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Some Physical and Chemical Properties of Dry Zone Forest Soils

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အပူပိုင်းဒေသ သစ်တောမြေ၏ အချို့သော ရူပနှင့် ဓါတုဂုဏ် သတ္တိများကိုလေ့လာခြင်း

စိန်သက် နှင့် တင်တင်အုံး
ရေမြေသားဌာနှင့် သစ်တောသယံဇာတဌာနခွဲ
သစ်တောသုတေသနဌာန၊ရေဆင်း

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံအပူပိုင်းဒေသတွင် ထင်းစိုက်ခင်းများအဖြစ် တည်ထောင်ရန် စီစဉ်လျက်ရှိပါသည်။ စိုက်ခင်းများ တည်ထောင်ရာတွင် အထောက်အကူပြုနိုင်ရန်အတွက် အပူပိုင်းဒေသ သစ်တောမြေများကို လေ့လာခဲ့ပါသည်။ ဤစာတမ်းတွင် အပူပိုင်းဒေသများဖြစ်သော ရူပါတောင်၊ အင်ပင်ဝ၊ ပျဉ်းမ စသည့် အခြေအနေခြားနားသည့် နယ်မြေများမှ သစ်တောမြေ၏ ရူပ-ဓါတု ဂုဏ်သတ္တိများကိုလေ့လာပြီး တင်ပြထားပါသည်။ ဒေသ(၃) ခု၏သစ်တောမြေ ဂုဏ်သတ္တိများနှင့် တွေ့ရှိရသည့် အခြေအနေတို့ကို နှိုင်းယှဉ်တင်ပြဆွေးနွေးထားပါသည်။

Some Physical and Chemical Properties of Dry Zone Forest Soils

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Abstract

The fuel wood supply project for dry zone is being considered in Burma. Soil studies for those areas were carried out to provide some information for establishment and management of plantation. This paper describes some physical and chemical properties of soil which are collected from three different sites Yupa-taung, Inbinwa and Pyinma plantation centres. The condition of the site from those three areas were comparatively observed according to their properties of soil.

Introduction

To day, the forest management is aiming to contribute the needs of the people while maintaining the Agro-climate environment for soil, water, wildlife and recreation in the forest. Forest soils were ruined by soil especially in the dry zone. So all forest areas should be revegetated where erosion were severe. The fuel wood is in great demand in the dry zone and a fuel wood supply project is being considered since fuel wood plantations are to be establishment on large scale in the dry zone, field observation and soil physical and chemical properties analysis of the dry zone soils were carried out to proved some information and guide lined for the establishment and management of plantations.

Study Areas

Three different locations in the dry zone were selected by visible observations.

(1) Yupa- taung plantation centre of Meiktila Forest Division, which is the best site in the dry zone.
(2) Inbinwa plantation centre of Meiktila Forest Division, which is about an average site in the dry zone, and
(3) Pyinma plantation centre of the Dry Zone Forest Division, which is the driest and the most degraded part of the dry zone.

Yupa- taung plantation area is in Thazi township. The highest elevation is (573) metres above sea level. Land-form is flat and the area is well drained and normally flow from east to west. Most of the area is apparently derived "in situ" from sand stone. Soil type is Reddish brown dry forest soil, granular structure and sandy clay loam texture.

Inbinwa plantation area is in Meiktila township. Land-form is flat and the area is well drained and generally flows from south east to north west, the highest elevation is (403) meters above sea level. Parent material is apparently derived " in situ" from sand stone. Soil type is yellowish brown dry forest soil, granular structure and sandy clay loam texture.

Pyinma plantation area is in Nyaung Oo township. The highest elevation is (353) meters above sea level. Land-form is flat and the area is well drained and normally flows from west to east. Most of the area is apparently derived "in situ" from sand stone. Soil type is Reddish brown dry forest soil, granular structure and sandy loam texture.

Within the study area the rainfall occurs during the period from May through October. Average annual rainfall is (1063) mm in Yupa-taung (778) mm in Inbinwa and (537) mm in Pyinma respectively. Average mean daily temperature ranges between 19.2° C to 29.2° C in the Dry Zone study area.

Methods

Field Techniques

(1) For Bulk Density

Fifteen samples of the surface soil were collected from each three plantation areas. The collection of soil sample for bulk density 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 core was dug out from the ground using a trowel and the surplus soil was trimmed at the ends of the core by means of a sharp knife. The soil core was extracted into a labelled plastic bag and returned to the laboratory.

For soil properties test, twenty one predetermined places in Yapataung and Inbinwa, twenty five predetermined places in Pyinma Plantation centre were selected. Soil samples

were collected from different deptns of horizon such as 0-10 cm, 20-30 cm, 40-50 cm, 60-70 cm, 80-90 cm and 100- 110 cm successively.

Laboratory Techniques

All soil samples were air dried and ground to be passed through 2 mm sieve prior 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 using the formula,

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

Where B.D. = Bulk Density g / cc

P.D .= Particle Density g / cc

(3) **Soil Colour**

In dry and wet condition, soil colour is mentioned in Munsell notations by using the Munsell (U.S.D.A Mis Pub 425) book of soil colour chips.

(4) **Partical size distribution**

Partical size distribution of soil samples were carried out by mechanical analysis using the modified hydrometer.

(5) **Organic Matter**

Organic matter was detected from the Loss-on-Ignition at 550° C for two hours by means of Muffle furnace.

(6) **Soil Reaction (P^H)**

P^H was determined by using Corning P^H meter 12 equipped with calomel glass electrodes on soil distilled water suspension (1: 2.5).

(7) **Electrical Conductivity (E.C)**

Electrical Conductivity was determined by using YS I Model 31 Conductivity Bridge meter and mentioned as m mhos/cm.

(8) **Cation Exchange Capacity (C.E.C)**

C.E.C was determined by using Ammonium acetate Methods and mentioned as m-e/ 100 gm of soil.

(9) **Total Nitrogen (N%)**

Total nitrogen levels were assessed by Kjeldhal's method by using Labconco Kjeldahl, disgestion and distillation unit.

(10) Available Phosphorous and other Available Cations (Ca, Mg,Na, Fe).

Available Phosphorus and other available cations (Ca, Mg,Na, Fe) were extracted by using Double Acid (0.05 N Hcl: 0.025 H_2So_4: H_2O= 28: 166:4000 cc). After extracting stage, available phosphorus were assessed with Phosphomolybdenum blue method by using Perkin Elmer 55 Spectrophotometer while available cations were determined by using Atomic Absorption Spectrophotometer 2280.

Results and Discussions

Soil Profile descriptions and Physical and Chemical Properties of Dry Zone Forest soils are presented in Appendix I and II. Some Physical and Chemical Properties of surface soils (0-10) cm of three different sites are comparatively described in Table I.

Table 1. Some Physical and Chemical Properties of Dry Zone Forest Surface Soils

Sr. No.	Properties	Depth (0-10) cm		
		Yupa-taung	Inbinwa	Pyinma
	Physical properties			
1.	Soil Colour notation (Dry)	7.5 YR 4/2	5 YR 4/6	5 YR 5/8
	Soil Colour notation (Wet)	5YR 3/2	2.5 YR 3/4	5 YR 3/4
2.	Bulk Density (gm/cc)	1.2	1.1	1.1
3.	Total Porosity (%)	47.75	44.21	38.90
4.	Texture	sandy clay loam	sandy clay loam	sandy clay loam
	sand (%)	65.0	63.3	70.5
	silt (%)	8.0	6.0	7.2
	clay (%)	22.5	29.2	17.6
	Chemical Properties			
5.	Soil Reaction (pH)	7.4	8.2	8.0
6.	Organic Matter content (%)	3.9	3.4	2.6
7.	Electrical Conductivity(m mhos/cm)	3.1	19.6	11.7
8.	Cation Exchange Capacity (m-e /100 gm)	18.7	15.0	22.1
9.	Total Nitrogen (N%)	0.06	0.05	0.04
10.	Available Phosphorus P (mg/100 gm)	1.14	0.07	0.14
11.	Available Potassium K (mg/100 gm)	10.50	4.60	4.40
12.	Available Calcium Ca (mg/100 gm)	67.50	110.30	81.30
13.	Available Magnesium K (mg/100 gm)	32.00	47.70	12.20
14.	Available Sodium Na (mg/100 gm)	29.30	3.90	1.60
15.	Available IronFe (mg/100 gm)	32.00	0.40	2.60
16.	Carbon -Nitrogen Ratio (C/N)	31.80	39.50	30.20

Soil Colour in itself is of little importance to tree growth. However, it serves as an indicator of several important characteristics of soil such as geologic origin and degree of weathering of soil material, degree of oxidation and reduction, content of organic material leaching or accumulation of such chemical compounds as iron, which may greatly influence site quality. Dark coloured surface soils, absorb heat more rapidly than light-coloured soils, but because of their generally higher content of organic matter, they often have higher moisture content (Prichett 1979). Table 1 shows the soil from Yupa-taung plantation area has the dark-coloured (7.5 YR 4/2) among three plantation areas. Light- colour and intermediate colour are observed in Inbinwa and Pyinma respectively. The best condition for the growth was found in Yupa-taung areas as compared to other to sites with regard to their soil colour (Table 2, plate 1b, 2b, 3b).

Table 2. The growth condition of Mazali *(Cassia siamea)* at different sites

Sr. No.	Particulars	Sites		
		Yupa-taung	Inbinwa	Pyinma
1.	Tree height (cm)			
	Average	183	122	91
	Maximum	396	335	213
	Minimum	61	61	30
2.	Crown height (cm)			
	Average	122	61	30
	Maximum	305	244	122
	Minimum	30	30	30
3.	Crown width (cm)			
	Average	91	91	61
	Maximum	183	183	183
	Minimum	30	30	30

The sandy clay loam texture was found in Yupa-taung plantation area and Inbinwa plantation area and the soil from Pyinma plantation area can be classified as sandy loam. The clay percent of Inbinwa area was higher than other two plantation areas and clay percent was increased gradually to the lower layer (100-110) cm. According to the texture, Yupa-taung and Inbinwa areas were more favourable to the tree growth than Pyinma area.

Many of the apparent direct effects of soil acidity on tree growth may, infact, result from its indirect effects on such soil condition as microbial activity and nutrient availability. Most tree species can be grown in soils within the range between pH 4.5 and 6.5 (Prichett, 1979). In those three plantation areas, soils reactions indicate that those three plantations are not of optimal condition for forest tree as for soil reaction is concerned. The unfavourable effects of soil alkalinity may be due not alone to the toxicity of the hydroxylions but also to the unavailability of nutrients such as phosphorous, iron or manganese. In general, tree seedling develop best in soil having reaction values pH 4.5 and 6.0 (Harold et al. 1966). With few exception, forest species are well adapted to acid soil conditions and, infact, grow best in fairly acid media. Some trees of forest species can be grown at Yupa-taung area where almost neutral soil reaction was observed. Two other areas were needed to select the species which adapted to alkali condition.

Considerable amount of organic matter was found in Yupa-taung and Inbinwa plantations while in Pyinma plantation area, it was low compared to normal forest soil.

Species of low requirements may be satisfied with a content of total nitrogen content as low as (0.07%) (Wilde et al 1972). In general the status of Nitrogen in each study area was not sufficient for the forest tree two grow well (Fig 1).

Available Phosphorous levels content were lower 15 mg / 100 gm of soil in three (Fig 1). So according to Wilde et al, 1972, in each and every site of study area the level of Phosphorous is lower than the requirement for normal plant growth. Phosphorous is essential for production of seed and the fibrous laterals of the root systems. According to their content of available phosphorous its seems to be different in all study sites which may be affected on development of the root systems especially after the transplanting period .

Although the highest amount of available Potassium levels was found in Yupa -taung compared to the other two areas, the available Potassium content was as much as above 2.5 mg/ 100 gm of soil in all three sites. Therefore the available Potassium in soil from each sites was quite sufficient for plant growth (Fig 1).

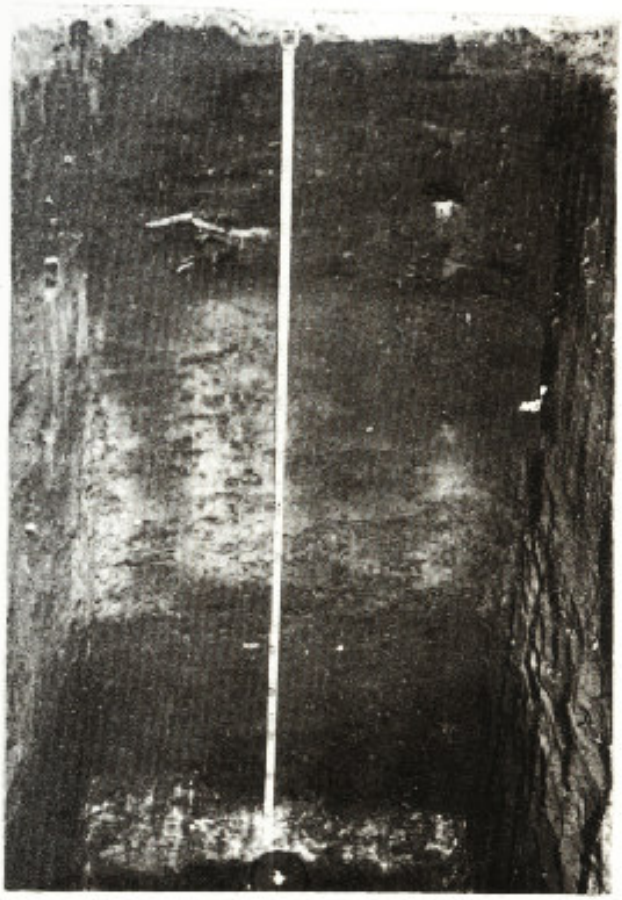

Plate 1–a Yupa-taung Soil Profile.
(Note- Sodium Salt accumulation between 40-90 cm)

Plate 1– b Two Years Old Cassia siamea trial plot at Yupa-taung

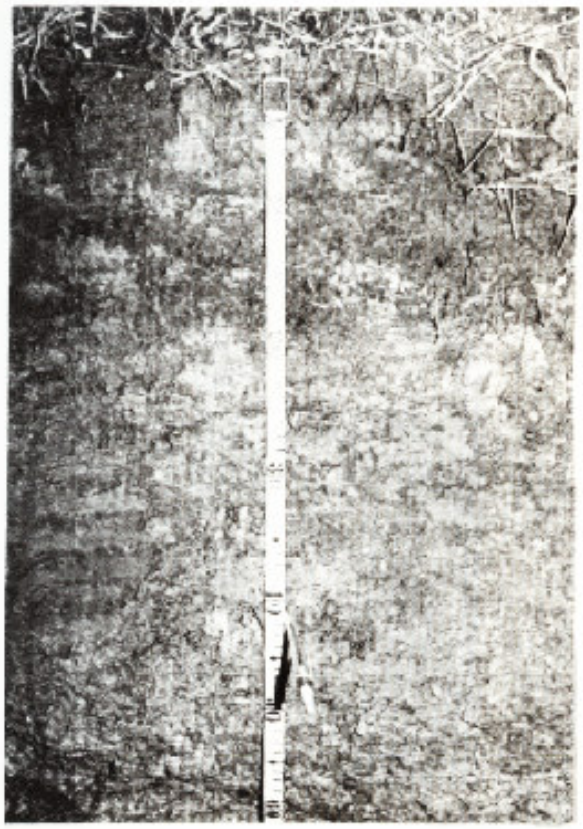

Plate 2 - a Irbinwa Soil Profile

(Note - Calcium and Magenesium Salt accumulation between 40 - 60 cm)

Plate 2 - b Species trial plot at Inbinwa .

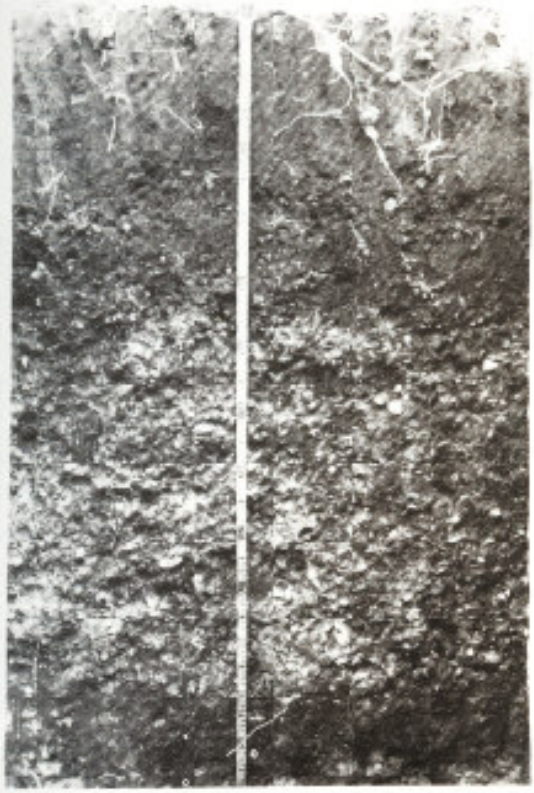

Plate 3-a

Pynma Soil Profile

(Note - Hard Pan between 30 - 100 cm due to Caloum Soil)

Plate 3-b

Stunted growth of Cassa sianea, Albizzia Lebbek at Pyinma species Trial plot.

In case of available calcium and magnesium the soil from Inbinwa was highest (Fig 1), and the concentration of available calcium, magnesium markedly increased between (40-90 cm) layer in each plantation. By profile observations of those sites, they have salt accumulation and hard Pan formation between 40-90 cm below top layer (Plates 1a, 3a, 5a) due to leaching and capillary action of other layer and accumulate at those layers.

The highest amount of Sodium was found in Yupa-taung but the concentration was not consistent, while in Inbinwa content of Sodium flactuated with different soil layers and only a small amount of Sodium was observed in Pyinma at all layers (Fig 1).

The highest amount of available iron was found in Yupa-taung as compared to other two study areas. Although available iron content was markedly higher at 20-30 cm soil layer, there were more or less the same amount at other layer, in Yupa-taung soil. But in case of Inbinwa and Pyinma, it was found that available iron content in all layers were almost the same.

The optimal Carbon - Nitrogen ratio for plant growing is 10-40 (Wilde et al 1972). Carbon - Nitrogen ratio of all sites (0-10 cm) and (20-30 cm) layers were almost under 40. Although the plants can be well developed at surface layer (0-30 cm), at deeper layer beyond 30 cm nitrogen immobilization might occur and effect the availability of plant nutrient.

Electrical Conductivity of soil from Inbinwa sites was higher than other two plantation sites. In all three sites the Electrical Conductivity increased with depths. Specific conductance approaching 1.0 milli mho/ cm is indicative of abnormally high concentration of soluble salts. Electrical Conductivity from each study area showed that the sites have higher concentration of soluble salts and warned to select resistant species for afforestation.

Cation Exchange Capacity of Yupa-taung, Inbinwa and Pyinma study area were 18.7, 15.0 and 22.2 m-e/100 gm respectively. In general its seems to be quite fair for the development of forest trees and it can not greatly influence an availability of plant nutrient in such Cation Exchange Capacity ranges.

Conclusion

Among those study sites Yupa-taung was superior to the other two sites as far as physical and chemical properties are concerned.

Since those three study sites can not meet the minimum requirement for the growth of normal forest tree species concerning nutrient levels of soil, the selection of forest tree species for afforestation leguminous or other soil improving species should be considered.

According to chemical analysis, and soil profile observation, it should be incorporated with special device or deeper narrow to disintegrate the hard pan which formed at 40-90 cm, so that moisture and plant nutrient can be distributed evenly and the plant roots can be developed. Amendment of chemical fertilizer or organic manure should be practiced especially at the time of planting, because present nutrient status of those study sites were not sufficient even for minimum requirement of the plant growth.

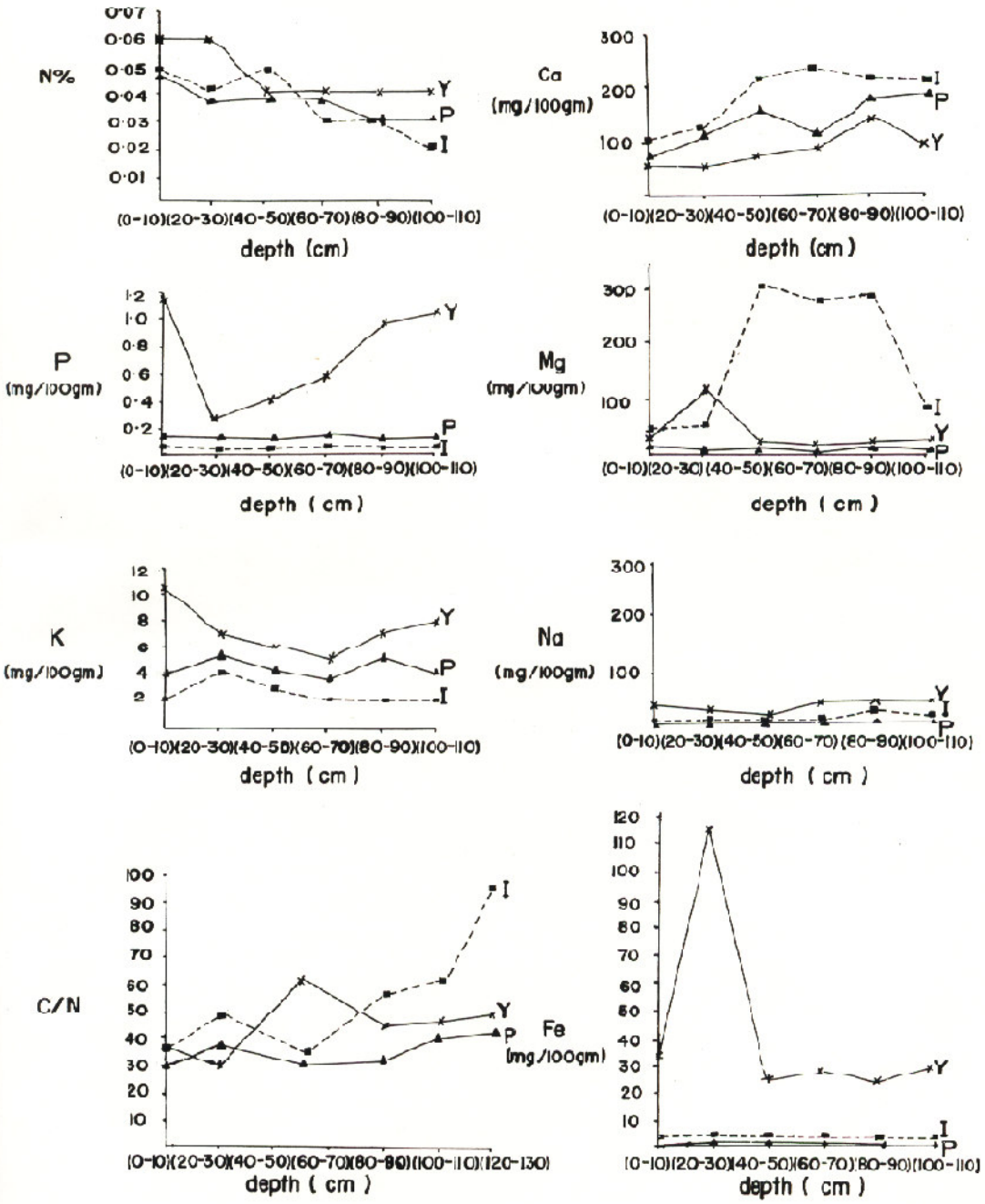

Fig: Nutrients level of Dryzone Forest Soils.

Y= Yupa – taung , I= Indinwa , P = Pyinma

Appendix I. Soil Profile Description of Dry Zone Forest Soils

Profile No. 1	
Soil Type	Reddish Brown Dry Forest Soil.
Date of Examination	25 September 1982.
Location	Yupa- taung Reserved Forest, about 4 miles from Meiktila/ Taunggyi Roads (26 miles from Meiktila)
Map Reference	LL 6654
Terrain	Flat
Landform	Flat, Drainage normally flow East to West
Slope	Flat
Aspect	West
Elevation	573 meters a.s.l
Drainage	Well drained
Forest Type	Tropical dry bamboo brakes
Parent Material	Apparently derived " insitu" from sandstone
Landuse	Reserved Forest, Denuded area
Profile:	
A 0-30 cm	Very dark gray (5 YR 3/1) moist and dark brown (7.5 YR 4/2) dry, Loamy sand, weakly developed medium granular structure, firm when moist, hard when dry, some roots, mainly grass roots, with some trace of termite & mice hole and diffuse boundary to -
B 30-150 cm	Dusky red (2.5 YR 3/2) moist and dark reddish brown (5YR 3/2) dry, loamy sand, weakly developed medium granular structure, firm when moist, hard when dry, non sticky, some roots, mainly fibrous roots, with many mottling and distinct boundary to -
C 150 cm +	Dark reddish brown (5 YR 3/2) moist and reddish brown (5YR 4/4) dry, sand, weakly developed medium granular structure, loose when moist, and dry with many mottling and without roots.
Profile No. 2	
Soil Type	Yellowish Brown Dry Forest Soil.
Date of Examination	24 September 1982.
Location	Inbinwwa Reserved Forest, About 1 ½ miles from Meiktila/ Kyaukpadaung roads (24 miles from Meiktila).
Map Reference	PP 9481
Terrain	Flat
Landform	Flat, Drainage generally flow South East to North West
Slope	Flat
Aspect	North West
Elevation	403 meters
Drainage	Well drained
Forest Type	Burma Dry Diospyros Forest
Parent Material	Apparently derived " insitu" from sandstone
Landuse	Reserved Forest, Denuded area
Profile	
B 0-45 cm	Dark reddish brown (25 YR 3/4) moist and reddish brown (5 YR 5/3) dry sandy loam, weakly developed medium granular structure, some roots, mostly grass, with diffuse boundary to -

C 45 cm +	Brown (7.5 YR 5/4) moist and light Yellowish brown (10 YR 6/4) dry, sandy loam, weakly developed medium granular structure,.
Profile No. 3	
Soil Type	Reddish Brown Dry Forest Soil.
Date of Examination	3, October 1982.
Location	Dahatsi Reserved Forest, Pyinma Sample plot, about 50 feet from Kyaukpadaung Nyaung Oo Road (10 miles from Kyaukpadaung).
Map Reference	PP 0638
Terrain	Flat
Landform	Flat, Drainage Normally flow West to East
Slope	Flat
Aspect	East
Elevation	353 metres a.s.l
Drainage	Well drained
Forest Type	Southern cutch thorn forest
Parent Material	Apparently derived " insitu" from sandstone
Landuse	Reserved Forest, Denuded area
Profile	
A0-40 cm	Dark reddish brown (5 YR 3/3) moist and Yellowish red (5 YR 5/6) dry, sandy loam, weakly developed medium granular structure, firm when moist, hard when dry, some grass roots and diffuse boundary to -
40 cm+	Red (2.6 YR 4/6) moist and Yellowish red (5 YR 5/6) dry, loamy sand, weakly develop medium granular structure, firm when moist, some roots mostly fibrous, few mottling, gravelly and trace of hard pan between 40-110 cm within the horizon.

Appendix II. Some Physical and Chemical Properties of Dry Zone Forest Soils
YUPA- TAUNG

Sr. No.	Properties	Layers (cm)					
		0-10	20-30	40-50	60-70	80-90	100-110
	Physical Properties						
1.	Soil colour notation (Dry)	7.5YR 4/2	7.5YR 4/2	5YR 3/3	5YR 3/2	5YR 3/2	10YR 3/2
	Soil colour notation (Wet)	5YR 3/1	5YR 2/1	2.5YR 3/2	5YR 2/2	5YR 2/2	10YR 3/2
2.	Bulk Density (gm/cc)	1.20	-	-	-	-	-
3.	Total porosity (%)	47.75	-	-	-	-	-
4.	Texture	sandy clay loam	sandy clay loam	sandy clay loam	sandy clay loam	sandy clay loam	sandy clay loam
	sand (%)	65.0	65.2	56.1	64.1	68.2	58.6
	silt(%)	8.0	8.0	8.0	8.0	7.3	7.3
	clay (%)	22.5	20.5	25.2	26.2	25.2	28.3
	Chemical Properties						
5.	Soil Reaction (P^H)	7.4	7.1	7.1	7.2	7.5	7.8
6.	Organic Matter content (%)	3.9	3.4	3.2	3.2	3.3	3.5
7.	Electrical Conductivity (m mhos/cm)	3.1	7.9	6.5	8.1	14.6	11.8
8.	Electrical Exchange Capacity (m.e/ 100 gm)	18.7	-	-	-	-	-
9.	Total Nitrogen N (%)	0.06	0.06	0.04	0.04	0.04	0.04
10.	Available Phosphorous P (mg/100gm)	1.14	0.28	0.39	0.58	0.99	0.80
11.	Available Potassium K mg/100 gm)	10.50	7.00	6.30	6.70	7.80	6.80
12.	Available Calcium Ca (mg/100gm)	67.50	57.80	78.60	87.00	131.00	80.10
13.	Available Magnesium Mg (mg/100 gm)	32.00	117.50	24.80	27.40	25.60	31.70
14.	Available Sodium Na (mg/100 gm)	29.30	23.00	12.00	33.00	33.60	33.30
15.	Available Iron Fe (mg/100 gm)	32.00	117.50	24.80	27.40	25.60	31.70
16.	Carbon- Nitrogen Ratio (C.N)	37.80	32.90	62.00	46.50	47.90	50.80

Appendix II. (Contd)Some Physical and Chemical Properties of Dry Zone Forest Soils INBINWA

Sr. No.	Properties	Layers (cm)					
		0-10	20-30	40-50	60-70	80-90	100-110
	Physical Properties						
1.	Soil colour notation (Dry)	5YR 4/6	5YR 4/6	5YR 4/6	5YR 5/6	7.5YR 5/4	7.5YR 6/8
	Soil colour notation (Wet)	2.5YR ¾	2.5YR 3/4	2.5YR 3/4	7.5YR 3/4	7.5YR 3/9	7.5 YR 4/4
2.	Bulk Density (gm/cc)	1.1	-	-	-	-	-
3.	Total porosity (%)	-	44.21	-	-	-	-
4.	Texture	sandy clay loam	sandy clay loam	sandy clay loam	sandy clay loam	sandy clay loam	sandy clay loam
	sand (%)	63.3	60.5	62.1	55.7	51.0	63.4
	silt(%)	6.0	12.0	7.3	9.3	13.3	10.0
	clay (%)	29.2	28.5	30.5	31.2	32.2	26.0
	Chemical Properties						
5.	Soil Reaction (P^H)	8.2	7.8	7.7	7.8	8.0	8.1
6.	Organic Matter content (%)	3.4	3.5	3.0	3.0	3.7	3.3
7.	Electrical Conductivity (m mhos/cm)	19.6	21.5	22.3	18.9	19.0	20.5
8.	Electrical Exchange Capacity (m.e/ 100 gm)	15.0	-	-	-	-	-
9.	Total Nitrogen N (%)	0.05	0.03	0.04	0.03	0.03	0.02
10.	Available Phosphorous P (mg/100gm)	0.07	0.06	0.04	0.02	0.10	0.08
11.	Available Potassium K mg/100 gm)	4.60	4.30	3.30	2.20	2.40	2.20
12.	Available Calcium Ca (mg/100gm)	110.30	120.00	224.00	230.00	214.60	213.40
13.	Available Magnesium Mg (mg/100 gm)	47.70	63.90	311.40	280.30	295.60	80.30
14.	Available Sodium Na (mg/100 gm)	3.90	3.50	12.00	2.10	10.30	2.80
15.	Available Iron Fe (mg/100 gm)	040	2.60	3.20	2.80	1.20	2.80
16.	Carbon- Nitrogen Ratio (C.N)	39.50	50.80	34.90	58.10	60.10	95.90

Appendix II. (Concld)Some Physical and Chemical Properties of Dry Zone Forest Soils
PYINMA

Sr. No.	Properties	Layers (cm)					
		0-10	20-30	40-50	60-70	80-90	100-110
	Physical Properties						
1.	Soil colour notation (Dry)	5YR 5/6	5YR 4/4	5YR 4/6	5YR 4/6	5YR 4/6	5YR 4/6
	Soil colour notation (Wet)	5YR 3/4	5YR 3/4	5YR 3/4	2.5YR 3/4	2.5YR 3/4	2.5 YR 3/4
2.	Bulk Density (gm/cc)	1.10	-	-	-	-	-
3.	Total porosity (%)	38.90	-	-	-	-	-
4.	Texture	sandy loam	sandy loam	sandy loam	sandy loam	sandy loam	sandy loam
	sand (%)	70.5	68.2	68.5	67.2	68.4	66.2
	silt(%)	7.2	7.6	6.9	7.6	7.9	7.9
	clay (%)	17.6	21.8	22.0	22.7	21.8	20.2
	Chemical Properties						
5.	Soil Reaction (P^H)	8.0	8.0	8.1	8.0	8.0	7.6
6.	Organic Matter content (%)	2.6	2.7	2.3	2.4	2.2	2.3
7.	Electrical Conductivity (m mhos/cm)	11.7	11.0	11.2	11.3	11.9	15.6
8.	Electrical Exchange Capacity (m.e/ 100 gm)	22.1	-	-	-	-	-
9.	Total Nitrogen N (%)	0.05	0.04	0.04	0.04	0.03	0.03
10.	Available Phosphorous P (mg/100gm)	0.14	0.15	0.12	0.20	0.14	0.15
11.	Available Potassium K mg/100 gm)	4.40	5.90	4.40	4.00	5.40	4.10
12.	Available Calcium Ca (mg/100gm)	81.30	121.50	155.50	119.00	155.70	159.30
13.	Available Magnesium Mg (mg/100 gm)	12.20	10.90	19.90	10.40	20.50	2.20
14.	Available Sodium Na (mg/100 gm)	1.60	1.50	1.30	1.50	2.10	1.60
15.	Available Iron Fe (mg/100 gm)	2.60	1.80	2.00	2.20	2.50	2.20
16.	Carbon- Nitrogen Ratio (C.N)	30.20	39.20	33.40	34.90	42.60	44.60

* mg/100 gm = % x 1000

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