



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



Growth Response of Hardwood Species in Pegu Yoma Forests

**Saw C. Doo, B.Sc. [For.] [Rgn.] M.Sc. [Haii], Divisional Head,
Forest Research Institute
1986**

ပဲခူးရိုးမတွင်စမ်းသပ်စိုက်ပျိုးထားသောအဖိုးတန်သစ်များ၏
ပေါက်ရောက်မှု၊အခြေအနေကိုစူးစမ်းလေ့လာခြင်း။

ဦးစောရန်အောင်စိဉ္စု B. Sc. (For.) (Rgn.), M.Sc. (Haih) ဌာနမှူး
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ပဲခူးရိုးမတွင်စမ်းသပ်စိုက်ပျိုးထားသော ကျွန်း၊ ပျဉ်းကတိုး၊ ပိတောက်နှင့် မအူလက်တံရှည်တို့၏ ပေါက်ရောက်မှု၊ အခြေအနေကိုလေ့လာ တင်ပြထားပါသည်။ ၎င်းအပင်များ စိုက်ပျိုးထားသော ပန္နက် အကွာအဝေး၊ မြေနေရာအနေအထားနှင့် အခြားစိုက်ပျိုးစုနည်းတို့ကြောင့် အပင်ပေါက်ရောက်မှု၊ အခြေ အနေများကို တင်ပြထားသော စာတမ်းဖြစ်ပါသည်။

Growth Response of Hardwood Species in Pegu Yoma Forests

Saw C. Doo, B.Sc. [For.] [Rgn.], M.Sc. [Hai.],
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Abstract

The paper dealt with the growth response of Teak (*Tectona grandis*), Yemane (*Gmelina arborea*), Ma-u-lettan-she (*Anthocephalus cadamba*), Pyinkado (*Xylia dolabriformis*), and Padauk (*Pterocarpus macorcarpus*). Effect of spacing, site variation and treatment response were also discussed.

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1. Introduction

Domestic and world need for wood products is placing stress on natural forests and the need for living space and food is continuously restricting forest areas available for growth of wood products. Consumption of wood in Burma has increased as the population increased.

The silvicultural system practiced in Burma is a selection system adopted more than a century (Blanford, 1956). Under the selection system regeneration is theoretically in continuous progress through the forest to provide sufficient young trees to maintain the growth and production at a sustained level. This has not been observed, especially in teak (*Tectona grandis* L. f.). In forests when the proportion of the more valuable species is too low, or through exploitation has been reduced, sometimes are underplanted using an artificial regeneration system known as enrichment. Gap planting, group plantings, strip planting, differential planting, and spatial planting are synonymous with enrichment planting and seek to improve the natural forests by planting valuable species at widely spaced intervals. (Baur, 1961).

An unfortunate factor in the management of natural forest is the common problem of achieving a worthwhile increase in output and productivity in a few decades or even in a full rotation. Growth responses and regeneration are often disappointing. Usually too little is known about the possibilities of inducing regeneration. However, it is essential that production of primary species be maintained at high levels for domestic and export use.

Another method of regeneration which has been used is the taungya method where strips are cleared and burned then planted to trees in the openings created in the forest (Poore, 1976).

Where the forest has been exploited heavily and the remaining stock too poor, a recognized means of increasing wood production is complete removal of remaining forest cover and planting selected species in a forest plantation.

On the other hand, as reported by Poore (1976), the consequences of total removal of Tropical Moist Forest is unimaginable and may be summarized as follows:-

- (1) Modification of climate
- (2) Biological consequences
- (3) Consequences to the indigenous forest people
- (4) Other Bio-cultural consequences
- (5) Consequences of soil and water erosion.

Considering these facts, the endeavor to replenish the Tropical Moist Forests by enrichment planting is worth a trial.

The Forest Department has stepped up planting teak and other valuable hardwood species. Hence much information is needed on silvical characteristics of the planted species and trial plantings of some of the important species is imperative.

This study is designed to test the plantation productivity of selected Burmese species and develop cultural means that will bring improvement in growth rate and quality of product of forest tree plantations.

Teak has been planted widely in the country. However, what could be considered as optimum initial spacing is still undetermined. The usual spacing of 9' x 9', and 12' x 12' and lately 8½ x 8½ are still on trial basis. It is well known that to minimize the establishment cost and at the time have a successful plantation, optimum spacing should be adopted.

In this study trials of spacing, enrichment planting, mixed planting, and planting of valuable species were made.

2. Literature Review

In the early days of Burmese forest management various planting distances were used in teak plantations. These were mainly 6 feet x 6 feet, 8 feet x 4 feet and 12 feet x 3 feet. Of the different planting distances mentioned, 6 feet x 6 feet proved the most convenient and gave the best growth and the earliest establishment (Blanford, 1923).

In 1914 experimental plantation of various spacing such as 9 feet x 9 feet, 12 feet x 12 feet, 15 feet x 15 feet and others were made (Murthy, 1974/75).

Bourme (1914) in his working plan for Nilumbur, India holds that wider spacing than 6 feet, 6 feet or more tends to produce forked stems. In 1914 a plot of 9 feet x 9 feet and 6 feet x 6 feet spacing were compared. The result was that, the diameter increment of the individual stems in the 9 feet x 9 feet plantation was greater than in 6 feet x 6 feet, while the height growth of dominant tree was the same.

Adegbehin (1982) reported that the mean diameter of dominant trees and basal area production are significantly affected by spacing. Furthermore, there seems to be very little or no advantage to be gained by adopting spacing of either smaller or wider than 9 feet x 6 feet or 9 feet x 12 feet respectively.

There were also reports recommending 8½' x 8½' for Burma and India in 1949, 1952 1955 (Murrhy, 1974/75).

With Yemane (*Gmelina arborea*) there has been report of spacing trials, however, there was a report stating that as Yemane, has a large crown, first thinning should be done in the 4th or 5th year (F.D. Instruction for thinning, 1939).

3. Materials and Methods

3.1 Spacing Trial

The trial was conducted in Kaboung Reserve Compartment 220 which has an average annual rainfall of 80 inches. There was a variation of micro-site, however, most of soil was sandy loam.

The experimental design used was a randomized block 80 feet x 80 feet per plot. Spacing of 7 feet x 7 feet, 8 feet x 8 feet, 9 feet, x 9 feet and 10 feet x 10 feet was tested. Two species Teak and Yemane were chosen for trial. In order to study micro-site variation, plot locations selected were the ridge top and the slope. Three replications of each treatment were made.

Seedling were grown in plastic bags and those of uniform growth were selected and planted simultaneously in the plots. Cultural operations such as weeding, fire protection and cleaning were performed until the fifth year after planting. A survival count was done in the first year followed by measurement of girth at breast height (b.h.) and total height in the fifth year.

3.2 Enrichment planting

Enrichment planting of teak was done in Kaboung Reserve Compartment 220, where there were gaps devoid of natural regeneration. After removal of commercial species, brushwood and canopy was cut down in strips about 15 feet wide at 40 foot

intervals in an East-West direction. After 2-3 days of drying the strips were burned. Trees were planted 6 ft x 6 ft in the cleaned strips to sample three aspects (NW, ridge, NE).

Seedlings were raised in a nursery bed and outplanted when the seedlings were 1 foot 6 inches high. Cleaning and weeding in the strip was done and fire protection was maintained throughout trial. Measurement of height was taken in the third year and girth at breast height and total height was taken in the fifth year.

3.3 Mixed Planting

Mixed planting of Teak. Pyinkado (*Xylia dolarbriformis* Benth.) and Padauk (*Pterocarpus macrocarpus* Kurz.) was tried in Kaboung Reserve Compartment 220. Two patterns were adopted. Pattern A was to plant single rows of each species alternately (teak, pyinkado, padauk, etc.). Pattern B was to plant species alternately in each row and stagger the rows. The seedling were raised in a nursery bed and were 1 foot high when planted in the field, spaced at 9 feet x 9 feet. Cultural operations such as weeding, cleaning, and fire protection were performed throughout the trial. Measurement of height was taken in the third year and girth at breast height and total height in the fifth year.

3.4 Trial Planting of Valuable Species

Trial planting of fast growing species were conducted in Kaboung Reserve Compartment 220 (Sein Ye) and Ngalaik Reserve Compartment 72 and 73 (Moswe). The two regions have a difference in climate and soil conditions. The former region has an average annual rainfall of 50 inches with sandy loam with a bit of lateric soil type on the ridge.

Five species, Teak, Yemane, Ma-u-lettan-she (*Anthocephalus cadamba* Miq.), Yon *Anogeissus acuminata* Wall.) and Taukkyan (*Terninalia tomentosa* W&A) were tried in the southern region (Kaboung Reserve). Four species Teak, Yemane, Padauk and Yinma (*Chukrasia tabularis* A. Juss.) were tried in the northern region (Ngalaik Reserve). The planting was spaced at 9 feet x 9 feet. Cultural operations such as weeding, cleaning and fire protection were performed throughout trial. Measurement of girth at breast height and total height was taken in the fifth year.

4. Results

4.1 Spacing Trial

Treatment No.	Spacing (feet)	Area per plot (sq.feet)	No.of trees per acre
A	7 x 7	49	889
B	8 x 8	64	681
C	9 x 9	81	538
D	10 x 10	100	436

4.2 Mean height (Teak)

There was significant difference at the 50% level between the treatments in terms of mean height. Treatment A outgrowth treatment B, C & D (Figure I). The distribution of mean height seems to decline from treatment A to D (Figure I) (Table 1 in appendix).

4.3 Mean height (Yemane)

In this case, there were no significant difference between the treatments in terms of mean height. However, the distribution of mean height seems also to increase slightly from treatment A to D. In addition, mean height of Yemane was greater than that of Teak.

4.4 Mean girth (Teak)

There was no significant difference between the treatments in terms of mean girth. The distribution of girth classes almost uniform as shown in (Fig II), but with larger trees in the wide spacings.

4.5 Mean girth (Yemane)

Here again, there were no significant difference between the treatments in terms of mean girth. The distribution of girth within the treatment was not as uniform as in teak. The population of trees was higher in lower girth class with narrow spacing (treatment A). Again the population of trees was higher in the girth limit with treatment C and D (Fig. III, IV).

4.6 Enrichment Planting

There aspects were assessed in the trial plots, NE aspect, Ridge, and NW aspect. There was no significant difference in terms of mean height or mean girth as shown in Table 2 and 3 in appendix.

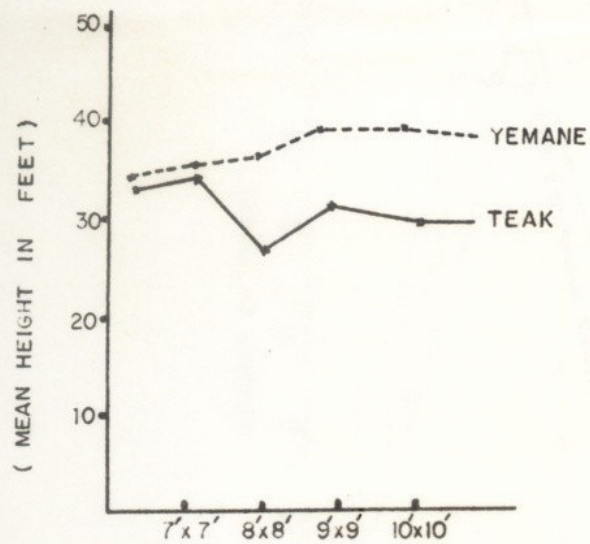


Figure I Response of height growth of teak and yemane in different spacing. Kaboung Reserve
compt. 220

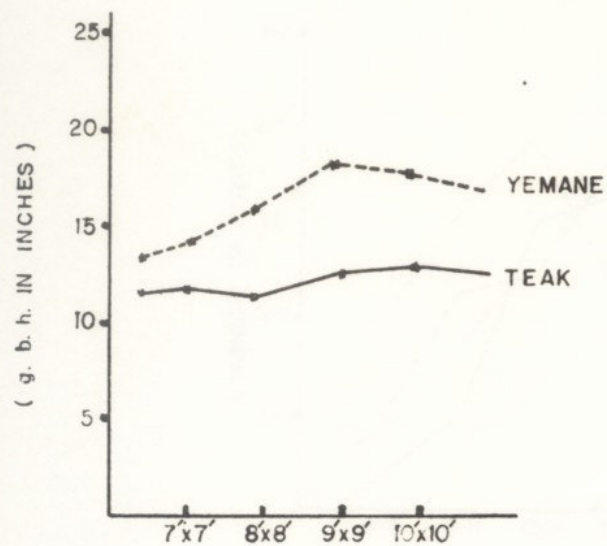


Figure II Response of growth of teak and yemane in different spacing.
Kaboung Reserve compt. 220

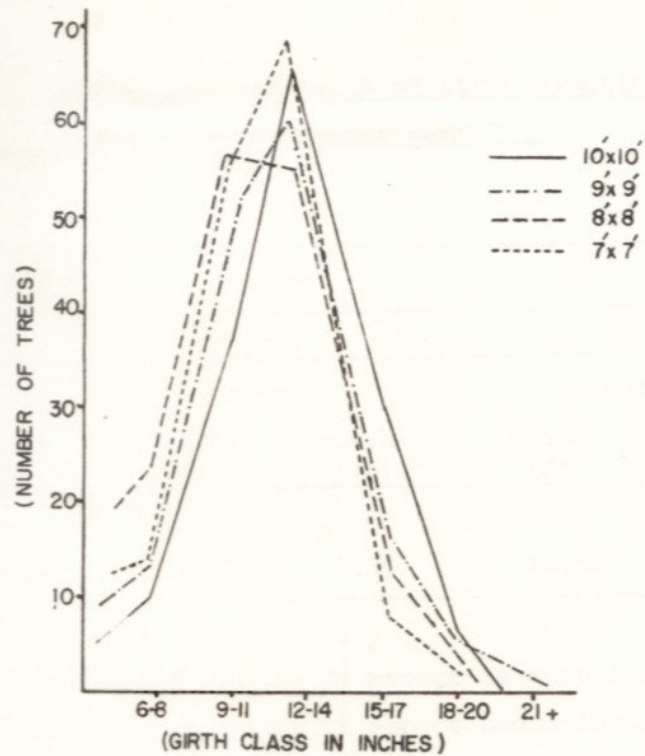


Fig. III. Comparison of distribution of girth class in different spacing of 5 year old Teak planted in Kaboung Reserve Compt. 220.

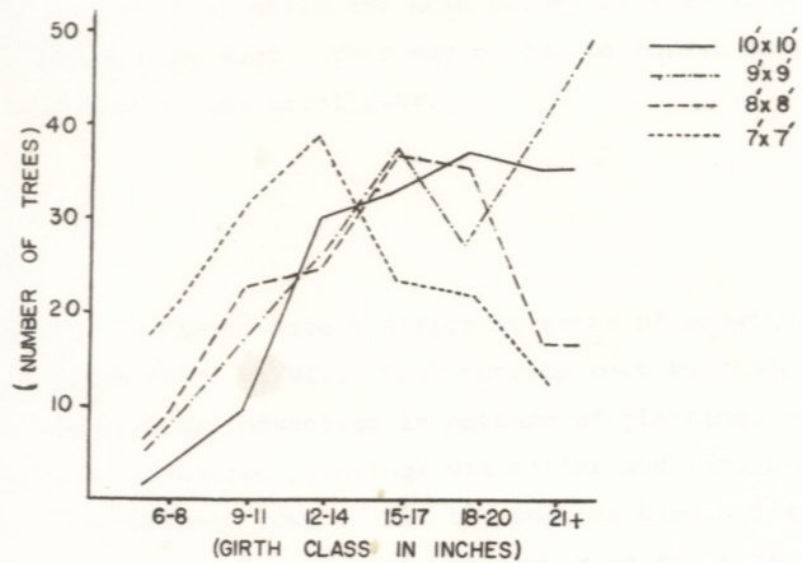


Fig. IV. Comparison of distribution of girth class in different spacing of 5 year old Yemane planted in Kaboung Reserve Compt. 220.

Mean height and girth of strip planting in Kaboung Reserve Compartment 221

Aspect					
NE		Ridge		NW	
Mean		Mean		Mean	
Height (ft)	g.b.h. (in)	Height (ft)	g.b.h. (in)	Height (ft)	g.b.h. (in)
23.33	8.23	21.68	7.39	23.65	6.60

However, the mean girth in the NW aspect is much smaller than the other. In the trial plot the NW aspect had a lower light intensity due to overshadow of the hill in the trial plot. It was also observed that the growth of teak in the strip planting were smaller in height and girth when compared to teak planted with taungya method. The mean height of 5 years old teak from taungya method was well over 30 feet while the mean height of teak from strip planting was only 23 feet. This may be due to forest canopy overshadowing the teak in the trial plot.

4.7 Mixed Planting

Teak, Pyinkado and Padauk have a different rates of growth in both height and grith (Fig. V, VI). Teak outgrew both Pyinkado and Padauk. There was a slight advantage in pattern of planting. The growth in Pattern B (staggered planting) was taller and larger than that of Pattern A (alternate rows). All the species have a faster rate of growth in the initial year, but was slower in the subsequent years (Fig. VIII). Teak has a larger crown as it outgrew Pyinkado and Padauk. The latter two were suppressed and judged to have little chance of survival in the future.

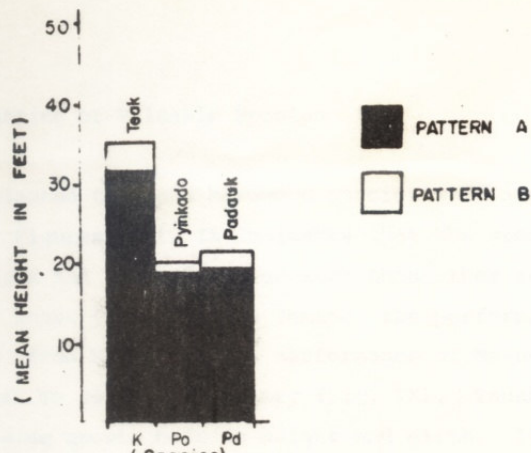


Figure V A comparison of pattern of planting. Average height of 5 year old mixed planting in Kaboung Reserve Compt. 220.

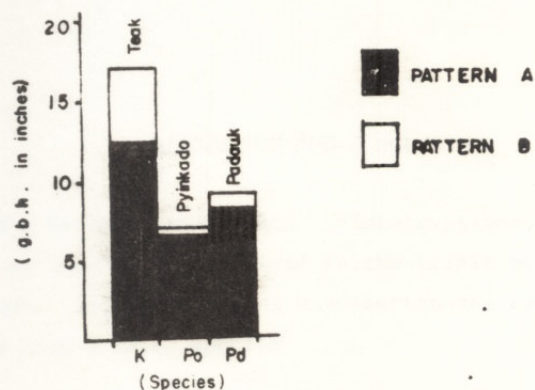


Figure VI A comparison of pattern of planting. Average g.b.h of 5 year old mixed planting in Kaboung Reserve Compt. 220.
 Pattern A = Species planted in rows alternately.
 Pattern B = Each species planted alternately.

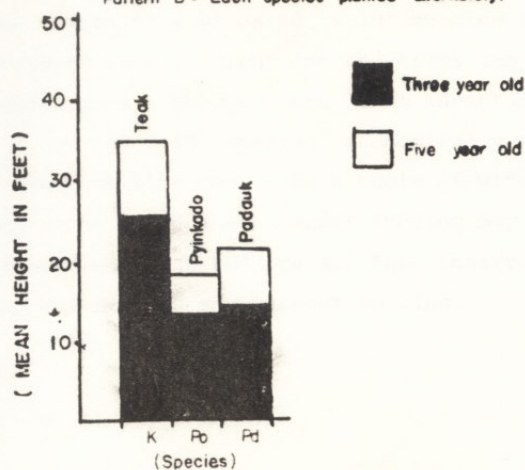


Figure VII Average height growth of 3 and 5 year old mixed planting in Kaboung Reserve Compt. 220.
 Pattern B = Each species planted alternately.

4.8 Trial Planting of Valuable Species

The planted teak and hardwood species were assessed from the 2 regions. Figures VIII, IX indicates that the growth of Yemane (both height and g.b.h.) was greater than other species, followed by teak. Apart from Teak and Yemane, the performance of Padauk and Yinma from Moswe and the performance of Ma-u-lettan-she and Yon in Sein Ye were satisfactory (Fig. IX). Taukkyan did not show any promising growth both in height and girth. It was very branchy and did not thrive very well.

It was also noted that most of the fast-growing species grew faster in the initial year and slowed down in the subsequent year (Fig. X).

5. Discussion and Conclusions

From the various experiments and observations, it is apparent that most of the species involved in the trials grew fast in the initial year. Teak, Yemane and Ma-u-lettan-she can be safely grouped as fast-growing species.

Spacing trial of Teak indicated that with spacing 7' x 7' or 8' x 8', the trees become crowded in the fifth year and thinning must be done. With 9' x 9' or 10' x 10' spacing there is still room for the canopy to receive light and the trees can be left to grow for a few more years. Though there is no advantage to grow teak using 7' x 7' or 10' x 10' spacing, economically a wider spacing will reduce the planting cost. Here again if wider spacing (10' x 10') is used, one might argue that a wider spacing may tend to produce epicormic branching or forked trees. From observation the tree form at 10' x 10' was as good as narrower spacing.

Some plots have to be omitted in analysis due to improper cultural operation, such as weeding and cleaning. It emphasizes the need, in the establishment of plantations, to weed, clean, and protect them as necessary, to have a successful plantation.

The Forest Department has set a weeding schedule for the whole country. The frequency of weeding must be localized as plantation sites vary from place to place. It would be hard to give a set of weeding schedules for all location. The forester concerned with each area should determine when and how often the weeding should be done. From these trials it was observed that cleaning must be done before and after planting and continued through the fifth year to achieve optimum growth in plantations. In the fifth year other trees from stumps sprouts and bamboo always hinder the canopy of the planted species.

Yemane, having a large crown even in the initial year of growth, should be grown with wider spacing. The competition of crown canopy can be observed as early as the first year, if narrow spacing is adopted. A spacing of not less than 10' x 10' and not more than 12' x 12' is suggested. While conducting the experiments on Yemane, problems were encountered. Firstly, shoot-borer damage, and second, the excess branchiness of trees occurred. However, Yemane although being attacked by insect in the first and second year, survived and catastrophe and grow again very well after the attack. The trees were as normal as trees free from the insect attack. In the early growing stage Yemane was very branchy, but natural pruning was so effective that after the fifth year there were many clean bloes in the trial plot.

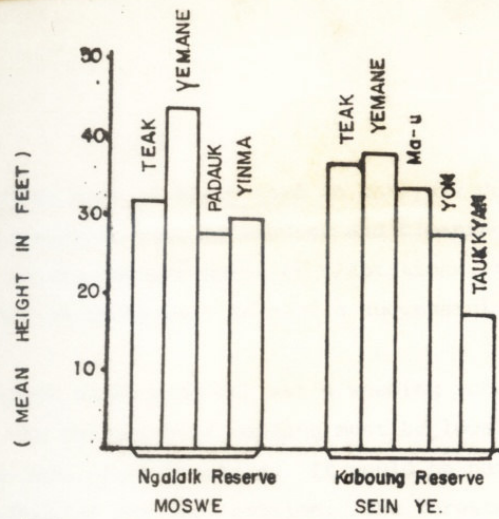


Figure VII A Comparison of height growth of 5 year old teak and other species in Ngalalk and Kaboung Reserve.

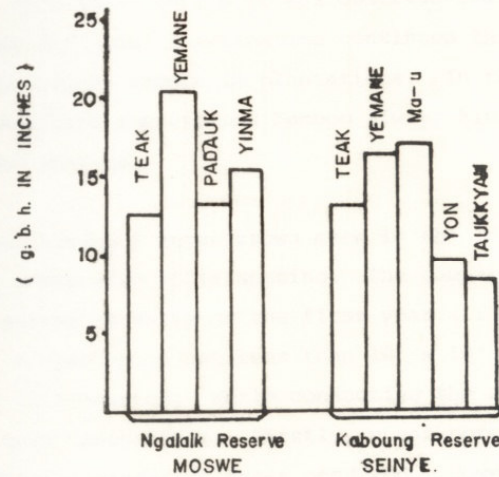


Figure VIII A Comparison of g. b. h. of 5 year old teak and other species in Ngalalk and kaboung Reserve.

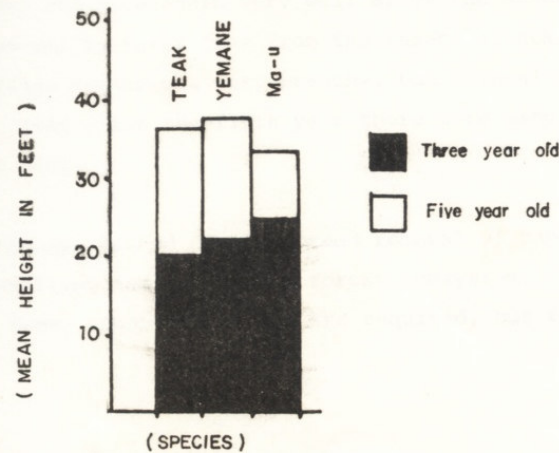


Figure IX Average height of 3 and 5 year old teak, yemane and ma-u-lettan-she in Kaboung Reserve compt. 220

The taungya method of widespread removal of company, may cause erosion problems and change the forest ecosystem. In enrichment planting heavy canopy openings are required, but they are smaller than taungya canopy removal. If done properly, it appears that successful regeneration can be achieved. Three weddings in the first and two in the second year required, followed by cleaning and canopy-opening twice a year until the fifth year, are needed. Crowded trees may be thinned out in the sixth year and the area left until the 10th year. Fire protection must be given every year until the tree are well above the ground fire reach. In strip planting, the strip should run in an East-West direction where possible to get good light intensity

In the establishment of mixed plantation, choice of species and pattern of planting is important. The species chosen should have equal rates of growth and crown size. A larger crown canopy will always hinder the growth of neighbor species. The pattern of planting should be provide space for each species to grow independently. If an area is to be mixed planted, block or group planting of each species is advisable. It will be simple to maintain and manage.

From the species trial it was shown that in areas where rainfall is more than 80 inches, species like Padauk and Yemane should not be chosen for planting. Teak and Yemane both will thrive in an area where the annual rainfall is 50 inches or more and with a sandy loam soil type. Yon is also quite a promising species for choice in plantation, although the rate of growth is much slower than Teak and Yemane. Planted Yon has clean straight bole and natural pruning is quite effective.

The performance of planted Taukkayan is very poor as it is prone to insect attack in the early stages of growth. This species should be chosen for planting only on unavoidable circumstances.

Table 1. Analysis of Variance

**Teak
Height**

Source	Degrees of Freedom	Sum of Squares	Mean sum of Squares	F. ratio
SITE	1	2.7847	2.7847	1.4808
SPACING	3	66.0352	22.0117	11.7050
ERROR	3	5.6416	1.8805	
TOTAL	7	74.4614		

* 5% level

Girth

Source	Degrees of Freedom	Sum of Squares	Mean sum of Squares	F. ratio
SITE	1	0.0842	0.0842	0.6937
SPACING	3	3.2588	1.0863	8.9464
ERROR	3	0.3643	0.1214	
TOTAL	7	0.7073		

Spacing

SITE	7 x 7		8 x 8		9 x 9		10 x 10	
	Mean		Mean		Mean		Mean	
	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)
ridge	35.21	11.7	25.23	10.86	31.25	12.47	29.96	13.07
slope	34.77	11.78	29.04	11.77	32.71	12.54	29.85	12.83
Total	34.99	11.74	27.14	11.32	31.98	12.51	29.91	12.95

Table 2. Analysis of Variance

**Yemane
Height**

Source	Degrees of Freedom	Sum of Squares	Mean sum of Squares	F. ratio
SITE	1	36.3809	36.3809	1.0328
SPACING	3	14.5586	4.8529	0.1378
ERROR	3	105.6797	35.2266	
TOTAL	7	156.6191		

Girth

Source	Degrees of Freedom	Sum of Squares	Mean sum of Squares	F. ratio
SITE	1	0.063	0.063	0.0081
SPACING	3	23.0776	7.6925	0.9939
ERROR	3	23.2187	7.7396	
TOTAL	7	46.3594		

Spacing

SITE	7 x 7		8 x 8		9 x 9		10 x 10	
	Mean		Mean		Mean		Mean	
	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)
ridge	35.25	14.77	30.7	13.9	42.26	20.5	34.51	16.19
slope	36.69	13.04	43.45	17.9	36.1	16.09	43.54	19.04
Total	35.97	13.9	37.08	15.9	39.18	18.3	39.03	17.62

Table 3. Analysis of Variance

**Teak
Height**

Source	Degrees of Freedom	Sum of Squares	Mean sum of Squares	F. ratio
TREATMENT	2	22.5933	11.2966	4.6082
LINE	3	4.9624	1.6541	0.6748
ERROR	6	14.7085	2.4514	
TOTAL	11	44.2642		

Girth

Source	Degrees of Freedom	Sum of Squares	Mean sum of Squares	F. ratio
TREATMENT	2	4.2375	2.1188	1.4854
LINE	3	1.0869	0.3623	0.3156
ERROR	6	6.8889	1.1481	
TOTAL	11	12.2133		

Aspect

	NE		C. Ridge		NW	
	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)	Height (ft)	g.b.h (in)
LINE I	23.33	8.420	21.68	7.390	23.65	6.600
LINE II	23.55	9.11	18.78	6.44	21.91	6.14
LINE III	23.57	8.27	21.50	6.96	22.54	5.88
LINE IV	22.30	7.04	20.27	7.87	26.64	8.62



Figure 1. Experimental plots of size 80' x 80' randomly selected for trial planting of Teak, Yemane, Ma-U-let-tan-she, Taukkyan and you.
Average g.b.h. (13.29), height (33.36)



Figure 2. Five-year old Yemane, showing good form & growth at a spacing of 8' x 8' Average g.b.h. (15.9") average height (37.1')



Figure 3. Five-year old teak, at a spacing of $8' \times 8'$ in Kabaung Reserve, Compartment 220. Average g.b.h. (11.31) in. average height (27.14)ft.



Figure 4. Five-year old teak, spacing $9' \times 8'$, in Kabaung Reserve, Compartment 220 Average g.b.h. (12.51) in., average height (31.98)feet



Figure 5. Five year old, Yon spacing $9' \times 9'$, with good form & growth in Kabaung Reserve, Compartment 220. Average g.b.h. 9.4 inches [average height (27.78) feet.

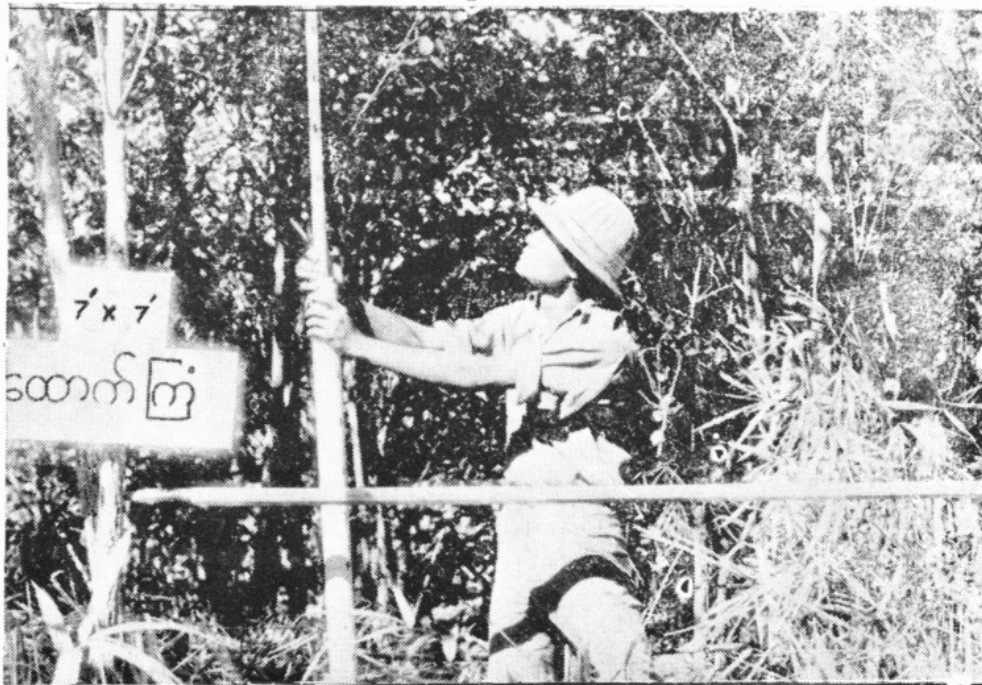


Figure 6. Taukkyan, $7' \times 7'$ spacing, showing poor growth and form at the age of (5) years Average g.b.h. (8.14) height (17.58)ft.

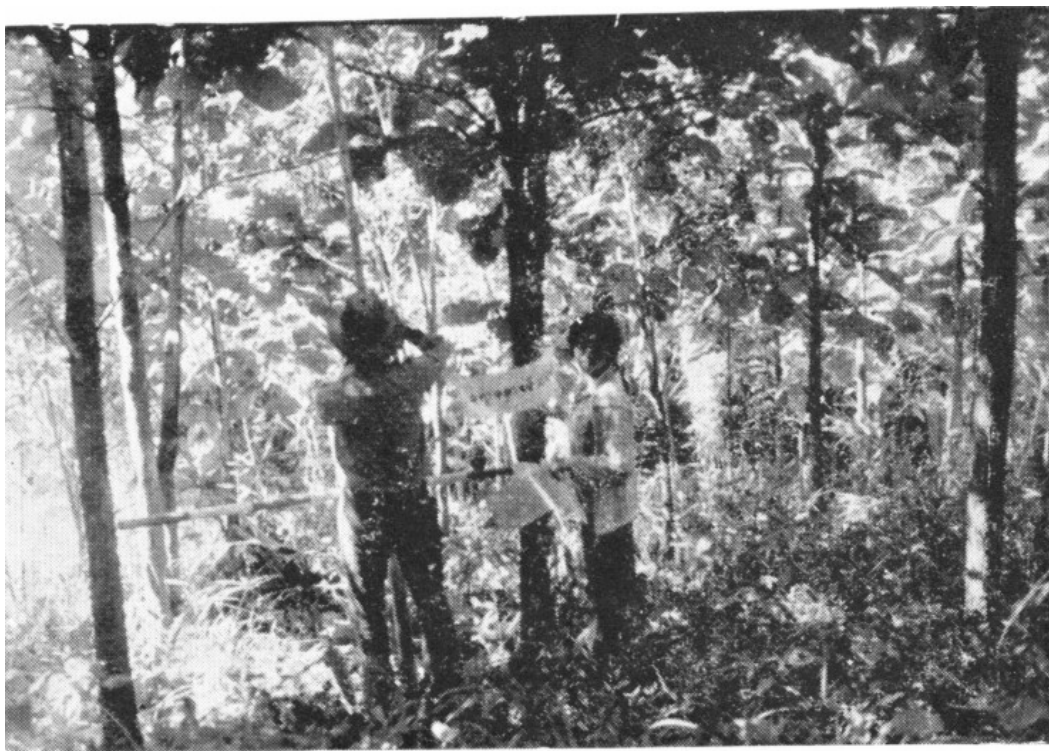


Figure 7. Mixed planting of teak, Pyinkado, Paduak in Kabaung Reserve, Compartment 220.



Figure 8. Enrichment planting of Teak in cleared strips of 15 width, at spacing of 6' x 6' Average g.b.h. (7.48"), Height (22.89')



Fig. 9. 5 year old Yemane plantation space out at 9'x9'. Suppressed trees were dying out. Ngelaik reserve compartment 73. Mean height 44', mean gbh 21 inches.



Fig. 10. 5 year old Padauk plantation in Ngelaik reserve compartment 72. Initial spacing 6'x6'. plantation was pruned in the 2nd and 4th year of planting and thinning in the 5th year observed clean bole. Mean height 28', mean gbh 13 inches.

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