very small quantities by trees and are not as likely to be deficient in soils (3).

Soil-site requirements of Teak have been studied to some extent and various scientists have written on the subject (2, 4, 6); but there is little general agreement among them. However, one might conclude that teak plantations should be located on deep, porous, friable sandy or silty clay loam, with well developed structure. Such sites may be on well drained alluvium found along banks of rivers, but care should be taken to avoid soils subjected to water-logging or stiff clayey soils. Teak appears to be more vigorous at the foot of ridges than the top, and there is a general deterioration in quality as one goes up the slope (5). It has also been pointed out that southern and western slopes are not as good sites as northern and eastern slopes (2). Teak does not appear to be as demanding in its nutrient requirements as it is in its requirement for soil moisture and physical conditions. None-the-less, teak does best on moderately acid soils (p^H 5.5-6.5), well supplied with calcium and magnesium and containing a moderate level of nitrogen and phosphorous (5).

Study Area

East Pegu Yoma Plantation Project area lies on the eastern slopes of Pegu Yoma, bounded on the west by its central ridge and on the east, the boundary extends beyond the Sittang river. It covers six Forest Divisions, namely South Pegu, North Pegu, South Toungoo, North Toungoo, Pyinmana and Yamethinn.

The configuration is mostly undulating, and the highest elevation is about 550 meters (1800 feet) above sea-level. The western portion of North Pegu Forest Division is extremely hilly with a series of ridges. Myayabinkyaw ridge in South Toungoo Forest Division rises abruptly from the plain up to a height of 245 meters (800 feet) above mean sea-level, and the country lying to the west of this ridge is hilly with steep slopes.

Most of the rainfall occurs during the period of May through October. Through there are a few showers in April and December, these do not contribute much to the annual total. Average annual rainfall ranges between 1494 mm (58.9 inches) to 3594 mm (141:6 inches), and average mean daily temperature ranges between 14.2˚C (57.6˚F – 98.6˚F).

Most of the project area is composed of soft Tertiary sandstones. Yellow Brown Forest Soils are dominant within the area, and Red Brown Forest Soils are also present in moister parts of the area. The soils are shallow, friable, well structured, with a loamy texture. Soil profile description of Pit No. 1 of Kabaung Reserve, compartment 221, South Toungoo Forest Division is given in Appendix I.

The chief determining factors in forest distribution throughout the project area rainfall and configuration. The five main forest types found in the area are:

(1) Evergreen forests.
(2) Moist Upper Mixed Deciduous forests. (MUMD)
(3) Dry Upper Mixed Deciduous forests. (DUMD)
(4) Lower Mixed Deciduous forests. (LMD)
(5) Dipterocarp forests.(Indaing)

Samples in East Pegu Yoma Project area were collected on subplot 1 of each Permanent Sample Plot (PSP) laid down by forest inventory party, in order to determine the optimum size and structure of permanent and temporary plots for the National Forst Inventory of Burma. However, surface soil samples and foliage samples for primary nutrient levels tests were collected from compartment 221, Kabaung reserve, South Toungoo Forest Division. General descriptions of the plots are shown in Table 1.

Table 1. General Descriptions of the Plots.

Plot No.	Forest Division	Reserve	Compartment No.	Aspect	Slope Steepness	Forest Type
1	2	3	4	5	6	7
1	Yamethin	Ngalaik	7	SW	8	MUMD
2	Yamethin	Ngalaik	24	-	-	Abandoned Taungya
3	Yamethin	Ngalaik	75	SW	18	MUMD
4	Yamethin	Ngalaik	11	-	-	MUMD
5	Pyinmana	Palwe	56	SW	22	DUMD
6	Pyinmana	Palwe	76	-	-	LMD
7	South Toungoo	Bondaung	1	N	31	MUMD
8	South Toungoo	Bondaung	15	N	36	DUMD
9	South Toungoo	Bondaung	16	SW	31	Abandoned Taungya
10	North Pegu	Yenwe	1	-	-	MUMD
11	North Pegu	Yenwe	97	-	-	MUMD
12	North Pegu	Yenwe	85	SE	5	LMD
13	North Pegu	Yenwe	3	NE	18	MUMD

14	North Pegu	Yenwe	5	SW	8	MUMD
15	North Pegu	Yenwe	83	NE	28	LMD
16	North Pegu	Yenwe	1	SW	40	MUMD

3. Methods

Field Techniques

(1) Forest Litter

Forest litter was collected at a distance of 1 m in the north of the centre of the plot. A square steel frame with an area of 1/16 m^2 (25 cm x 25 cm) was pressed into the litter, and a sharp knife is used to cut the litter around the perimeter of the frame. All the litter within the frame was removed down to the mineral soil, placed in a labelled plastic bag and returned to the laboratory.

(2) Bulk Density

Bulk density of the surface soil was collected at a distance of 2 m in the north of the centre of the plot. The collection of bulk density sample was done by using a steel bulk density corer (10 cm x 10 cm x 15 cm). The corer was driven into the ground with minimum disturbance using a hammer and wooden block. The corer was dug from the ground using a trowel, and surplus soil trimmed from the ends of the core by means of a sharp knife. The soil core was extruded into a labelled plastic bag and transported to the laboratory.

(3) Soil Samples

Soil samples for testing soil properties were collected at a distance of 3 m in the north of the centre of the plot, by using the soil auger to bore the soil to different depths. The soil samples from the depths, 0-10 cm, 20-30 cm, 40-50 cm, 60-70 cm, 80-90 cm, 100-110 cm, were collected, placed in separate labelled plastic bags and taken to the laboratory.

(4) Surface Soil And Foliage Samples

Surface soil (0-20 cm) and foliage samples, for testing threshold levels of primary plant nutrients were collected from one year old teak plantation and natural forest of compartment 221, Kabaung reserved, South Toungoo Forest Division.

Four randomly selected composite soil samples from three different sites, namely, natural forest area, good and health plantation site, poor and unhealthy plantation site, were collected, placed in separate labelled plastic bags and returned to the laboratory.

Foliage samples were collected from near by four trees at each site, placed in separate labelled plastic bags and taken to the laboratory.

4. Laboratory Techniques

All soil samples were air-dried and passed through a 2 mm sieve prior to analysis.

All foliage samples were dried at 70˚C and ground to pass a 1 mm sieve prior to chemical analysis.

(1) Bulk Density

The soil bulk cores were weighed immediately after being returned from the field, oven-dried at 105˚C for 24 hours and the oven-dried weight determined. The bulk density is expressed in grams per cubic centimeter of soil.

(2) Total Porosity (%)

Total Porosity (%) was calculated by the formula,

$$\text{Total Porosity (\%)} = 100 - \left(\frac{BD \times 100}{PD}\right)$$

Where BD = Bulk Density – g/cc
PD = Particle Density – g/cc

The Particle Density (the density of the soil particles collectively, expressed as the ratio of the total mass of solid particles to their volume in g/cc) was determined in the laboratory for each soil bulk samples and the respective total porosity was calculated with the corresponding bulk density.

(3) Soil Colour

The Munsell (U.S.D.A. Mis. Pub. 425) book of soil colour chips was used and Munsell notations were applied to determine the colour of air-dried 'fine earth' of each sample, for comparison.

(4) Particle Size Distribution

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

(5) Organic Matter And Loss-On-Ignition

On the fine earth, Organic matter was determined on a small (app. 5 gms) samples in porcelain crucibles dried overnight at 105˚C. This sample was then brought to the muffle furnace maintained at 550˚C and ignited for two hours to determine Loss-On-Ignition as percent (LOI %).

(6) Soil Reaction (P^h)

On fine earth, soil/distilled water suspensions (1:2:5) were shaken for half an hour with a shaking machine, and two P^H reading taken, using a Corning-EEL p^H meter 12 equipped with calomel glass electrodes. Mean p^H was calculated to the nearest 0.1 unit.

(7) Electrical Conductivity (E.C)

On fine earth, soil/distilled water suspensions (1:1) were stand for one hour, stirring at regular intervals. Reading were assessed in micro-mhos per centimeter by using YSI Model 31 Conductivity Bridge.

(8) Total Nitrogen (Total N%)

Soil and foliage total nitrogen levels were assessed by Kjeldahl method by using Labconco Kjeldahl, digestion and distillation unit.

(9) Available Phosphorous (Ava. P %)

On fine earth, available phosphorous levels were assessed with Double-acid extracting solution and Phosphomolybdenium-blue complex method by using Perkin-Elmer 55 E, Spectophotometer set at 600 mu wave length.

(10) Total Phosphorous (Total P %)

Foliage total phosphorous levels were assessed with Wet digestion method and Molybdivando phosphoric acid method by using B & L Spectronic 20, set at 420 mu wave length.

(11) Available Potassium (Ava. K %)

On fine earth, available potassium levels were assessed with Double-acid extraction solution, by using Perkin-Elmer, Atomic Absorption Spectrophotometer 2280 set at 767 wave length.

(12) Total Potassium (Total K %)

Foliage total potassium levels were assessed with Wet digestion method by using Varion Techtron AA6 model Atomic Absorption Spectrophotometer.

5. Results and Discussions

Physical and Chemical properties of East Pegu Yoma forest soils are presented in Appendices II and III. Some physical and chemical properties of surface soils (0-30 cm) are shown in Table 2.

Table 2. Some Physical and Chemical Properties of East Pegu Yoma Forest Surface Soils.

Plot No.	Physical Properties			Chemical Properties				
	Bulk Density gm/cc	Total Porosity %	Silt + Clay %	PH	OM %	Total N %	Available P %	Available K %
1	2	3	4	5	6	7	8	9
1	1.1	52.9	26.0	5.3	4.61	0.0966	0.0001	0.0141
2	1.3	47.0	22.0	6.3	2.61	0.0665	0.0004	0.0125
3	1.1	50.6	63.4	6.1	7.77	0.1148	0.0007	0.0143
4	1.2	47.3	42.7	5.8	4.29	0.0896	0.0015	0.0139
5	1.2	56.4	21.8	6.2	2.58	0.0833	0.0014	0.0102
6	0.9	61.6	37.0	6.5	4.67	0.1071	0.0002	0.0206
7	1.3	52.4	30.3	6.6	7.28	0.0557	0.0002	0.0013
8	1.2	38.6	43.3	6.2	6.96	0.0683	0.0002	0.0013
9	1.1	56.9	25.4	6.5	6.44	0.0462	0.0003	0.0011
10	1.0	44.4	22.8	5.7	3.07	0.0840	0.0002	0.0068
11	1.3	46.9	48.3	6.0	3.33	0.0980	0.0002	0.0012
12	1.4	37.3	55.8	5.9	4.65	0.1299	0.0002	0.0004
13	1.0	53.2	2.9	6.6	4.72	0.0728	0.0002	0.0002
14	1.2	41.1	56.5	5.6	4.90	0.1330	0.0002	0.0006
15	1.1	44.1	55.8	5.5	5.42	0.1610	0.0003	0.0184
16	0.9	55.0	31.3	5.7	4.55	0.1103	0.0001	0.0011

Forest litter accumulation is well developed under all types of forests within the study area. Oven dry weight of litter ranges between 0.48 Kg/m^2 to 6.69 Kg/m^2. The litter and humus layers of forests provide extra protection from the direct impact of raindrops, apart from improving the soil infiltration capacity. All sites under different forest types of East Pegu Yoma, except abandoned taungya, accumulated more than enough biomass of forest litter to control surface runoff and soil loss.

Physical properties, such as bulk density, total porosity, particle size distribution of the soils under different forest types and different localities are not significantly different and all are favourable for teak.

All forest surface soils within the study area, of East Pegu Yoma, are moderately acidic (P^H 5.3-6.6), well supplied with organic matter and containing a moderate levels of nitrogen, phosphorous and potassium, which are ideal for teak.

Primary plant nutrient levels of foliage and surface soils (0-20 cm) are shown in Table 3.

Table 3. Primary Plant Nutrient levels of sites

Sites	Surface Soil			Foliage		
	Total N %	Available P_2O_5 %	Available K %	Total N %	Total P %	Total K %
1	**2**	**3**	**4**	**5**	**6**	**7**
Natural Regeneration one year old	0.1070	0.0013	0.0224			
Teak				1.88	0.24	2.47
Pyinkado				2.56	0.13	1.29
Good and healthy one year old Teak Plantation	0.1003	Trace	0.0293	2.23	0.25	2.06
Poor and unhealthy one year old Teak Plantation	0.0731	Trace	0.0307	1.40	0.14	1.85

Fire affected the soil by drastic reduction of organic carbon, total nitrogen and available P_2O_5 (1). It indicated that reduction of total nitrogen and available P_2O_5 levels and increased in available potassium levels in plantation sites compare to the natural forest are due to burning in taungya method.

None-the-less, all soils under different forest types in East Pegu Yoma, contained satisfactory levels of primary plant nutrients required for Teak and Pyinkado.

Figures 1 and 2, show the relationship between slope steepness and surface soils, porosity, clay content, total nitrogen and available phosphorous in East Pegu Yoma forests. All parameters showed that slopes between 20 and 30 percent in East Pegu Yoma are the most favourable condition for tree growth.

6. Conclusion

Forest soils in East Pegu Yoma, under all types of forest namely DUMD, MUMD, LMD, including abandoned taungya area have favouable condition of physical and chemical properties and satisfactory levels of primary plant nutrients for tree growth. Among them, moderately steep slopes between 20 and 30 percent are the most favourable sites. So, from the northern to southern portion of East Pegu Yoma forests, selection of sites for teak and other high value commercial species could be focused on partially denuded area of East Pegu Yoma area for reforestation. It is wise to avoid selecting very high productive sites of natural forests which could be improved by other silvicultural means to increase the potential of these forests.

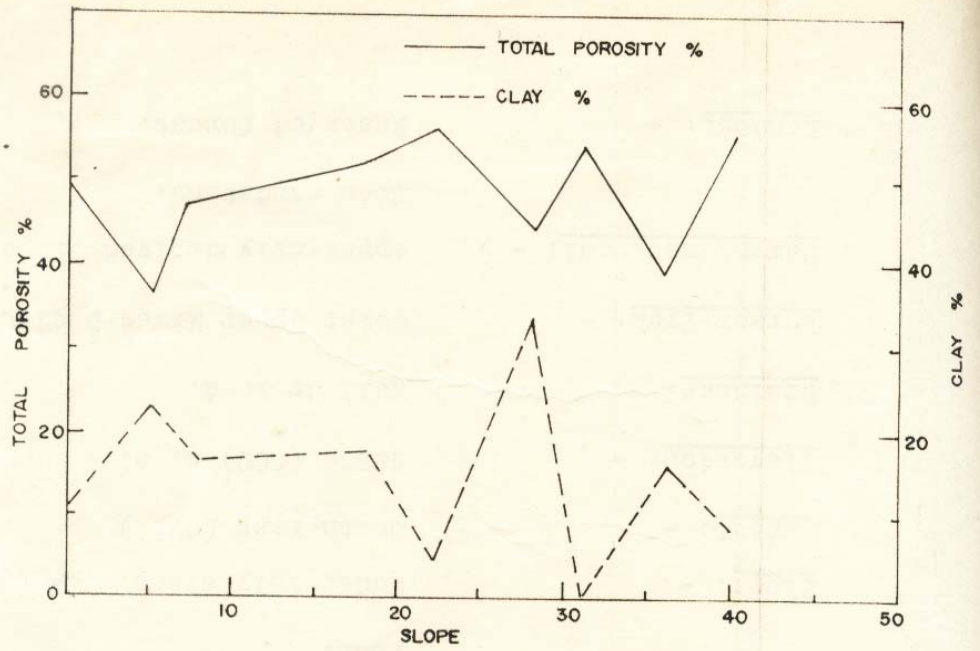

Figure 1. Relationship between porosity and clay content of surface soil and slope steepness of East Pegu Yoma forests.

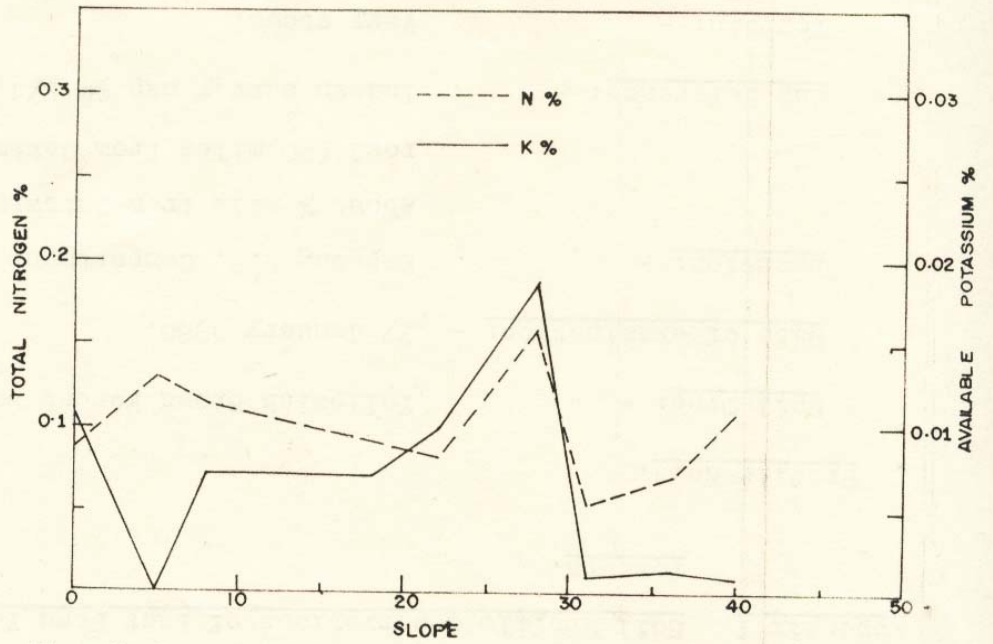

Figure 2. Relationship between total nitrogen and available potassium levels of surface soils and slope steepness of East Pegu Yoma forests.

Appendix I Soil Profile description of East Pegu Yoma forests.

Profile No. 1.

Soil Type:-	Yellowish Brown Forest Soil.
Date of examination:-	27 January 1980.
Location:-	Kabaung R.F, Compartment 221. About ¼ mile from Oattwin/Prome road (20 miles from Oattwin).
Map Reference:-	Indian survey map 94 B/1.
Terrain:-	Very steep.
Landform:-	On moderately steep convex solpe, at summit of rise with steeply dissected surrounding. Drainage normally flow west to east.
Slope:-	Moderately steep. 22% (13˚)
Aspect:-	South East (175˚)
Elevation:-	183 m (600)' a. s. l
Drainage:-	Well drained.
Forest Type:-	Moist Upper Mixed Deciduous.
Parent material:-	Apparently derived "in situ" form sandstone.
Landuse:-	Reserved forest.

Profile:-

A 0-30 cm	Yellowish red (5 YR 5/8) moist and reddish yellow (5 YR 6/8) dry, fine sandy loam, weakly developed medium granular structure, friable when moist, sticky, some roots, with sharp boundary to –
B 30-70 cm	Reddish brown (5 YR 4/4) moist and reddish brown (5 YR 5/4) dry, sandy loam, weakly developed medium granular structure, friable moist, with abundant distinct fine speckled mottling, trace of few iron accumulation, sticky, few fine roots and with sharp boundary to –
C 70-200 cm	Strong brown (7.5 YR 5/6) moist and reddish yellow (7.5 YR 7/6) dry, sandy loam, single grain, loose when moist and slightly sticky.

Appendix II. Physical Properties of East Pegu Yoma forest Soils.

Plot No.	Depth (cm)	Colour	Forest litter Kg/m^2	BD gm/cc	Total porosity %	Partical size distribution %		
						Sand	Silt	Clay
1	0-10	10 YR 3/3	2.46	1.1	52.9	72.7	4.0	18.8
	20-30	10 YR 4/3				70.4	5.4	23.8
	40-50	10 YR 4/3				65.2	6.4	26.8
	60-70	5 YR 4/6				34.8	6.0	59.6
	80-90	5 YR 5/6				60.1	5.0	31.8
	100-110	5 YR 5/6				59.0	8.0	31.8
2	0-10	5 Y 6/6	0.68	1.3	47.0	77.6	8.0	14.0
	20-30	5 Y 6/6				76.0	6.0	16.0
	40-50	2.5 Y 6/4				77.4	6.0	14.0
	60-70	2.5 Y 6/6				88.4	4.0	10.0
	80-90	2.5 Y 5/6				73.0	8.0	18.0
	100-110	2.5 Y 6/6				71.2	8.0	18.0
3	0-10	2.5 YR 5/6	3.54	1.1	50.63	33.8	8.0	56.0
	20-30	7.5 YR 5/6				36.8	10.0	52.8
	40-50	7.5 YR 6/6				40.4	13.0	46.8
	60-70	7.5 YR 6/8				44.0	10.0	44.8
	80-90	7.5 YR 6/6				47.2	12.0	40.8
	100-110	7.5 YR 6/6				52.2	10.0	36.8
4	0-10	10 YR 5/4	1.39	1.2	47.31	50.6	16.0	30.8
	20-30	10 YR 5/6				58.0	13.0	25.5
	40-50	10 YR 5/6				28.2	13.0	26.8
	60-70	10 YR 5/4				63.2	9.0	25.8
	80-90	10 YR 6/6				64.0	10.0	25.8
	100-110	10 YR 6/6				67.2	10.0	22.8
5	0-10	10 YR 4/3	1.41	1.2	56.4	72.8	6.0	16.8
	20-30	10 YR 5/4				78.6	6.0	14.8
	40-50	10 YR 4/3				76.6	6.0	16.8
	60-70	10 YR 5/6				78.1	4.0	16.8
	80-90	10 YR 5/6				77.1	7.0	16.8
	100-110	10 YR 5/6				74.0	9.0	18.8
6	0-10	10 YR 4/2	2.09	0.9	61.6	57.0	14.0	26.0
	20-30	10 YR 4/6				62.6	10.0	24.0
	40-50	2.5 Y 6/6				56.4	13.0	30.0
	60-70	2.5 Y 6/6				52.8	17.0	38.0
	80-90	2.5 Y 6/6				46.6	14.0	36.0
	100-110	2.5 Y 7/6				44.0	15.0	37.0
7	0-10	10 YR 6/6	6.69	1.3	52.38	68.4	9.0	21.8
	20-30	7.5 YR 6/8				67.6	7.0	22.8
	40-50	10 YR 5/6				61.9	11.0	23.9
	60-70	10 YR 6/6				57.2	13.0	28.8
	80-90	10 YR 6/6				69.7	8.0	18.8
	100-110	10 YR 6/6				51.9	14.0	32.8
8	0-10	2.5 Y 5/4	0.08	1.2	38.6	49.8	17.0	28.8
	20-30	2.5 Y 5/6				59.1	16.0	24.8
	40-50	2.5 Y 7/6				65.8	26.6	6.2
	60-70	5 Y 7/6				48.1	20.0	30.8
	80-90	5 Y 7/6				61.6	39.2	6.6
	100-110	2.5 Y 7/6				71.8	22.6	6.2

Plot No.	Depth (cm)	Colour	Forest litter Kg/m^2	BD gm/cc	Total porosity %	Partical size distribution %		
						Sand	Silt	Clay
9	0-10	2.5 Y 5/4	0.48	1.1	56.9	79.3	24.0	-
	20-30	2.5 Y 6/6				72.2	22.0	4.8
	40-50	2.5 Y 6/6				78.2	23.8	5.0
	60-70	2.5 Y 6/6				82.8	14.0	-
	80-90	2.5 Y 6/6				59.0	10.0	5.8
	100-110	2.5 Y 5/4				83.0	7.0	10.8
10	0-10	2.5 Y 5/6	0.98	1.0	44.4	77.0	12.0	10.8
	20-30	2.5 Y 6/6				77.0	12.0	10.8
	40-50	2.5 Y 7/6				81.0	10.0	10.8
	60-70	2.5 Y 7/6				77.0	12.0	10.8
	80-90	2.5 Y 6/6				77.0	12.0	10.8
	100-110	2.5 Y 5/6				75.0	14.0	10.8
11	0-10	2.5 Y 6/4	1.08	1.3	46.9	35.4	20.0	44.8
	20-30	5 Y 6/4				32.8	21.0	43.8
	40-50	5 Y 6/4				32.0	24.0	46.8
	60-70	5 Y 6/4				34.0	22.0	46.8
	80-90	5 Y 5/3				33.6	25.0	39.8
	100-110	5 Y 5/3				35.0	24.0	40.8
12	0-10	2.5 Y 5/4	0.69	1.4	37.3	48.4	20.0	28.8
	20-30	2.5 Y 6/6				38.1	26.0	36.8
	40-50	2.5 Y 6/4				29.4	30.0	40.8
	60-70	2.5 Y 6/4				38.1	22.0	39.8
	80-90	2.5 Y 6/4				33.4	24.0	40.8
	100-110	2.5 Y 6/				37.1	24.0	39.8
13	0-10	10 YR 5/6	2.89	1.0	53.2	92.0	0.4	5.0
	20-30	10 YR 5/8				98.8	0.4	-
	40-50	10 YR 5/6				99.6	0.4	-
	60-70	10 YR 6/6				99.6	0.4	-
	80-90	10 YR 6/6				96.0	3.2	-
	100-110	10 YR 5/8				96.0	3.2	-
14	0-10	2.5 Y 6/4	1.14	1.2	41.1	38.8	34.0	28.8
	20-30	2.5 Y 6/6				46.4	16.0	34.2
	40-50	2.5 Y 6/4				41.0	17.0	40.8
	60-70	2.5 Y 6/6				40.0	18.0	40.8
	80-90	5 Y 6/6				47.0	19.0	33.8
	100-110	5 Y 6/6				49.0	18.0	32.8
15	0-10	5 Y 5/3	1.68	1.1	44.1	40.0	18.0	40.8
	20-30	5 Y 6/3				27.0	26.0	46.8
	40-50	5 Y 6/6				49.0	17.0	33.8
	60-70	5 Y 5/4				39.0	24.0	36.8
	80-90	5 Y 6/4				39.0	23.0	35.8
	100-110	5 Y 6/6				81.0	10.0	8.8
16	0-10	10 YR 4/4	4.15	0.9	55.0	61.2	14.0	19.8
	20-30	10 YR 5/6				68.1	10.0	18.8
	40-50	10 YR 6/8				68.0	14.0	18.8
	60-70	10 YR 6/6				64.8	14.0	10.8
	80-90	2.5 Y 6/6				42.2	22.0	34.8
	100-110	2.5 Y 6/4				45.5	21.0	33.8

Appendix III. Chemical Properties of East Pegu Yoma Forest Soils

Plot No.	Depth (cm)	P^H	OM %	EC (u mhos/cm)	Primary nutrients levels %		
					Total N %	Ava. P %	Ava. K %
1	0-10	7.0	4.32	12.50	0.0994	0.0001	0.0179
	20-30	5.1	4.90	5.25	0.0938	0.0001	0.0102
	40-50	5.2	4.00	2.63	0.0812	0.0003	0.0091
	60-70	5.2	3.90	1.50	0.063	0.0003	0.0083
	80-90	5.1	3.90	1.038	0.0658	0.0005	0.0079
	100-110	5.3	3.80	1.69	0.0714	0.0004	0.0069
2	0-10	6.6	2.85	7.75	0.0574	0.0003	0.0132
	20-30	6.1	2.37	9.50	0.0756	0.0007	0.0118
	40-50	6.3	2.86	10.00	0.0602	0.0021	0.0097
	60-70	6.4	2.08	2.94	0.1218	0.0001	0.0056
	80-90	6.2	3.26	3.75	0.1036	0.0004	0.0096
	100-110	6.2	2.64	3.50	0.1036	0.0005	0.0064
3	0-10	6.8	8.76	2.88	0.1316	0.0006	0.0161
	20-30	5.3	6.78	1.31	0.098	0.0008	0.0124
	40-50	5.3	5.40	1.38	0.0868	0.0005	0.0075
	60-70	5.1	6.40	1.75	0.0826	0.0002	0.0064
	80-90	5.3	4.00	2.00	0.0786	0.0003	0.0075
	100-110	5.2	4.00	2.31	0.0714	0.0023	0.0072
4	0-10	6.5	4.03	7.88	0.0924	0.0016	0.0174
	20-30	5.1	4.56	2.00	0.0868	0.0013	0.0103
	40-50	5.2	3.28	2.13	0.063	0.0002	0.0086
	60-70	5.5	4.06	2.13	0.0406	0.0002	0.0079
	80-90	5.2	3.48	2.38	0.0476	0.0009	0.0089
	100-110	5.4	4.20	2.88	0.0504	0.0026	0.0093
5	0-10	6.8	2.88	6.63	0.1064	0.0014	0.0114
	20-30	5.6	2.28	2.88	0.0602	0.0014	0.0089
	40-50	5.7	2.3	3.13	0.0756	0.0017	0.0101
	60-70	7.0	3.32	2.75	0.077	0.0016	0.0101
	80-90	6.7	3.32	2.88	0.063	0.0001	0.0078
	100-110	6.5	3.14	3.88	0.0602	0.0001	0.0078
6	0-10	6.7	4.54	11.00	0.1428	0.0001	0.0264
	20-30	6.4	4.8	4.00	0.0714	0.0001	0.0148
	40-50	6.2	4.8	2.13	0.0532	0.0002	0.0166
	60-70	6.1	3.88	1.88	0.049	0.0002	0.0173
	80-90	6.0	4.76	2.44	0.349	0.0002	0.0170
	100-110	5.9	4.77	1.50	1.0518	0.0009	0.0171
7	0-10	6.8	7.46	3.50	0.0623	0.0003	0.0013
	20-30	6.5	7.10	2.06	0.049	0.0001	0.0013
	40-50	6.0	7.40	1.88	0.0371	0.0001	0.0009
	60-70	5.8	7.45	2.75	0.0574	0.0001	0.0010
	80-90	5.9	2.74	1.75	0.028	0.0001	0.0011
	100-110	5.7	3.35	1.63	0.0399	0.0002	0.0018
8	0-10	6.5	8.03	4.75	0.0833	0.0002	0.0013
	20-30	5.9	5.88	2.13	0.0532	0.0002	0.0012
	40-50	5.8	5.59	1.88	0.0462	0.0002	0.0015
	60-70	5.7	6.19	1.88	0.0539	0.0002	0.0015
	80-90	5.8	4.60	1.75	0.0434	0.0002	0.0010
	100-110	5.9	4.63	1.69	0.0378	0.0001	0.0010

Plot No.	Depth (cm)	P^H	OM %	EC (u mhos/cm)	Primary nutrients levels %		
					Total N %	Ava. P %	Ava. K %
9	0-10	6.1	5.61	6.75	0.0553	0.0004	0.0007
	20-30	7.0	3.18	6.13	0.0371	0.0004	0.0011
	40-50	6.9	2.35	2.38	0.049	0.0006	0.0010
	60-70	6.7	2.09	1.63	0.0343	0.0003	0.0009
	80-90	6.6	1.69	1.63	0.0287	0.0002	0.0008
	100-110	6.2	2.70	2.00	0.0406	0.0001	0.0009
10	0-10	5.9	3.99	6.00	0.0994	0.0002	0.0088
	20-30	5.6	2.14	1.75	0.0686	0.0001	0.0048
	40-50	5.4	2.42	1.75	0.0700	0.0001	0.0048
	60-70	5.3	2.95	1.50	0.0616	0.0001	0.0031
	80-90	5.3	2.40	1.75	0.056	0.0001	0.0044
	100-110	5.4	2.77	2.13	0.053	0.0001	0.0045
11	0-10	6.0	2.24	5.63	0.1162	0.0004	0.0002
	20-30	6.0	4.42	4.38	0.0798	0.0002	0.0022
	40-50	5.9	4.78	2.63	0.0805	0.0002	0.0007
	60-70	5.8	6.86	4.88	0.0784	0.0003	0.0001
	80-90	5.9	6.75	3.38	3.0644	0.0006	0.0012
	100-110	6.0	7.26	4.00	0.0728	0.0004	0.0003
12	0-10	6.3	4.79	7.00	0.1435	0.0001	0.0003
	20-30	5.5	4.51	3.63	0.1161	0.0002	0.0004
	40-50	5.4	3.97	2.50	0.0952	0.0002	0.0003
	60-70	6.3	3.23	2.38	0.0798	0.0001	0.0002
	80-90	5.6	3.34	2.63	0.0826	0.0001	0.0002
	100-110	6.8	3.09	2.63	0.084	0.0003	0.0003
13	0-10	6.3	3.56	7.75	0.0952	0.0002	0.0001
	20-30	6.9	5.88	4.43	0.0504	0.0002	0.0003
	40-50	6.9	6.02	4.00	0.092	0.0002	0.0006
	60-70	6.6	2.20	2.00	0.0378	0.0005	0.0012
	80-90	6.5	2.34	1.13	0.0392	0.0007	0.0007
	100-110	6.3	7.41	2.13	0.0266	0.0004	0.0004
14	0-10	5.8	2.75	5.50	0.1484	0.0002	0.0007
	20-30	5.4	7.05	2.38	0.1176	0.0002	0.0005
	40-50	5.2	5.20	2.063	0.1134	0.0001	0.0004
	60-70	5.1	6.36	1.75	0.0994	0.0002	0.0005
	80-90	5.4	3.11	1.75	0.063	0.0001	0.0067
	100-110	5.2	6.37	1.38	0.0644	0.0001	0.0074
15	0-10	5.9	5.36	12.38	0.1974	0.0005	0.0228
	20-30	5.2	5.47	5.00	0.1246	0.0001	0.0140
	40-50	5.1	4.5	2.75	0.0994	0.0002	0.0130
	60-70	5.2	3.76	2.50	0.0728	0.0001	0.0120
	80-90	6.8	3.21	2.88	0.0728	0.0017	0.0160
	100-110	6.3	5.7	2.13	0.084	0.0009	0.0240
16	0-10	6.4	4.85	7.50	0.1211	0.0001	0.0009
	20-30	5.0	4.25	5.00	0.0994	0.0001	0.0013
	40-50	5.1	2.62	2.75	0.0749	0.0001	0.0015
	60-70	5.4	2.97	2.19	0.0581	0.0001	0.0015
	80-90	5.1	5.48	2.13	0.0819	0.0002	0.0010
	100-110	6.2	6.06	1.50	0.0602	0.0003	0.0015

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