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GENETIC IMPROVEMENT OF TEAK (TECTONA GRANDIS L.f.) IN KERALA

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ABSTRACT

Though teak plantation programme in Kerala commenced in 1841, attempts to genetically improve the planting stock were initiated in 1961 only when a few plus trees were selected. As no further work continued since then, this project was initiated with the objectives of selection of seed stands and plus trees and establishment of pilot seed orchards. Plantations superior in vigour and growth compared to adjoining areas were selected and converted to seed production areas after removal of inferior trees. Fifty trees, outstanding in growth and stem form designated as plus trees have been selected in different teak growing areas in Kerala using check tree method. Bud grafts of the plus trees were prepared using scion from upper one third part of the tree crown. and stock prepared from 1- to 2-year-old teak stumps collected from Forest Department nurseries. Grafts raised in polypots during February-April were outplanted in the orchard site by the onset of monsoon in June. For planting, 8 m quincuncial espacement was adopted, using a poly cross design. Altogether three pilot seed orchards were established at three representative locations. They were Nilambur in the Northern, Palappilly in the Central and Arippa in the Southern Forest Circles of Kerala. Fifteen, twenty and twentyfive clones are represented in these orchards respectively. Having begun the basic work in the genetic improvement programme, future scheme of work is also suggested.

INTRODUCTION

Teak is one of the most widely planted tropical hardwoods. In view of its importance, attempts to raise teak plantation in Kerala were started in 1841. But no scientific strategy for its genetic improvement was evolved till recently. Sofar the criteria for selection of seeds were their capacity to germinate and availability. Matthews (1961) in his report to Government of India, on a programme of Genetics and Tree Breeding Research, emphasised that top priority should be given to genetic improvement of teak. Accordingly a programme of genetic improvement was outlined (Kedharnath and Matthews, 1962). Grafting technique for vegetative propagation was standardized and an experimental clonal seed orchard established subsequently at Dehra Dun (Kedharnath and Venkatesh, 1963). Later, as part of genetic improvement work, states like Andhra Pradesh, Gujarat, Madhya Pradesh, Tamil Nadu and Uttar Pradcsh have also established seed orchards.

The important improvement objectives in teak are generally same as for other timbers. The aim is to improve growth rate and tree form so that higher volumes, larger length of clear bole and straight grained timber are available in short rotation. Lesser degrade of timber due to branch knots. flutes, buttress, spiral grain and blisters was also aimed at. Resistance to defoliator and skeletoniser insect attack is also desired. Concurrent improvement in the aforementioned several features cumulatively contribute to increased productivity of forest land and improved quality of timber for market.

Kerala is one of the prime teak growing states in India. Attempts to improve planting stock genetically were made as early as 1961 when Kedharnath and Mathews did the first selection of plus trees of teak. However, no further work was done in the state to utilize these plus trees for the establishment of clonal seed orchards. This project was undertaken with the objectives of (i) selection of good stands and their conversion into seed production areas, (ii) selection of plus trees and (iii) establishment of clonal seed orchards.

LITERATURE REVIEW

The knowledge, that the characters of trees are not simply the consolidation of environmental pressures, but also the expression of their genetic constitution, has given way to scientific improvement of trees like in other crops and animals, based on genetic principles. Work on genetical improvement of trees dates back to 19th century. Later, attempts have been made in almost all the tree crops in the western hemisphere and substantial number of tree species in the eastern hemisphere. Among the tropical trees, teak is one of the species on which much genetic improvement work is being done in India and elsewhere. Laurie (1932) emphasised the necessity for ascertaining the good origin of seeds, for raising tree plantation. Sen Gupta (1939) reported the superiority of seeds of local origin to those from elsewhere in the region of the natural range of teak. He pointed out that Nilambur origin grows well in relatively very dry zones compared to others tested. Kadambi (1945) also found that seeds of Nilambur origin were better suited for dry zones of Mysore like Shimoga. Egenti (1977) reported variation in vigour and form between provenances. According to him provenances from India and elsewhere showed clear differences in branching habit and foliage. Trials conducted by Delaunay (1977) and Jacques (1977) brought out some very interesting differences between groups of origin. The West African type was found inferior in bole length as compared to that of India. Ferguson (1938) reported that in teak, factors controlling stem form and branching are constant for individual tree. He pointed out that the only way to improve the quality of the stem is by using seeds from selected trees. Studies conducted by Egenti (1977) have shown that there is variation in growth rate and form in teak. It was shown to be hereditary too. Kedharnath ***et al.*** (1969) have also reported that various tree characters are heritable and that considerable genetic gain can be achieved by selection. Keiding (1966) suggested selection of seed production areas as an interim source for seed collection until seed orchards are sufficiently productive. Selection of seed stands which are superior compared to nearby stands, marking and removing all the undesirable trees and retaining only good trees, has been suggested as the procedure for seed production area formation.

As reported by various authors, selection of plus trees and its regeneration by grafting in seed orchard is considered to be the ideal methodology for the first phase of tree improvement programme (Kedharnath and Matthews, 1962). Jones (1969) described the typical defects in the form of trees to be avoided during selection of

plus trees. The characters like vigour, height, girth, fibril angle, fluting. buttressing, etc. were all reported to be heritable.

The technique of grafting as a method of vegetative propagation is known for centuries, Ferguson (1938) mentioned vegetative propagation by grafting as a possible method for raising plants for establishment of teak seed orchards. This technique has been standardised in teak by Kedharnath and Venkatesh (1963) and Rawat and Kedharnath (1968).

The effect of inbreeding due to predominent selfing has been reported by various authors. Teak, though it is mostly crossbred, is self-compatible (Hedegart, 1976). To avoid enhanced inbreeding in the adjacent trees of the same clone, a layout with randomised design of planting, where two ramets of the same clone are not placed side by side has been suggested. Hedegart ***et al***. (1975) has reported a spacing of 12 x 12 x 12m between grafts as suitable for teak seed orchards. Whereas Nanda (1962) has suggested quincuncial design of 8 m as sufficient for seed production. No reports are yet available as to how far teak pollen can be carried naturally for pollination (Hedegart *et al*. 1975). Since, unlike confiers, it is an insect pollinated species (Hedegart, 1979), a radial isolation distance of 200 m is considered to be enough *to* prevent contamination of orchard from extraneous pollen.

According to Venkatesh (1980), though a teak inflorescence develops 5000- 10000 flowers, hardly 40- 100 fruits attain maturity. Abscission rate of opened flowers and developing fruits is very high. This failure may be. partly due to lack of cross pollination (Hedegart, 1976).

Very little information is available on the productivity of teak seed orchard. One teak seed orchard in Thailand reportedly came into production five years after planting. About 28 percent of ramets flowered at this age and 46.4 kg fruits were collected per hectare. Highest yielding ramets produced upto 3 kg fruits each (Hedegart *et al.,* 1975). Based on this evidence a conservative estimate of seed production in a fully developed orchard is 200 kg/ha. According to Sowani (pers. communication) the teak seed orchard established in Maharastra about 10 years ago with intensive management is now giving average yields of about 800 g seeds per ramet, which works out to about160-180 kg/ha. At Dehra Dun 15-year-old grafts are yielding as much as 5 kg seeds each.

MATERIALS AND METHODS

Various teak seed stands and plus trees selected and used in this project work belongto the plantations raised in the main teak growing forest divisions of Kerala. The materials used for raising grafts and establishing clonal seed orchard were from the plus trees selected using check tree method. The stock for grafting was obtained from Forest Department teak nurseries.

The selection of plus trees was restricted to plantations only as it is easier to assess the superiority of trees in an even-aged plantation compared to natural stand. For this purpose important teak growing forest divisions of the State, such as Wynad, Nilambur, Nemmara, Malayattoor, Konni, Kottayam and Thenmala were surveyed.

1. **Seed stand selection**

Various teak stands proposed for conversion to teak seed production areas were inspected and its suitability assessed. From the selected stands inferior trees with poor growth, bole form etc. were marked and removed. This work was mainly carried out by the Kerala Forest Department. However, expertise was provided in selection and maintenance of the stands.

2. Plus tree selection

Teak plantations in the various forest divisions were surveyed and outstanding trees having desirable characters without any defect were marked. The characters evaluated for selection of plus trees were as follows,

i. Superiority in height and girth at breast height (gbh),
ii. Straightness and length of clear bole,
iii. Absence of bumps, flutes, epicormic shoots, buttresses, twisting etc.
iv. Narrow compact crown with light branches and
v. Moderate seed production.

On the first cruise, trees which were seen as outstanding with regard to the features referred above were marked with yellow band around the trunk at breast height. Measurements of height, gbh, length of clear bole, etc. were noted These trees were then considered as plus tree candidates. The superiority of these trees over the adjoining five trees within a radius of 25-50 m designated as trees of comparison was assessed. From the candidate trees the best were selected as plus

trees and given two yellow bands in the trunk at breast height. The five trees of comparison were also marked. The details of the plus tree and the trees of comparison including approximate location-map and photograph of the plus tree were recorded in the plus tree register (Appendix 1).

3. Establishment of Seed Orchard

The seed orchards were established using grafts of selected plus trees.

Grafting

i. ***Collection of scion-wood***

Scion wood for grafting was collected during the month of February-April from the selected plus trees. Small branches bearing suitable bud from the upper one third of the tree crown were collected. Bud-wood cuttings, 10-30 cm in length were prepared from these branches. These were bundled together, wrapped in polythene bags and transported to the grafting sites. The cuttings remained viable for 2-3 days.

ii. ***Preparation of stock for grafting***

One or two year old teak stumps about 15 to 25 mm in diameter at the collar region were used as stock for grafting. Such seedlings were collected from the nursery and stumps 15-20 cm long were prepared out of it.

iii. ***Grafting technique***

Though two types of grafting such as cleft grafting and bud grafting have been experimented in teak the latter was preferred due to the following reasons:

a) It ensures greater economy of bud-wood material. Depending upon the number of good buds on the bud-wood, it is possible to make 3-5 grafts from a single bud-wood instead of only one as in cleft grafting.

b) it is easier and quicker than cleft grafting.

c) it suits for grafting on naked stumps.

Budding was done in the collar region of the stump. A rectangular patch of the outerbark hearing the bud was removed from scion-wood, An equal sized bark was removed from the collar region of the stump, and bark with the bud from the scion-wood was fixed there and tied with polythene tape. The upper cut-end of the stump was covered with wax. Grafted stumps were then labelled and planted in polythene containers (25x15 cm) filled with sieved soil. The containers were kept under shade or a thatch. Watering was done twice daily. Unwanted sprouts arising directly from the stump, other than the affixed bud, were [removed. Successful grafts sprouted in 10-20 days giving out first pair of leaves. Established buldlings were kept in the nursery throughout the summer (Fig. 1).

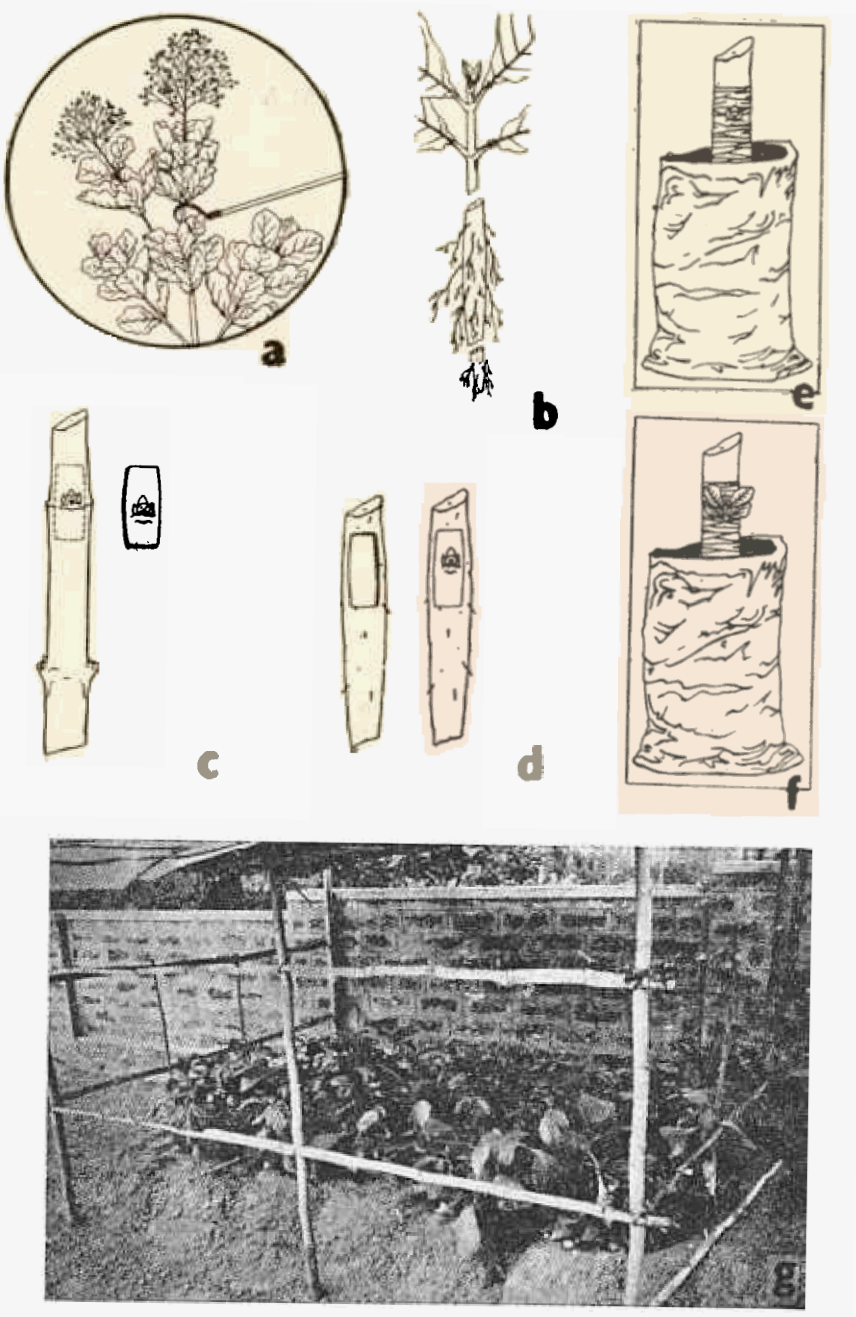

Fig. Grafting technique (a) collection of scion-wood; (b) preparation of stump; (c) removal of bud from scion-wood; (d) affixing bud on stump at collar region; (e) bud tied with polythene tape and stump planted in polypot filled with soil; (f) bud sprouting; (g) sprouted budlings under thatch.

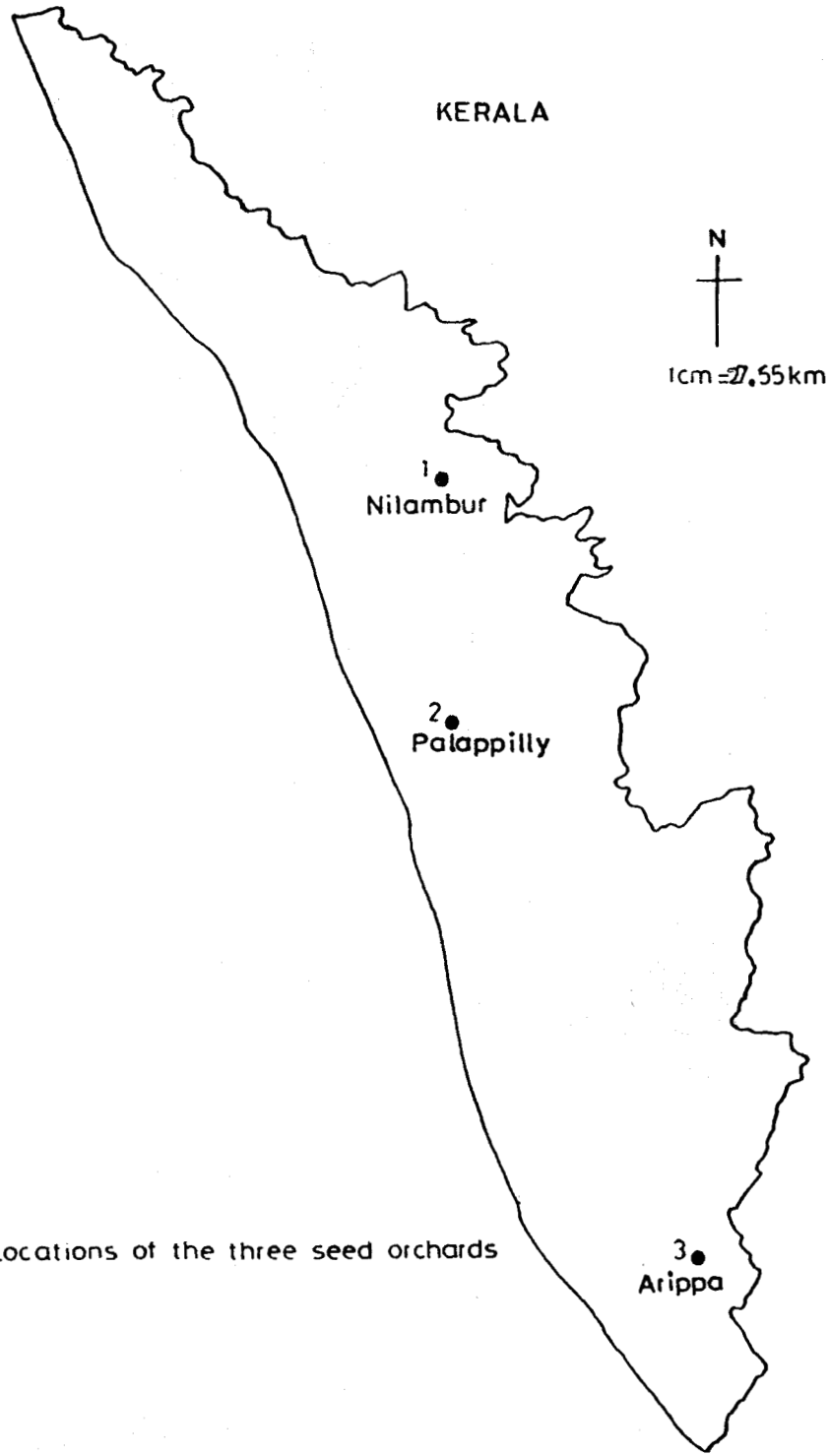

Fig 2. Locations of the three seed orchards

Planting of grafts in the orchard site

With the onset of monsoon showers the grafts were transferred to the orchard site and planted in previously prepared pits of size 50x50x50cm.

Location of orchards

Three representative site were located in Southern, Central and Northern Forest Circles of Kerala (Fig. 2).

Lay out design

The grafted ramets were planted in the orchard site in a randomized polycross design. This is to ensure maximum degree of intercrossing among the assembled plus tree clones and reduce inbreeding between ramets belonging to the same clone.

Spacing

In all the orchards an espacement of 8 x 8 m (quincuncial) was adopted. Such wider espacement is meant to ensure open sun-light condition which is essential for good flowering and seed production.

Isolation

All the three orchards are isolated by more than 200 meters from the nearest teak stands.

RESULTS AND DISCUSSION

Seed production areas

About 750 ha. of teak stands were selected and converted to seed production areas (Table **1).** Until the seed orchards are able to provide sufficient seeds for the plantation in the State and elsewhere, these seed production areas are likely to meet part of the seed requirement.

Plus tree selection

Wynad, Nilambur, Konni and Thenmala Divisions were surveyed for plus trees and altogether 50 plus trees selected (Table **2,** Fig. 3). Details of plus trees and the trees of comparison, register number, total height, height of clear bole, and gbh are given in Table 3. The selection differential of the above characters are also included.

Plus tree register

Appendix I shows the facsimile of the plus tree register being compiled, incorporating details of plus trees and trees of comparison.

Seed orchard establishment

Observation during the present work indicated that in Kerala, flushing phenology of teak trees varied from one locality to another. In fact plus trees located in the same stand varied by as much as a month

Fig. 3. A teak plus tree

in this character. Some plus trees flushed as early as February while some other flushed in March-April. Such variation necessitated two or sometimes three visits to the same area during a single season for collecting scion wood in appropriate stage from all the local plus trees. This difficulty can be obviated when all the plus trees have been assembled in a clone bank.

Table. 1. List of teak seed stands selected in Kerala (till 1983)

Sl. No.	Year of planting	Area in ha	Locality	Year of formation
			Wynad	
1.	1953	20	Begur Range	1979
2.	1954	20	Begur Range	1980
3.	1955	26	Begur Range	1980
4.	1956	30	Begur Range	1980
5.	1917, 1921 and 1939	25	Begur Range	1980
6.	1930	24.20	Begur Range	1981
7.	1932	24.48	Begur Range	1981
8.	1933	21.20	Begur Range	1981
9.	1934	9.1 2	Begur Range	1982
10.	1936	30.50	Begur Range	1982
11.	1937	23.70	Begur Range	1982
			Nilambur	
1.	1936	14.02	Edacode South	1981
2.	1935	11.71	Aravallicavu	1981
3.	1930	9.43	Nellicutha	1981
4.	1932	16.76	Panayangode	1982
5.	1942	12.64	Walluvasseri	1982
6.	1943	17.29	Walluvasseri	1982
7.	1933	25.00	Panay de	1983
8.	1937	10 00	Panayankode	1983
			Nenmara	
1.	1925	67.60	Sungam	1979
2.	1943	27.00	Sungam	1978
3.	1924	80.20	Sungam	1980
4.	1945	5000	Sungam	1982
5.	1946/ 47	75.00	Sungam	1982
			Peermedu	
1.	1954/55	50.00	Kalaketty (Erumeli Range)	1982
			Konni	
1.	1950	25.09	Naduvathumuzhy	1982
2.	1959	4.24	Kakkathode	1982
		Total 750.18 ha		

Table 2. Number of plus trees selected in different forest divisions

No.	Division	Number of trees selected
1.	Wynad	3
2.	Nilambur	15
3.	Konni	10
4.	Thenmala	22
	Total	50

Grafting

In Kerala, unlike in some other parts of the country, a long continuous grafting season is available from January to June. However, a period from February - April was found to be the best because budding established at this time grow to the right size by transplanting time. If stumps are grafted early in January they become over grown and their roots tend to break out of the container and penetrate the soil. In the case of late grafting in May, stumps are too small at the time of outplanting which may be affecting their establishment due to competition from weeds.

Planting ofgrafts in orchard site

Three pilot seed orchards were established at Nilambur, Palappilly and Arippa (Fig. 2) Table 4 shows details of the three orchards. These three experimental seed orchards established are not intended to meet the whole seed requirement of the State. With the material from these orchards commercial orchards of greater extend could be established later.

1) Teak seed orchard, Nilambur

This orchard was established in two phases. An area of 1. 25 ha was planted in 1979 with 15 clones of Nilambur origin (Fig. 4). Later, in 1980 it was extended by planting another 1. 25 ha with 15 clones, 13 clones from Nilambur and two clones from Konni. The list of plus trees incorporated is shown in Table 5. Appendix 2 gives the lay out of the orchard.

2) Teak seed orchard, Palappilly

This orchard was established in 1981. A total of 20 clones, eight from Nilambur, three from Konni and nine from Arienkavu (Thenmala) were included. Table 6 gives the list of clones in corporated in the orchard. Appendix 3 shows the lay out of the orchard.

Table 3. Teak plus trees selected in Kerala, their growth measurements and selection differential in %

Sl. No.	Tree No.	Locality	Height (m)			Clear bole (m)			Girth (bh) (cm)		
			PT	TC	SD	PT	TC	SD	PT	TC	SD
1	T 1	Nilambur	35.00	32.20	8.69	19.00	16.20	17.28	235.00	206·80	13.6
2	T 2	Nilambur	40.00	38.80	3.09	22.00	17.60	25.00	236.00	185.00	27.4
3	T 3	Nilambur	37.00	32.40	14.19	22.00	17.00	29.40	218.00	189.20	15.2
4	T 4	Nilambur	36.00	35.40	1.69	24.00	18.60	29.03	165.00	166.20	0.7
5	T 5	Nilambur	38.00	35.40	7.34	28.00	16.20	72.83	240.00	220.80	8.6
6	T 6	Nilambur	43.00	36.00	19.44	26.00	21.00	23.80	282.00	234.25	20 0
7	T 7	Nilambur	33.00	27.60	19.56	20.00	14.80	35.13	180.00	138.60	29.8
8	T 8	Nilambur	36.00	33.80	6.50	23.00	19.60	17.34	187.00	154.40	21.1
9	T 9	Nilambur	38.00	31.80	19.49	26.00	18.80	38 29	180 00	133.40	34.9
10	T 10	Nilambur	40.00	32.20	24.22	23.00	18.80	22.34	192.00	146.60	30.9
11	T 11	Nilambur	32.00	28.60	11.88	18.00	14.40	25.00	152.00	115.20	31.9
12	T 12	Nilambur	41.00	37.80	8.46	23.00	16.80	36 00	216.00	192.00	12.5
13	T 13	Nilambur	36.00	31.20	15.38	21.00	15.40	36.36	161.00	127.20	26.5
14	T 14	Konni	32.00	27.40	16.78	20.00	14.40	38.88	146.00	148.80	1.8
15	T 15	Konni	31.00	29.60	4.72	19.00	15 00	26.66	132.00	128.60	2.6
16	T 16	Konni	31.00	29.60	4.72	23.00	15.00	53.33	137.00	128.60	6.5
17	T 17	Konni	33.00	31.20	5.76	24.00	16.20	48.14	140 00	134 00	4.4
18	T 18	Konni	39.00	34.40	13.37	21.00	19.00	10.52	196.00	149.60	31.0
19	T 19	Konni	35.00	34.40	1.74	23.00	19 00	21.05	152.00	149.60	1.6
20	T 20	Konni	34.00	27.40	24.08	24.00	11.60	106.89	134.00	100 60	33.2
21	T 21	Konni	36.00	29.80	20.80	22.00	17.80	23.59	132 00	106.20	24.2
22	T 22	Wynad	32.00	27.00	18.51	22.00	14.20	54.92	173.00	140.60	23.0
23	T 23	Konni	35.00	26.60	31.57	22.00	14.60	50.68	139 00	89.60	55.1
24	T 24	Nilambur	37.00	34.20	19.88	24.00	16.00	50.00	191·00	134.20	42.3

Table 3. Contd.

1	2	3	4	5	6	7	8	9	10	11	12
25	T 25	Nilambur	45.00	37.20	20.96	26.00	19.20	35.41	230.00	195.40	17.7
26	T 26	Arienkavu	37.00	29.80	24.16	19.00	16.20	17.28	199.00	197.00	1.0
27	T 27	Arienkavu	34.00	33.80	0.59	22.00	20.80	5.76	201.00	201.40	0.1
28	T 28	Arienkavu	34.00	33.80	0.59	17.00	15.66	8.56	195.00	201.40	3.1
29	T 29	Arienkavu	33.00	27.40	20.43	20.00	17.60	13.63	138.00	116.80	18.1
30	T 30	Arienkavu	34.00	28.80	18.05	22.00	16.40	34.14	174.00	150.40	15.6
31	T 31	Arienkavu	32.00	31.80	0.62	20.00	18.20	9.89	170.00	139.20	22.1
32	T 32	Arienkavu	32.00	29.60	8.10	23.00	16.60	38.55	172.00	145.20	18.4
33	T 33	Arienkavu	34.00	32.40	4·93	23.00	16.20	41.97	182.00	162.00	12.3
34	T 34	Arienkavu	33 00	32.40	1.85	21.08	16.20	29.62	165.00	162.00	1.8
35	T 35	Arienkavu	36.00	30.60	17.64	25.00	17.00	47.05	169.00	140.20	20.7
36	T 36	Arienkavu	32.00	31.20	2.56	17.00	17.00	0.00	165.00	160.60	3.1
37	T 37	Arienkavu	39.00	31.20	25.00	19.00	17.00	11.76	229.00	160.60	42.5
38	T 38	Arienkavu	35 00	32.00	9.37	22.00	17.60	25.00	178.00	142.80	24.6
39	T 39	Arienkavu	35.00	32.40	8.02	17.00	16.60	2.40	203.00	158.20	28.3
40	T 40	Arienkavu	34.00	32.80	3.65	18.00	16.60	8.43	151.00	141.60	6.6
41	T 41	Arienkavu	39.00	36.60	6.55	21 00	15 60	34.61	176.00	137.80	27.7
42	T 42	Arienkavu	44.00	32.20	36.64	24.00	14.80	62.16	217.00	139.80	55.2
43	T 43	Konni	34.00	32.00	6.25	18.00	16.80	7.14	144.00	137.49	1.8
44	T 44	Arienkavu	36.00	31.00	16.12	25.00	16.80	48.80	183.00	146.40	25.0
45	T 45	Arienkavu	30.00	28.40	5.63	21.00	16.80	25.00	152.00	131.40	15.6
46	T 46	Arienkavu	40.00	33.00	21.21	21.00	17.60	19.31	243.00	166.60	45.8
47	T 47	Arienkavu	32.00	31.20	2.56	18.00	17.00	5.88	184.00	160.60	14.5
48	T 48	Arienkavu	34.00	32.80	3.04	19.00	16.60	14.45	166.00	141.60	17.2
49	T 49	Wynad (Begur)	28.00	22.80	22.80	17.00	10.60	60.37	183.00	142.40	28.5
50	T 50	Wynad (,,)	29.00	26.60	9.02	19.0[0]	12.60	50.79	174.00	166.60	4.3

PT Plus tree * TC Trees on comparison * SD Selection differential

Fig. 4. Teak seed orchard, Nilambur (2-year-old)

Table 4. Location. year of planting, area, spacing and number of clones in-the orchards

SI No.	Location		Month and year of planting	Area (ha)	Spacing (m)	No. of clones
1	Nilambur Division Nilambur Range KFRI Subcentre campus	i. ii.	June 1979 June	1. 25 1. 25	8x8 quincuncial 8x8 quin.	15
2	Chalakudy Division Palappilly Range, Varandarappilly		June 1981	1. 80	8x8 quin.	20
3	Trivandrum Division Kulathupuzha Range Arippa		July 1981	1. 80	8x8 quin.	25

Table 5. List of teak clones planted in the Nilambur orchard

SI. No.	Clone No.	Location
i. 1979 planting		
1	T I	Nilambur
2	T 2	Nilambur
3	T 3	Nilambur
4	T 4	Nilambur
5	T 5	Nilambur
6	T 6	Nilambur
7	T 7	Nilambur
8	T 8	Nilambur
9	T 9	Nilambur
10	T 10	Nilambur
11	T 11	Nilambur
12	T 12	Nilambur
13	T 13	Nilambur
14	T 24	Nilambur
15	T 25	Nilambur
ii. 1980 planting		
1	T I	Nilambur
2	T 2	Nilambur
3	T 3	Nilambur
4	T 4	Nilambur
5	T 5	Nilambur
6	T 6	Nilambur
7	T 7	Nilambur
8	T 8	Nilambur
9	T 9	Nilambur
10	T 10	Nilambur
11	T 11	Nilambur
12	T 12	Nilambur
13	T 13	Nilambur
14	T 23	Konni
15	T 21	Konni

Table 6. List of teak clones planted in the Palappilly orchard

Sl. No.	Clone No.	Location
1	T I	Nilambur
2	T 3	Nilambur
3	T 4	Nilambur
4	T 7	Nilambur
5	T 10	Nilambur
6	T 11	Nilambur
7	T 12	Nilambur
8	T 13	Nilambur
9	T 18	Konni
10	T 20	Konni
11	T 21	Konni
12	T 26	Arienkavu
13	T 27	Arienkavu
14	T 28	Arienkavu
15	31	Arienkavu
16	T 33	Arienkavu
17	T 34	Arienkavu
18	T 39	Arienkavu
19	T 41	Arienkavu
20	T 42	Arienkavu

3) Teak seed orchard, Arippa

This orchard, also planted up in 1981 is represented with 25 clones. Of these 11 are from Nilambur, four from Konni and ten from Arienkavu (Thenmala). A list of plus trees assembled in the Arippa orchard is given in Table 7. Appendix 4 shows the lay out of the orchard

Comparative superiority of the orchards

Mean comparative superiority of the parent trees over the trees of comparison in the different orchards is given in Table 8. Though marked superiority was seen in all the characters noted, it was maximum in the case of log volume and clear bole length.

Table 7. List of teak clones planted in the Arippa orchard

Sl. No.	Clone No.	Location
1	T I	Nilambur
2	T 3	Nilambur
3	T 4	Nilambur
4	T 6	Nilambur
5	T 7	Nilambur
6	T 8	Nilambur
7	T 9	Nilambur
8	T 10	Nilambur
9	T 11	Nilambur
10	T 12	Nilambur
11	T 13	Nilambur
12	T 17	Nilambur
13	T 18	Konni
14	T 20	Konni
15	T 21	Konni
16	T 26	Arienkavu
17	T 27	Arienkavu
18	T 28	Arienkavu
19	T 29	Arienkavu
20	T 31	Arienkavu
21	T 32	Arienkavu
22	T 33	Arienkavu
23	T 34	Arienkavu
24	T 35	Arienkavu
25	T 39	Arienkavu

Table 8. Mean comparative superiority (in-%) of the parent trees represented in different orchards

Growth parameters	Location of orchards			
	Nilambur I	Nilambur	Palappilly	Arippa
Height	13.38	14.15	12.31	12.02
Clear bole height	32.94	32.19	29.23	28.59
Girth	22.19	23.43	20.09	17.94
Volume of log	95 05	86.68	83.09	75.82

CONCLUSION

Selection of teak seed production areas, selection of plus trees and establishment of three pilot seed orchards at Nilambur, Palappilly and Arippa form the first phase of a planned genetic improvement attempt in teak in Kerala. However, if this work is followed by future course of work as envisaged in the recommendation for future plan of work, will give substantial improvement in the teak production in Kerala with respect to quantity and quality.

Recommended future plan of work

The following plan of work is recommended for future.

1. The search, selection and registration of plus trees particularly in Wynad and Parambikulam.
2. Establishment of a clone bank.
3. A follow up project on management of seed orchards with a view to maximise seed productivity.
4. One parent - progeny trials of plus trees for estimating genetic parameters, parent - offspring and juvenile - adult correlations.
5. Investigation on possibilities of inducing early and augmented flowering in the orchards.
6. Investigation on natural resistance of plus trees to insect pests like skeletoniser and defoliator.
7. Assessment of plus trees for different wood properties using non-destructive core sampling.
8. Investigation on the identity and behaviout of teak pollinators to explore the possibility of increasing seed productivity in seed orchards by increased pollination.
9. It is estimated that about 6-8 kg of seed would be required to establish one hectare of teak plantation at an initial spacing of 2 x 2m. To meet the annual teak planting target of 1200 ha in Kerala, 30-40 ha of commercial orchards would be required for state. This is not a difficult task to achieve and can be accomplished in a phased manner at the rate of 5-10 ha per year.

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Appendix 1. Facsimile of Plus tree registration form

GF-2

KERALA FOREST RESEARCH INSTITUTE GENETICS DIVISION	PLUS TREE REGISTER	Name of the Tree TECTONA GRANDIS	Date of Approval 1/1/1980	Register No: KFRI/T/3

1 LOCATION

Country INDIA
State KERALA
Division NILAMBUR
Range NILAMBUR
Beat EDACODE
Forest Dept. Ref. No. (if any) KLN 3
Date of Planting 1924 Age 56 Years
Spacing
Thinning History

2 SITE FACTORS

Altitude 30.6 m
Latitude 11° 9'
Inclination
Average Temperature 27°C (17° 37°)
Average Rainfall 2600 m m
Soil type River alluvium
Site class I
Drainage Good

3 PHOTOGRAPH

4 SITUATION

Solitary ✓
Rows
Pairs
Others

5 ORIGIN OF STAND

Natural
Sown ✓
Cuttings
Coppice

6 DESCRIPTION OF STAND

Forest Type Plantation
Origin
Native ✓
Introduced
Unceratain
Stand Condition

7 CANOPY

One storey stand ✓
Two storey stand
More storey stand

8 INCREMENT

Good
Medium
Bad

9 MANAGEMENT SYSTEM

High Forest
Middle Forest
Coppice Forest
Pasture Forest

10 DESCRIPTION OF THE PLUS TREE

i General

Height 37 m

Clear Bole 22 m

Crown Height 15 m

Gbh 218 cms

Crown Diameter 14.60 m

Volume Appr 8.46 m^3

Diseases

Insects

HYBLAEA PUERA

PYRAUSTA MACHAERALIS

Defects

ii Description of stem

Straight ~

Slightly curved at

Curved at

Self Pruned

Bark

Fine

Medium ~

Coarse

Taper Moderate

iii Crown

Proportional ~

Wide

Narrow

Pyramidal

Dense

Sparse

Branches

Angle Above 45°

Length 7.3 m

Fine

Medium

Coarse

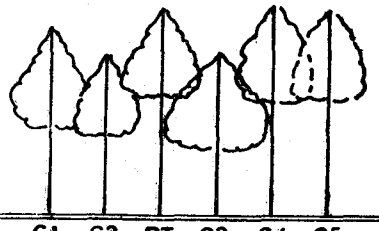
11 PHENOLOGY

	1979	1980	1981	1982	1983	1984	1985
Flushing							
Beginning of crown formation							
End of crown formation							
Beginning of flowering							
End of flowering							
Beginning of leaf shedding							
End of leaf shedding							
Fruit Ripening							
Fruit Dispersal							
100 Seed weight							
Germination Energy							
Germination Capacity							

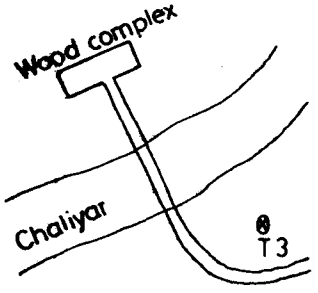
12 TREES OF COMPARISON

Tree No	Height	Clear Bole	GBH
P. T	37	22	218
C 1	32	17	167
C 2	29	13	181
C 3	28	14	149
C 4	36	20	239
C 5	37	21	210

Diagrammatic Representation



13 MAP



14 SCORE

Character	PT	C_1	C_2	C_3	C_4	C_5
Volume						
Crown						
Branches						
Log Length						
Stem Form						
Sweeps						
Kinks						
Buttrees						
Taper						
Total						

15 NOTE

16 Name of Reporter

Mathew P. Kadly

(Formerly selected by FRI, Genetics Branch)

17 Signature of the approving authority

C. S. Venkatesh

SCIENTIST - IN - CHARGE

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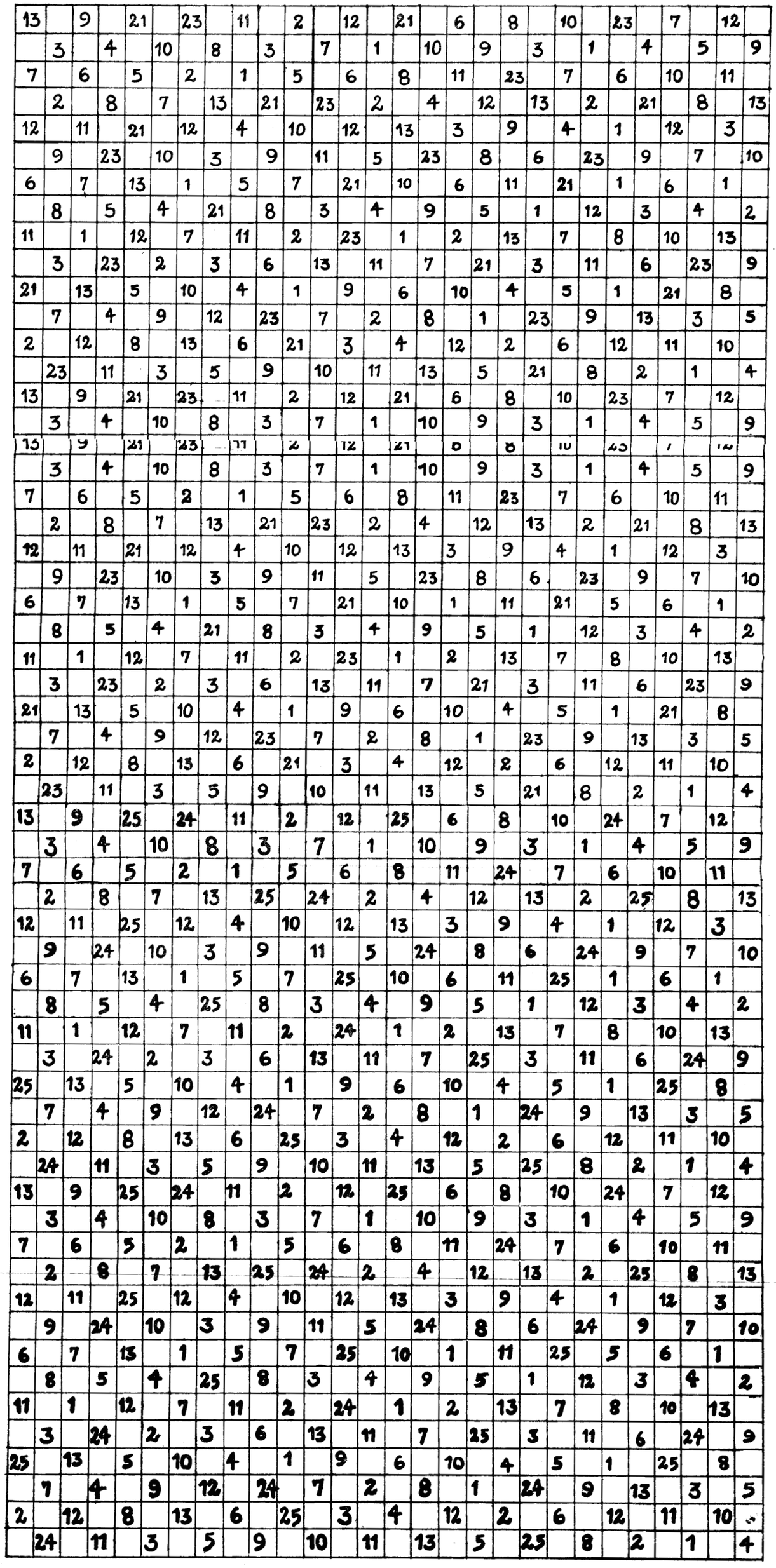

Appendix 2. Lay out design of Teak seed orchard, Nilambur

Appendix 3. Lay out design of Teak seed orchard, Palappilly