



**Government of the Union of Myanmar  
Ministry of Forestry  
Forest Department**



**Evaluation of the Provenance Trials of  
Some Tropical Pine Species in  
Shan State and Pyin-Oo-Lwin Township**

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ဒေသအမျိုးမျိုးမှ ရရှိသော အပူပိုင်းထင်းရှူးသစ်မျိုးအချို့အား ရှမ်းပြည်နယ် နှင့် ပြင်ဦးလွင်မြို့နယ်၌ စမ်းသပ်စိုက်ပျိုးခြင်း။

ဦးကျော်သန်း၊ B.Sc.(For.)(Rgn.) ? ဦးစီးအရာရှိ၊  
ဦးခင်မောင်ဦး၊ B.Sc.(For.)(Rgn.), M.S. (SUNY)?  
ဒုတိယညွှန်ကြားရေးမှူး၊ ကရင်ပြည်နယ်၊  
ဦးမောင်မောင်ခင်၊ B.Sc.(For.)(Rgn.)? တောအုပ်ကြီး၊  
နှင့်  
ဦးလှိုင်မင်းမောင် ၊ B.Sc.(For.)(Yezin.) တောအုပ်ကြီး၊  
သစ်တောသုတေသနဌာန၊ ရေဆင်း။

### စာတမ်းအကျဉ်းချုပ်

ရှမ်းပြည်နယ်၌ ၁၉၈၀ ခုနှစ်မှစ၍ ထင်းရှူးစိုက်ခင်းများအား ဒေသမျိုးဖြင့် တည်ထောင် ခဲ့ကြသည်။ ဒေသမျိုးသည် ကြီးထွားမှု၊ နှေးခြင်း၊ သစ်ပင်ပုံသဏ္ဍာန် မကောင်းခြင်းတို့ကြောင့် နိုင်ငံခြား ထင်းရှူးသစ်မျိုး များအား စမ်းသပ်စိုက်ပျိုးခဲ့သည်။ ဤသုတေသန စမ်းသပ်ချက်အား ၁၉၈၈-ခုနှစ်၌ ရှမ်းပြည်နယ်တွင် ဒေသ(၁၅)မျိုးမှ ရရှိသော *Pinus maximinoid* ၊ ဒေသ(၇)မှ ရရှိသော *Pinus caribaea* ၊ ဒေသ(၇)ခုမှ ရရှိသော *Pinus oocarpa* ၊ ဒေသ(၅)ခုမှ ရရှိသော *Pinus patula* နှင့် ဒေသ(၄)ခုမှ ရရှိသော *Pinus kesiya* မျိုးတို့ကို စမ်းသပ်စိုက်ပျိုးခဲ့သည်။ ၁၉၈၉ ခုနှစ်တွင် ပြင်ဦးလွင်မြို့နယ်၌ ဒေသ(၆)ခုမှ ရရှိသော *Pinus oocarpa* ဒေသ(၅)ခုမှ ရရှိသော *Pinus patula* ၊ ဒေသ(၉)ခုမှ ရရှိသော *Pinus oocarpa* နှင့် ဒေသသစ်မျိုး တစ်မျိုးဖြင့် စမ်းသပ်ခဲ့သည်။ ယေဘုယျ အားဖြင့် *Pinus maximinoid* နှင့် *Pinus caribaea* သစ်မျိုးတို့တွင် Honduras နိုင်ငံမူရင်းမျိုးများသည် ကောင်းမွန်ပြီး၊ *Pinus oocarpa* နှင့် *Pinus patula* သစ်မျိုးတို့တွင် Nicaragua နိုင်ငံမူရင်းမျိုးများသည် ကောင်းမွန် ကြောင်းတွေ့ရှိရပါသည်။

# **Evaluation of the Provenance Trials of Some Tropical Pine Species in Shan State and Pyin-Oo-Lwin Township**

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## **Abstracts**

Due to slow growth rate and deformity of the indigenous pines, some exotic tropical pine species were introduced and provenance trials were carried out. In the experiment, in Shan State, 15 provenances for *Pinus maximinoi*, 7 provenances for *Pinus caribaea*., 7 provenances for *Pinus oocarpa*, 5 provenances for *Pinus patula* and 4 provenances for *Pinus kesiya* were tested in 1988. In Pyin-Oo-Lwin 6 provenances for *Pinus caribaea*, 5 provenances for *Pinus patula*, 9 provenances for *Pinus oocarpa* and an indigenous species, *Pinus kesiya* were also tested in 1989. Generally, it was found that *Pinus maximinoi* and *Pinus caribaea* of Honduras origins were the best and Nicaragua origins were the best in *Pinus oocarpa* and *Pinus patula*.

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## 1. Introduction

Shan State is one of the natural pine regions in Myanmar. Due to over cutting, forest fires and grazing, some forests of these hill region became deteriorated and some area became denudated. Resulting in erosion and degradation of soil. Thus in these regions erosion control and soil conservation were urgently needed. To curb those adverse affects, plantation establishment was necessary. Due to experiences gained from plantation establishment, pine plantation establishment is found to be more suitable for this region. An indigenous pines species, *Pinus kesiya* Royle ex. Gordon was planted initially. However, old plantation *Pinus kesiya* in the Shan State exhibited very poor from. Height growth is also very slow. Thus some exotic tropical pines of fast growing species were introduced as the species trial in the lowland and hilly region. At first, *Pinus caribaea* Mor, *Pinus oocarpa* Shiede, *Pinus elloittii* Engelm. and *Pinus teada* L. were imported by the support of East Pegu Yoma Plantation Project (E P P). Later *Pinus patula*, *Pinus maximinoi* and *Pinus kesiya* of exotic origin were introduced.

At present, the paper industry is highly dependent upon bamboo resources as the sole fiber raw material. In the future, these pine plantations from the accessible area will become sources of supply of raw material for the pulp and paper industry. These plantations may become a successfully substitute for the bamboo fiber pulp.

In the past published papers pertaining to exotic pines species, the species tested were described as suitable. This trial present some suitable provenances for each tested species. In the experiment 5 species of 38 provenances were tested in Shan State. 3 species of 20 provenances were tested in Pyin-Oo-Lwin.

## 2. Materials and Methods

### 2.1. Seed Source

*Pinus maximinoi* from (15) provenances, *Pinus caribaea* from (8) provenances, *Pinus oocarpa* from (10) provenances *Pinus patula* from (5) provenances and *Pinus kesiya*, from (3) provenances were imported and an indigenous species of *Pinus kesiya* were tested in the trial. Detail origin of each species are shown in table (1).

**Table (1) Detail Origin of Each Species**

F.R.I Lot No.	Name	Sources	Latitude	Longitude	Altitude
041/86	<i>Pinus caribaea hondurensis</i>	La mosquite Honduras	15° 00' N	84° 00' W	11-170(m)
042/86	<i>Pinus caribaea hondurensis</i>	Puerto cabezas, Nicaragua	14° 12' N	83° 30' W	20 (m)
043/86	<i>Pinus caribaea hondurensis</i>	Guanaja, Island, Honduras	16° 28' N	85°54' W	50-100(m)
044/86	<i>Pinus caribaea hondurensis</i>	Sta, Cruz de Yojoa, Honduras	14° 28' N	88° 15' W	475(m)
045/86	<i>Pinus caribaea hondurensis</i>	Los Limones, Honduras	14° 01' N	86° 48' W	600-800(m)

**Continue from Table (1)**

<b>F.R.I Lot No.</b>	<b>Name</b>	<b>Sources</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Altitude</b>
046/86	Pinus caribaea hondurensis	L. Lanos de Alamicamba Nicaragua	13° 34' N	84° 17' W	20.30(m)
047/86	Pinus caribaea hondurensis	Santa Clara, Nicaragua	13° 48' N	86° 12' W	700(m)
048/86	Pinus caribaea hondurensis	Mountain pine Ridge, Belize	17° 00' N	88°55' W	400(m)
049/86	Pinus caribaea hondurensis	Los Limones Honduras	14° 03' N	86°42' W	700(m)
050/86	Pinus caribaea hondurensis	Trojfs, Honduras	14° 03' N	85° 58' W	680-760(m)
051/86	Pinus caribaea hondurensis	Queensland, Australia			
052/86	Pinus oocarpa	Fince la Lagunilla, Guatemala	14° 42' N	89° 57' W	1600(m)
053/86	Pinus oocarpa	San Fernando Nicaragua	13° 46' N	86° 22' W	1000-1200(m)
054/86	Pinus oocarpa	Honduras Republic, La Union	14° 32' N	86° 38' W	2625'
055/86	Pinus oocarpa	Guaimaca Honduras	14° 35' N	86° 49' W	3281'
056/86	Pinus oocarpa	San Jose de Cusmapa Nicaragua	13° 17' N	86° 39' W	1250(m)
057/86	Pinus oocarpa	Sebaco Nicaragua	12° 50' N	86° 18' W	950 (m)
058/86	Pinus oocarpa	Nicaragua, Jalapa	13° 50' N	86° 15' W	1000-1300m
059/86	Pinus oocarpa	El Junquillo Nicaragua	13° 42' N	86°35' W	1000 (m)
060/86	Pinus oocarpa	Dipilto Nicaragua	13° 43' N	86° 32' W	1000-1200-m
107	Pinus oocarpa	Guatemala	15° 22' N		
062/86	Pinus patula tecumumanii	San rafael del Norte, Ncaragua	13° 14' N	86° 8' W	1200(m)
061/86	Pinus patula tecumumanii	Matagalpa Nicaragua	12° 55' N	85° 47' W	900(m)
063/86	Pinus patula tecumumanii	Matagalpa Nicaragua	12° 54' N	85°56' W	950(m)
064/86	Pinus patula tecumumanii	Cayo Belize	17° N	88°55' W	700(m)
066/86	Pinus patula tecumumanii	Jitotil Mexico	17° 05' N	92° 30' W	1600(m)
065/86	Pinus pseudostrobus	Tecpan, Guatemala			
067/86	Pinus maximinoi	Volcan Yali Nicaragua			
068/86	Pinus maximinoi	Loma de ochoa Honduras	14° 48' N	87° 30' W	1200(m)

## Continue from Table (1)

F.R.I Lot No.	Name	Sources	Latitude	Longitude	Altitude
069/86	Pinus maximinoi	San Juan Sacatepequez Guatemala			
070/86	Pinus maximinoi	Guatemala			
071/86	Pinus maximinoi	Dipilto Nicaragua	13° 43' N	86° 30' N	3609'
072/86	Pinus maximinoi	Comalapa, Guatemala			
073/86	Pinus maximinoi	Dantali Nicaragua	13° 08' N	85° 57' W	3281'
074/86	Pinus maximinoi	Jinotega, Ncaragua			
075/86	Pinus maximinoi	Guinope, Honduras	13° 54' N	86° 54' W	4747'
076/86	Pinus maximinoi	San Rafael del Norte, Ncaragua			
077/86	Pinus maximinoi	Tatumbra, Honduras			
078/86	Pinus maximinoi	Cofradia Honduras	14° 00' N	87° 06' W	
079/86	Pinus maximinoi	Dulce Nombre, Honduras	14° 52' N	88° 49' W	1300 (m)
080/86	Pinus maximinoi	Dantali Nicaragua	13° 08' N	85° 57' W	3281'
081/86	Pinus maximinoi	Jinotega Nicaragua	13°02' N	85° 59' W	4757'
082/86	Pinus maximinoi	Minas de Oro, Honduras			
083/86	Pinus maximinoi	La fortuna, Honduras			
811/85	Pinus maximinoi	Origin Honduras, Guatenala	14°10' N	86° 35' W	1250 (m)
812/85	Pinus maximinoi	Origin Honduras Guatenala	13° 53'- 13° 55'N	86° 53'- 86° 55' W	1300- 1600-m
208/87	Pinus kesiya	Bodana population Madagascar	14° 44' N	90° 37' W	1600 (m)
207/87	Pinus kesiya	Bodana population Madagascar			
344/83	Pinus kesiya	Setropa Ltd P.O Box 203, 1400 AEBUSSUM, Holland			
Indigen-ous	Pinus kesiya	Kalaw, Myanmar			

Seeds were sown in seed bed and the seedlings pricked into 3" x 7" polythene bags when they turn to green color at the upper part of seedling. At that time seed coat is not getting out from seedling.

## 2.2. Design

A randomized complete block design with five replication were used. The spacing adopted was 8.5' x 8.5'. Each plot have 7 x 6 = 42 trees. The seedlings were transplanted from Research station (3), Taunglaylone, Taunggyi Township and Kandawgyi Catchment in Pyin-oo-lwin Township. Experimental plantations were planted in 1988 at Taunggyi Township and in 1989 at Pyin-oo-lwin Township.

Tending operations consisting of 3 weedings at 1<sup>st</sup> Year, 2 weedings each at 2<sup>nd</sup> and 3<sup>rd</sup> year were carried out. Height measurement were taken in 1989, 1990, 1991, 1992, 1993 1995 and 1996 at Taunglaylone and in 1991, 1992, 1993, 1994 and 1996 at Pyin-oo-lwin. Girth measurements were taken only in 1992, 1993, 1995 and 1996 at Taunglaylone and in 1994 and 1995 at Pyin-oo-lwin.

Duncan's new multiple-range test (DMRT) was used in comparing the height and girth of the provenance tested.

## 2.3. Problems

Experimental plot of Pyin-oo-lwin was burnt over by a forest fire in 1993. In Shan State, the trial plots were attacked by shoot borer in almost all tested species. The plot site is in the valley and the slope is a little steep in Shan State. Occasionally parent rock are visible.

## 3. Results

In these trials, the data at 7<sup>th</sup> year of age are compared in both sites of Shan State and Pyin-oo-lwin. The results of height and girth measurements for all provenance of tested species are shown in the following tables accompanied by the rankings in order of magnitude.

Rankings in order of magnitude are given with lines linking those provenance which did not differ significantly. Ranking order is from lowest to highest.

### 3.1. Comparison of Height Measurement for *Pinus maximinoides* in Shan State

F.R.I Lot. No	Species	Provenance	Mean Heights
812/85	<i>Pinus maximinoides</i>	Origin Honduras, Guatemala.	22.064
811/85	<i>Pinus maximinoides</i>	Origin Honduras, Guatemala.	25.228
067/86	<i>Pinus maximinoides</i>	Volcan Yali, Nicaragua.	21.638
069/86	<i>Pinus maximinoides</i>	San Juan Sacatepequez, Guatemala.	21.172
081/86	<i>Pinus maximinoides</i>	Jinotega, Nicaragua.	20.106
070/86	<i>Pinus maximinoides</i>	Guatemala	13.388
080/86	<i>Pinus maximinoides</i>	Dantali, Nicaragua.	22.726



072/86	<i>Pinus maximinoi</i>	Comalapa, Guatemala.	13.312
068/86	<i>Pinus maximinoi</i>	Loma de Ochoa, Honduras.	23.330
078/86	<i>Pinus maximinoi</i>	Cofradia, Honduras.	23.110
079/86	<i>Pinus maximinoi</i>	Dulce Nombre, Honduras.	21.336
075/86	<i>Pinus maximinoi</i>	Guinope, Honduras.	21.378
082/86	<i>Pinus maximinoi</i>	Minas de Oro, Honduras.	19.060
083/86	<i>Pinus maximinoi</i>	La fortuna, Honduras.	22.770
065/86	<i>Pinus pseudostrabus</i>	Tecpan, Guatemala.	13.654
		Mean	20.285

### 3.1.a. The Table of Rankings for Height Measurement

F.R.I Lot. No	Provenance	Ranks
811/85	Origin Honduras, Guatemala.	15
068/86	Loma de Ochoa, Honduras.	14
078/86	Cofradia, Honduras	13
083/86	La Fortuna, Honduras	12
080/86	Dantali, Nicaragua	11
812/85	Origin Honduras, Guatemala.	10
067/86	Volcan Yali, Nicaragua.	9
075/86	Guinope, Honduras	8
079/86	Dulce Numbre, Honduras.	7
069/86	San Juan Sacatepequez, Guatemala	6
081/86	Jinotega, Nicaragua	5
082/86	Minas de Ora, Honduras	4
065/86	Tecpan, Guatemala.	3
070/86	Guatemala	2
072/86	Comalapa, Guatemala	1

Rankings in order of magnitude are give with lines linking those provenance which did not differ significantly. From the latitude 13.53'-13.55' N, longitude 86.53' W and altitude 1300-1600 maters provenance of Guatemala is the best but it's origin is Honduras. Comalapa provenance of Guatemala is the poorest.

The trial include two taxa, *Pinus maximinoi* and *Pinus pseudostrabus* which are generally the same. The form of aphenotype with asymmetrical crown of fine branches, with fine buds covered by long thin needles which tend to droop is *Pinus maximinoi*. The form having a long, thick, branchless leader, thick buds and long coarser needles is *Pinus pseudostrabus*.

### 3.2. Comparison of Girth Measurement for *Pinus maximinoi* in Shan State.

F.R.I Lot. No	Species	Provenance	Mean Girths
812/85	<i>Pinus maximinoi</i>	Origin Honduras, Guatemala.	12.724
811/85	<i>Pinus maximinoi</i>	Origin Honduras, Guatemala.	13.960
067/86	<i>Pinus maximinoi</i>	Volcan Yali, Nicaragua.	12.778
069/86	<i>Pinus maximinoi</i>	San Juan Sacatepequez, Guatemala.	13.746
081/86	<i>Pinus maximinoi</i>	Jinotega, Nicaragua.	11.230
070/86	<i>Pinus maximinoi</i>	Guatemala	9.964
080/86	<i>Pinus maximinoi</i>	Dantali, Nicaragua.	13.040
072/86	<i>Pinus maximinoi</i>	Comalapa, Guatemala.	9.536
068/86	<i>Pinus maximinoi</i>	Loma de Ochoa, Honduras.	13.116
078/86	<i>Pinus maximinoi</i>	Cofradia, Honduras.	12.546
079/86	<i>Pinus maximinoi</i>	Dulce Numbre, Honduras.	11.956
075/86	<i>Pinus maximinoi</i>	Guinope, Honduras.	12.276
082/86	<i>Pinus maximinoi</i>	Minas de Oro, Honduras.	11.746
083/86	<i>Pinus maximinoi</i>	La fortuna, Honduras.	13.162
065/86	<i>Pinus pseudostrabus</i>	Tecpan, Guatemala.	9.170
		Mean	12.063

#### 3.2.a. The Table of Rankings for Girth Measurement

F.R.I Lot. No	Provenance	Ranks
811/85	Origin Honduras, Guatemala.	15
069/86	San Juan Sacatepequez, Guatemala	14
083/86	La Fortuna, Honduras	13
068/86	Loma de Ochoa, Honduras.	12
080/86	Dantali, Nicaragua	11
867/86	Volcan Yali, Nicaragua.	10
812/85	Origin Honduras, Guatemala.	9
078/86	Cofradia, Honduras	8
075/86	Guinope, Honduras	7
079/86	Dulce Numbre, Honduras.	6
082/86	Minas de Ora, Honduras	5
081/86	Jinotega, Nicaragua	4
070/86	Guatemala	3
072/86	Comalapa, Guatemala	2
065/86	Tecpan, Guatemala.	1

The provenance of between latitude 13.53' N and 13.55' N, longitude 86.53' W- 86.55' W and altitude 1300-1600 meter, provenance of Guatemala is the best with its origin from Honduras. Tecpan provenance of Guatemala is the poorest.

### 3.3. Comparison of Height Measurement for *Pinus caribaea* in Shan State.

F.R.I Lot. No	Species	Provenance	Mean Heights
049/86	<i>Pinus caribaea</i>	Los Limones, Honduras	17.756
048/86	<i>Pinus caribaea</i>	Mountain Pine Ridge, Belize	20.240
043/86	<i>Pinus caribaea</i>	Guanaja Island, Honduras	20.326
042/86	<i>Pinus caribaea</i>	Pureto cabezas, Nicaragua	18.142
050/86	<i>Pinus caribaea</i>	Trojfs, Honduras	21.280
045/86	<i>Pinus caribaea</i>	Los Limones, Honduras	19.826
047/86	<i>Pinus caribaea</i>	Santa Clara Nicaragua	20.712
		Mean	19.755

#### 3.3.a. The Table of Rankings for Height Measurement

F.R.I Lot. No	Provenance	Ranks
050/86	Trojfs, Honduras	7
047/86	Santa Clara Nicaragua	6
043/86	Guanaja Island, Honduras	5
048/86	Mountain Pine Ridge, Belize	4
045/86	Los Limones, Honduras	3
042/86	Pureto cabezas, Nicaragua	2
049/86	Los Limones, Honduras	1

### 3.4. Comparison of Height Measurement for *Pinus caribaea* in Pyin -oo-lwin

F.R.I Lot. No	Species	Provenance	Mean Heights
049/86	<i>Pinus caribaea</i>	Los Limones, Honduras	24.606
045/86	<i>Pinus caribaea</i>	Los Limones, Honduras	24.862
048/86	<i>Pinus caribaea</i>	Mountain Pine Ridge, Belize	24.958
047/86	<i>Pinus caribaea</i>	Santa Clara Nicaragua	25.766
050/86	<i>Pinus caribaea</i>	Trojfs, Honduras	24.384
051/86	<i>Pinus caribaea</i>	Queensland, Australia.	26.216
		Mean	25.132

#### 3.4.a. The Table of Rankings for Height Measurement

F.R.I Lot. No	Provenance	Ranks
051/86	Queensland, Australia.	6
047/86	Santa Clara Nicaragua.	5
048/86	Mountain Pine Ridge, Belize.	4
045/86	Los Limones, Honduras.	3
049/86	Los Limones, Honduras.	2
050/86	Trojfs, Honduras	1

In Shan State, latitude 14.03' N, longitude 85.58' W and altitude 680-760 meters provenance of Honduras is the best. Los Limones provenance, latitude 14.03' N, longitude 86.4' W and altitude 700 meters of Honduras is the poorest. But the ranks tested are the same.

In Pyin-oo-lwin, Queensland provenance of Australia is the best. Trojfs provenance of Honduras is the poorest.

### 3.5. Comparison of Girth Measurement for *Pinus caribaea* in Shan State

#### 3.5.a. The Table of Ranking for Girth Measurement

F.R.I Lot. No	Provenance	Ranks
050/86	Trojfs, Honduras	6
045/86	Santa Clara Nicaragua	6
047/86	Guanaja Island, Honduras	5
043/86	Mountain Pine Ridge, Belize	4
042/86	Los Limones, Honduras	3
049/86	Pureto cabezas, Nicaragua	2
048/86	Los Limones, Honduras	1

### 3.6. Comparison of Grith Measurement for *Pinus caribaea* in Pyin-oo-lwin

F.R.I Lot. No	Species	Provenance	Mean Heights
049/86	<i>Pinus caribaea</i>	Los Limones, Honduras	18.212
045/86	<i>Pinus caribaea</i>	Los Limones, Honduras	18.480
048/86	<i>Pinus caribaea</i>	Mountain Pine Ridge, Belize	19.524
047/86	<i>Pinus caribaea</i>	Santa Clara Nicaragua	18.644
050/86	<i>Pinus caribaea</i>	Trojfs, Honduras	18.886
051/86	<i>Pinus caribaea</i>	Queensland, Australia.	20.206
		Mean	18.992

#### 3.6.a. The Table of Rankings for Girth Measurement

F.R.I Lot. No	Provenance	Ranks
051/86	Queensland, Australia.	6
048/86	Mountain Pine Ridge, Belize.	5
050/86	Trojfs, Honduras	4
047/86	Santa Clara Nicaragua.	3
045/86	Los Limones, Honduras.	2
049/86	Los Limones, Honduras.	1

The provenance of Trojfs, latitude 14.03' N, longitude 85.58' W and altitude 680-760 meters of Honduras is the best. Mountain pine Ridge provenance of Belize is the poorest in Shan State.

Queensland provenance of Australia is the best and Los Limones provenance of Honduras is the poorest in Pyin-oo-lwin.

### 3.7. Comparison of Height Measurement for *Pinus oocarpa* in Shan State

F.R.I Lot. No	Species	Provenance	Mean Heights
054/86	<i>Pinus oocarpa</i>	Honduras Republic, La Union	17.090
052/86	<i>Pinus oocarpa</i>	Finca La Lagunilla, Guatemala	18.854
107	<i>Pinus oocarpa</i>	Guatemala	15.890
056/86	<i>Pinus oocarpa</i>	San Jose da Cusmapa, Nicaragua	21.266
058/86	<i>Pinus oocarpa</i>	Jalapa, Nicaragua	21.068
059/86	<i>Pinus oocarpa</i>	El Junquillo, Nicaragua.	21.378
053/86	<i>Pinus oocarpa</i>	San Fernando, Nicaragua	19.976
		Mean	19.360

#### 3.7.a. The Table of Rankings for Height Measurement

F.R.I Lot. No	Provenance	Ranks
059/86	El Junquillo, Nicaragua.	7
056/86	San Jose da Cusmapa, Nicaragua	6
058/86	Jalapa, Nicaragua	5
053/86	San Fernando, Nicaragua	4
052/86	Finca La Lagunilla, Guatemala	3
054/86	Honduras Republic, La Union	2
107	Guatemala	1

### 3.8. Comparison of Height Measurement for *Pinus oocarpa* in Pyin-oo-lwin

F.R.I Lot. No	Species	Provenance	Mean Heights
056/86	<i>Pinus oocarpa</i>	San Jose da Cusmapa, Nicaragua	22.936
053/86	<i>Pinus oocarpa</i>	San Fernando, Nicaragua	24.158
055/86	<i>Pinus oocarpa</i>	Guaimaca Honduras.	23.972
052/86	<i>Pinus oocarpa</i>	Finca La Logunilla, Guatemala	23.442
058/86	<i>Pinus oocarpa</i>	Jalapa, Nicaragua	25.362
054/86	<i>Pinus oocarpa</i>	Honduras Republic, La Union	23.906
060/86	<i>Pinus oocarpa</i>	Dipilto Nicaragua	22.186
057/86	<i>Pinus oocarpa</i>	Sebaco Nicaragua	24.314
059/86	<i>Pinus oocarpa</i>	El Junquillo, Nicaragua.	25.196
		Mean	23.941

### 3.8.a. The Table of Rankings for Height Measurement

F.R.I Lot. No	Provenance	Ranks
058/86	Jalapa, Nicaragua	9
059/86	El Junquillo, Nicaragua.	8
057/86	Sebaco Nicaragua.	7
053/86	San Fernando, Nicaragua	6
055/86	Guaimaca Honduras.	5
054/86	Honduras Republic, La Union	4
052/86	Finca La Logunilla, Guatemala	3
056/86	San Jose da Cusmapa, Nicaragua	2
060/86	Dipilto Nicaragua	1

El Junquillo, latitude 13.42' N, longitude 86.35' W, altitude 1000 meters of Nicaragua is the best and latitude 15.22' N of Guatemala is the poorest in Shan State.

The Jalapa provenance of 13.50' N and altitude 1300 meters of Nicaragua is the best and Dipilto, latitude 13.43' N, longitude 86.32' W and altitude 1000-1200 meters of Nicaragua is the poorest in Pyin-oo-lwin.

### 3.9. Comparison of Girth Measurement for Pinus oocarpa in Shan State

F.R.I Lot. No	Species	Provenance	Girths
054/86	Pinus oocarpa	Honduras Republic, La Union	10.010
052/86	Pinus oocarpa	Finco La Lagunilla, Guatemala	10.876
107	Pinus oocarpa	Guatemala	11.676
056/86	Pinus oocarpa	San Jose da Cusmapa, Nicaragua	11.758
058/86	Pinus oocarpa	Jalapa, Nicaragua	11.366
059/86	Pinus oocarpa	El Junquillo, Nicaragua.	12.058
053/86	Pinus oocarpa	San Fernando, Nicaragua	12.358
		Mean	11.443

### 3.9.a. The table of Rankings for Girth Measurement

F.R.I Lot. No	Provenance	Ranks
053/86	San Fernando, Nicaragua	7
059/86	El Junquillo, Nicaragua.	6
056/86	San Jose da Cusmapa, Nicaragua	5
107	Guatemala	4
058/86	Jalapa, Nicaragua	3
052/86	Finca La Lagunilla, Guatemala	2
054/86	Honduras Republic, La Union	1

### 3.10. Comparison of Girth Measurement for *Pinus oocarpa* in Pyin-oo-lwin.

F.R.I Lot. No	Species	Provenance	Girths
056/86	<i>Pinus oocarpa</i>	San Jose da Cusmapa, Nicaragua	15.550
053/86	<i>Pinus oocarpa</i>	San Fernando, Nicaragua	16.468
055/86	<i>Pinus oocarpa</i>	Guaimaca Honduras.	16.320
052/86	<i>Pinus oocarpa</i>	Finco La Logunilla, Guatemala	17.938
058/86	<i>Pinus oocarpa</i>	Jalapa, Nicaragua	17.506
054/86	<i>Pinus oocarpa</i>	Honduras Republic, La Union	16.950
060/86	<i>Pinus oocarpa</i>	Dipilto Nicaragua	15.460
057/86	<i>Pinus oocarpa</i>	Sebaco Nicaragua	16.574
059/86	<i>Pinus oocarpa</i>	El Junquillo, Nicaragua.	17.152
		Mean	16.152

#### 3.10.a The Table of Rankings for Girth Measurement

F.R.I Lot. No	Provenance	Ranks
052/86	Finca La Logunilla, Guatemala	9
058/86	Jalapa, Nicaragua	8
059/86	El Junquillo, Nicaragua.	7
054/86	Honduras Republic, La Union	6
057/86	Sebaco Nicaragua.	5
053/86	San Fernando, Nicaragua	4
055/86	Guaimaca Honduras.	3
056/86	San Jose da Cusmapa, Nicaragua	2
060/86	Dipilto Nicaragua	1

San Fernando, latitude 13.46' N, longitude 86.22' W and altitude 1000-1200 meters of Nicaragua is the best and latitude 14.32' N, longitude 86.38' W and altitude 3281 feet of Honduras Republic, La Union is the poorest in Shan State.

Finca La Lagunilla, latitude 14.42' N, longitude 89.57' W and altitude 1600 meters of Guatemala is the best and Dipilato provenance, latitude 13.43' N, longitude 86.35' W and altitude 1000 meters of Nicaragua is the poorest in Pyin-oo-lwin.

### 3.11. Comparison of Height Measurement for *Pinus patula* in Shan State

F.R.I Lot. No.	Species	Provenance	Mean Heights
061/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	23.480
062/86	<i>Pinus patula</i>	San Rafael del Norte, Nicaragua	22.746
066/86	<i>Pinus patula</i>	Jitotil, Mexico	20.988
063/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	23.632
064/86	<i>Pinus patula</i>	Cayo Belize.	19.820
		Mean	22.153

### 3.11.a. The Table of Rankings for Height Measurement

F.R.I Lot. No.	Provenance	Ranks
063/86	Matagalpa, Nicaragua	5
061/86	Matagalpa, Nicaragua	4
062/86	San Rafael del Norte, Nicaragua	3
066/86	Jitotil, Mexico	2
064/86	Cayo Belize.	1

### 3.12. Comparison of Height Measurement for *Pinus patula* in Pyin-oo-lwin

F.R.I Lot. No.	Species	Provenance	Mean Heights
066/86	<i>Pinus patula</i>	Jitotil, Mexico	24.130
064/86	<i>Pinus patula</i>	Cayo Belize	25.954
063/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	24.584
062/86	<i>Pinus patula</i>	San Rafael del Norte, Nicaragua	23.560
061/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	26.250
		Mean	24.896

### 3.12.a. The Table of Rankings for Height Measurement

F.R.I Lot. No.	Provenance	Ranks
061/86	Matagalpa, Nicaragua	5
064/86	Cayo Belize	4
063/86	Matagalpa, Nicaragua	3
062/86	Jitotil, Mexico	2
061/86	San Rafael del Norte, Nicaragua	1

Rankings in height comparisons are the same in both of Shan State and Pyin-oo-lwin. According to the ranks, Matagalpa, latitude 12.54' N longitude 85.56' W and altitude 950 meters of Nicaragua is the best in Shan State. Matagalpa, latitude 12.55' N, longitude 85.47' W and altitude 900 meters is the best in Pyin-oo-lwin. But all provenances are acceptable.

### 3.13. Comparison of Girth Measurement for *Pinus patula* in Shan State

F.R.I Lot. No.	Species	Provenance	Mean Heights
061/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	14.390
062/86	<i>Pinus patula</i>	San Rafael del Norte, Nicaragua	13.138
066/86	<i>Pinus patula</i>	Jitotil, Mexico	12.438
063/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	12.966
064/86	<i>Pinus patula</i>	Cayo Belize	12.666
		Mean	13.120



### 3.13.a. The Table of Rankings for Girth Measurement

F.R.I Lot. No.	Provenance	Mean Heights
61/86	Matagalpa, Nicaragua	5
062/86	San Rafael del Norte, Nicaragua	4
063/86	Matagalpa, Nicaragua	3
064/86	Cayo Belize	2
066/86	Jitotil, Mexico	1

### 3.14. Comparison of Girth Measurement for *Pinus patula* in Pyin-oo-lwin

F.R.I Lot. No.	Species	Provenance	Mean Heights
066/86	<i>Pinus patula</i>	Jitotil, Mexico	16.838
064/86	<i>Pinus patula</i>	Cayo Belize	18.720
063/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	18.616
062/86	<i>Pinus patula</i>	San Rafael del Norte, Nicaragua	18.922
061/86	<i>Pinus patula</i>	Matagalpa, Nicaragua	19.926
		Mean	18.604

### 3.14.a. The Table of Rankings for Girth Measurement

F.R.I Lot. No.	Provenance	Mean Heights
061/86	Matagalpa, Nicaragua	5
062/86	Cayo Belize	4
064/86	Matagalpa, Nicaragua	3
063/86	Jitotil, Mexico	2
066/86	San Rafael del Norte, Nicaragua	1

In Shan State all provenances are of the same rank. Among them Matagalpa latitude 12.55' N, longitude 85.47' W and altitude 900 meters is the best. In Pyin-oo-lwin, Matagalpa, latitude 12.55' N, longitude 85. 47' W and altitude 900 meters of Nicaragua is also the best and Jitotil, latitude 17.05' N, longitude 92.30' W and altitude 1600 meters of Mexico is the poorest.

### 3.15. Comparison of Height Measurement for *Pinus kesiya* in Shan State

F.R.I Lot. No.	Species	Provenance	Mean Heights
208/87	<i>Pinus kesiya</i>	Bodana Population, Madagascar.	15.884
207/87	<i>Pinus kesiya</i>	Bodana Population, Madagascar.	15.690
344/83	<i>Pinus kesiya</i>	Setropa Ltd., Holland	22.632
ind	<i>Pinus kesiya</i>	Kalaw, Myanmar	13.080
		Mean	13.822

### 3.15.a. The Table of Rankings for Height Measurement

F.R.I Lot. No.	Provenance	Mean Heights
344/83	Setropa Ltd., Holland	4
208/87	Bodana Population, Madagascar.	3
207/87	Bodana Population, Madagascar	2
ind	Kalaw, Myanmar	1

ind = Indigenuous species

In the height growth, the *Pinus kesiya* imported from Setropa Ltd., Holland is the best whose origin is not available. Indigenous specie is the poorest.

### 3.16. Comparison of Girth Measurement for *Pinus kesiya* in Shan State

F.R.I Lot. No.	Species	Provenance	Mean Heights
208/87	<i>Pinus kesiya</i>	Bodana Population, Madagascar.	12.288
207/87	<i>Pinus kesiya</i>	Bodana Population, Madagascar.	11.438
344/83	<i>Pinus kesiya</i>	Setropa Ltd., Holland	13.776
ind	<i>Pinus kesiya</i>	Kalaw, Myanmar	11.038
		Mean	12.135

### 3.16.a. The Table of Rankings for Girth Measurement

F.R.I Lot. No.	Provenance	Mean Heights
344/83	Setropa Ltd., Holland	4
208/87	Bodana Population, Madagascar.	3
207/87	Bodana Population, Madagascar	2
ind	Kalaw, Myanmar	1

The results of girth growth are the same as height growth for *Pinus Kesiya*.

## 4. Conclusion

From the results obtained from these experiments, the suitable provenance by ranks are shown.

### 4.1. For the Height Comparison

1. Honduras origin of Guatemala, F.R.I Lot. No.811/86 is the best for *Pinus maximinoi* in Shan State.

2. Trojas provenance of Honduras, F.R.I Lot. No.050/86 is the best in Shan State and Queensland provenance of Australia. F.R.I Lot No. 051/86 is the best in Pyin-oo-lwin. Although those provenance are the best for each site, all tested provenance are of the same rank for *Pinus caribaea*.

3. El Junquillo provenance of Nicaragua, F.R.I Lot No.059/86 is the best in Shan State, as well as Shan Jose de provenance of Nicaragua, F.R.I Lot No.056/86 and F.R.I Lot No. 058/86, Jalapa of Nicaragua are also the best. F.R.I Lot No.058/86 of Nicaragua is the best and others are of the same rank in Pyin-oo-lwin for *Pinus oocarpa*.

4. Matagalpa provenance of Nicaragua, F.R.I Lot No. 063/86 is the best in Shan State and F.R.I Lot No. 061/86, Matagalpa provenance of Nicaragua is also the best in Pyin-oo-lwin. But, in both sites, all tested provenance are of the same rank for *Pinus patula*.

5. Imported from Setropa Ltd. of Holland, F.R.I Lot No.433/83 is the best in Shan State for *Pinus kesiya*.

#### **4.2. For Girth Comparison**

1. Honduras origin of Guatemala, F.E.I Lot No. 811/86 is the best in Shan State and F.R.I. Lot No. 069/86, San Juan Sacatepequez provenance of Guatemala is also the best for *Pinus maximinoi*.

2. In Shan State, Trojas provenance and Los Limones provenance of Honduras are the best. In Pyin-oo-lwin all are of the same rank. Among them, Queensland provenance of Australia is the best for *Pinus caribaea*.

3. For *Pinus oocarpa*, San fernando provenance of Nicaragua is the best and EL Junquillo provenance of Nicaragua is second best in Shan State. In Pyin-oo-lwin, all tested species are of the same rank. Among them, Finka La Laguilla provenance of Guatemala is the best.

4. For *Pinus patula*, all are of same rank. Among them, Matagalpa provenance of Nicaragua is the best in Shan State. In Pyin-oo-lwin, Matagalpa provenance of Nicaragua is also the best.

5. For *kesiya*, the one imported from Setropa Ltd. of Holland, F.R.I Lot No. 344/83 is the best in Shan State.

#### **5. Discussion**

In the experiment, all data at 7<sup>th</sup> year plantations are used for both Shan State and Pyin-oo-lwin. Although using the same age of data., average height and average girth in both sites are quite different. Pyin-oo-lwin fares much better than Shan State. It may be due to two main factors; soil and insect.

Trial site of Pyin-oo-lwin is in the reserve forest. The ground is flat and the soil condition is good for planting. Although, it was burnt over by a forest fire in early 1994, the affect was not serious. It is not attacked by insect till the time of measurement of this year. Trial site of Shan State is in the unclass forest which consists of denuded land. It has shallow soil and frequent rock outcrops. Moreover, the trial site was attacked by shoot borer every year since 1992. It adversely affected the height and girth growth.

Due to slow growth rate and deformity of indigenous pine species, some exotic tropical pine species were introduced and provenance trials were carried out. In the provenance trials, 15 provenances for *Pinus maximinoi*, 7 provenances for *Pinus caribaea*, 7 provenances for *Pinus oocarpa*, 5 provenances for *Pinus patula* and 4 provenances for *Pinus Kesiya* were tested in the Shan State in 1988. In Pyin-oo-lwin, 6 provenances for *Pinus caribaea*, 5 provenances for *Pinus patula*, 9 provenances for *Pinus oocarpa* and an indigenous species of *Pinus kesiya* were also tested in 1989.

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