Leaflet No. (2)

Government of the Union of Myanmar
Ministry of Forestry
Forest Department
Forest Research Institute

Estimation of Potential Germination Capacity of Teak (*Tectona grandis* Linn.f) Fruits from (10) Provenances by Cutting Test

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May, 2000

ကျွန်းပေါက်ရောက်သော ဒေသ (၁၀)ခုမှ ကျွန်းသီးများ၏ အစေ့ပေါက်စွမ်းအင် ပိုတင်ရှယ်ကို အက်ကွဲခြင်းဖြင့် ခန့်မှန်းလေ့လာခြင်း

ဒေါ်သိန်းကြည်၊ (B.Sc.) (Bot.)။ လက်ထောက်သုတေသနအရာရှိ
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သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်းချုပ်

ကျွန်းသစ်သည် မြန်မာနိုင်ငံ၏ အရေးကြီးဆုံး သစ်မျိုးဖြစ်သည့်အပြင် ကမ္ဘာတွင်လည်း ရေပန်းစားပြီး အရေးကြီးအသုံးဝင်ဆုံး သစ်မျိုးတမျိုးလည်း ဖြစ်ပါသည်။ အရည်အသွေးအကောင်းဆုံး ကျွန်းသစ်များ ထာဝစဉ် ပို၍ပို၍ လိုအပ်လျက်ရှိသည်နှင့်အညီ အစဉ်တိုးခဲ့လျက်ရှိသော ကျွန်းစိုက်ခင်းများ အတွက် အရည်အသွေးကောင်းသော ကျွန်းစေ့များ ရရှိရန်လိုအပ်ပါသည်။ ဤစာတမ်းတွင် ကျွန်းပေါက်သော ဒေသ(၁၀)ခုမှ ကျွန်းသီးများကို စုဆောင်း၍ အစေ့ပါဝင်မှုနှင့် အစေ့မဲ့မှုများ၏ ဆက်နွယ်မှုကို လေ့လာဆွေးနွေး တင်ပြထားပါသည်။ အစေ့မဲ့မှုသည် ဒေသတစ်ခုမှတစ်ခု ကွဲလွဲမှုရှိပြီး အသီးတွင်ပါဝင်သည့် အစေ့ အရေအတွက်မှာ (၁)စေ့မှ (၄)စေ့ ရှိသည်ကို တွေ့ရှိရပါသည်။ အစေ့(၁)စေ့ ပါဝင်သည့် အသီးအရေအတွက်သည် အမြင့်ဆုံးဖြစ်၍ (၂)စေ့ ပါဝင်နှုန်းသည် ဒုတိယအများဆုံး ဖြစ်ပါသည်။ (၃)စေ့ပါဝင်သည့် အရေအတွက်သည် နည်းပါးပြီး (၄)စေ့ ပါဝင်မှုသည် အလွန်ရှားပါးသည်ကို တွေ့ရှိရပါသည်။ ထို့ပြင် ကျွန်းသီးများကို အသီးအရွယ်အစားအလိုက် အကြီး၊ အလတ်၊ အသေးဟူ၍ အတန်းအစား (၃)မျိုးခွဲခြားနိုင်ပြီး ကျွန်းသီးအရွယ်အစားအကြီးဆုံးသည် အောင်လုံမှုရာခိုင်နှုန်း အများဆုံး ရှိသည်ကို တွေ့ ရှိရပါသည်။

Estimation of Potential Germination Capacity of Teak (*Tectona grandis* Linn.f) Fruits from (10) Provenances by Cutting Test

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Abstract

Teak is the most important timber species of Myanmar and one of the most important commercial timber species of the world. With the ever increasing demand of timber of superior quality it needs sound seed with high germinating capacity to be used in the ever increasing planting targets. Teak fruits (seeds) from (10) provenances were collected for the test, and the relative seededness and emptiness were studied and discussed about the potential capacity of germination. Investigations showed that the emptiness of teak fruit varies from one provenance to another, and also that the number of seeds in teak fruits range from 1 to 4. It is also found that frequency of one seeded fruits is the highest, followed by the fruits with two seeds. The frequency of three seeded fruits is still less and four seeded ones very rare. It was observed that teak fruits could generally be graded into group sizes of large, medium and small and that larger fruits have higher viability percentage. Present study was therefore taken up on relative emptiness and seededness varied from provenance to provenance.

Contents

1. Introduction

A member of the family Verbenaceae, Teak (*Tectona grandis* Linn.f.) is a large tropical deciduous forest tree species which is native to South-East Asia. Its natural distribution is in South-East Asia, from the Indian subcontinent through Myanmar and Thailand to Laos, i.e. approximately 75°-103° E longitude. In India its Southern limit is approximately 9°N latitude and in Myanmar it approaches 25½°N (Troup, 1921). Teak plantations in SouthEast Asia have been established both within and outside the natural range. As an exotic it is planted in Bangladesh, Borneo, Cambodia, Malaysia, Pakistan, Philippines, Sri Lanka and Vietnam (Hedegart, 1976). In its natural habitat teak occurs in mixed deciduous forests in a number of different forest type, normally occupying a few percent of the total number of species, but occasionally almost pure stands are found (Keding, 1984).

In Myanmar, the Northern limit of teak is about 25° 30' N latitude. That is some distance outside the tropics which passes through Kachin State. The Southern limit in the Tanintharyi Division is about 10°N latitude, on the East, teak occurs throughout Shan State and extends beyond the frontier into Thailand and Laos. In the Northwest, teak does not extend beyond the western watershed of the Ayeyarwady and Chindwin rivers, while in the Southwest, it occurs on the west bank of the Ayeyarwady which is extending in the foothills of the Rakhine Yomas in decreasing abundance to about 18°N latitude (Ko Ko Gyi, 1991).

Owing to its unique timber qualities, it is extensively used for ship building, furniture, carving and numerous other purposes. The demand for teakwood still remains high. The teak plantation program has been introduced to areas outside its natural range since the 14th to 16th centuries (Altona, 1922). In Myanmar, teak is the major species in planting programs and is responsible for 44.7% of the overall species planted. (Forestry Fact Sheets, 1993). Among the many problems in teak planting programs seed supply is the major problem among other problems like site selection, insect and disease.

Moreover, germination of teak is relatively low (25 - 35)% and time needed to germinate is sporadic (between 10-90 days and extending over several years after sowing) (Bryndum, 1966; Hedegart, 1974; Keiding and Knudsen, 1974). Such germination behaviour of the fruit causes a large variation in both quantity and quality of the seedlings in nursery production.

The fruit of teak (***Tectona grandis* Linn.f.)** is a hard, irregularly rounded droup varying in size and containing 4 seed chambers, which are surrounded from inside by three following layers: 1) a dark brown stoney endocarp, 2) a thick, felty, light brown mesocarp, 3) a thin papery exocarp formed from the persistant calyx. The seeds are oval in shape and measure about 6 mm in length and 4 mm in width. Only rarely have all 4 seed chambers fully developed seeds, the normal number being 1-2. The fruit varies in size from 5-20 mm in cross section, the most common size being between 11 and 17 mm (Keiding, 1985).

Schubert (1974) stated that teak fruit consists of a subglobose, four-lobed, hard bony stone about ½ inch in diameter, surrounded by a thick felty light brown covering, the whole enclosed in an inflated bladderlike papery involucre. The stone contains one to three, rarely four seeds.

The term "teak seed" used in the nursery and plantation practice is botanically known as "teak fruit". According to the International Seed Testing Association (ISTA), "teak seed" is classified as the compound seed structure (ISTA, 1976).

Gupta & Kumar (1976) screened mass collected seeds of 23 sources from 9 states of India and found that relative emptiness and seedness varied from source to source. Emptiness ranged from 13% - 86% and that frequency of one seeded fruits was highest followed by 2-3 seeded and 4 seeded was rare.

Ko Ko Gyi, et.al (1984) also investigated that mass collected seeds of 18 provenances and found that relative emptiness and seedness varied from one provenance to another. The number of empty seeded fruits ranged from 14% - 43% and that frequency of one seeded fruits was highest followed by 2-3 seeded and 4 seeded was rare. In teak the number of sound seeds per fruit can vary between 0 and 4 (Kamra, 1973).

Kaosa-Ard (1986) described the data of variation in the number of seeds per fruit by eight site in Thailand. According to the data, it was also found that the relative emptiness and seedness varied from source to source. Emptiness ranged from 9%-45% and the percentage of one seeded fruits was highest i.e.35%-54%, followed by two seeded fruits (15%-28%), three seeded fruits (3%-8%) and only rarely had four seeded fruit (1%-2%). Moreover, the viability of teak seed varies depending on several factors, such as seed size, seed sources, seed year, the climatic conditions during the flowering and fruit-setting period.

There was a number of studies on the relationship between seed size and viability. The studies indicated that seed viability increases with the increase in seed size (Murthy, 1973;Headgart, 1974; Suangtho,1980; Bhumibhamon et al, 1980; Kaosa-ard, 1981a).

Baldwin (1942) classified direct test of viability into three categories namely: physical, biochemical and physiological. Cutting test is the simplest viability and the most inexpensive test among the physical tests. With certain large, slow-germinating seeds of ***Fagus spp***, ***Abies pectinata*** the cutting test was commonly the only viability test made.

The viability of teak seed is commonly examined by the X-ray and the cutting methods. The X-ray method is widely used in laboratories for research purposes. For practical purpose, the easier and cheaper cutting method is widely used The cutting test indicated a germination capacity of the seed in nursery as high as 75% (Hedegart,1974).

Keiding (1985) also found that the cutting test is useful test for distingushing the non-viable seeds of teak. Seeber and Agpaoa (1976) observed good correlation between cutting and germination tests in fairly large seeded species such as ***Leucaena***, ***Intsia bijuga*** and ***Lagerstroemia speciosa*** seed. They also observed that bisection of ***Aleurites moluccana*** was a rapid test of viability; viable seed had white and firm embryos, whereas dead seed had brown or rotten embryos. Leloup(1955) also reported that cutting test is most useful as a quick method of checking on the value of a lot of seed in the field to estimate the maturity or quality of seed in collecting operations. Large, heavy seeds, such as acorns and chestnuts are best tested by cutting. Moreover, many seeds that exhibit dormancy are commonly tested by cutting test. As indicated by Bonner et.al.(1994) cutting test is the quickest and simplest and can be performed in the field with fresh seeds.

Read(1932) described that hammer test is easier and quicker than a knife for the usual cutting test and can be used on practically all tree seeds. Commenting on Read, Baldwin (1932) says "cutting test is extremely useful in seed extraction operations, in order to determine whether seed should be recleaned to eliminate 'blind' seeds". He concluded that cutting test is usually considered sufficient for ***Abies pectinata***.

Teak exhibits considerable variation in germination in nursery. Since teak fruits are directly sown in nursery, obviously germination depends upon the presence of well developed seeds in the fruits. Present study was therefore to study the seededness in teak fruits obtained from different provenances by cutting test.

2. Materials and Methods

Teak fruits from ten provenances covering four Divisions and three States of Myanmar were obtained from natural forest along with details of their date of collection, number of compartment (or) coupe. The ten provenances taken up for the study consisted of three from Bago Division (viz., Bago, Taungoo and Padaung), one from Mandalay Division (viz., Pyinmana), one from Sagaing Division (viz., Kalay), one from Magway Division (viz., Saw), one from Mon State (viz., Mudon), one from Kachin State (viz., Moenyin) and two from Northern Shan State (viz., Moemeik and Mabein). They were selected using climatological data and their latitudinal distribution as a basis. Details are shown in Figure 2 and 3.

Mass collected teak fruits of ten provenances in Myanmar were used for this study. Teak seeds (fruits) were collected from March to April. Collection from each provenance was done from 25 superior trees selected from natural forest only.

Teak fruits collected from each provenance were thoroughly mixed together to form the homogeneous "composite" samples by handmixing. So the sample on which the test is made has to be representative of the whole.

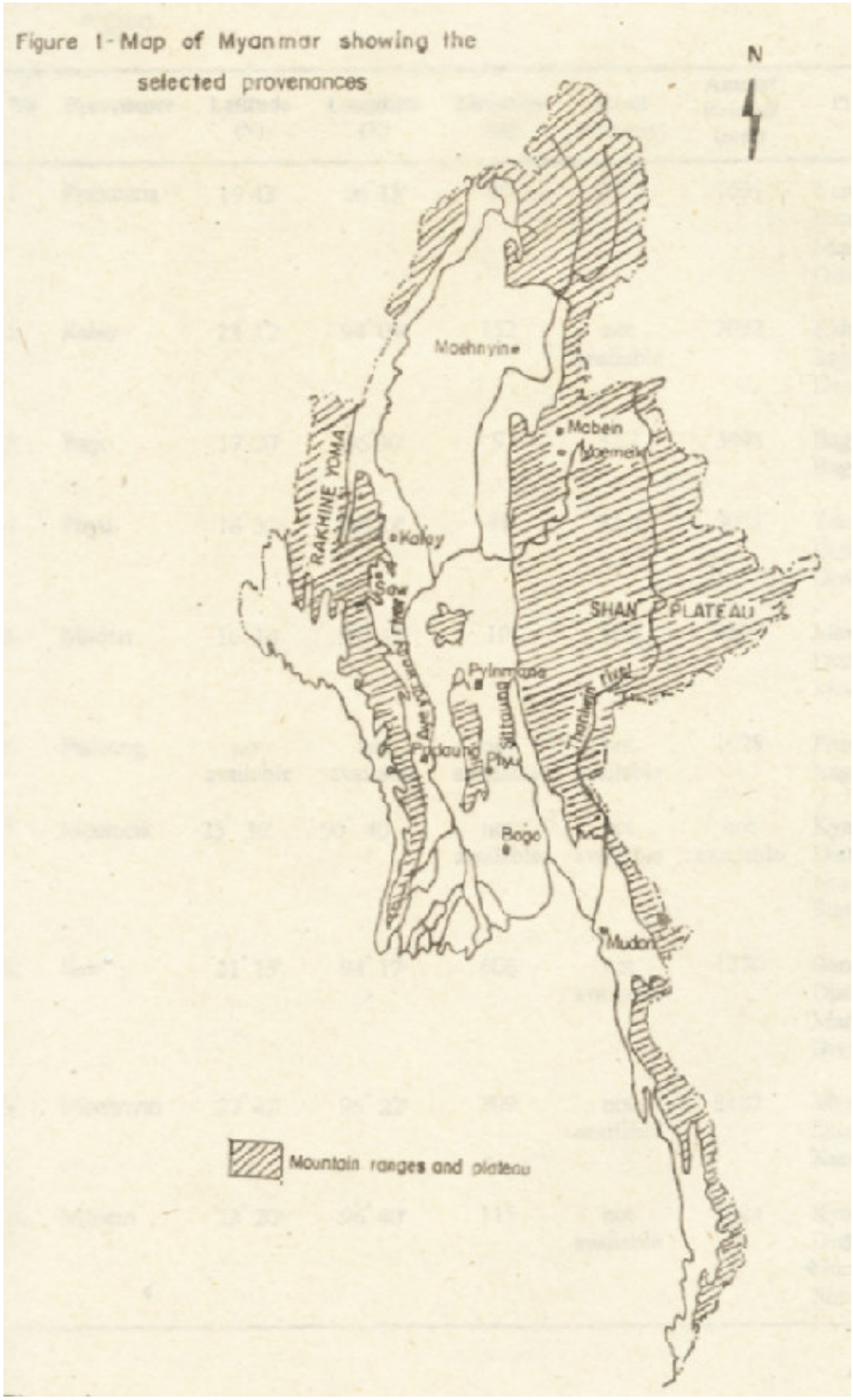

Figure 1- Map of Myanmar showing the selected provenances

Fig 2. Details of provenance collection sites and their allocation to provenance region.

No	Provenance	Latitude (N)	Longitude (E)	Elevation (m)	Mean tempt. (c)	Annual Rainfall (mm)	Provenance Region
1.	Pyinmana	19°43'	96° 13'	95	27. 6	1631	Yemathin District Mandalay Division
2.	Kalay	23° 12'	94° 04'	152	not available	2032	Kalay District Sagaing Division
3.	Bago	17° 20'	96°30'	9	32.3	3448	Bago District Bago Division
4.	Phyu	18° 30'	96°27'	48	32.0	3071	Taungoo District Bago Division
5.	Mudon	16° 14'	97° 43'	10	31.2	4697	Mawlamyaing District Mon State
6.	Padaung	not available	not available	not available	not available	1028	Prome District Bago Division
7.	Moemeik	25° 36'	96° 40'	not available	not available	not available	Kyaukme District Northern Shan State
8.	Saw	21° 15'	94° 17'	606	not available	1270	Gangaw District Magway Division
9.	Moehnyin	27° 47'	96° 22'	209	not available	2187	Myitkyine District Kachin State
10.	Mabein	23° 20'	96° 40'	115	not available	1524	Kyaukme District Northern Shan State

Fig.3. Source of superior trees and date of collection of teak seeds used for the study.

No	Township	Reserved (or) un-classed Forest	Compartment or Coupe	Date of Seed Collection
1.	Pyinmana	Ngaleik Reserved Forest	Compartment (18)	10 - 3 - 1997 to 29 - 3 - 1997
2.	Kalay	Bone Reserved Forest Myitha un-classed Forest	Compartment (69), (70) XIX and XXII	8 - 3 - 1997 to 2 - 4 - 1997
3.	Bago	Southzamari Reserved Forest	Compartment (22), (23)	28 - 3 - 1997 to 29 - 3 - 1997
4.	Phyu	Phyuchaung Reserved Forest	Compartment (31)	4 - 2 - 1997 to 12 - 3 - 1997
5.	Mudon	not available	not available	not available
6.	Padaung	Padaung un-classed Forest	Coupe (122)	22 - 3 - 1997 to 26 - 3 - 1997
7.	Moemeik	not available	not available	not available
8.	Saw	Letpan Reserved Forest Letpan Un-classed Forest	Compt (87)	25 - 3 - 1997 to 30 - 3 - 1997
9.	Moenhyin	Nantpanaung Reserved Forest	Compartment (3)	23 - 3 - 1997
10.	Mabein	Nantpaw Reserved Forest	Compartment (1)	25 - 3 - 1997 to 27 - 3 - 1997

Cutting test

Depending on the quantity of fruits available, representative samples of 200 or 600 fruits were taken from each provenance. A light weight hammer was used for crushing the teak fruits. Teak fruits were placed perpendicular to the hard surface with their apex upward, on a cushion of cloth, to hold them properly in position while hammering. In the beginning 4-6 gentle strokes were essential to crush the fruit. The frequency of stroke depends on the hardness of teak fruit. This often resulted in complete crushing of fruits. Sometime the technique was perfected two gentle strokes without causing any damage to the seeds. The broken fruits were carefully observed for number of seeds in each one of them.

The broken teak fruits were divided into five groups depending on the number of well developed seed present in fruits as follows:

(1) Empty fruits - having no seeds in any of the locules.
(2) One seeded fruits - having a single seed in any one of the locules.
(3) Two seeded fruits - having two seeds in any two of the locules.
(4) Three seeded fruits - having three seeds in any of the three locules.
(5) Four seeded fruits - having seeds in all the four locules.

The locules of teak fruits which had underdeveloped or shrivelled seed were considered as empty. The emptiness and number of seeded fruit is shown in plate 1.

Viability test according to fruit size

Depending on size of teak fruits, samples of 900 fruits from each provenance were graded into 3 groups sizes of large (diameter 14 mm & above), medium (dia. 11mm & 13 mm) and small (dia. 8 mm & 10 mm) respectively. In this experiment, which was replicated thrice, 100 fruits of each size class from each provenance were also divided into five groups by cutting test mentioned above. The 3 group sizes are shown in plate 2.

3. Results and Discussion

The results of the cutting test were as shown in Table 1. The cutting test on teak fruits revealed that four seeded fruits were found only in two provenances viz., Pyinmana 1%, Padaung 1% and that also in the negligible numbers. The absence of four seededness appears to be a general feature in teak fruits. The percentage of three seeded fruits is also quite low. Pyinmana, Phyu and Padaung have given the maximum number of three seeded fruits i.e. 5% and 8% respectively. Two seeded fruits were found higher in number than the three seeded fruits in all the provenances. Percentage of two seeded fruits varied from 3 to 25. In this case also fruits of Pyinmana have exhibited the maximum percentage of 25.

Table 1. Variation in the number of seed per fruit by provenance (Data presenting the percentage value from the cutting test).

Provenance	Percentage Fruits with o-4 seeds					Fruits	
	0	1	2	3	4	Empty	With Seeds
Pyinmana	28	41	25	5	1	28	72
Kalay	31	54	14	1	0	31	69
Bago	21	71	8	0	0	21	79
Phyu	24	50	21	5	0	24	76
Mudon	52	41	6	1	0	52	48
Padaung	31	45	15	8	1	31	69
Moemeik	42	46	11	1	0	42	58
Saw	49	48	3	0	0	49	51
Moenyin	27	50	20	3	0	27	73
Mabein	32	49	16	3	0	32	68
AVERAGE	33	49	14	3	0	33	66

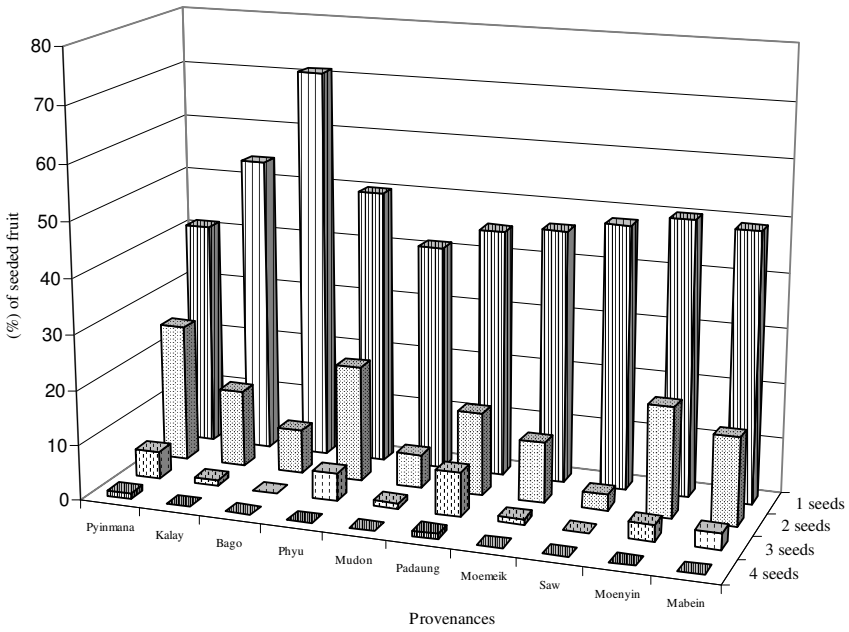

Fig.4. Variation in the number of seed per fruit by provenance

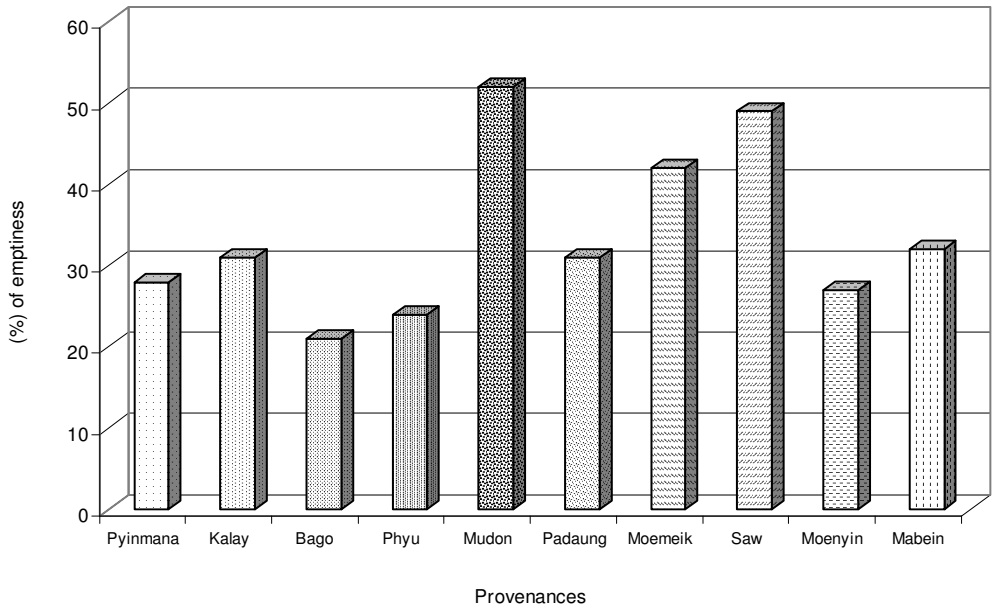

Fig.5. The percentage of emptiness by provenances

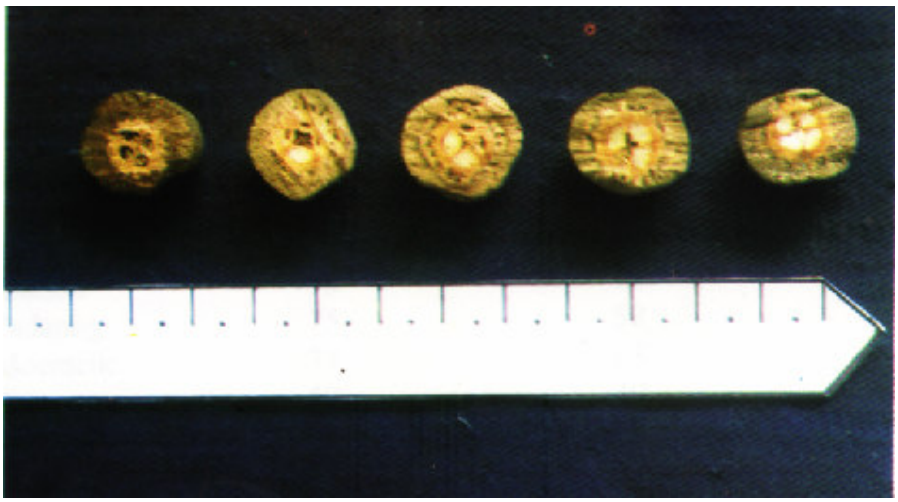

Plate 1. View of emptiness and number of well developed seed present in teak fruit (1 cm scale)

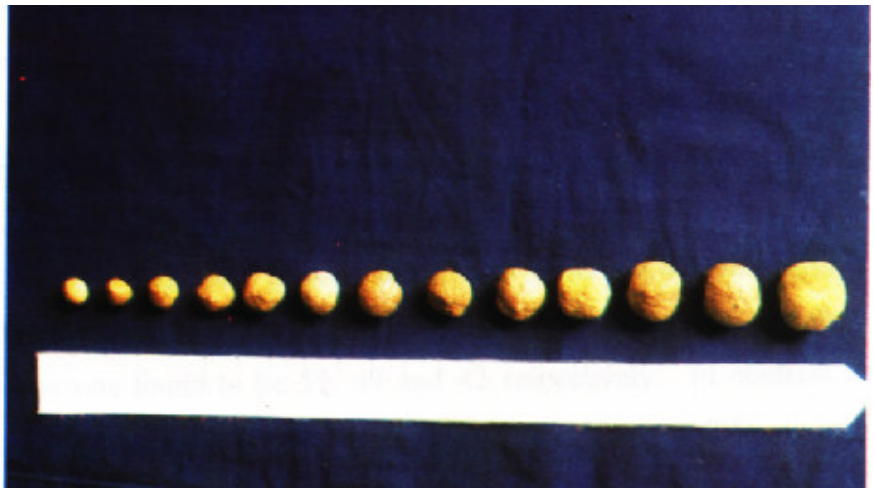

Plate 2. View of 3 groups sizes of small (diameter 8mm – 10mm), medium (dia. 11mm – 13 mm) and large (dia. 14 mm & above) (1cm scale)

Table 2. Percentage viability of Teak fruit graded by size

Sr. No.	Provenance	Large fruit (dia. 14mm & above)	Medium (dia. 11 - 13mm)	Small (dia. 8 - 10mm)
1.	Pyinmana	68	65	40
2.	Kalay	85	43	38
3.	Bago	90	83	50
4.	Phyu	75	68	48
5.	Mudon	53	48	28
6.	Padaung	75	58	40
7.	Moemeik	75	63	23
8.	Saw	57	40	25
9.	Moenyin	95	80	40
10.	Mabein	83	58	33
	Average	**75.6**	**60.6**	**36.5**

The percentage of one seeded fruits was found to be maximum in all the provenances. Highest figure was obtained in Bago, which was 71% followed by Kalay 54%, Phyu and Moenyin 50%. Slightly lower percentage of one seeded fruits was observed in Mabein 49%, Saw 48%, Moemeik 46%, Padaung 45% and, Pyinmana and Mudon 41% respectively.

The result of this study agrees with the study by Ko Ko Gyi, et.al (1984) that the average percentage of one seeded fruit was approximately 50% but more than Apichart Kaosa-Ard (1986) and Gupta & Kumar (1976), i.e. 45% and 35%.

For the emptiness in teak fruits, it is observed that this phenomenon is common to all the provenances. In Mudon, Saw and Moemeik, the percentage of emptiness was found to be 52, 49 and 42 respectively. In contrast, much less emptiness was observed in Bago 21%, Phyu 24%, Moenyin 27%, Pyinmana 28%, Kalay and Padaung 31%, and Mabein 32%. The extent of emptiness varies from provenance to provenance. Emptiness is one of the major causes of failure of germination in teak nurseries.

Dabral (1976) ruled out that the emptiness in the loculi of teak is due to non-fertilisation of ovules. Site has been found to have highly significant effect on emptiness. Gupta and Pattanath (1975) have reported that fertility index of site is reflected in germination capacity of teak seed. They also have described that teak fruits collected from sources deficient in nutrients germinate better if the imbalance is made up by soaking the fruits in sach's nutrient solution. This supports the finding that the site has a correlation with development of the embryo.

In this study, the analysis of the data showed that Bago has minimum emptiness and maximum number of one seeded fruits compared to all other provenances. Pyinmana source which gave 28% empty fruits was found to contain maximum two seeded fruits i.e., 25%.

The experiment, viability test according to size, showed that the larger fruits have higher viability percentage than the smaller one (Table 2). In the case of larger fruits, 75.6% was viable, whereas only 60.6% and 36.5% of the medium and small-sized fruits was viable respectively.

Kaosa-ard (1981a) reported that the average viability of teak seed in diameter classes of 0.9 - 1.0, 1.0 - 1.1, 1.1 - 1.2 cm and larger than 1.2 cm are 41, 53, 62 and 71% respectively.

Viability test indicates the potential germination capacity of a seed lot and, provided this potential is properly utilized by applying the right pretreatment and sowing techniques, also indicate the germination percentage.

There are indications of evidence that seed size and seed viability in a given seed lot are closely related, i.e. bigger seeds have higher viability percentage (Kaosa-ard, 1986). Therefore, by removal of small-seed fractions which consist of a large portion of aborted and insect-damaged seed, the viability percentage of the remaining seed fraction will be largely increased. In practice, the low-viability seed-fraction of a given seed lot can be evaluated by grading and cutting test.

Seed setting is influenced by the prevailing physiological and weather conditions right from the time of floral initiation till maturity of the fruits (Austin, 1972, Schopmeyer, 1974). Investigations carried out at the Teak Improvement Centre (TIC) indicate that teak is primarily an out-crossing species, but self-pollination is possible (Bryndum & Hedegart, 1969; Hedegart, 1973). In general, outcrossing species have a low Pre-emergent Reproductive Success (PRS), often below 30%, whereas inbreeding species have a high PRS, often greater than 90% (Weins et al., 1987). In some species, 1000 or more flowers can be produced for each fruit. In Tectona spp., only 2% and in Pterocarpus spp., 7% of flowers mature (Bawa & Webb, 1984).

Both the ratios of fruit/flower and seed/ovule are affected by predation, weather conditions, and the ability of the maternal parent to provide the necessary resources for development (Stephenson, 1981). The ratio can be affected in similar or different ways and at different times. Factors that adversely affect fruit development also affect ovule development within the fruit. Any loss of ovules can directly or indirectly affect fruit development. The most frequent cause of poor seed or fruit production is the failure to initiate floral structures. Floral initiation is strongly affected by the environment interacting with tree age and bud and shoot development (Owens, et al., 1991).

The very rare occurrence of the pollen tube entry in the embryo sac of teak i.e. only three clear cases out of more than 5000 ovules studied, might be one of the reasons of low percentage of successful fruit formation, compared to the number of flower buds (U Soe Myint, 1993). The major cause of seed abortion was failure of endosperm development which may result from a higher incidence of self-pollination. Low fruit set was the major constraint in teak reproduction. The abortion of fertilised pistils occurred during fruit development and maturation (Palupi & Owens, 1996). The major causes for limited fruit set in teak are insufficient insect pollinators and their effectiveness. Although in open-pollination, 78% of teak flowers are pollinated, there appears to be a high amount of selfing due to the behaviour of pollinators (Suwan T. & Owens, 1996).

Open-pollinated teak flowers receive less than two pollen grains per ovule and approx. 42% receive only zero to three pollen grain per flower, which is less than the number of ovules (four) per flower. Therefore, although 78% of flowers are pollinated the number of pollen grains per ovule may be too low for good seed set (Suwan & Owens, 1997).

4. Conclusion

According to the present study the emptiness in teak is a common feature. Seed is one of the most important inputs for forest nursery production and plantation establishment. The seeds used in nursery production must have good viability and germination potential in order to obtain a large number of seedlings from the seed sown and uniform seedlings, and to reduce the cost of seedling production. Moreover, it is to facilitate nursery operation.

The present study also suggests that for silvicultural purpose, large and medium teak fruits should be preferred so that the efficiency in raising seedlings in the nursery is increased.

Production of large number and uniform seedlings from the seed sown depends on the presence of well developed and good viability of seed in teak fruit. So the quantity of teak fruit to be used in the nursery should be considered keeping in view the emptiness which is phenomenon of teak prevailing in the teak fruits of different provenances.

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