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Interim Report on Teak Provenance Trial (Seed Characteristics)

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Forest Research Institute
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အနယ်နယ်မှ ကျွန်းစေ့များကို စမ်းသပ်စိုက်ပျိုးခြင်း

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ကျွန်းစိုက်ပျိုးသော ကမ္ဘာ့နိုင်ငံ အတော်များများသည် ကျွန်းမျိုးကောင်း မျိုးသန့်များကို စိုက်ပျိုးထုတ်လုပ်ရန် ကြိုးပမ်းလာကြပေသည်။ မြန်မာနိုင်ငံသည်လည်း မိမိကျွန်းစျေးကွက်ကို ဂုဏ်ရှိစွာ ဆက်လက် ထိန်းသိမ်းနိုင်ရေးအတွက် ကျွန်းမျိုးကောင်း မျိုးသန့်များကို ရွေးချယ်စိုက်ပျိုးရန် လိုအပ်လာပါသည်။ ပေါက်ရောက်မှုနှုန်းနှင့် ကြီးထွားမှုနှုန်းအကောင်းဆုံးထုတ်လုပ်ပေးနိုင်သော နယ်ကိုရွေးချယ်နိုင်ရန် ဤစာတမ်းတွင် နယ်ပေါင်း (၁၈) နယ်မှကျွန်းစေ့များကို စုဆောင်း၍ ယင်းကျွန်းစေ့များ၏ လက္ခဏာများကို လေ့လာဆွေးနွေးထားပါသည်။

Interim Report on Teak Provenance Trial (Seed Characteristics)

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Abstract

Burma has been growing teak without much concern for the origin of the seed. However, many teak growing countries are now intensively engaged in tree improvement work and the time has come when Burma should also selected the seed used in plantation establishment, in order to maintain its quality of timber. Initially selection of correct provenance is needed. Seeds from (18) provenance was collected and the differences in their characteristics was studied and discussed in this paper.

Introduction

Differences among individuals of any population of cross fertilizing or sexually reproducing organisms have existed very early in the beginning of life. They differ in either one character or the other. This holds good either for people, animal or trees.

Variation in tree species is due to variations in both the genetic make up of the individuals of the species and in the environment (Turesson 1923, Clausen and Hiesey, 1958; Heslop - Harrison, 19 64; Zobel,1964; Langlet, 1967). The expression of every character in a particular species is potentially controlled by the genotypic constitution of the individual, whilst the eventual phenotypes produced are due to reaction of the genotypes with the environment. Turesson, 1922. Burley, 1963). The result is a variation from locality to the frequency of many characteristics common to individuals of a particular species (Burley, 1965, Florence and Malajezuk, 1971), and these individuals of a particular species that have many common characteristics are said to belong to the same provenance or race.

Many tree species occur over a wide range encompassing a large number of locally different environments. Such species frequently display geographic difference in one or more important characteristics. Squillace (1966) in his stud on *Pinus elliottii* Engelm found seed yield, germinability and speed of germination, total height, stem diameter and stomatal measurements showed significant difference associated with the geographic source of the material. Similarly Luckhoff (1964) found *Pinus caribaea* from Bahamas, Cuba and Central America mainland formed three well defind geographic variants with a distinct latitudinal trend, and suppurated the sub-division of the of the species into three separate taxonomic entities.

Variation through the species range may be clinal (continuous) or ecotypic (discontinuous) since climate factors change gradually along geographical or latitudinal gradients, the resulting variation pattern is normally clinal (Critchfield, 1957 ; Squillace, 1966, Langlet, 1967; Butjenen and Stern, 1967). However, discontinuous habitats can results in ecotypic variation (Squillace, 1966).

Pockets of ecotypes may also occur in a great stretch of a continuously variable species (Pryor,1963; Heslop & Harrison, 1964). Squillace, 1966 considered such a combination of both clinal and ecotypic variation can result from either past or present isolation.

Variation in the species assumes considerable importance in the establishment of plantations. If one provenance gives timber of superior quality or size others then clearly that particular provenance should be selected for seed collection and plus tree selection for tree breeding work. The value of provenance trial is undisputable, but the process is lengthy.

Several board studies have examined geographic variation in teak, and the existence of such variation within the species is well established (Beard ,1943; Mathanda 1951; Keiding et al, 1964; Cameron, 1966; Maung Gale (2) and Nyunt Naing , 1967; Hedegart, 1971; Ko Ko Gyi, 1972). Information however is still incomplete.

This study covers the complete latitudinal range (15° 09'N to 25° 16'N) within Burma where teak occurs naturally. Detail study will be starting from seed to at least half the rotation. This is the first series of report for this study and intermediate findings will be reported whenever possible.

Table 1. Mean monthly humidity for selected provenances

Provenance	Mean monthly humidity												Mean annual humidity (%)
	J	F	M	A	M	J	J	A	S	O	N	D	
Myitkyina	79.68	70.72	61.72	62.72	69.77	85.5	88.81	85.18	86.00	83.25	82.90	83.45	78.31
Bhamo	78.23	66.23	55.09	37.77	62.62	81.91	84.05	85.55	83.11	80.23	81.23	32.00	73.14
Katha	78.25	70.21	60.28	59.39	69.61	79.39	81.39	82.50	78.26	76.68	76.57	76.43	74.08
Shwebo	69.13	53.75	45.80	47.19	60.94	71.75	74.88	79.75	81.11	80.69	76.98	76.64	68.21
Madaya	61.78	50.05	41.23	44.86	60.95	68.64	67.50	74.45	75.95	76.85	76.55	71.45	64.16
Lower Chindwin	60.55	50.64	39.64	43.82	57.23	67.11	67.11	73.45	70.84	67.84	67.85	64.96	60.89
Pakokku	78.42	69.75	66.20	62.38	66.08	75.67	78.25	89.00	79.88	79.10	82.90	81.00	75.26
Minbu	58.75	48.00	41.15	48.70	55.88	69.56	76.28	75.89	77.17	73.72	67.33	65.81	63.18
Magwe	59.64	49.00	34.70	41.00	56.88	76.25	75.83	76.50	77.75	74.38	66.88	66.80	63.13
Yamethin	58.50	6.00	10.80	35.44	39.45	85.90	95.60	14.82	158.9	87.79	61.34	11.86	74.45
Meiktila	58.05	45.45	41.50	44.95	60.14	74.32	76.27	79.45	78.95	77.41	73.86	66.73	64.76
Pyinmana	60.20	50.30	44.95	49.85	67.00	80.55	84.15	85.75	83.30	79.40	74.60	67.90	69.04
Thatyet	-	-	-	-	-	-	-	-	-	-	-	-	Not available
Prome	60.05	48.82	45.00	49.45	66.77	81.41	83.91	85.27	83.77	80.41	75.41	64.38	68.72
South Tanugoo	68.95	26.27	56.00	55.13	71.09	85.36	88.77	88.72	84.13	81.86	77.68	74.20	71.51
Tharrawaddy	67.80	57.60	50.70	49.45	69.32	84.00	87.30	8818	77.20	80.91	80.04	75.50	72.33
Bilin	63.41	61.14	66.10	67.36	80.14	88.64	91.77	92.69	86.50	78.45	74.59	65.86	76.39
Ye	59.36	66.14	61.59	69.59	80.73	87.89	89.55	91.04	87.68	79.59	71.27	64.32	76.73

Material and Methods

Provenance to be tested were selected using climatological data and their latitudinal distribution as a basis. The selected provenances were:-
(See figure 1 to 6 and Table 1.)

Sr. No.	Latitude	Forest Division	Reserved Forest	Compt. No.
1.	25° 16'N	Myitkyina	Maingnaung	117
2.	24° 26'N	Bhamo	Mosit	1.2.3
3.	24° 10'N	Katha	Petsut	40
4.	23° 52'N	Shwebo	Kyaukpya	17,18
5.	22° 30'N	Madaya	Lower Madaya	35,36,37,38,64,65,66,71,72,73,
6.	22° 16'N	Lower Chindwin	Pintaung	9,10
7.	21° 29'N	Pakokku	Peinne	22
8.	20° 23'N	Minbu	Sami	-
9.	19° 50'N	Magwe	Kyauk -mi-chaung	9,115,127
10.	19° 38'N	Yamethin	Ngalaik	19
11.	19° 36'N	Meiktila	Kubyin	24,25,29
12.	19° 30'N	Pyinmana	Minbyin	31,32,46,47
13.	19° 16'N	Thayet-Myo	Thumbula	2
14.	19° 03'N	Prome	Chaungzauk	10
15.	18° 32'N	Shouth Toungoo	Kabaung	9,10,15
16.	18° 03'N	Tharrawaddy	Mok-ka	32
17.	17° 18'N	Belin	Un-classed	-
18.	15° 09'N	Ye	Un-classed	-

Seed Collection

Seeds were collected from the middle of February to March 1981. For each provenance collection was done from 20-25 dominant and codominant disease free, healthy and normal trees. These 20-25 trees had to be distributed in MUMD type of forest which situated approximately at the centre of the reserved forests selected.

Seed sampling

Four baskets of fruits were collected from each of the 18 provenance. For each provenance, fruits were thoroughly mixed and then divided down into approximately amount required for the studies mentioned below. The extra fruits were put in air tight containers and stored at the seed storage room where an average temperature of 22 °C was maintained.

1000 fruit weight

According to the international Seed Testing Association rule (Turnbull 1975), 100 teak fruits were weight 8 times with electrical precision balance and recorded for each provenance , 1000 fruit weight was obtained by multiplying the average weight of 100 fruits by 10.

The results for mean of 100 fruits were analysed using the standard analysis of variance technique and individual provenances were compared using the LSD test.

Teak Fruit diameter

For each provenance 100 teak fruits were sampled and radial diameters were measured twice by means of a slide caliper. Measurements were taken at 90° to each other and the average of the two measurements were calculated.

Teak seed dimension

The sampled teak fruits were hammered with a hammer and the fruit coats were removed. For each fruit only one seed was taken. Seeds that were damaged were discarded. The process was repeated until 10 seeds were obtained for each provenance. The length and width of 10 seeds for each provenance were measured using an occular metre in a olumpus dissecting microscope. Seed coat texture was also studied under the microscope and described.

Cutting test

For each of the 18 selected provenances, 100 fruits were sampled and cutting test was carried out. For each of the selected provenances 100 fruits were sampled and out radially with a sharp knife (dhama). Number of seeds in each fruit was counted and recorded.

Germination test

Germination test was conducted immediately after collection.

Sampled teak fruits for each of the provenances selected were first pretreated by soaking in water for 3 days. The pretreated fruits were sown in germination boxes containing pure sand. Watering was done once at 8 a.m. and once at 3 p.m. daily. Germination record was taken daily up to 44 days after sowing. Since some teak fruits produced up to 4 seedlings per fruit, records for both (a) number of fruits that germinate, and (b) number of seedlings produced were taken daily.

For this test 100 fruits were replicated 4 times.

Germination of teak fruit was expressed both as "germination percent" and " germination value". Germination value was also calculated as totality of germination or germination percent can vary with the length of time the test is conducted (Czabator, 1962). Interpretation of the results may therefore be incorrect or misleading if only total germination is considered. Czabator (1962) developed a method of assessment where both speed and totality of germination were expressed as a single numerical value called germination value (GV).

i.e. GV = PV x MDG
where PV = peak value, and
MDG= mean daily germination.

Peak value which is the measure of the vigor of the seed is expressed in terms of the highest germination percent in relation to elapse of time room the start of the test. This is determined by successively dividing the cumulative germination percent by the number of days until a quotient giving the highest value (i.e. pv) is obtained.

Mean daily germination is the average number of seeds germination per day of the actual test period to the date of measurement. It is calculated by dividing the total germination percent on the closing day by the total number of days.

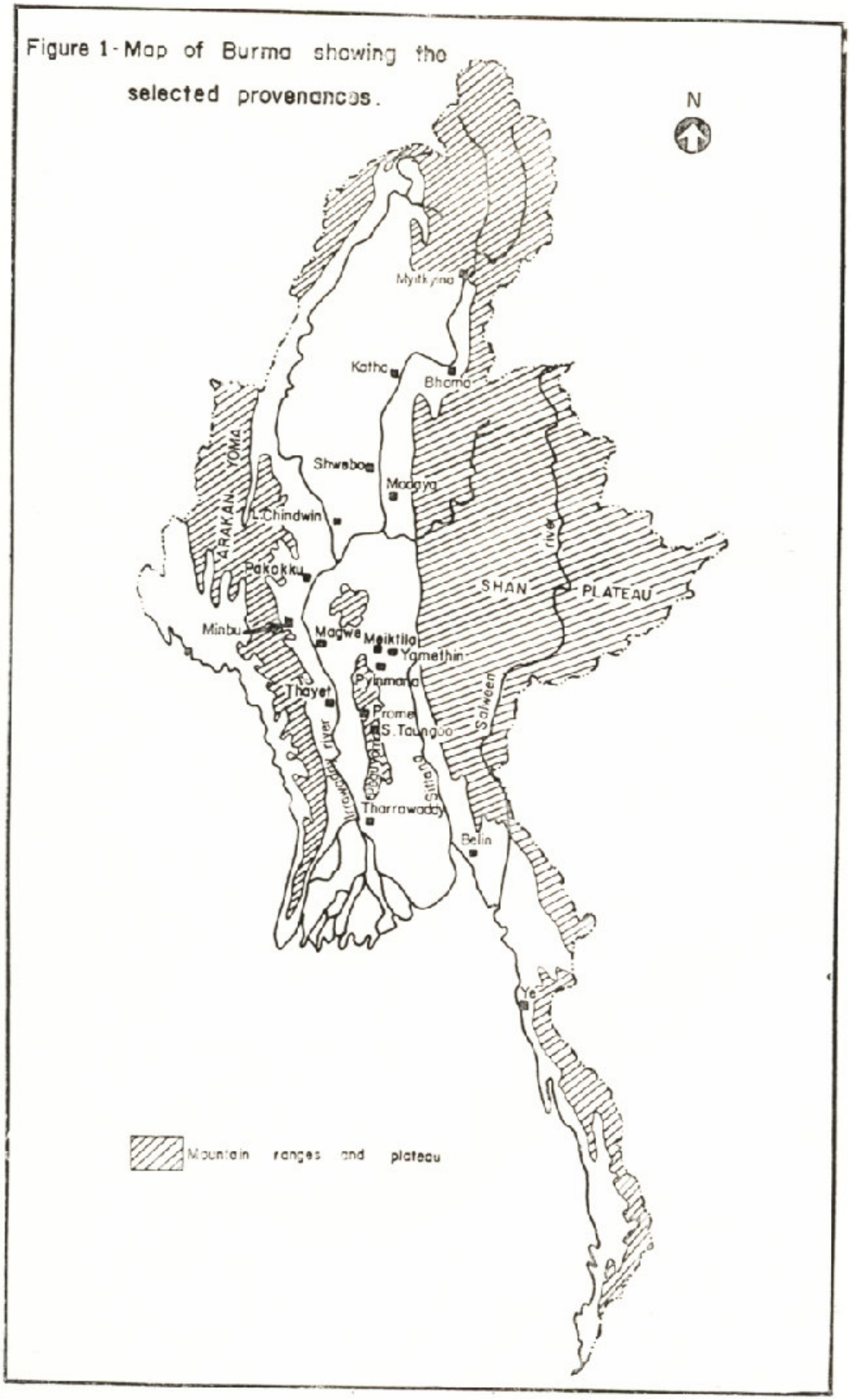
The results of germination percent and germination value were analysed using the standard analysis of variance technique and individual provenances were compared using the LSD test.

Log_e Shoot/ Log_e Root Ratio (Dry Weight)

From each provenance ten teak seedlings were selected randomly from seedlings planted in seed beds at Moswe out station nursery. The selected seedlings were thoroughly washed without loosing any of the lateral roots and was then cut at the root collar. The root and shoot portions were put in separate paper bags and were dried in an oven maintained at 70 C for 3 days. Dried materials were allowed to cool and stabilize in a dessicator for at least halt an hour before weighing. Root and shoot of an individual seedling were weighed seperately; Log_e shoot/ Log_e root (dry weight) ratio were calculated for each individual seedling.

The results were analysed using a standard analysis of variance technique and individual provenances were compared using the LSD test.

Figure 1 - Map of Burma showing the selected provenances.



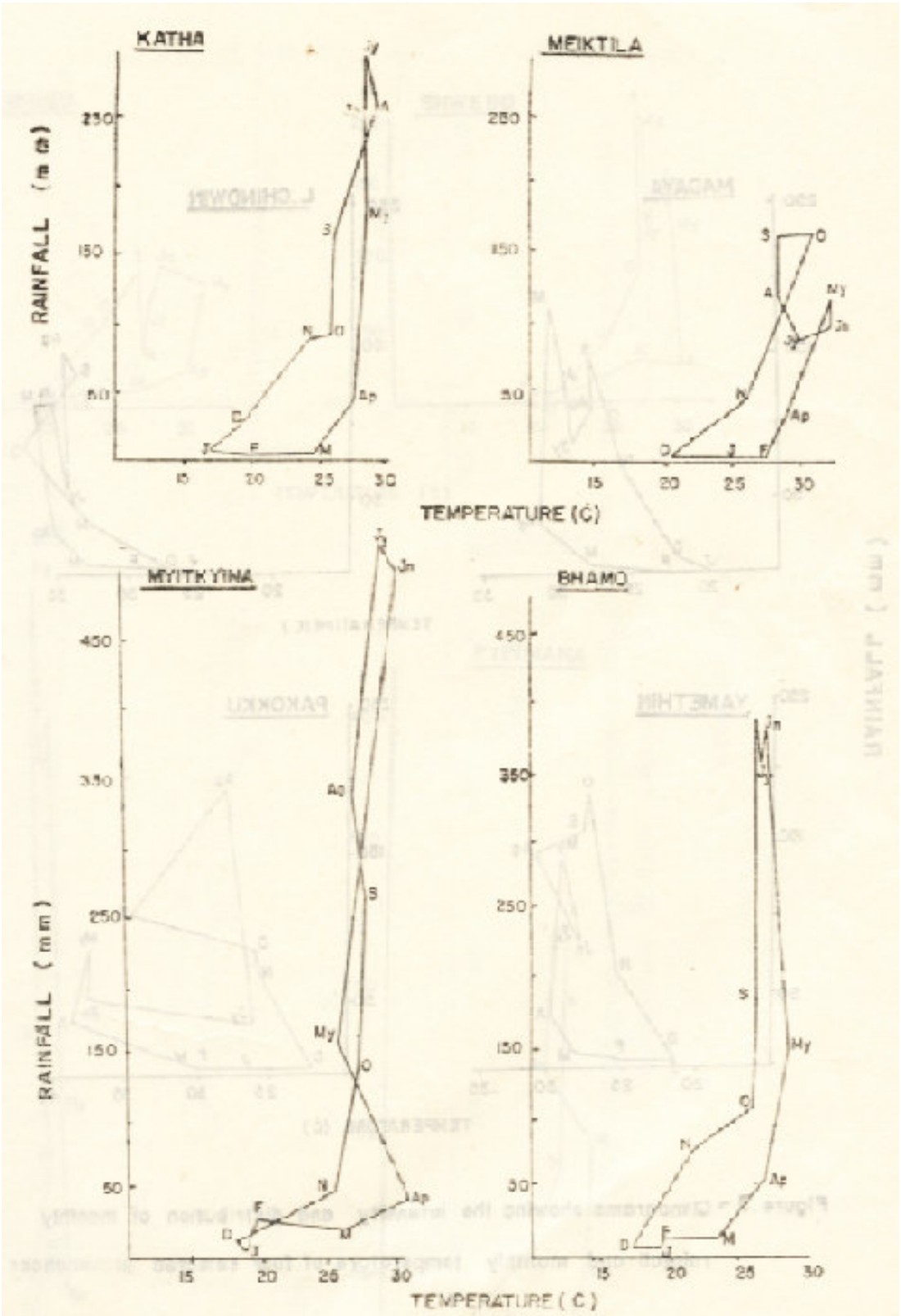


Figure 2.- Climograms showing the intensity and distribution of monthly rainfall and temperature of four selected provenances.

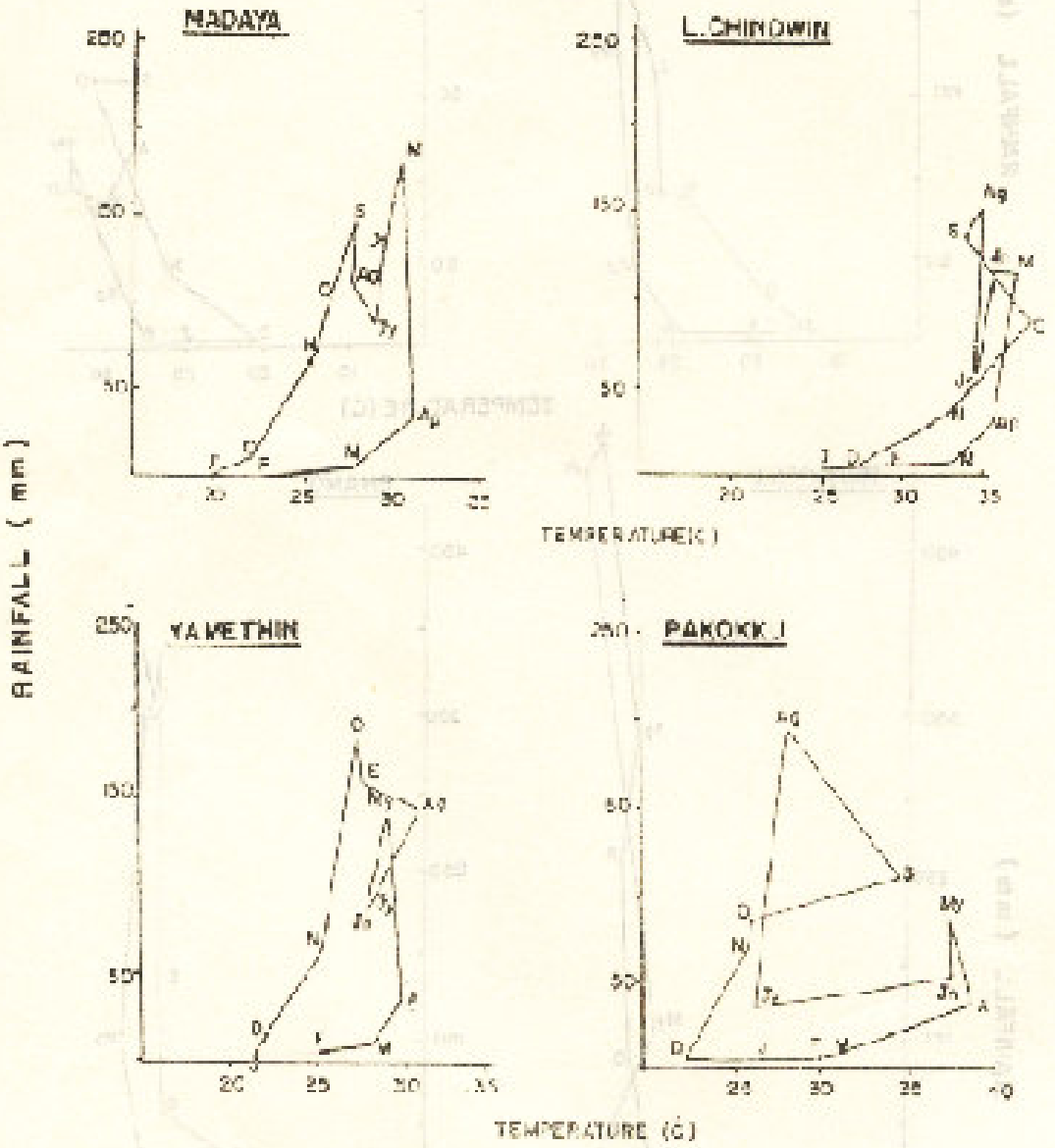


Figure 3 - Climograms showing the intensity and distribution of monthly rainfall and monthly temperature of four selected provenances

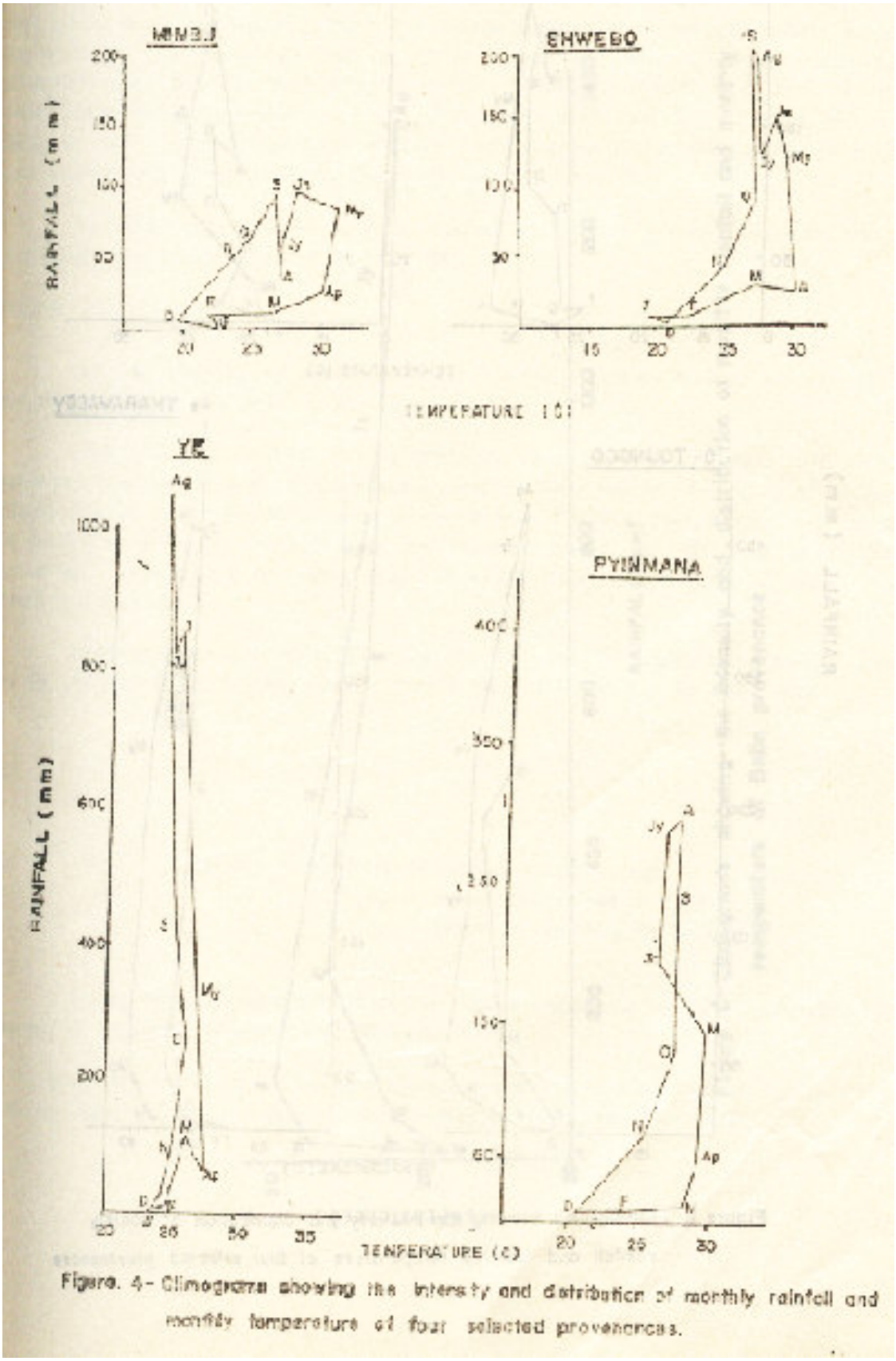


Figure. 4- Climograms showing the intensity and distribution of monthly rainfall and monthly temperature of four selected provenances.

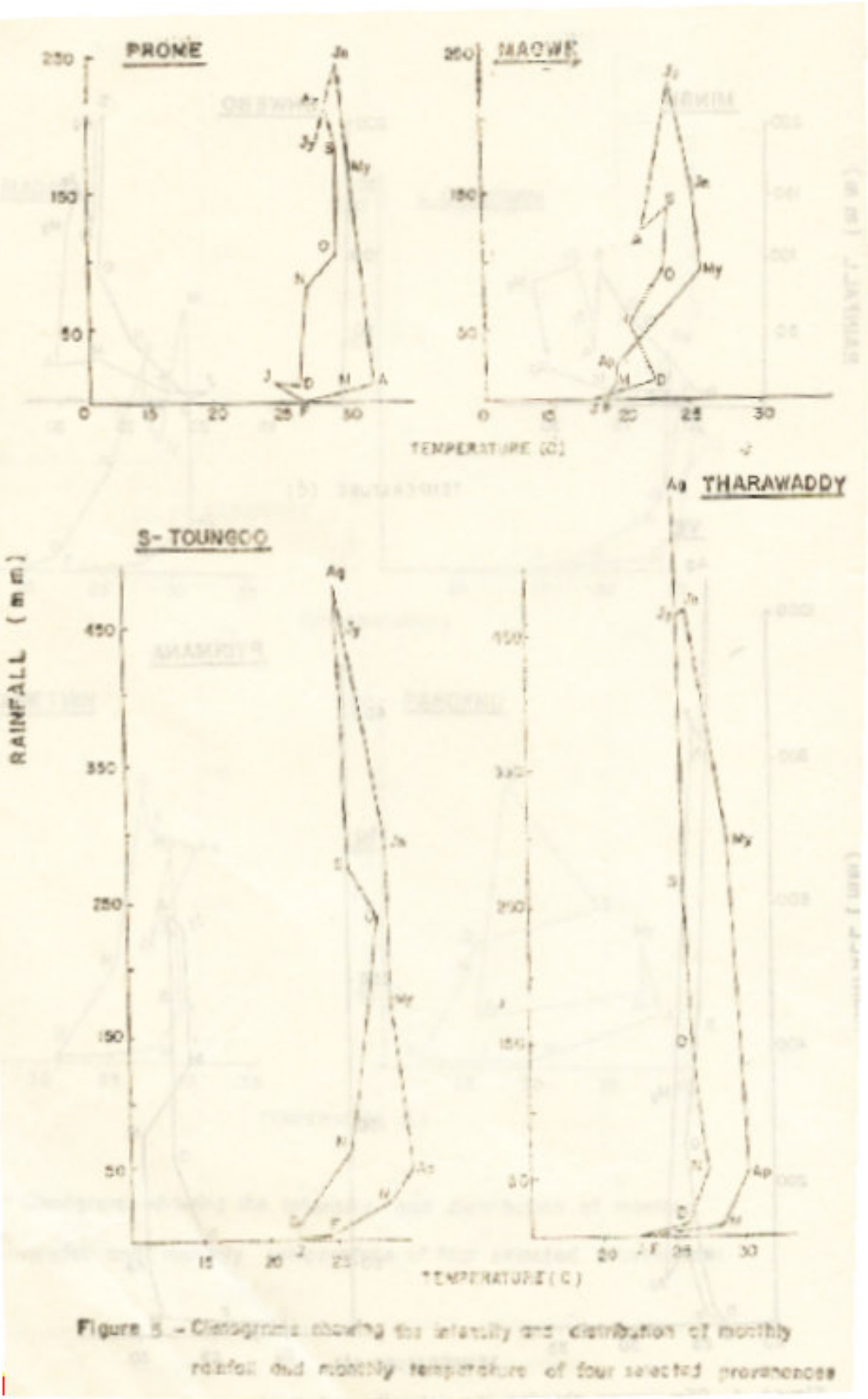


Figure 5 – Climograms showing the intensity and distribution of monthly rainfall and monthly temperature of four selected provenances

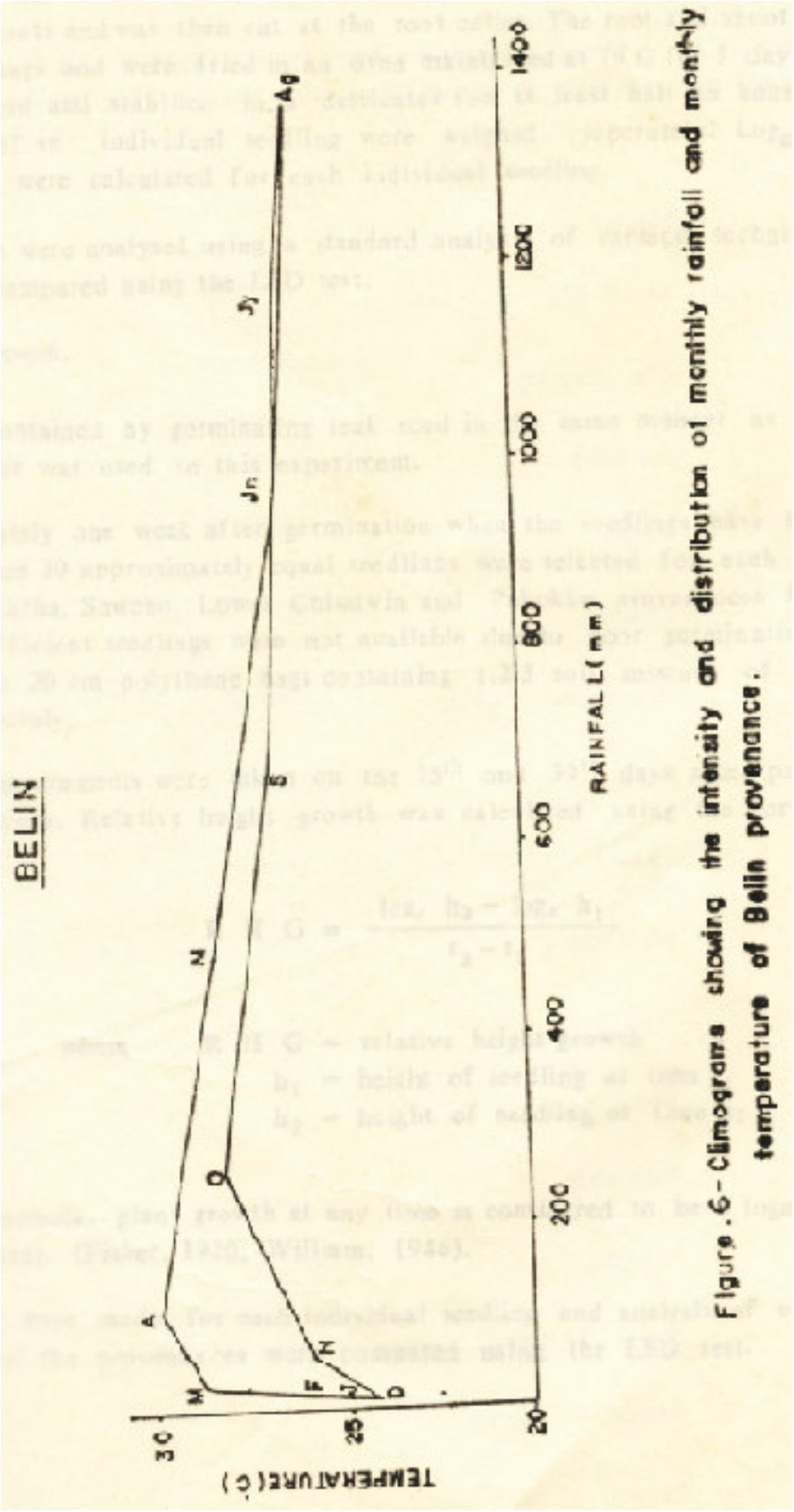


Figure.6- Climograms showing the intensity and distribution of monthly rainfall and monthly temperature of Belin provenance.

Relative height growth.

Seedlings obtained by germinating teak seed in the same manner as was described in germination test was used in this experiment.

Approximately one week after germination when the seedlings have their first pair of leaves well developed 30 approximately equal seedlings were selected for each of the provenances studied. Bhamo, Katha, Shwebo. Lower Chindwin and Pakokku provenances had to be excluded in this test as sufficient seedlings were not available due to poor germination. Seedlings were potted in 7.5 cm x 20 cm polythene bags containing 1:2:3 soil mixture of sand, manure and forest soil respectively.

Height measurements were taken on the 25th and 30th days after potting the seedlings in the polythene bags. Relative height growth was calculated using the formula :

$$RHG = \frac{\log_e h_2 - \log_e h_1}{t_2 - t_1}$$

where RHG = relative height growth

h_1 = height of seedling at time t_1

h_2 = height of seedling at time t_2

In this formula, plant growth at any time is considered to be a logarithmic function of the size of the plant. (Fisher, 1920; William, 1946).

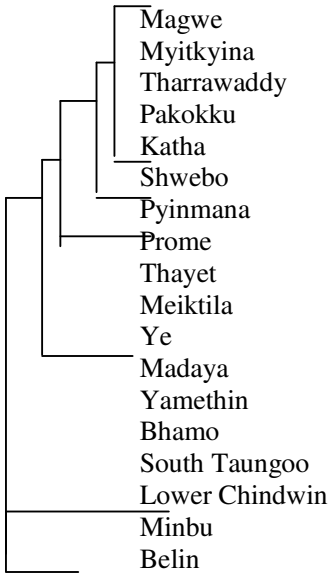
Assessments were made for each individual seedling and analysis of variance was carried out. The means of the provenance were compared using the LSD test.

Results

Comparison of the general characteristics of teak fruit and seed from different provenances

Fruit Weight

There appear to be definite differences between some provenances in fruit weight (see Table. 2). For simplicity rankings are given below with lines linking provenances which did not differ significantly.



Since ranking of the fruit weights of different provenances tends to form groups that overlap, we can only say generally that fruits from Magwe, Myitkyina, Thrrawaddy, Pakokku and Katha are the heaviest where those from Minbu and Belin are significantly the smallest.

Fruit diameter

Assessment of fruit diameter also gave significant differences among some of the provenances studied. Rankings are given below with lines connecting the provenances that are not significantly different.

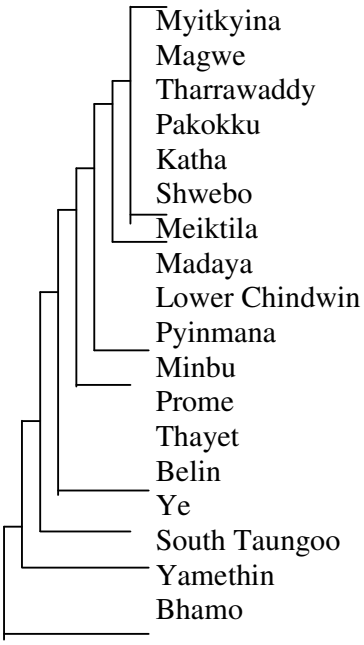


Table 2. Comparison of general characteristics of teak fruit and seed from different provenances.

Sr. No.	Provenance	1000 fruit weight * (gms)	Fruit diameter (cm)	Seed dimension	
				length (mm)	width (mm)
1.	Myitkyina	901.5	1.565	6.24	3.73
2.	Bhamo	708.8	1.340	5.77	3.60
3.	Katha	824.2	1.515	5.90	3.47
4.	Shwebo	813.5	1.500	5.97	3.70
5.	Madaya	723.8	1.485	5.91	3.67
6.	Lower Chindwin	687.1	1.470	6.17	3.68
7.	Pakokku	832.4	1.525	6.05	3.71
8.	Minbu	594.0	1.435	6.17	3.42
9.	Magwe	904.2	1.565	5.83	3.71
10.	Yamethin	708.8	1.340	5.80	3.74
11.	Meiktila	738.2	1.490	6.09	3.47
12.	Pyinmana	767.1	1.460	5.90	3.73
13.	Thayet	739.6	1.425	6.24	3.15
14.	Prome	745.7	1.435	5.90	3.73
15.	South Taungoo	695.4	1.360	5.40	3.66
16.	Tharrawaddy	882.0	1.555	6.00	3.5
17.	Belin	529.6	1.425	5.96	3.67
18.	Ye	726.8	1.410	6.00	3.62

* Comparison was done only for 100 seed weight.

Generally, it can be said that Myitkyina, Magwe, Tharrawaddy, Pakokku, Katha and Shwebo produce bigger seeds while Sought Taungoo, Yamethin and Bhamo seeds are the smallest.

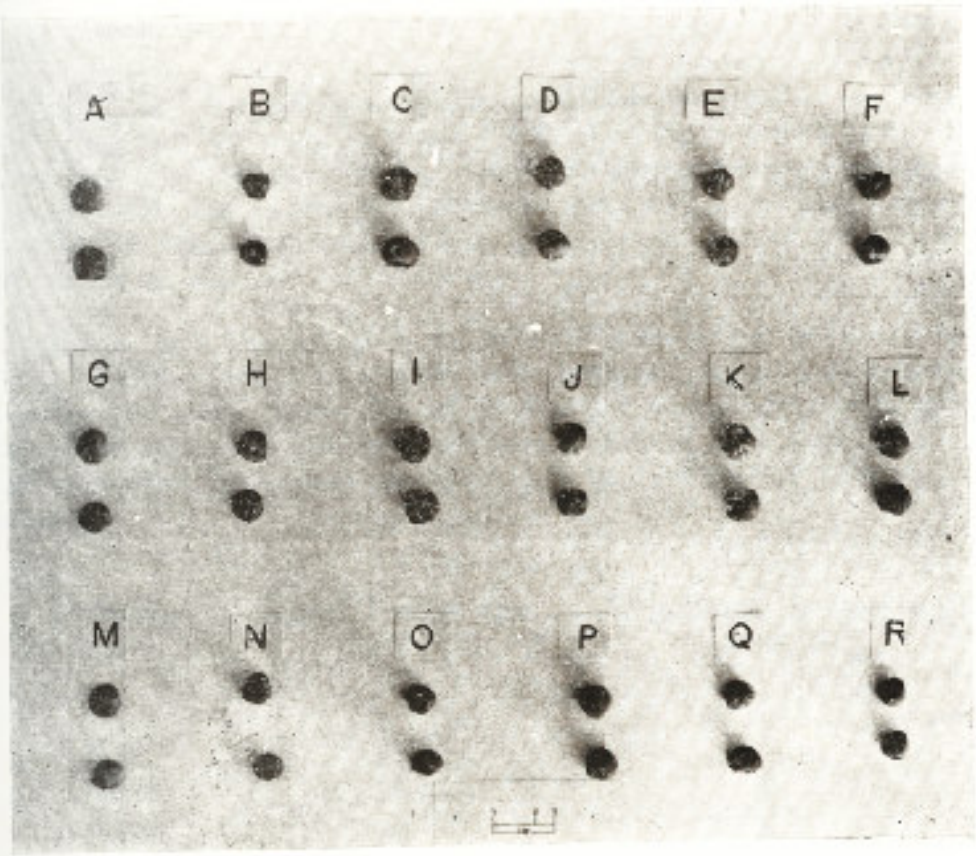


Figure 7. - Top and side view of representative teak fruit from the following 18 provenances.

A—Myitkyina, B—Bhamo, C—Katha, D—Swebo, E—Madaya,
F—L.Chindwin, G—Pakokku, H—Minbu, I—Magwe, J—Yamethin,
K—Meiktila, L—Pyinmana, M—Toungoo, N—Prome, O—S. Taungoo,
P—Tharrawaddy, Q—Bassein, R—Ye.

Seed dimension

No significant difference was observed among the proveances in respect to seed dimension (see table 2.). However, in Figure 9 (A) and 9 (B), it will be noticed that the seed shape varies. Seeds from Myitkina, Magwe, Yemethin, Meiktila, Pyinmana, Thayet, South Toungoo, Tharawaddy, Belin and Ye were more slender whereas those from Bhamo, Katha, Shwebo, Madaya, Minbu and Prome have rounded base. Seeds from Bhamo and Katha were also more thick and rounded on the side.

Differences were also noticed in the texture of some of the seed coat (see Figure 10) Texture A was found in all the provenances studied. Texture B and C were found in some of the samples from Minbu, Magwe, Thayet, Tharrawaddy, Yamethin, Pyinmana, South Toungoo and Prome, whereas Texture D was found only in some samples from Minbu. The frequency of the stripe and designed, and normal texture found in the provenances mentioned above were as given below.

Provenance	Normal Texture (A)	Striped and designed texture (B,C,D)
Minbu	21	9
Magwe	22	8
Thayet	24	6
Tharrawaddy	28	2
Yamethin	24	6
Pyinmana	25	5
South Toungoo	28	2
Prome	29	1

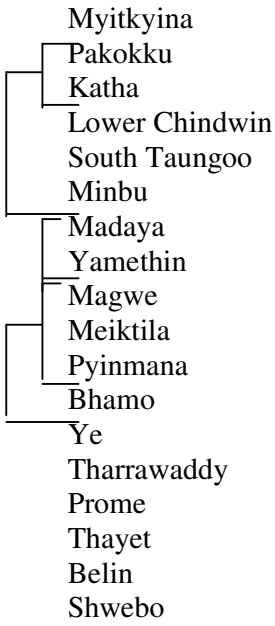
The seeds of the remaining 10 provenances have only the normal seed texture.

Table 3. Results of Cutting Test for each of the provenances studied.

Sr. No.	Provenance	Total No. of seeded fruit	Seeded pattern in 100 fruit				
			(1) seeded	(2) seeded	(3) seeded	(4) seeded	(0) seeded
1.	Myitkyina	86	59	23	2	2	14
2.	Bhamo	73	53	11	9	-	27
3.	Katha	82	66	14	2	-	18
4.	Shwebo	57	37	11	9	-	43
5.	Madaya	77	56	19	2	-	23
6.	Lower Chindwin	81	49	27	5	-	19
7.	Pakokku	83	46	29	6	2	17
8.	Minbu	81	49	23	8	1	19
9.	Magwe	75	53	12	9	1	25
10.	Yamethin	77	51	19	7	-	23
11.	Meiktila	75	55	19	-	-	25
12.	Pyinmana	74	45	26	2	1	26
13.	Thayet	62	49	11	2	-	38
14.	Prome	65	55	9	1	-	35
15.	South Taungoo	81	60	18	3	-	19
16.	Tharrawaddy	68	49	17	1	1	32
17.	Belin	59	31	23	5	-	41
18.	Ye	70	52	17	1	-	30

Cutting test

The results of the cutting test was as shown in Table 3. For the convenience of analysis, ranking of total number of seeded fruits is given below with lines linking those provenances which did not differ significantly.



The number of seeded fruits for different provenances were significantly different. Myitkyina, Pakokku, Katha, Lower Chindwin, South Toungoo and Minbu have significantly a much higher number of total number of seeded fruit. Ye, Tharrawaddy, Prome, Thayet, Belin, and Shwebo have significantly vary number of seeded fruit. The difference among these latter provenances are also significant. It was also o observed that 1.3% of the fruits of all the provenances are 4 seeded, 4.4 % are 3 seeded, 18.2% are 2 seeded, 50.8% are 1 seeded and 25.3% have no seeded at all.

Table 4. Germination comparison of the provenances.

Sr. No.	Provenance	Germination Percent (%)	Germination Value
1.	Myitkyina	2.75	0.017
2.	Bhamo	0.50	-
3.	Katha	-	-
4.	Shwebo	0.25	-
5.	Madaya	15.50	0.235
6.	Lower Chindwin	3.50	0.004
7.	Pakokku	-	-
8.	Minbu	53.00	2.683
9.	Magwe	30.00	0.209
10.	Yamethin	11.50	0.700
11.	Meiktila	13.00	0.016
12.	Pyinmana	18.00	0.255
13.	Thayet	34.00	0.454
14.	Prome	16.50	0.677
15.	South Taungoo	35.25	0.780
16.	Tharrawaddy	49.50	2.463
17.	Belin	13.50	0.204
18.	Ye	14.50	0.237

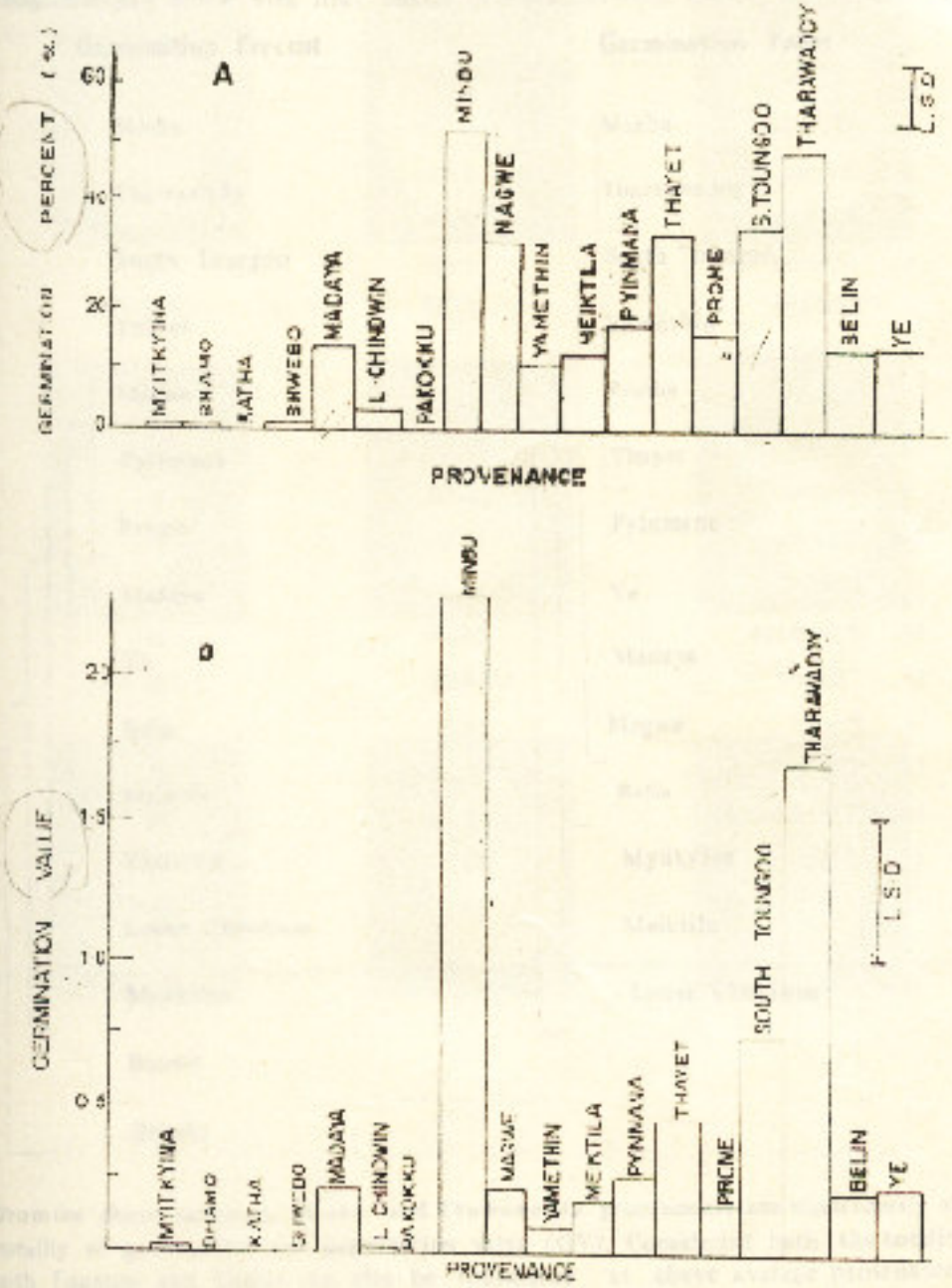
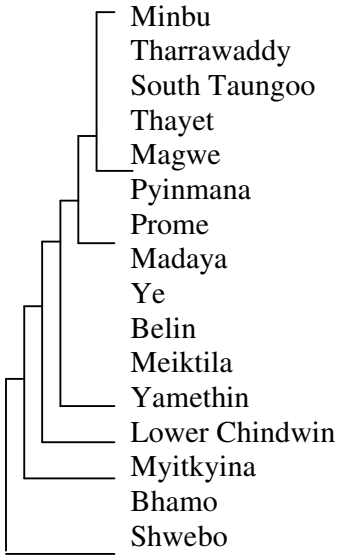


Figure. 8 . Germination comparison of (18) different provenance.

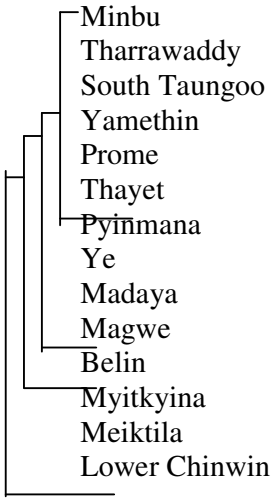
Germination comparison of the provenances.

Germination percent and germination value of the provenances selected showed significant differences among some of the provenances (see Table 4 and Figure 8). Rankings are given diagramatically below with lines linking provenances which did not differ significantly.

Germination Percent



Germination Value



From the above rankings, Minbu and Tharrawaddy provenances are significantly the best both in totality of germination and germination value (GV). Considering both the totality and (GV), South Toungoo and Thayet can also be considered as above average provenances that does not appear in the rankings, (i.e. Bhamo, Katha, Pakokku and Shwebo) either does not germinate or germination is to low calculate the (GV).

Table 5. Number of seedlings produce per 100 teak fruits.

Sr. No.	Provenance	Germination (%)	Number of seedlings produce per 100 fruits
1.	Myitkyina	2.75	3
2.	Bhamo	2.00	2
3.	Katha	0.30	1
4.	Shwebo	1.00	1
5.	Madaya	15.50	16
6.	Lower Chindwin	3.50	4
7.	Pakokku	1.00	1
8.	Minbu	53.00	61
9.	Magwe	33.00	35
10.	Yamethin	11.50	13
11.	Meiktila	13.00	15
12.	Pyinmana	18.00	19
13.	Thayet	34.00	37
14.	Prome	16.5	17
15.	South Taungoo	35.25	38
16.	Tharrawaddy	49.00	53
17.	Belin	13.5	15
18.	Ye	14.5	16

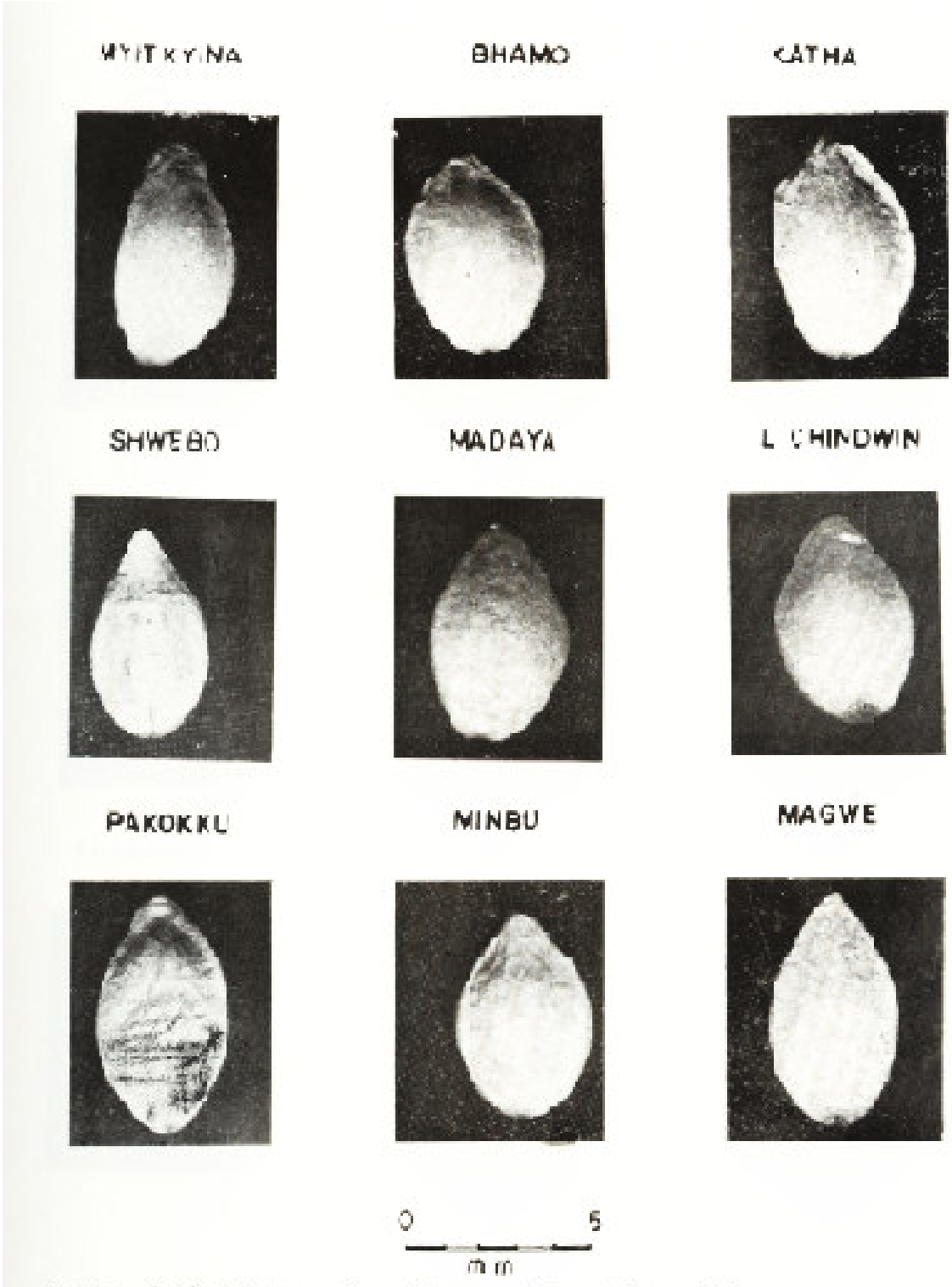


Figure. 9 [A] - Close up view of representative teak seed from provenances under study.

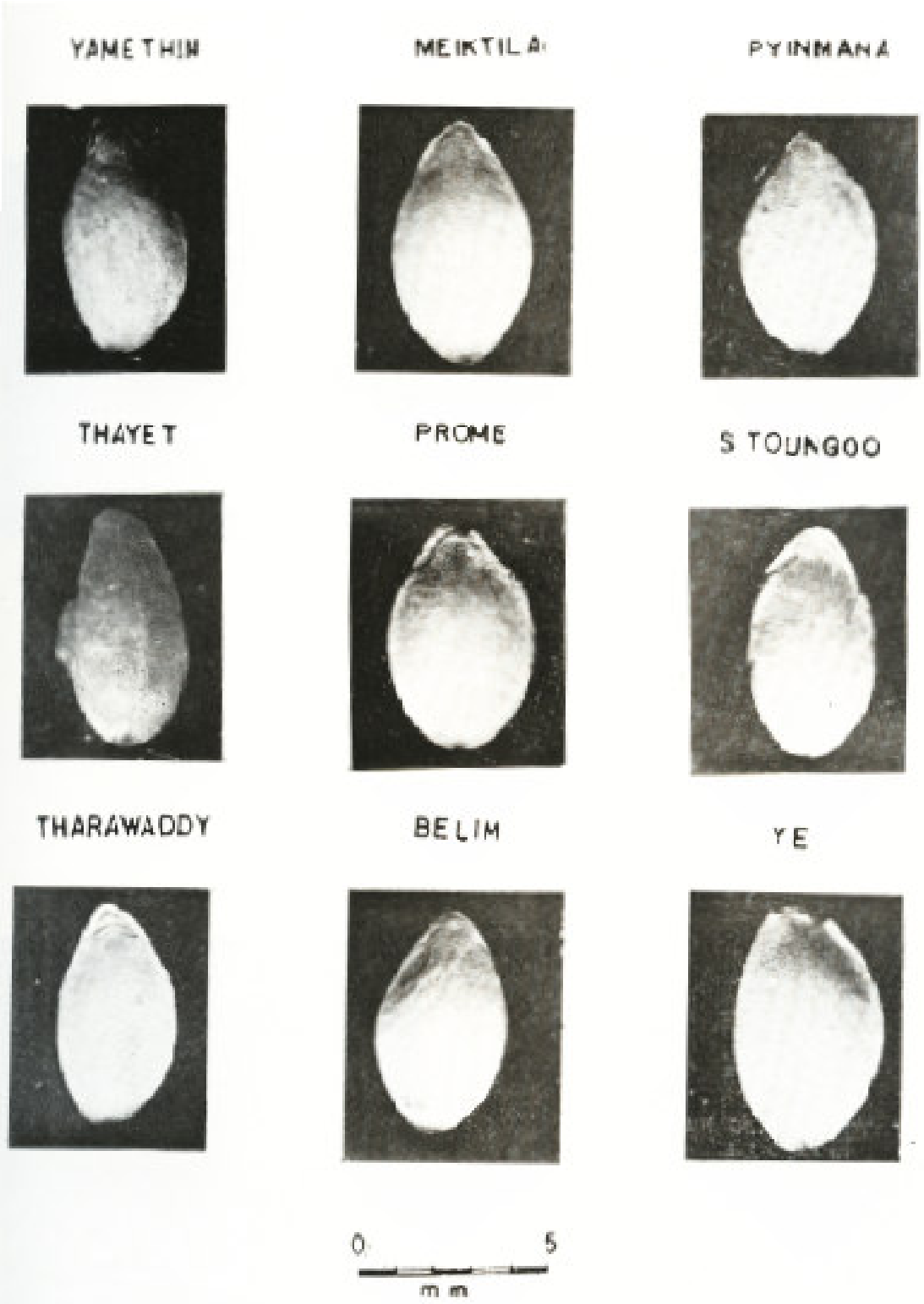


Figure. 9 [B] - Close up view of representative teak seed from provenances under study.

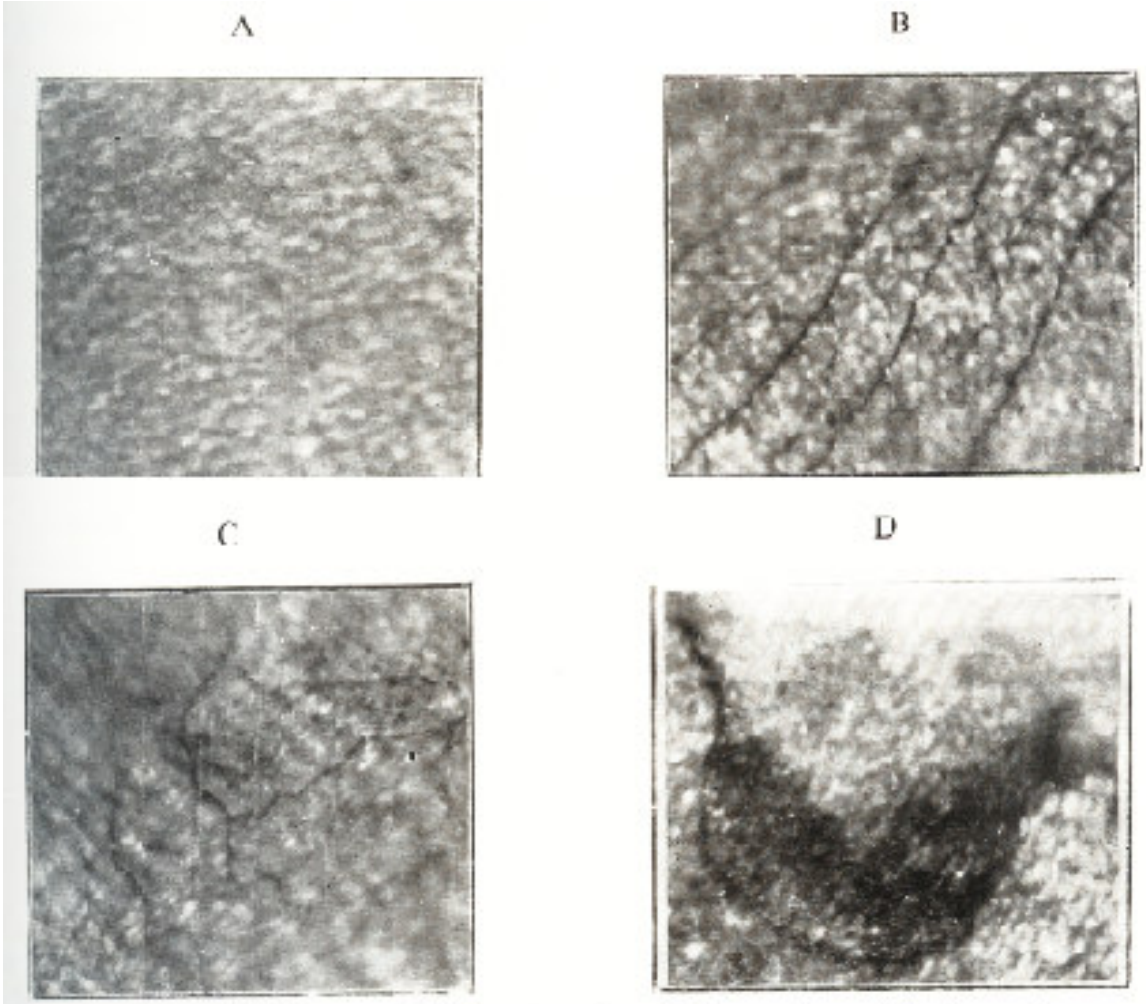
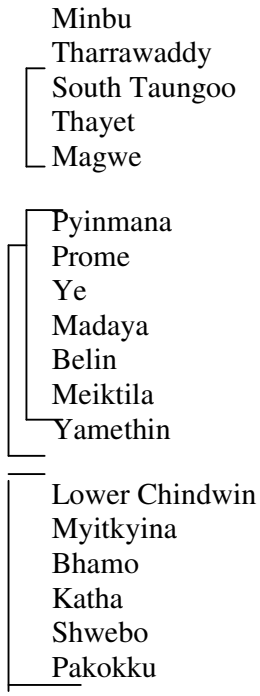


Figure 10. Close up of different seed coat textures observed in the study.

Number of seedlings produced per 100 fruit.

The results for the number of seedling produced per 100 fruit was as given in Table 5. For Simplicity of analysis, rankings of provenances are given below with lines liking those that were not significantly different.



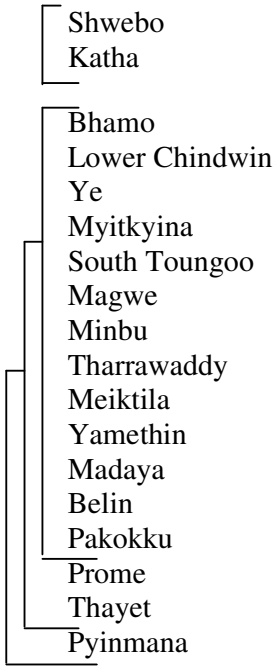
The results of this study is very clear. In the production of number of seedling per 100 fruits, Minbu ranked first, Tharawaddy second, South Toungoo, Thayet and Magwe as a group ranked third; although Pyinmana is significantly better than Yamethin, the whole series from Pynimana to Yamethin can be considered as fourth and the series from Lower Chindwin to Pakokku can be considered as the poorest. The differences were found to be significant.

Table 6. Log_e shoot/ log_e root ratio of the provenances studied.

Sr. No.	Provenances	Log_e shoot/ Log_e root ratio (dry weight) gms
1.	Myitkyina	0.475
2.	Bhamo	0.501
3.	Katha	0.632
4.	Shwebo	0.707
5.	Madaya	0.390
6.	Lower Chindwin	0.501
7.	Pakokku	0.385
8.	Minbu	0.427
9.	Magwe	0.440
10.	Yamethin	0.394
11.	Meiktila	0.400
12.	Pyinmana	0.301
13.	Thayet	0.340
14.	Prome	0.366
15.	South Taungoo	0.442
16.	Tharrawaddy	0.426
17.	Belin	0.390
18.	Ye	0.481

Log_e shoot/ Log_e root Ratio

The log_e shoot/ log_e root ratio of the different provenances is given in Table 6 and Figure 11. Rankings for different provenances are given below with lines linking those that were not significantly different.



From the diagram above, Shwebo and Katha have significantly higher Log_e shoot/ Log_e root than the rest of the provenances. Prome, Thayet and Pyinmana tend to have the lowest root shoot ratio.

Table 7. Comparison of Relative Height Growth of teak seedlings from 13 of the selected provenances.

Sr. No.	Provenance	Relative Height Growth (cm/cm/day)
1.	Myitkyina	0.0256
2.	Madaya	0.0214
3.	Minbu	0.0165
4.	Magwe	0.0302
5.	Yamethin	0.0488
6.	Meiktila	0.0203
7.	Pyinmana	0.0237
8.	Thayet	0.0256
9.	Prome	0.0237
10.	South Taungoo	0.0150
11.	Tharrawaddy	0.0202
12.	Belin	0.0275
13.	Ye	0.0223

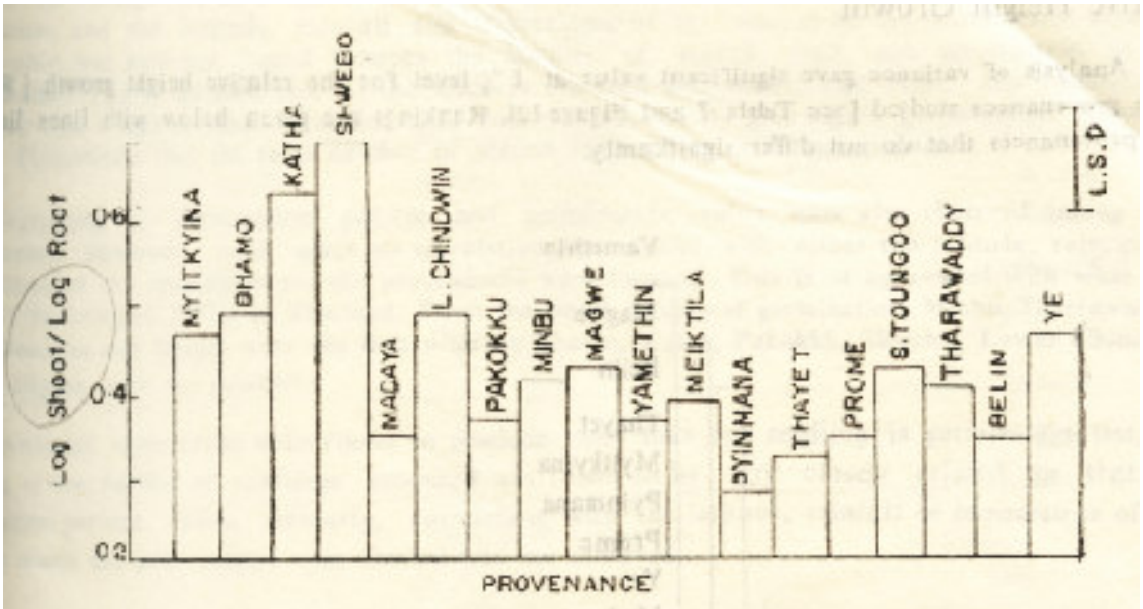


Figure 11 - Log Shoot/Log Root comparison of (18) different provenances

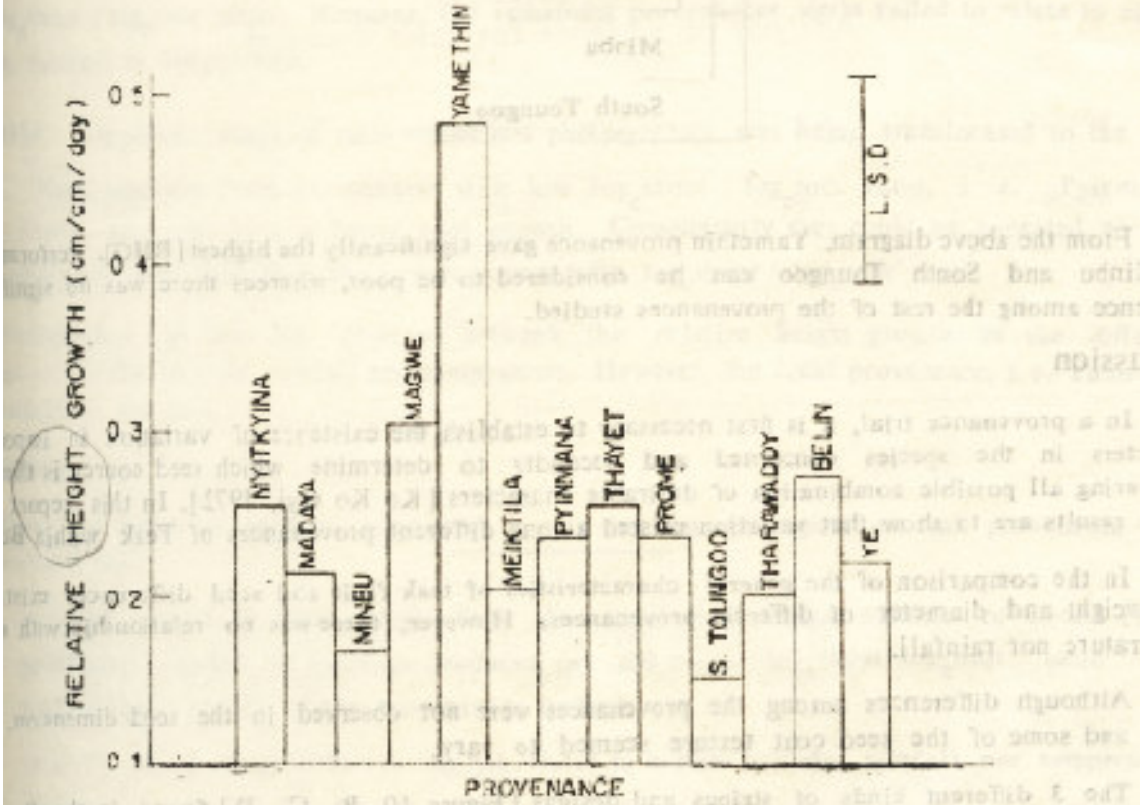
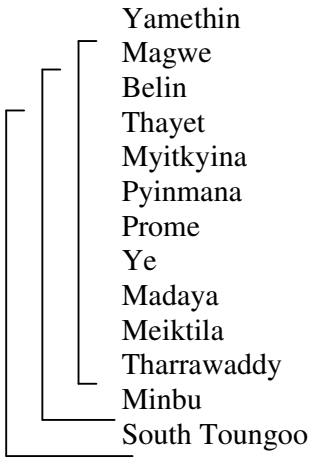


Figure 12 - Relative height growth comparison of (30) days old seedlings of teak provenances

Relative Height Growth

Analysis of variance gave significant value at 1% level for the relative growth (RHG) of the provenances studied (See Table 7 and Figure 12). Rankings are given below with lines linking those provenances that do not differ significantly**.**



From the above diagram, Yamethin provenance gave significantly the highest (RHG). Performance of Minbu and South Toungoo can be considered to be poor, whereas there was no significant difference among the rest of the provenances studied.

Discussion

In a provenance trial, it is first necessary to establish the existence of variation in important characters in the species concerned and secondly to determine which seed source is the best considering all possible combination of desirable characters (Ko Ko Gyi , 1972). In this report most of the results are to show that variation existed among different provenances of Teak within Burma.

In the comparison of the general characteristics of teak fruit and seed differences existed in fruit weight and diameter of different provenances. However, there was no relationship with either temperature nor rainfall.

Although differences among the porvenances were not observed in the seed dimension, seed shape and some of the seed coat texture seemed to vary.

The 3 different kinds of strips and designs (Figure 10.B, C,D) found in the 8 of the 18 porvenances were interesting. Apart from Tharawaddy and South Toungoo, the remaining 6 porvenances were all dry areas (see Figures 2-6) where frequency of black stripe teak can be expected. However the frequency these stipes and designs were found in Tharawaddy and South Toungoo were very low (i;e 6.7%). There is possibility that the seeds with striped and designs seed coat texture could produce black stripe teak. This needs further research on progeny testing in order to confirm of reject this assumption.

In the cutting test, no relationship was found between the number of seeded fruit of different provenances and the latitude, rainfall and temperature of the location of the provenances studied. Relationship was also not found between the number of seeded fruit and germination of the provenances. This is because not all the seeds in the fruit are viable, and from this experiment, it is clear that a high umber of seeded fruit dose not necessarily given higher germination. However, it dose demonstrate that the total number of seeded fruit varies with provenance.

Variations in germination percent and germination value were also observed among the provenances. However, here again no correlation was found either the latitude, rainfall or temperature of the locality where the provenances were located. This is in agreement with what was South Toungoo and Thayet were the best where as Bhamo, Pakokku, Shwebo, Lower Chindwin and Myitkyina were the poorest.

Although some fruits were found to produce more than one seedling in germination test, the ranking of the number of seedlings produced was found to be closely related to that of germination percent. Thus, similarly, correlation with the latitude, rainfall or temperature of the locality where the provenances were located was not observed.

In the study on the $\log_e$ shoot/ $\log_e$ root ratio of the different provenances, shwebo, Katha, Bhamo and Lower Chindwin which belong to the northern provenances tented to form a group with high $\log_e$ shoot/ $\log_e$ root ratio. However, the remaining provenances again failed to relate to either latitude, rainfall or temperature.

High $\log_e$ shoot/ $\log_e$ root ratio means less photosynthate was being translocated to the root portion. Thus, seedlings from provenances with low $\log_e$ shoot/ $\log_e$ root ratio, i. e. Pyinmana, Thayet Prome etc., will have a better root growth. Consequently they could be expected to given better survival in the field than those provenances with $\log_e$ shoot/ $\log_e$ root ratio**.**

Relationship was also not observed between the relative growth of the different provenances and the latitude, rainfall and temperature. However, the local provenance, i.e. Yamethin was significantly the best.

Conclusion

From the series of studies conducted in this interim report on teak provenance trial it is concluded that:

(1) variation existed in fruit weight, fruit diameter, seed shape number of seeded fruits, germination, number of seedlings produced per 100 fruits, $\log_e$ shoot/ $\log_e$ root ratio and relative height growth of the provenances studied,

(2) variation among the provenances was not related to neither latitude, rainfall nor temperature.

(3) seedlings from Pyinmana, Thayet and Prome exhibit very $\log_e$ shoot/ $\log_e$ root ratio and thus may be useful for regeneration in adverse site.

(4) stripes and designs observed on seed coat some seeds of certain provenances deserve further research.

Appendix I

Analysis of variance for (100) teak fruits weight of selected provenances

Source	Df	Sums of squares	Mean squares	F
Treatment	17	179563.49	10562.55	
Error	126	9192.92	72.95	144.79**
Total	143	188756.41		

L S D = 8.78

Appendix II

Analysis of variance for fruit diameter.

Source	df	Sums of squares	Mean squares	F
Block	9	0.274		
Treatment	17	4.61	0.2711	
Error	153	0.866	0.0056	48.41**
Total	179	5.75		

L S D = 0.0655

Appendix III A.

Analysis of variance for seed with of the selected provenances.

Source	df	Sums of squares	Mean squares	F
Treatment	17	1.92	0.1129	
Error	162	1383.41	8.539	0.0132 NS
Total	179	1385.33		

Appendix III B.

Analysis of variance for seed length of the selected provenances.

Source	df	Sums of squares	Mean squares	F
Treatment	17	6.069	0.357	
Error	162	76.541	0.4724	0.7557 NS
Total	179	82.61		

Appendix IV

Analysis of variance for cutting test of selected provenances

Source	df	Sums of squares	Mean squares	F
Block	10	39.11	3.911	
Treatment	17	117.4	6.9	
Error	152	285.49	1.87	3.6**
Total	179	442.00		

L S D = 1.198

Appendix V.

Analysis of variance for germination test of the selected provenances

Germination percent.

Source	df	Sums of squares	Mean squares	F
Treatment	17	19174.4	1127.92	
Error	54	2840.3	52.59	21.44**
Total	71	22015		

L S D = 10.24

Appendix V. (Concld) .

Germination value

Source	df	Sums of squares	Mean squares	F
Treatment	13	39.596	3.045	
Error	42	3.92	0.093	32.74**
Total	55	43.516		

L S D = 0.505

Appendix VI.

Analysis of variance for number of seedlings produce per 100 fruit.

Source	df	Sums of squares	Mean squares	F
Treatment	3	22884.3	7628.1	
Error	68	833.5	12.25	622.7**
Total	71	23717.8		

L S D = 4.9496

Appendix VII.

Analysis of variance Log_e shoot/ Log_e Root ratio (dry weight) of the selected provenances

Source	df	Sums of squares	Mean squares	F
Treatment	17	1.64	0.0964	
Error	162	3.08	0.019	5.0736**
Total	179	4.72		

L S D = 0.1208

Appendix VIII.

Analysis of variance for Relative Height Growth of selected provenances

Source	df	Sums of squares	Mean squares	F
Treatment	12	0.0323	0.0026	
Error	377	0.2243	0.00059	4.40**
Total	389	0.2566		

L S D = 0.0125

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