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Species Trial for Pulpwood Production

U Mehm Ko Ko Gyi, Head of Division
U Zaw Win, Deputy Research Officer,
Forest Research Institute
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စက္ကူပျော့ဖတ်အတွက်သစ်မျိုးများစမ်းသပ်စိုက်ပျိုးခြင်း

ဦးမင်းကိုကိုကြီး၊ B.Sc. (For.) (Rgn.), M.Sc. (ANU)၊ ဌာနမှူး
နှင့်
ဦးဇော်ဝင်း၊ B.Sc. (For.) (Rgn.)၊ စိုက်ကွက်မှူး
သစ်တောသုတေသနဌာန၊ ရေဆင်း။

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံ၌ စက္ကူထုတ်လုပ်ရာတွင် ဝါးကို အဓိကကုန်ကြမ်းအဖြစ် အသုံးပြုလျှက်ရှိပါသည်။ သို့ရာတွင် ဝါးသည် တောနေလူတန်းစားအတွက် မရှိမဖြစ်သော လူသုံးကုန်ပစ္စည်းဖြစ်ခြင်း၊ ဝါးတောများ မပြုန်းတီးစေရန် စနစ်တကျ မီမံအုပ်ချုပ်ရန်ခက်ခဲခြင်း၊ ဝါးစိုက်ခင်းများ ကျယ်ကျယ်ပြန့်ပြန့် ထူထောင်ရန် မလွယ်ကူခြင်းတို့ကြောင့် အစားထိုး စက္ကူကုန်ကြမ်းသုံးစိုက်ခင်းများ ထူထောင်ရန် လိုအပ်လာပါသည်။ သို့ဖြစ်ရာ သစ်တောသုတေသနအနေဖြင့် စက္ကူပျော့ဖတ်စိုက်ခင်းများ ထူထောင်ရာ၌ အထောက်အကူ ဖြစ်စေရန်အတွက် ရည်ရွယ်၍ အပေါက်မြန်သစ် (၁၇) မျိုးကို စမ်းသပ်စိုက်ပျိုးခဲ့ပါသည်။ ယင်းသစ်မျိုးများ အနက် ဘောစကိုင်း၊ ယူကလစ်နှင့်ပေါက်ပန်းဖြူတို့ကို အကောင်းဆုံးအနေဖြင့် တွေ့ရှိခဲ့ပါသည်။ တွေ့ရှိချက်များကို ဤစာတမ်းတွင် သုံးသပ်ဆွေးနွေး တင်ပြထားပါသည်။

Species Trial for Pulpwood Production

U Mehm Ko Ko Gyi, B.Sc. (For.) (Rgn.), M.Sc. (ANU), Head of Division
and
U Zaw Win, B.Sc. (For.) (Rgn.), Deputy Research Officer
Forest Research Institute, Yezin

Abstract

The paper industry in Burma depends mainly on bamboo pulp for raw material. On the other hand the rural people, who make up the majority of the population in Burma, also depend heavily on bamboo for building and other uses. Moreover, it is very difficult to establish a vast area of bamboo plantations and to manage natural bamboo forests scientifically. Thus, it is evident that bamboo should be supplemented with other fibre pulp in order to conserve the supply of bamboo. One answer is to establish plantations of suitable fast-growing tree species. Trials of 17 prospective fast- growing tree species were carried out at the Yeni paper mill compound. Out of the species tested, Bawzagaing (*Leucaena leucocephala*), Eucalyptus (*Eucalyptus camaldulensis*), and Pauk-pan-byu (*Sesbania grandiflora*) were found to be the best. The results are presented and discussed in this paper.

Contents

1. Introduction

Plantation policy in Burma has changed with time and the improvements in technology. Plantations are now being established for industrial raw material. Although Bamboos (*Bambusa polymorpha* Munro. and *Cephalostachyum pergracile* Munro.) are being used for pulp currently, it is necessary to find suitable tree species as substitutes to reduce the pressure on the natural bamboo forests.

In the past, the objective of establishing plantations in Burma was mainly for the production of high value timber, namely teak (*Tectona grandis* Linn. F.). The pattern in wood usage has changed and consequently, so has the demand. At present plantations are being established for watershed management, aesthetic values, the production of high value timber, fuelwood and industrial raw material.

The most outstanding feature in the forestry sector all over the world has been the rise in the use of wood for pulping (Logan, 1967). Although pine with its long fibre is the most suitable among the woody species, fast growing hardwoods have also been tried and found useable as pulp (Ballon *et.al.,* 1971,1972; Bawngan & Zerrudo, 1969; Nicolas & Ballon, 1968; PCARR & USNAC, 1977; Hillis & Brown, 1978). The Central Research Organization (CRO) of Burma has tested 50 local hardwood species and 2 exotic hardwood species for their pulp properties (CRO-1984 Personal Correspondence with Dr. Me Aung). However, their silvicultural characteristics are still unknown.

At present, the paper industry in Burma has two paper mills, one at Sittang and the other at Yeni. Both depend on bamboo for raw material. Bamboo, termed "the poor man's lumber" is also heavily used by rural people. They utilize it for building, food (bamboo shoots), farm tools, flooring mats, fence posts, baskets, musical instruments, and etc.

On the other hand, establishment of vast areas of bamboo plantations is not an easy task. Bamboo can be propagated either by seedlings, culm cuttings or rhizomes. Since the local bamboos do not flower very often, it is not possible to get a regular supply of seed for large scale plantation establishment. Use of culm cuttings is not very reliable. Although rhizome gives good results it is not practicable to collect large numbers of rhizomes (Doo *et. al*., 1983).

Considering the great pressure on the natural bamboo forests and the difficulty in artificial regeneration of Bamboo, it is evident that other sources of raw material for pulp should be made available. One answer is to identify suitable fast-growing tree species.

In 1981, the Project Director of Pulp and Paper Mill No.2 requested the Forest Research Institute (FRI) to carry out a trial in their compound with pine and a few local hardwood species that are suitable as raw material for pulp. A preliminary planting without any statistical design was carried out on a ten-acre plot. Following the results of the first year planting, a statistically designed species trial was established in 1982 on a five-acre plot. This paper deals specifically with the results of these species trials.

2. Materials and Methods

Experiments were carried out in two consecutive years.

First year experiment

A preliminary experiment was carried out in 1981 on a ten acre plot in the compound of Pulp and Paper Mill No. (2), Yeni. Species used were:

1.	Bawzagaing K $_{28}$	(*Leucaena leucocephala)*
2.	Pyauk-seik	(*Holoptelea integrifolia* Plauch)
3.	Pauk-pan-byu	(*Sesbania grandiflora* Pers.)
4.	Yemane	(*Gmelina arborea* Roxb.)
5.	Bonmeza	(*Albizzia chinensis* (Osbeck) Merr.)
6.	Thit-magyi	(*Albizzia odoratissima* Benth.)
7.	*Pinus caribaea* var. *hon.* More.	
8.	*Pinus caribaea* var. *caribaea.* More.	
9.	*Pinus elliottii* Engelm.	

The whole plot was cleared and plowed before planting. Spacing of 7' x 7' was adopted. The trial was not statistically designed as planting had to be carried out on very short notice. Three weedings were done each year and insecticide was sprayed whenever insect attack was observed. Fire went through the Yemane, Bonmeza and Thitmagyi plots in April 1983. The Yemane and Bonmeza plots had to be coppiced and the measurements taken in 1984 for these plots were of the coppice shoots which came up after the original stem had been cut.

Second year experiment

Another set of experimental plots was established in the compound of Yeni Mill in 1982. The following fast growing species were included in the trial.

1.	Letpan	(*Salmalia malabarica* (DC). Schott & Endl)
2.	Didu	(*Salmalia insignis* Schott & Endl)
3.	Sit	(*Albizzia procera* Benth.)
4.	Thabye	(*Eugenia jambolana* Lamk.)
5.	Binga	(*Mitragyna rotundifolia* O. Ktze)
6.	Bonmeza	(*Albizzia chinensis* (Osbeck) Merr.)
7.	Ma-u-lettan-she	(*Anthocephalus cadamba* Miq.)
8.	Eucalyptus	(*Eucalyptus camaldulensis* Dehm.)
9.	Pantama	(*Melia azedarach* Linn.)
10.	Pauk-pan-byu	(*Sesbania grandiflora* Pers.)
11.	Bawzagaing	(*Leucaena leucocephala)*
12.	*Pinus caribaea* var. *hon.* More.	

Of the 12 species listed above, the first eight species had already been tested by CRO for their pulp properties.

The whole area was cleared and plowed before planting. Since the area was flat and the use of tractors for tending was possible, a spacing of 6' x 10' was adopted. The seedlings were planted the 21st of June, 1982. Three weedings were made in both the first and the second year and insecticide was sprayed whenever insect attack was observed. Each seedling was given one ounce NPK chemical fertilizer (2-1-1 ratio) in the first week of August 1982.

In this experiment, a randomized complete block design was used. The trial was replicated three times. Each replicate contained 12 plots. Each plot consisted of 5 trees x 11 rows (= 55 trees) of each of the species listed above. Statistical F and LSD tests of significance were used in the analysis of data.

3. Results

First year experiment

First year survival, height growth and diameter growth are shown in Figure (1), (2) and Table (I).

Survival

Bawzagaing was the best in survival followed by Bonmeza, Yemane, Pauk-pan-byu, Pyauk-seik and Thitmagyi respectively. Survival of *Pinus caribaea* var. *hon.* was very poor, whereas *Pinus caribaea* var. *caribaea* and *Pinus elliottii* can be considered as complete failures.

Height & Diameter

Bawzagaing and Pauk-pan-byu equally showed very good height growth (Table I and Figure 2). Pauk-pan-byu, however appeared to have the greatest radial growth (Table I). From 1983 height measurement data, it can be seen that Yemane, Bonmeza, Pyauk-seik and Thitmagyi tend to form a group in which Bonmeza is the best and Thitmagyi the poorest. (1984 measurements for Yemane, Bonmeza and Thitmagyi cannot be considered in the comparison as Yemane and Bonmeza are coppice shoots and not that of the original tree and Thitmagyi was badly damaged by fire). Until 1984, *Pinus caribaea* var. *car*. showed the poorest diameter and height growth. Whereas *Pinus caribaea* var. *caribaea* and *Pinus elliottii* were complete failures.

Second year experiment

Results of survival in the first year, height growth and diameter growth are shown in Figures (3) and (4) and Table (II).

Table I Data Summary for Pulpwood Species Trial (1981 Plot, Yeni)

Species	Survival (%)	Height (ft.)			Diameter (in)*
	Dec / 82	Dec / 82	Mar / 83	Mar / 84	Mar / 84
Yemane	87	3.1	4.5	4.3	0.9
Bonmeza	89	3.5	5.4	4.4	0.5
Pyaukseik	63	2.5	3.9	4.8	0.7
Thit-ma-gyi	62	1.3	4.3	3.3	0.4
Pauk-pan-byu	77	5.4	7.8	19.5	3.8
Bawzagaing	90	3.6	12.1	21.0	2.3
P.caribaea v.*car*	6	0.6	-----	-----	-----
P.caribaea v. *hor*	20	0.6	1.7	2.3	0.7
P. elliottii	6	0.5	-----	-----	-----

* Measured at 18" from the ground.

Table II Mean survival percent, height and diameter of (12) tested species (1982 Plot, Yeni)

Species	March, 1983 Measurement		March, 1984 Measurement	
	Survival (%)	Height (ft)	Height (ft)	Diameter (in)
Sit	80.0	2.2	3.6	0.75
Didu	52.7	1.3	3.3	0.95
Bonmeza	75.2	3.1	5.3	0.67
Bawzagaing	100.0	9.2	20.7	2.58
Binga	90.3	1.7	4.9	1.08
Thabye	94.5	2.1	3.8	0.48
Ma-u-lettan-she	70.9	1.9	5.7	1.17
P.caribaea var. *hon.*	60.6	1.8	2.9	0.74
Pauk-pan-byu	45.0	4.6	9.9	1.63
Eucalyptus	93.5	4.6	12.9	1.43
Pantama	84.9	2.7	5.4	0.72
Letpan	42.3	0.8	2.0	0.86
L.S.D	10.26	0.889	1.462	0.22

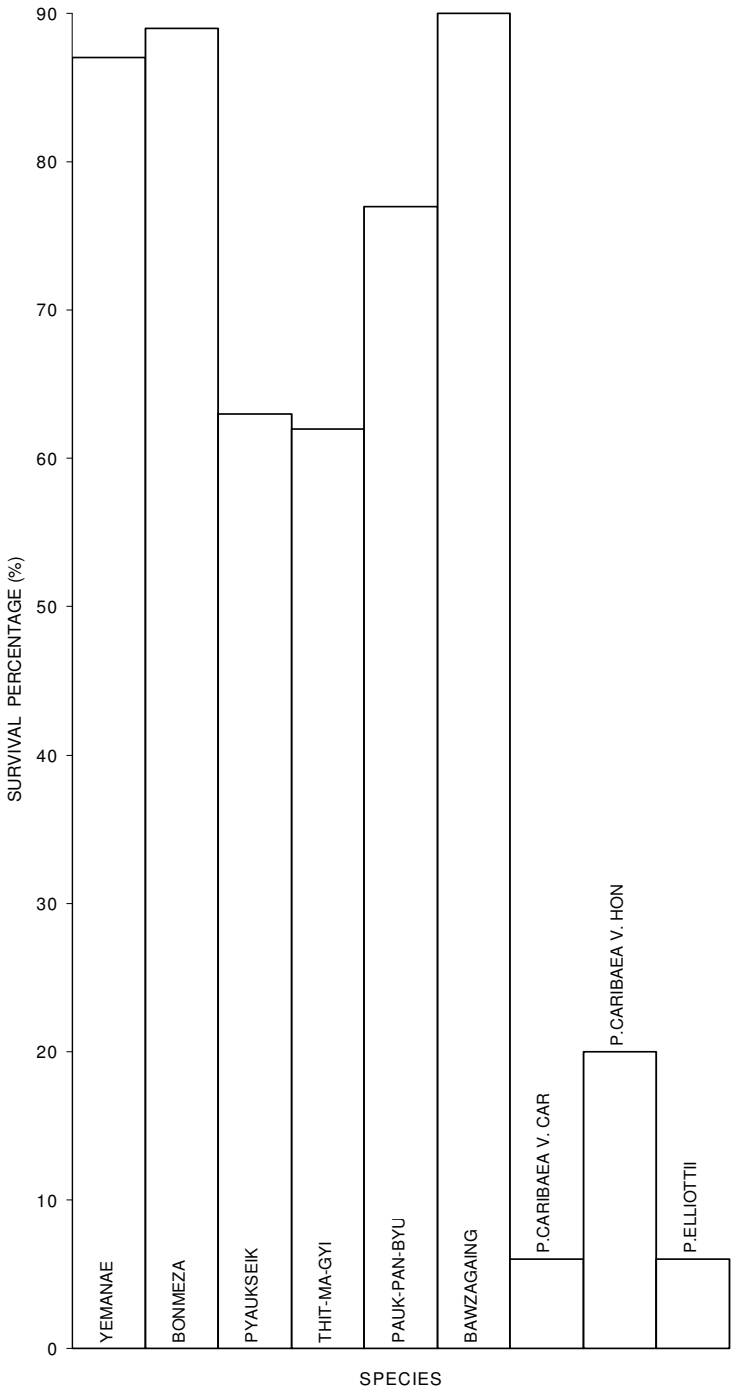


FIGURE 1. Survival percentage comparison of tested species (1981 Plot, measured on Dec. 1982)

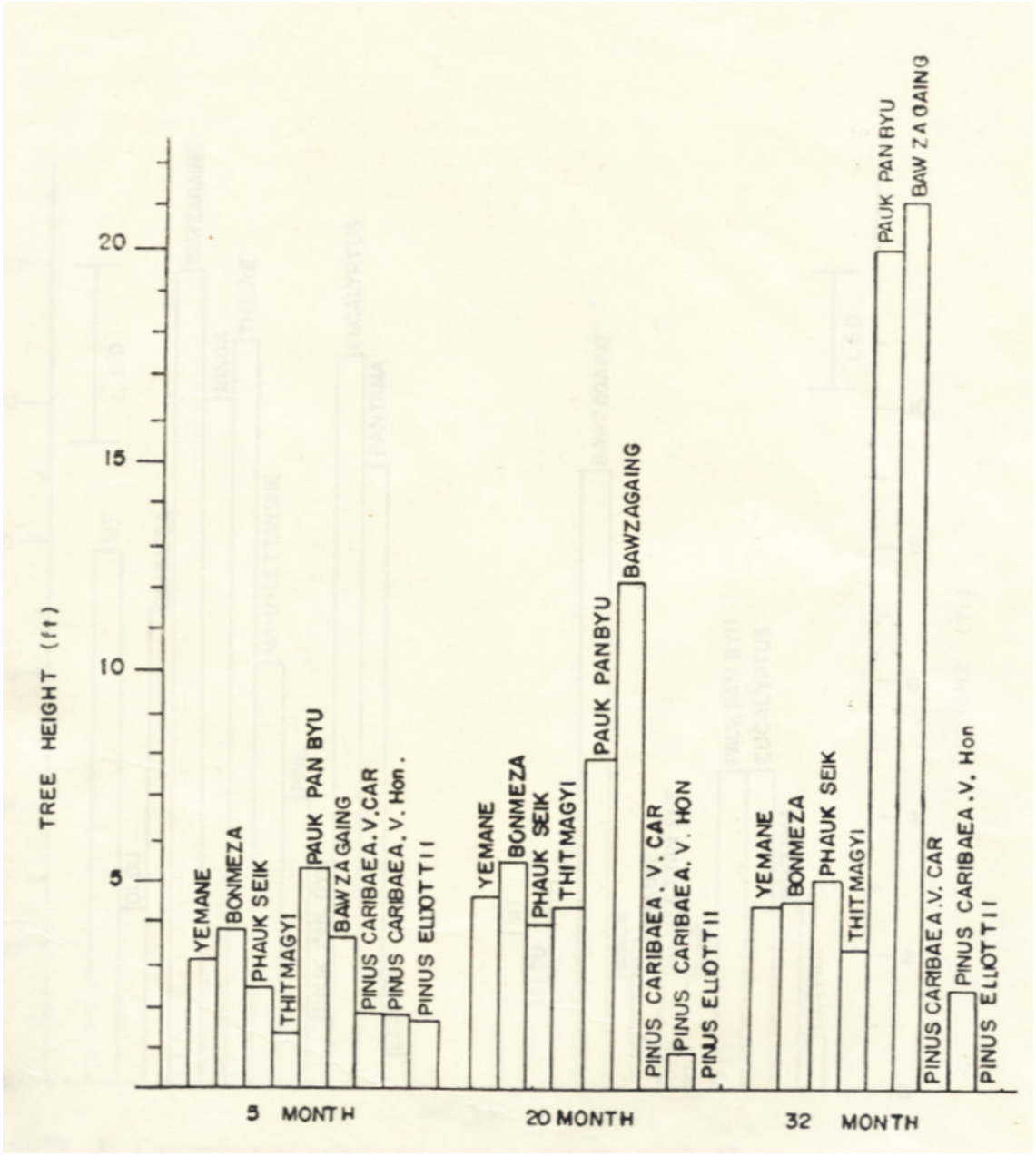


FIGURE 2. Height growth comparison of 9 species at various ages (1981 Plot, Yeni)

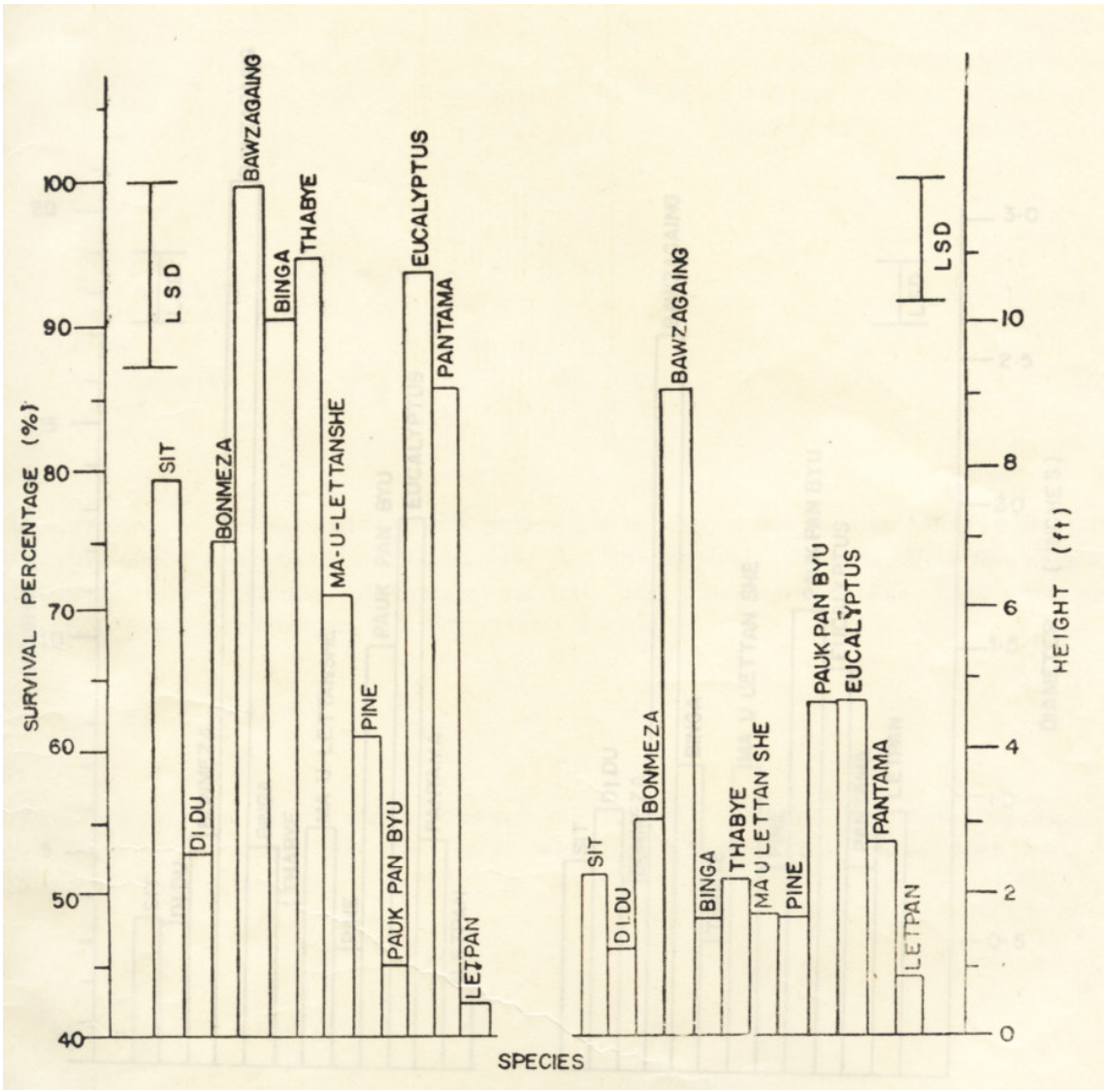


FIGURE 3. Comparison of height and survival percentage of 12 tested species (1982 Plot, measured on March, 1983)

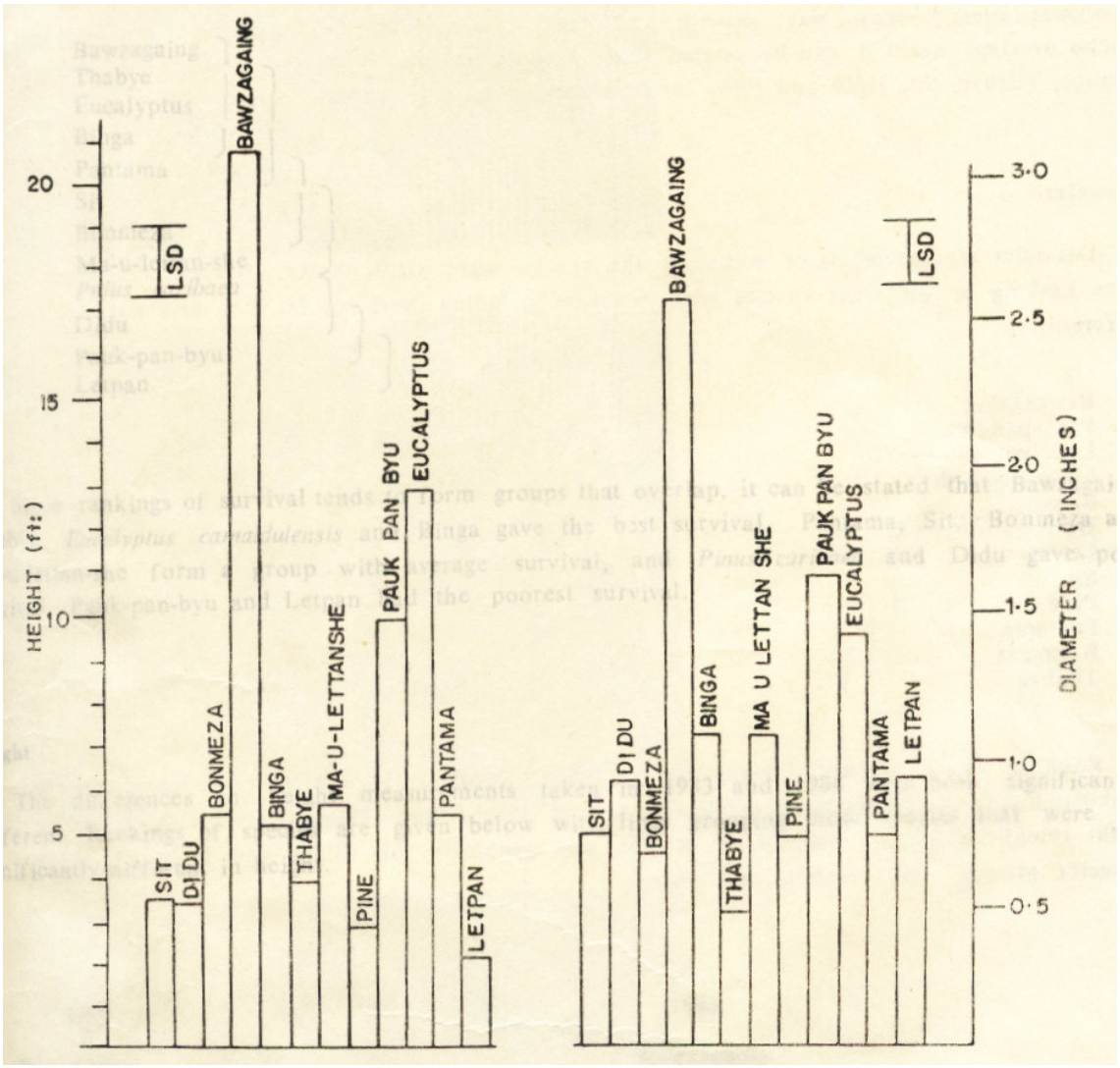
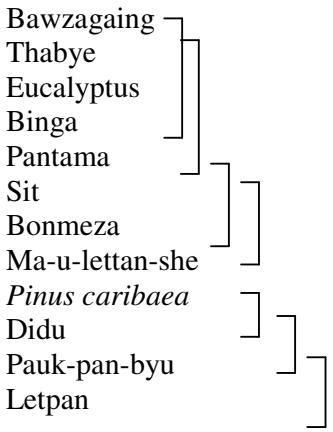


FIGURE 4. Height and diameter comparison of tested species (1982 Plot, measured on March, 1984)

Survival

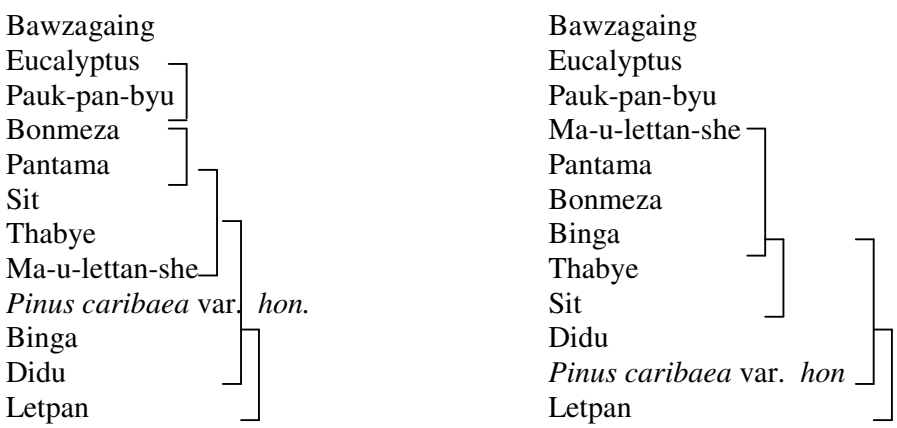
The differences in survival among the species tested were found to be significant (See Appendix V). For simplicity, ranking of the species are given below with lines grouping those species that were not significantly different.



Since rankings of survival tends to form groups that overlap, it can be stated that Bawzagaing, Thabye, *Eucalyptus camaldulensis* and Binga gave the best survival. Pantama, Sit, Bonmeza and Ma-u-lettan-she form a group with average survival, and *Pinus caribaea* and Didu gave poor survival. Pauk-pan-byu and Letpan had the poorest survival.

Height

The differences in height measurements taken in 1983 and 1984 were both significantly different. Rankings of species are given below with lines grouping those species that were not significantly different in height.

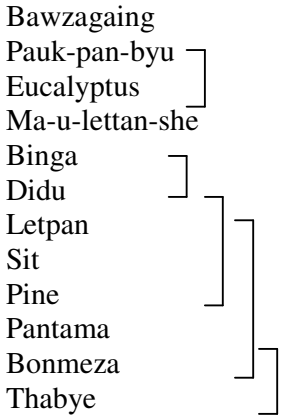


1983 height measurements showed Bawzagaing as being significantly the best and *Eucalyptus camaldulensis* and Pauk-pan-byu ranked second. As the ranking of the remaining species overlap, it can be stated that Didu and Letpan had the poorest height growth while the remaining species can be considered as average.

Height measurements taken in 1984 also ranked Bawzagaing as being significantly the best. *Eucalyptyus camaldulensis* was second and Pauk-pan-byu third. As ranking for the remaining species overlap, again it can be stated that Ma-u-lettan-she, Pantama, Bonmeza and Binga are average, Thabye, Sit, Didu and *Pinus caribaea* are poor, and Letpan is the very poor.

Diameter

Diameter measurements of some of the species were significantly different. Diagram below gives ranking of different species with brackets including those species that were not significantly different.



Ranking above showed Bawzagaing as being significantly the best in diameter growth. Pauk-pan-byu and *Eucalyptus camaldulensis* ranked second and Ma-u-lettan-she third. As ranking of the remaining species overlap, it can be said generally that Binga and Didu are average diameter growth, and the rest are poor.

4. Discussion

First year experiment

The first year (1981) results, indicated that Bawzagaing, Bonmeza, Yemane and Pauk-pan-byu had good survival percentage, whereas survival for Pyauk-seik and Thitmagyi was slightly less. Survival for Thitmagyi was not reliable as the plot containing this species was greatly damaged by pigs from the nearby village. The three Pinus species were almost a complete failure. However, as long fibre pulp is needed for mixing with hardwood pulp, *Pinus caribaea* var. *hon*. (20% survival) should not be completely rejected.

Of the 12 species tested, Bawzagaing and Pauk-pan-byu grew best in height. It is interesting to note that although Bawzagaing was shorter than Pauk-pan-byu in the first measurement, it overtook Pauk-pan-byu in the third and fourth measurements. It was reported that Pauk-pan-byu was attacked by insects and some young leaves were used by the nearby inhabitants for soup which could explain the change.

Height measurements taken in 1984 cannot be used for comparison as they were taken after a fire occurred in some of the plots. However, it is interesting to notice how fast Yemane and Bonmeza coppice shoots can grow within a year.

FIGURE 5

a. Bonmeza coppice, 28 months old

b. Bawzagaing Established 1981; 40 months old

c. Pauk-pan-byu; Established 1981; 40 months old

FIGURE 6

a. Yemane coppice; 28 months old

b. Bonmeza coppice; 28 months old

c. Pauk- pan-byu stem; damaged by stem borer

FIGURE 7

(a)

a. Sit; Established 1982; 28 months old

(c)

c. *Pinus caribaea* var hon; Established 1982; 28 months old.

(b)

b. Ma-u-lettanshe; Established 1982; 28 months old

(d)

d. Didu and *Eucalyptus camaldulensis*; Established 1982; 28 months old

Second year experiment

Following the results of the first year experiment and a request by the paper mill officials, a statistically-designed experiment was conducted in 1982. Of the 12 species tested only the survival data for *Pinus caribaea* var.*hon.*, Didu, Pauk-pan-byu and Letpan were below average while the remaining eight species were average or above.

It can be noticed that survival for *Pinus caribaea* var. *hon.* was very much improved (from 20% to 60.6%) over the first experiment. This may be due to the use of better stock of seedling the second year.

Both survival and growth of Pauk-pan-byu were poor in this experiment. It was reported that two plots of the three were heavily attacked by stem borer (See Appendix V). Normally, survival and growth of Pauk-pan-byu should be comparable to that of Bawzagaing (See Figure 1, 2 and Table I).

Although survival for Sit was good, height and diameter growth was not up to expectations. This species is normally fast growing. The poor performance of this species may have been due to frequent and heavy insect attack on the leaves which left the branches bare.

5. Conclusion

1. Within the 17 species tested at Yeni Paper Mill No.2 compound, Bawzagaing, *Eucalyptus camaldulensis* and Pauk-pan-byu can be considered the best both in height and radial growth.
2. Bawzagaing and *Eucalyptus camaldulensis* also rank best in survival, while survival for Pauk-pan-byu is unreliable, as the species is highly prone to insect attack.
3. Most of the fast-growing species tested were prone to insect attack. Control measures should be seriously considered before establishing a large-scale plantation.
4. Although not the best, Ma-u-lettan-she, Pantama, Bonmeza and Binga can be considered as being acceptable both in survival and growth.
5. It may be too early to decide on the poor performances of Thabye, Sit, Didu, Letpan and *Pinus caribaea* var. *hon.* as they may accelerate in growth later in the rotation.

Appendix I.

Analysis of Variance for survival percentage of 12 tested species. (March, 1983)

Source	d.f	Sums of Squares	Mean Squares	F
Treatment	11	10372.97	942.99	2.7956**
Error	24	8095.45	337.31	
Total	35	18468.42		

L. S. D = 10.26

Appendix II A

Analysis of Variance for tree height measurements of 12 tested species. (March, 1983)

Source	d.f	Sums of Squares	Mean Squares	F
Treatment	11	174.98	15.90	6.2845**
Error	24	60.82	2.53	
Total	35	235.8		

L. S. D. = 0.889

Appendix II B

Analysis of Variance for tree height measurements of 12 tested species. (March, 1984)

Source	d.f	Sums of Squares	Mean Squares	F
Treatment	11	953.38	86.67	12.6710**
Error	24	164.25	6.84	
Total	35	1117.63		

L. S. D = 1.462

Appendix III

Analysis of Variance for tree diameter measurements of 12 tested species (March, 1984)

Source	d.f	Sums of Squares	Mean Squares	F
Treatment	11	11.2	1.01	6.7333**
Error	24	3.75	0.15	
Total	35	14.95		

L.S.D. = 0.22

Appendix IV

Pulpwood Species Trial Plot (1982) Yeni

N

Scale 1 inch = 100 ft

BLOCK I		BLOCK II		BLOCK III	
1	8	9	6	3	11
9	10	5	1	6	2
4	12	11	12	12	7
3	6	2	10	5	1
11	5	7	4	4	8
2	7	8	3	9	10

References

Experimental Plot (each plot contains 5 Rows x 11 Rows)
Ordinary Plantinc Plot
Nos (1-12) Trial Species

1 - LETPAN
2 - DIDU
3 - SIT
4 - THABYE
5 - BINGA
6 - BONMEZA
7 - PANTAMA
8 - PAUK-PAN-BYU
9 - MA – U – LETTAN –SHE
10 - E-CAMALDULENSIS
11 - PINUS CARIBAEA VAR.Hon
12 - BAWZAGAING

Appendix V

Data Summary of Pulpwood Species Trial (1982 Plot, Yeni)

Species	Block I				Block II				Block III			
	Sur (%)	Height (ft)		Dia (in)	Sur (%)	Height (ft)		Dia (in)	Sur (%)	Height (ft)		Dia (in)*
	Mar/83	Mar/83	Mar/84	Mar/84	Mar/83	Mar/83	Mar/84	Mar/84	Mar/83	Mar/83	Mar/84	Mar/84
Sit	70.7	1.4	2.9	0.62	78.2	1.8	22.0	1.1	90.9	3.5	5.7	0.54
Didu	34.6	2.2	3.6	0.75	96.4	0.9	1.2	0.25	27.3	1.8	4.9	1.43
Bonmeza	89.1	3.0	4.7	0.58	87.3	3.4	4.0	0.50	49.1	2.9	7.3	0.93
Bawzagaing	100	8.9	20.5	2.55	100	9.9	21.8	2.67	100	8.7	19.7	2.51
Binga	96.4	1.6	4.6	1.06	89.1	2.0	4.9	1.12	85.5	1.5	5.0	1.07
Thabye	98.2	2.3	4.0	0.49	92.7	1.8	4.3	0.54	92.7	2.2	3.1	0.42
Ma-u-lettan-she	89.1	2.0	6.8	1.47	76.31	2.8	6.5	1.34	47.3	1.5	3.7	0.71
P.caribaea	50.9	1.8	3.9	1.0	89.1	1.9	3.4	0.92	41.8	1.6	2.0	0.30
Pauk-pan-byu	29.1	4.3	3.5	0.5	72	5.4	16.3	2.6	34.0	4.0	9.9	1.8
E.camaldulensis	91.7	2.2	14.9	1.8	92.7	6.0	12.2	1.3	96.4	5.7	11.7	1.2
Pantama	70.9	2.9	4.7	0.51	92.7	2.6	7.2	1.22	91.0	2.7	4.4	0.41
Letpan	47.3	0.4	2.7	1.11	42.9	1.4	1.6	0.75	36.8	0.6	1.8	0.72

*** Measured at 18" from the ground.**

References

1. Ballon, C. H. *et . al.* (1971) Prospect of *Gmelina arborea* for pulping and printing paper Philippines Forest 5 (1).
2. Bawagan, P. V. and J. V. Zerrudo (1969) Pulping variables as of gubas cold soda pulps. Lumberman.
3. CRO Personal Correspondence.
4. Doo, C. *et. al.* (1983) Regional studies of Bamboo Propagation. FRI., Leaflet No. 5/82-83.
5. Frank Freese (1967) Elementary Statistical Methods for Foresters. Agri. Handbook No. 317, US Forest Service.
6. Hillis W. E. & A. G. Brown (1978) Eucalyptus for wood production.
7. Logan, W. E. M., (1967) FAO World Symposium on Man made Forest and their Industrial importance. Unasylva, Vol. 21 (3-4)
8. Philippine Council for Agriculture and Resources Research and the United States National Academy of Sciences (1977). Leucaena, Promising Forage and tree crop for the tropics.
9. Victoria T. Lasmarias, Adelaida A. Bumarlong, Felix F. Ordinario, Aida B. Lapis & Agustin A. Pinol (1982.) How to grow Bamboo. FRI., Philippine.