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A Follow-up Study on Provenance Trial of Teak

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အနယ်နယ်မှကျွန်းမျိုးများ၏ကြီးထွားနှုန်းများကိုနှိုင်းယှဉ်စမ်းသပ်ခြင်းအားဆက်လက်လေ့လာခြင်း

ဝင်းမြင့်
လက်ထောက်ညွှန်ကြားရေးမှူး
သစ်တောသုတေသနဌာန

ရန်မျိုးနိုင်
တောအုပ်ကြီး
သစ်တောသုတေသနဌာန

၁၉၈၆ ခုနှစ်တွင်တည်ထောင်ခဲ့သော အနယ်နယ်မှ ကျွန်းမျိုးများကို နှိုင်းယှဉ်လေ့လာခြင်း စမ်းသပ်ကွက်ကို ၂၀၀၉ ခုနှစ်တွင် ဆက်လက်တိုင်းတာ လေ့လာခဲ့ခြင်းဖြစ်ပါသည်။ စမ်းသပ်ကွက် သည် ပျဉ်းမနားမြို့နယ်၊ တောင်ညိုကြိုးဝိုင်း၊ အကွက်အမှတ် ၅၇ တွင်တည်ရှိပြီး ဒေသ ၁၂ ခုမှ ကျွန်းမျိုး များပါဝင်ပါသည်။ ယခုအကြိမ်လေ့လာမှုတွင် အမြင့်နှင့် ရင်စို့လုံးပတ် များကိုပြန်လည် တိုင်းတာပါသည်။ ဒေသမျိုးဖြစ်သည့် ပျဉ်းမနားမျိုးသည် လေ့လာသည့်ကာလ နှစ်ခုစလုံးတွင် ယှဉ်ပြိုင်ကြီးထွာမှု အကောင်းဆုံးနှင့် တောင်တွင်းကြီးမျိုး သည် အညံ့ဆုံး ဖြစ်သည်ကို တွေ့ရှိရပါသည်။ ပေါင်းတည်မျိုးသည်လည်း ကာလနှစ်ခုစလုံးတွင် ဒုတိယ အကောင်းဆုံး အဖြစ် တွေ့ရှိရပါသည်။ အချို့ဒေသမျိုးများသည် ကာလနှစ်ခုအကြားတွင် နှိုင်းယှဉ်မှုအဆင့်များ ပြောင်းလဲမှုရှိကြောင်းတွေ့ရှိရပါသည်။ ယွင်က အညံ့ဆုံးအုပ်စုတွင်ရှိသော မင်းဒုံးဒေသမျိုးသည် ယခုအကြိမ်တွင် ကြီးထွားနှုန်းပျမ်းမျှအဆင့်အတန်း နီးပါးနေရာသို့ ရောက်ရှိလာပါသည်။ ဤလေ့လာမှုမှ အောင်မြင်သောကျွန်းစိုက်ခင်းများအတွက် ဒေသမျိုးသည် အကောင်းဆုံးဖြစ်ပြီး စိုက်မည့်နေရာနှင့် မျိုးစေ့ရရှိသောနေရာတို့၏ ရာသီဥတုတို့ အနီးစပ်ဆုံး ကိုက်ညီမှုရှိရေးသည် လည်း အရေးကြီးကြောင်းပြသပါသည်။

အဓိကစာလုံးများ။ ။ ကျွန်း၊ အနယ်နယ်၊ ဒေသအမျိုးမျိုး၊ ကြီးထွားနှုန်း

A Follow-up Study on Provenance Trial of Teak

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Abstract

A previous teak provenance trial established in 1986 was reassessed as a follow-up study in 2009. The trial was at compartment 57 of Taungnyo Reserved Forest, Pyinmana and included 12 provenances. In this study, height and girth were reassessed. Results were similar to that of the previous assessment in 1994. Consistency of comparative growth performances between two periods were found for the local provenance from Pyinmana the best whereas Taungdwingyi provenance the poorest. Paungde also consistently showed promising growth next to Pyinmana. A change in ranking positions for some species was observed. Mindon provenance once in the poorest group tends to shift to the average level. Growth performances of some provenances continue to change with time. It is well approved by this study that the local provenance is the best and thus matching climatic condition the provenance, seed source, and planting site is important consideration for a successful teak planting program.

Keywords: Teak, provenances, growth performance

Contents

A Follow-up Study on Provenance Trial of Teak

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1. Introduction

Teak is a well known worldwide and economically sought after tropical timber species for its premier wood quality. Relatively ever increasing demand for teak wood coupled with declination of natural supply through deforestation of teak bearing forests induces investment in teak plantations as a lucrative business. Therefore teak plantations are increasingly being established not only within its natural range, but outside even in tropics of different continents in the world. Myanmar has, in fact, a lengthy experience with establishment of teak plantation for century. Given a plenty of planting stock for a modest scale of teak plantation, seed source or seed supply was not a concern in the past. However, by the coincidence of yearly increasing teak plantation program under the decentralized teak plantation policy, allowing private companies to grow teak, with almost extinction of mother trees and seed source area, to ensure seed supply for teak plantations has become an intense problem in recent years. More importantly, proper matching of seed source or provenance and planting site is essential pre-requisite for a successful teak plantation to produce higher yield with quality timber.

In 1986, the Forest Research Institute (FRI), Forest Department, established a teak provenance trial in plantation from using 12 different provenances, at Compartment (57), Taungnyo Reserved Forest, Pyinmana. Ko Ko Gyi, the former researcher, worked out until 8 years old of the trial and presented a paper to a Teak Symposium in 1995. Ko Ko Gyi made a comment on his trial in need of further investigation till the results are stable as the age of 8 years was still immature for a teak plantation. Therefore, assuming that 15 years is a long enough time span to make a reassessment for the provenance trail and 23 years old age is maturity stage for teak to show stable results, this follow-up study is carried out with second assessment in November 2009. Traits to indicate growth performance only rather than stem quality could be assessed this time.

2. Literature Review

For species with naturally wide geographical of ecological ranges, provenance testing is essential (J. Burley and P.J. Wood 1976). Teak is expected to be numerous provenances because of its wide and discontinuous distribution (Ko Ko Gyi 1972, White 1991).

A good deal of literature on provenance variation of teak had been cited in the first assessment paper for this trial (Ko Ko Gyi 1995). Test on provenance variation of teak in nursery stage was conducted by Ko Ko Gyi (1972) using seeds from Myitkyina, Taungoo, India (Kerala State), Java (Pati) and Laos (Pakse) under various day/night temperatures: 30°/22°C, 30°/31°C, 33°/22°C, 33°/31°C, 36°/22°C and 36°/31°C. He found that Java gave the best germination at 36°/31°C, followed by Taungoo. However, Myitkyina provenance was found to be the best in seedling development followed by Indian provenance.

Ko Ko Gyi, et. al (1984), in a next provenance test of nursery stage using 18 provenances from Myanmar, found that variation among provenances exists, however they were not related to either latitude, rainfall nor temperature, and Pyinmana, Thayet and Pyay provenances have low shoot/root ratio.

Another teak provenance trial which dealt with plantation stage had been in Bago Yomas with 4 trial sites: two in the east of the Yomas and the other two in the west using 10 provenances across the country. The first assessment for up to the age of 5^{th} year (Min Zaw Oo and Kyaw Lwin 2004) and the second assessment for the age of 8^{th} year (Ohn Lwin 2008) were carried out. Min and Lwin stated that although no significant differences in survival and height at 1.5th year, significant differences were found for height and diameter at 5^{th} year only in Phyu site. Ohn Lwin generalized that provenances closed to trail sites generally perform better except in Paungde trial site.

An International Series of Teak Provenance Trials was established at 48 trial sites using 75 provenances (seed sources), Myanmar provenance was not included, during1973-74. For a number of economic traits, the first assessment was carried out on 21 trials during 1981-84 when trials were 8 -10 years old (Keiding et al.1986) and the second assessment on 8 trials was during 1991-94 when 17-19 years old (Kjaer, E.D. et al. 1995). That a series of trials well recognized the clear existence of provenance variations on many traits assessed. However, the first assessment suggested that different seed sources will be superior in different regions. In the second assessment also, it was important to give different recommendation for the different trial regions. In general terms, important variation between provenances within the larger regions were found for many traits (Kjaer, E.D. et al. 1995).

3. Materials and Methods

As this is a follow-up study, the materials and methods are the previous ones which Ko Ko Gyi, the former researcher, established in 1986. In the study, 12 provenances of teak seeds were used. Seedlings of the same size were selected and planted at 8.5 x 8.5 ft spacing. Experimental plot was designed in Randomized Complete Block Design with four replications in the form of blocks. Therefore each block has 12 experimental units representing 12 provenances. In each experiment unit carry 49 (= 7x7) plants. The layout of the experiment design and name of provenances with respective code numbers are as follows.

303	323	322	317	418	414	420	419
301	321	304	314	423	422	404	421
312	320	318	319	401	417	412	403
114	117	120	104	214	203	222	219
119	101	118	123	201	212	223	221
103	121	122	112	218	204	217	220

First number = Code number of the block
The following numbers = Code number of the provenance

Provenances (seed sources):

01 = Myintkyina
03 = Katha
04 = Shwebo
12 = Pyinmana
14 = Taungoo
17 = Belin
18 = Ye
19 = Taungdwingyi
20 = Mindon
21 = Paukkhaung
22 = Thandaung
23 = Paungde

In the first measurements, for height were done in 1987, 1989, 1991 and 1994, and for girth (gbh) were in 1989, 1991 and 1994 by the former researcher.

Cleaning undergrowth and erecting demarcation posts for each provenance according the previous layout design were carried out prior to the make reassessment for this follow-up study. For the second assessment made in November 2009, height and girth (gbh) measurements for each provenance were recorded and data were analyzed using Gen Stat Statistical Soft Wear.

4. Results

4.1 Height Measurement

Height measurements in this study and the previous measurements (Ko Ko Gyi 1995) are provided as in Table 1.

Table 1. Height Measurements (feet)

Code	Provenance	1989* (3 yrs old)	1991* (5 yrs old)	1994* (8yrs old)	2009 (23 yrs old)
1	Myitkyina	7.69	8.3	11.35	51.62
3	Katha	7.09	8.13	11.95	55.27
4	Shwebo	6.76	8.78	11.48	52.11
12	Pyinmana	7.12	10.08	12.98	57.86
14	Taungoo	6.73	8.78	11.75	50.18
17	Belin	6.28	9.1	11.75	54.19
18	Ye	7.97	9.28	12.15	50.52
19	Taungdwingyi	5.46	7.08	9.98	45.44
20	Mindon	4.83	6.98	10.08	52.5
21	Paukkhaung	6.4	8.4	10.98	51.99
22	Thandaung	7.19	9.43	12.6	50.36
23	Paunde	8.03	9.78	12.6	53.05

Source * Ko Ko Gyi (1995)

For the test of hypothesis about mean heights, the F test of the analysis of variance (ANOVA) is conducted and the result is given as in Table 2.

Table 2. Analysis of variance for height measurements

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	Computed F value	Tabular F value 5%	1%
Block	3	871.85	290.62	12.96		
Provenance	11	409.77	37.25	1.66^{ns}	2.09	2.84
Experimental error	33	739.83	22.42			
Total	47	2021.45				

CV = 9.4%, ^{ns} = non significance

According to the ANOVA of the F test, the experiment failed to detect the significant difference among mean heights of provenances at 5% probability. For the evaluation of all possible pairs of means, Duncan' multiple range of test (DMRT) is applied. The result of the test is given in Table 3.

Mean heights are ranked in order of magnitude of the value. Provenances those are designated by the same letter do not differ significantly each other at 5% level significance. There are two large groups which over lap largely. In the first higher group, Pyinmana stands the best followed by Katha and Belin. In the lower second group Taundwingyi is the poorest and significantly different from the highest three provenances. The rest provenances were not significantly different from each other.

Table 3. Comparison of all pairs of mean height in DMRT.

Provenances	Height (ft)	DMRT
Pyinmana	57.86	a
Katha	55.27	a
Belin	54.19	a
Paunde	53.05	ab
Mindon	52.50	ab
Shwebo	52.11	ab
Paukkhaung	51.99	ab
Myitkyina	51.62	ab
Ye	50.53	ab
Thandaung	50.36	ab
Taungoo	50.18	ab
Taungdwingyi	45.44	b

4.2 Girth Measurement

Height measurements in this study and the previous measurements (Ko Ko Gyi 1995) are provided as in Table 4.

Table 4. Girth at Breast Height (GBH) Measurements (inch)

Code	Provenance	1989* (3 yrs old)	1991* (5 yrs old)	1994* (8yrs old)	2009 (23 yrs old)
01	Myitkyina	9.87	13.45	22.58	24.84
02	Katha	9.23	13.32	23.78	26.26
04	Shwebo	9.49	14.02	21.15	26.12
12	Pyinmana	9.62	16.44	30.8	28.25
14	Taungoo	8.5	13.19	22.23	24.57
17	Belin	8.73	14.12	22.88	25.06
18	Ye	10.99	15.55	24.2	24.64
19	Taungdwingyi	7.66	11.23	18.98	23.07
20	Mindon	7.7	11.33	16.85	25.15
21	Paukkhaung	9.73	13.38	21.45	25.97
22	Thandaung	10.02	14.98	25.43	25.52
23	Paunde	11.24	16.01	25.88	26.22

Source * Ko Ko Gyi (1995)

For the test of hypothesis about mean GBH, the F test of the analysis of variance (ANOVA) is conducted and the result is given as in Table 5.

Table 5. Analysis of variance for GBH measurements

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	Computed F value	Tabular F value 5%	1%
Block	3	165.128	55.043	7.70		
Provenance	11	67.036	6.094	0.85 ^{ns}	2.09	2.84
Experimental error	33	235.940	7.150			
Total	47	468.105				

CV = 10.48 %, ^{ns} = non significance

According to the ANOVA of the F test, the experiment failed to detect the significant difference among mean GBHs of provenances at 5% probability. For the evaluation of all possible pairs of means, Duncan' multiple range of test (DMRT) is applied. The result of the test is given in Table 6.

Table 6. Comparison of all pairs of mean GBH provenances.

Provenances	GBH (ft)	DMRT
Pyinmana	28.25	a
Katha	26.26	ab
Paungde	26.22	ab
Shwebo	26.12	ab
Paukkhaung	25.97	ab
Thandaung	25.52	ab
Mindon	25.15	ab
Belin	25.06	ab
Myitkyina	24.84	ab
Ye	24.64	ab
Taungoo	24.57	ab
Taungdwingyi	23.07	b

Mean girths at breast height (GBH) are ranked in order of magnitude of the value. Provenances those are designated by the same letter do not differ significantly each other at 5% level significance. There are also two large groups which over lap largely. In the first higher group, Pyinmana again stands the best followed by Katha and Paungde. In the lower second group Taundwingyi is again the poorest and significantly different from the highest of Pyinmana provenance alone. The rest provenances were not significantly different from each other.

4.3 Volume Measurement

Mean values of volume which is product of girth and height measurements are stated in Table 7. Form factor of 0.524 for volume calculation is conducted using 12 sample trees from the trial plot.

Table 7. Basal areas and volume measurements at 23 years old

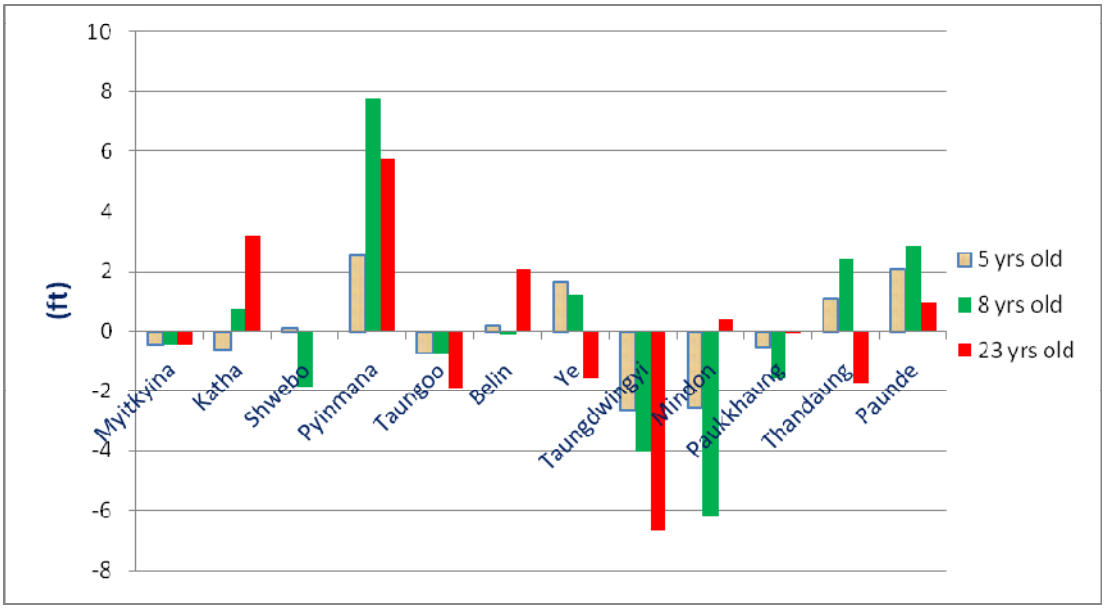
Provenance	Per Tree		Per Acre			MAI	
	BA (ft^2)	Vol (ft^3)	Tree	BA (ft^2)	Vol (ft^3)	(ft^3/ac)	(m^3/ha)
Myitkyina	0.34	9.22	160	56.42	1475.32	64.14	4.49
Katha	0.38	11.04	166	66.45	1833.26	79.71	5.57
Shwebo	0.38	10.29	175	70.59	1804.98	78.48	5.49
Pyinmana	0.44	13.37	181	85.53	2426.42	105.50	7.38
Taungoo	0.33	8.77	209	73.88	1834.87	79.78	5.58
Belin	0.35	9.85	191	70.63	1879.46	81.72	5.72
Ye	0.34	8.88	181	66.07	1612.11	70.09	4.90
Taungdwingyi	0.29	7.00	138	43.12	969.26	42.14	2.95
Mindon	0.35	9.62	166	62.29	1597.23	69.44	4.86
Paukkhaung	0.37	10.15	188	75.53	1904.98	82.83	5.79
Thandaung	0.36	9.50	166	62.02	1577.65	68.59	4.80
Paungde	0.38	10.56	154	62.44	1624.26	70.62	4.94

4.4 Provenance Means above and below Average

In order to have holistic view of mean comparison for three different ages, mean values are subtracted from overall mean to see how much differ and whether (+) or (-) from the respective overall means at each age: 5, 8 and 23 years old. Data for the ages, the 5 th and the 8th years are from Ko Ko Gyi (1995). His earliest measurements done at 1987 (1 year old) and 1989 (3 years old) are left supposing premature and unstable. The result for height measurements appear in Figure 1 and GBH measurements in Figure 2. In the figures, zero grid line refers to the average of all means or overall mean and provenance means are assessed whether they are above or below the average.

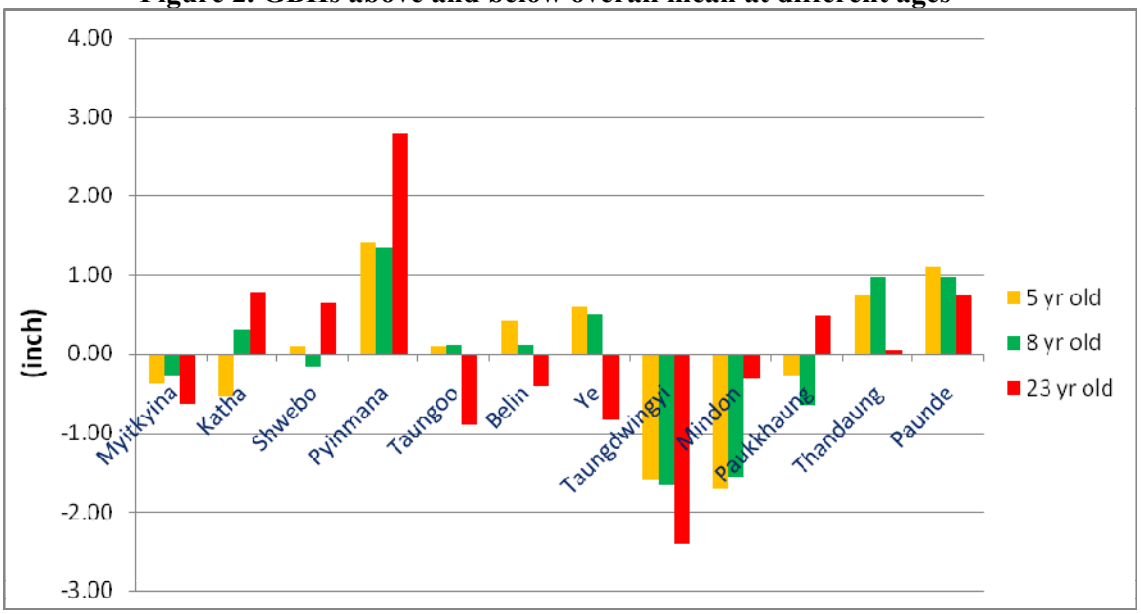
In Figure 1 of height means, Pyinmana provenance has shown clearly the highest for all successive ages since 5 years old. Similarly, Paunde provenance also has shown consistency of good performance above the average since the 5th year. Once amongst the superior group at the 8th, Katha and Belin tend to continue to grow well above average, whereas Thandaung and Ye tend to decline below average in the 23rd. Taugdwingyi has obviously been in the poorest group since the 5th whereas Mindon tends to improve from the poor group to the above average in the 23th.

Figure 1. Heights above and below overall mean at different ages



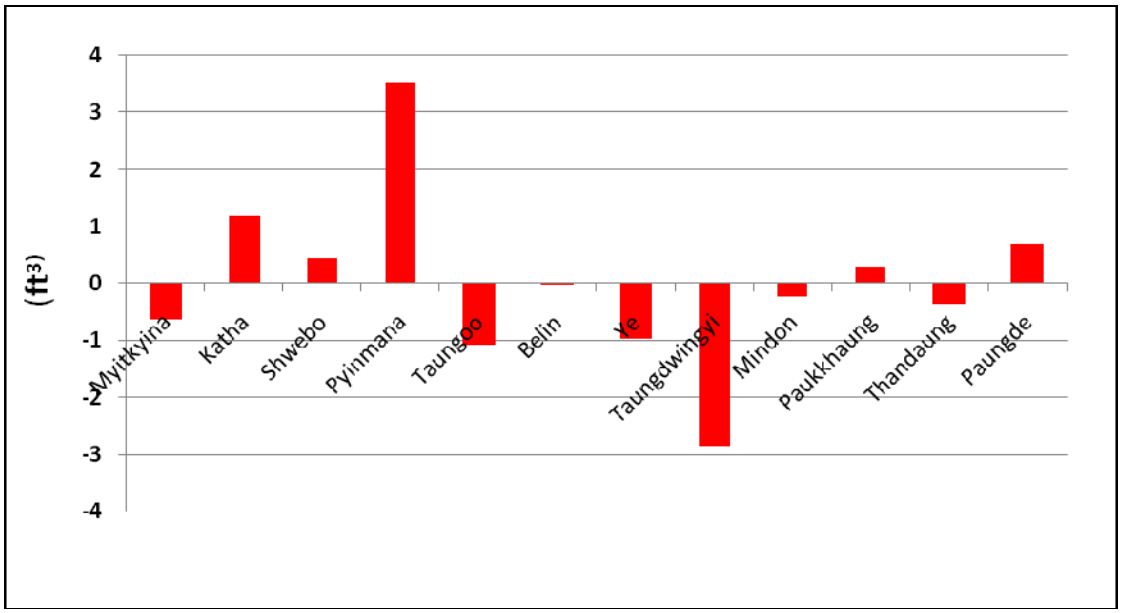
In Figure 2 of GBH means also, Pyinmana and Paunde have consistently shown on the top of the most superior group since the 5th followed by Katha, Shwebo and Paukkhaung though not listed during the 5th and the 8th years. Once amongst the superior group, Thandaung just keep at the average whereas Ye, Belin and Taungoo tend to decline. While Taungdwingyi has remained as the poorest since the 5th, Mindon tends to shift to the average.

Figure 2. GBHs above and below overall mean at different ages



In comparison of mean volumes as in Figure 3, Pyinmana provenance is obviously well above the overall mean. It is followed by Katha and Paunde provenances. Taungdwingyi remains the poorest and followed by Taungoo, Ye, and Myitkyina. Shwebo, Paukkhaung, Belin, Mindon and Thandaung are around the overall mean level.

Figure 3. Mean volumes above and below overall mean at 23 years old



5. Discussion

This follow-up study was conducted at a point of time, 23 years old of the provenance trial. The results from this study are very similar to that of the previous studies conducted on the same trial through a series of measurement up to 8 years old by Ko Ko Gyi (1995). It was a 15 years long span of time between the two studies.

At this time also, it is although statistically failed to detect significance in mean differences, Pyinmana and Taungdwingyi provenances have consistently comparative performances as the best and the poorest respectively. Stability of their respective growth performances on height and girth both over such a long period of 15 years (from 8 to 23 years old) supports to draw a conclusion that Pyinmana, the local provenance, is the best and Taundwingyi, the representative to drier sites, is the poorest. Similarly, Paunde also has shown stable growth performance next to Pyinmana.

It is a noticeable change for Mindon provenance from the poorest group during the past two periods to the average level this time. Further clarification on the seed source of Mindon was whether from definitely dry site or not is needed to support the answer in this point. Some of the rest provenances also show variation by interchanging their ranking positions either in height or girth performance during the period, between 8th and 23rd year

olds. In this context, a noteworthy question "when and how such changes have taken place during relatively long span of 15 years" is remained to be answered. For example, ranking positions of Thandaung and Ye provenances above the average at 8 years old have a tendency to be replaced by Katha in terms of both variables, Shwebo and Paukkhaung in terms of girth and Belin in terms of height at 23 years old. Myitkyina provenance was observed being placed consistently closed to, but never above, the average for all periods in both variables.

Similar comparative growth performances among the provenances are observed in volume variable which is the product of height and GBH. Apart from significant difference between Pyinmana, the local provenance, and Taungdwingyi, the definitely dry site provenance, the other notable observation is that provenances like Paunde, Paukkhaung and Shwebo, those are presumably similar climatic condition to Pyinmana are above the average level, but provenances like Ye, Taungoo, and Myitkyina, receiving much more rainfall than Pyinmana are below the average level. This may suggest that matching of climatic condition between the provenance, seed source, and planting site is important consideration for teak planting program.

In the International Series of Teak Provenance Trials, with regards situations between two assessments: 7-9 years old and 17 years old, while significant mean differences of survival, health, and persistence of axis dominance disappeared, mean differences of stem form and tree size appeared significantly different (Kjaer, E.D. et al. 1995).

In a situation where later assessments are significant while effect of early assessment may or may not be significant, it must be concluded that the increment/decrease has been significantly different for different provenances. The differences reflect a new genetic pattern, because the changes cannot be explained simply by differences already seen at the younger age (Kjaer, E.D. et al. 1995).

Provenance trials require closed and continuous investigation on when mean differences set in and how long it will be stable. Much more provenance trials using potential seed sources in major plantation sites should be carried out for further understanding of teak variation. Studies on stem and timber quality are also needed for teak provenances.

6. Conclusion

This study agrees with the previous conclusion made in 8 years old in the same provenance trial. The local provenance, Pyinmana, is the best and Taugndwingyi, the representative to dry sites is the poorest in growth performance. Paungde provenance is also a promising provenance next to Pyinmana. Among the rest which are around the overall mean levels, Katha followed by Shwebo, and Paukkhaung tend to be suitable in the study site, Moeswe. It is well approved by this study that the local provenance is the best and thus matching climatic condition the provenance, seed source, and planting site is important consideration for a successful teak planting program.

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