ANNUAL REPORT ON SILVICULTURAL RESEARCH IN THE MADRAS PRESIDENCY FOR THE YEAR 1937-38

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PART I

RESULTS—WORKING PLANS—STATISTICS—STAFF

PART II

EXPERIMENTAL DATA

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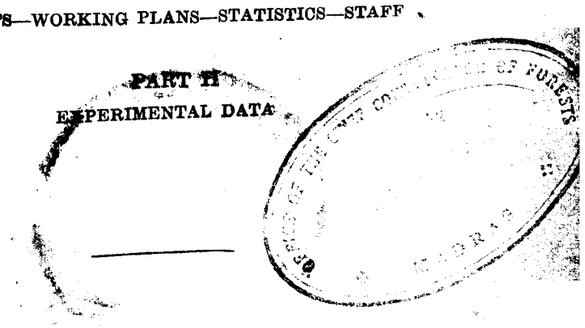

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PART II.

ANNUAL REPORT ON SILVICULTURAL RESEARCH IN THE MADRAS PRESIDENCY FOR THE YEAR 1937-38.

PART I.

I. RESULTS AND INDICATIONS.

(i) General.

1. As in previous years, a large amount of the work done this year has been small scale [Stage I (*a*)] investigations in experimental gardens. Inevitably, a large proportion of the work done consisted of repetitions of previous experiments in order to confirm the results and indications obtained from them, and also of routine seed germination and weighment tests.

2. The most important results obtained during the year are probably the following :—

(*a*) The extension and great improvement in the regeneration of our dry fuel forests by the "rab" method and its combination with the raising of field crops (*rab-cum-kumri*). In many districts with the most unpromising soil and climatic conditions success with this kind of work is now routine and height growth of 2 to 5 feet in the first year is common.

(*b*) Further demonstration of the great benefits obtained by soil working by forking in the early stages of the "*rab*" regeneration of our dry fuel forests.

(*c*) In very poor areas in our dry fuel forests, the successful raising of plantations for manure leaves of *Cassia siamea* and *Poinciana elata* and plantations for the tan bark of *Cassia auriculata* (avaram).

(*d*) Continued success in the control of new outbreaks of the spike disease of sandal. We have eradicated the disease in the case of eight small outbreaks and controlled the disease and kept it confined to its original limits in four cases of large blocks of 300 to 400 acres each.

(*e*) We have made progress towards the identification of the insect or insects responsible for the spread of the spike disease of sandal. We now have proved—

(i) that it is one or more of less than 100 species of insects;

(ii) that it is an insect that operates at night and between August and November as its main infective season;

(iii) that its size is between one-twentieth and one-fourth of an inch.

(*f*) The conclusion of the investigations into the best date of stump planting and best size of stumps to use with most of our important species at most of the centres.

(*g*) The further collection by experiment of statistics of teak stump production in nurseries and the methods by which economies can be made. In conjunction with this is the demonstration of the fact that in years of shortage, undersized stock in the nursery can be developed into good stock for the following year. These results are particularly important in view of the fact that two of the past four years have been exceedingly poor seed years for teak and great shortage of stumps has followed.

(*h*) Our work on the controlling of the mahogany pests by silvicultural methods, such as using shade crops and segregation of mahogany blocks is showing marked success.

(*i*) The production of new yield tables for Nilambur teak by the Central Silviculturist, Dehra Dun, has shown that the number of stems per acre, basal area per acre, and volume per acre, when expressed in terms of "top" height are independent of age and quality, and hence we have been able to produce a table of thinnings which will be of the greatest use to district officers.

3. *Financial aspect of silvicultural research.*—The silvicultural research work of this Province during the past five to ten years has had a great effect on the financial side of the silviculture of our forests. It is not however generally realized how great this effect has been and therefore below are given a few striking investigations with their financial results. The list given is not exhaustive but consists merely of a few striking facts.

4. *Teak plantations.*—Teak plantation technique has been revolutionized during the past ten years. We have changed (as a result of research) from dibbling of seed to stump planting, from stump planting in expensive pits to stump planting in cheap crowbar holes, and from stump planting in the monsoon rains to stump planting well before the monsoon. We have thus produced very much quicker early growth with greater certainty of good stocking.

In our early tending we have changed from the expensive weeding by forking to the cheaper weeding by scraping.

The financial result of all this work is that in *practically all teak districts* the cost of formation of teak plantation has been reduced by Rs. 10 to Rs. 15 per acre in the last ten years.

In detail, changing from pit planting to crowbar hole planting has saved us Rs. 2–12–0 per acre; changing from weeding by forking to weeding by scraping has saved us Rs. 9 per acre (usually three weedings are done in the course of the first two years and each saves Rs. 3 per acre), i.e., a total saving on these two items alone of Rs. 11–12–0 per acre.

5. When it is realized that we are making 1,400 acres of teak plantation a year in the Presidency *this saving comes to rupees 16,850 per year.*

With all these new methods saving years of time in the early stages of the life of a plantation and improved tending and thinning in the later stages all indications at present are that the teak plantation rotation will be reduced by about ten years without sacrifice of quality or quantity.

The average quality at Nilambur is that of good third quality and this at seventy years produces a final yield of approximately 3,200 cubic feet per acre which sells at approximately Rs. 2 per cubic foot or Rs. 6,400 per acre or Rs. 91–7–0 per acre per annum. If the rotation is reduced to sixty years this becomes Rs. 106–11–0 per acre per annum. We have thus increased the potential value of the plantations by Rs. 15–4–0 per acre per annum.

At Nilambur there are approximately 8,000 acres of plantation or *the potential value of these plantations has been increased by Rs. 1,22,000 per annum, in this one division alone.*

It should also be remembered that there are approximately 22,000 acres of teak plantations in the Presidency to which these facts also apply in different scales according to locality.

6. *Control of new outbreaks of the spike disease of sandal.*—In 1917 Dr. Coleman worked out the average loss due to the spike disease of sandal in Mysore for the period 1903 to 1910 at *rupees 4·4 lakhs per annum.* For the period 1910 to 1917 he worked at the corresponding average loss to Coorg as *Rs. 1 lakh per annum.* (Mysore State Department of Agriculture, Mycological series Bulletin No. 3, May 1917.)

In 1923, Mr. Latham worked out the loss from this disease in North Salem Division as *Rs. 1·55 per tree per annum*—Madras Forest Bulletin No. IV, 1923. From 1919 to 1931, 349,312 dead spiked trees were extracted from North Salem Division alone. On Mr. Latham's calculation this is an average annual loss of *Rs. 5¼ lakhs per annum* over an area of 35,000 acres of sandal forest

In areas where "spike" is not controlled the average annual spread is roughly twice the original extent.

7. Excluding work in other districts, the research staff in North Salem Division during the past five years have eradicated the disease in eight localities and controlled the disease and kept it confined to its original limits in four large blocks.

The total of this diseased area actually dealt with is 1,400 acres or using Mr. Latham's figures *we have averted an average annual loss of Rs. 21,000 by these control operations in one district alone.*

All the above financial facts have been due to research alone and it is thus seen that the money spent on silvicultural research has been a very profitable investment quite apart from the other advantages that have accrued that cannot be expressed in rupees, annas and pies.

8. *Climates.*—In an endeavour to give an idea of the climates in which the experiments have been done, a rainfall statement for all research centres is given in paragraph 327. In this statement the rainfall figures are given in inches monthwar and underneath this is given the number of rainy days in that month, e.g.,

$$\frac{\text{10·71 (inches of rain in the month)}}{\text{15 (rainy days in the month)}}.$$

In addition to this, the last column of the table gives the average annual rainfall of the place over as long a period of years as is possible together with the average number of rainy days per year where it is known. The period of rainfall given (1st April 1937 to 1st June 1938) covers all the 1937 experiments. The rainfall is totalled for the year 1st April 1937 to 1st April 1938, as this period covers most measurements and is to be compared with the average annual rainfall given in the last column.

(ii) Natural Regeneration.

9. *By seed—Attempts to induce natural regeneration under mother trees—Hopea parviflora.*—In Experimental Plot 51, South Coimbatore Division, *Hopea* mother trees were selected and in half the ground projection of the crown, weed growth was removed and the soil raked just before seed fall. This was started in 1933 and each year since that date the existing natural seedlings have been counted, pulled out, and the treatments repeated.

During the five years that have elapsed there has been very little seed fall but enumerations show that the treatment has had no beneficial effects in inducing natural regeneration as the numbers of seedlings resulting in the treated and untreated plots are

almost exactly the same. The effect of a full seed fall remains to be seen.

10. *Calophyllum elatum.*—Experimental Plot 56, South Coimbatore Division, which is a similar experiment has given no results as there has been practically no seed fall at all since the experiment was started five years ago.

11. *Mesua ferrea.*—Experimental Plot 23, Wynaad Division, and 55, South Coimbatore Division, are similar experiments with *Mesua.* Seed fall with this species has been very slight during the last five years but the treatment has shown no beneficial or deleterious effects.

12. *Dysoxylum malabaricum.*—Experimental Plot 23, Wynaad Division, is a similar plot with *Dysoxylum malabaricum.* There has been very little seed fall during the last five years but the treatment has shown no beneficial or deleterious effect.

13. *Swietenia macrophylla.*—It is very noticeable that some mahogany mother trees produce abundant natural regeneration under them while others produce little or none. Previous experiments to induce regeneration where it is absent or scanty by clearing undergrowth and raking the soil have proved unsuccessful. To continue this investigation Experimental Plot 142, Nilambur Division, has been started in which burning before and after the seed fall has been added to the above treatments.

Enumeration at the end of February 1938 shows that burning either before or after seed fall is very deleterious as is seen by the following result :—

	Seedlings.
(A) Undergrowth cut and burned before seed fall	560
(B) Do. after seed fall	57
(C) Control—not cut or burned	1,049

14. In Experimental Plot 141, Nilambur Division, mature seed bearers which bear normally a fair amount of fruit but which produce little or no regeneration have been selected. So far, up to the end of the first year of the experiment the trees have produced a normal quantity of normal seed and this seed germinated and produced seedlings a normal number of which have survived the hot weather (162 per tree average). It remains to be seen when and why this regeneration disappears.

15. *Canopy manipulation over natural regeneration—Hopea parviflora.*—Experimental plots 37, 38 and 39, South Coimbatore Division, were opened in 1931 in Kariau shola to study the effect of canopy manipulation on natural regeneration of *Hopea parviflora* 5 feet to 10 feet high. Three treatments were applied in

which (A) all but the top canopy was cut, (B) the undergrowth was cut, and (C) control in which nothing was done.

Casualties have been negligible and during the seven years the plots have been open the treatments have shown the following average annual height increment: (A) 13·9 inches, (B) 7·3 inches and (C) 7·3 inches. Although the experiment has been primarily concerned with regeneration 5 feet by 10 feet high the treatments have shown the following recruitment to regeneration over 3 feet high (A) +25 per cent, (B) + 20 per cent, (C) — 11 per cent.

The above figures well demonstrate the benefit obtained by the canopy opening. The plants in the area where the undergrowth was cut (B) have put on fair girth increment but have suffered from bark stripping by deer.

16. Experimental Plots 12 and 13, South Coimbatore Division, were opened in 1932 in Karian shola to study the effect of canopy manipulation on unestablished natural regeneration of *Hopea parviflora*. Two treatments were applied in which (A) all but the top canopy was removed and (B) control in which nothing was done. In addition in the (A) treatment part was fenced and the remainder left unfenced.

During the time the plots have been opened the unestablished regeneration in the three treatments have shown the following average annual percentage increase in the indicator plots :—

	PER CENT.
A-1. Top canopy—fenced	132
A-2. Do. unfenced	118
B. Full evergreen shade unfenced control	9

In the whole of the plots, and they total 2·7 acres the established regeneration has shown the following average annual percentage increase (A) top canopy only (unfenced) 180 per cent, (B) full evergreen shade (control), 45 per cent.

These figures well illustrate that to establish young regeneration of *Hopea* it is very beneficial indeed to open the canopy.

17. In order to continue this investigation two more sets of plots were opened during the year. In the first set (Experimental Plots 75 and 76, South Coimbatore Division), the progress of established regeneration of *Hopea parviflora* 3 feet to 8 feet high will be observed under the conditions of (*a*) clear felling and (*b*) top canopy cover. In the second set (Experimental Plots 72, 73 and 74 of South Coimbatore Division) the progress of established regeneration of *Hopea parviflora* 3 feet to 10 feet high will be observed under the conditions of (*a*) clear felling, (*b*) top canopy, (*c*) full evergreen cover-control. In this second new set of plots the effect of the three treatments on the unestablished regeneration on the ground will also be watched.

18. *Mesua ferrea*.—Experimental Plots 44 and 45 of South Coimbatore Division were opened in 1932 to test the effect of canopy opening on natural regeneration of *Mesua ferrea* 5 feet to 10 feet high. Two treatments were applied (A) in which only the top canopy was left and (B) the control in which nothing was done. The two treatments show an average annual height increment of (A) 9·6 inches and (B) 5·6 inches, but the small regeneration on the ground is not quite as good as it was in either plot.

Experimental Plots 3 and 4, Wynaad Division, were opened in 1932, and two treatments applied—(A) cutting undergrowth and (B) control. They show an average annual height increment of (A) 5·4 inches and (B) 1·4 inches. The state of small regeneration on the ground has not moved.

Experimental Plots 5 and 6, Wynaad Division, were similarly opened in 1932. In these two experiments the treated and control plots have shown a mean annual height increment of 5·4 inches and 3·3 inches, respectively, and the small regeneration on the ground has not moved at all. The above experiments show that for *Mesua ferrea* it is not advantageous to open the canopy or remove undergrowth at least before the natural regeneration is 5 feet by 10 feet high.

19. *Palaquium ellipticum*.—During the year a set of plots in Palghat Division (Experimental Plots 163, 164 and 165), have been opened to determine the effect of various shade conditions on established regeneration 4 feet to 6 feet high and unestablished regeneration on the ground of this species. The shade conditions are (A) clear felling, (B) top canopy shade only and (C) full evergreen cover control.

20. *Pterocarpus santalinus*—(Red sanders).—A valuable species in some of the dry districts, often regenerates itself by seed profusely but the regeneration dies back each year although it increases in density year by year. The District Forest Officer, Chittoor, has been very successful in bringing on this regeneration into a sapling and pole stage by opening the canopy over a " mat " of seedlings which was considered dense enough to open over.

This procedure has also been recognized in other districts but no records have been kept of work done and no counts made to give an idea of when regeneration is sufficient to start operations. Controlled experiments with this object were started two years ago and preliminary counts showed that this " mat " of regeneration contains approximately 550 seedlings per 100 square feet.

Although the past two years have been poor ones climatically with only two-thirds of the normal rainfall, enumerations show that the established regeneration class (over 3 feet high) has

increased by 284 per cent while the total number of seedlings has decreased due to early dying back of younger seedlings by only 15 per cent. The treatment of opening the canopy by 30 per cent to 50 per cent has thus been markedly successful in the first two years.

21. *By coppice.*—In Experimental Plot 11, Chittoor Division, three species (*Acacia sundra*, *Albizzia amara* and *Azadirachta indica*) were dealt with and three treatments applied (1) high cutting with trimming, (2) low cutting with trimming and (3) low cutting without trimming. The fourth treatment of high cutting without trimming was omitted as a sufficient number of stools were not available and it was considered best to get more reliable results with fewer treatments.

Measurements three and a half years after applying treatments show the following mortalities of stools :—

Species.	Percentage of stools dead.		
	High cutting with trimming.	Low cutting with trimming.	Low cutting without trimming.
	PER CENT.	PER CENT.	PER CENT.
Acacia sundra	5	12	12
Albizzia amara	3	11	8
Azadirachta indica	6	9	*
Average for all three species	5	11	10

* Treatment omitted owing to insufficient number of stools.

The three treatments in ordinary district work correspond to good, poor and very poor work, and it is seen that for all three treatments and all three species (1,221 stools) the ordinary operation of coppicing has caused 9 per cent mortality.

22. This comparatively high mortality once again brings into prominence the necessity for "rab" regeneration in fuel forests to make up the loss of stock caused by coppice felling.

It is to be noted that the highest mortality in all species has been caused by the treatments of low cutting and this in practice has been considered to be the best type of work. It is possibly due to the shaking of the roots in a dry soil.

It will of course be many years before we can determine the effect of the treatments on the volume of fuel produced.

It is to be noted that further casualties have occurred during the last eighteen months in all treatments.

23. *Teak coppice—Mortality of stools.*—During the year a large-scale experiment covering 30 acres in area was started in order to determine the effect of different methods of coppicing on the mortality of stools and the resulting coppice shoots. Nine hundred and sixty teak trees in the area having only one

shoot per stool were allotted to four treatments and these treatments were equally spread over the area of the coupe and over the range of diameter classes, thus randomising the treatments as far as was practicable.

The treatments were (A) low cutting, as near the ground as possible, stools not trimmed, (B) low cutting, as near the ground as possible stools trimmed, (C) high cutting 9 inches to 12 inches above the ground stools not trimmed and (D) high cutting 9 inches to 12 inches above the ground stools trimmed.

Treatments were carried out in July 1937 after clear felling all other species (including the non-treated teak) in the coupe. Enumeration in February 1938 showed that mortality of stools had up to then been negligible [(A) 0·8 per cent, (B) 0·4 per cent, (C) 1·2 per cent and (D) 1·7 per cent.] and coppice shoots averaged 51 inches high.

24. It is of particular interest to note that with this species the coppice shoots come from very near ground-level irrespective of the height of coppicing. In the case of the high cutting treatments the main shoots come from ground-level but a few feeble shoots appear from the cut edge but these die off in the first few months.

25. *Effect of thinning teak coppice shoots.*—In Experimental Plot 142 of Palghat division an experiment was started to determine whether it is advisable to thin out teak coppice when grown for the purpose of producing poles. The thinning out was done when the coppice was eighteen months old and consisted of four treatments—

(A) reduction to one shoot per stool,

(B) reduction to two shoots per stool,

(C) reduction to four shoots per stool, and

(D) control, unthinned.

It was found that eighteen months old was too young to do this operation for the thinned shoots produced secondary shoots which did not die off at once but persisted.

When the coppice was four years old these secondary shoots were removed and in addition, shoots of miscellaneous species that were interfering with the teak coppice were felled, stacked and sold as fuel. Further secondary shoots have not yet appeared.

This cleaning operation was very remunerative and it appears that if such coppice is to be thinned, four years old is about the right time to do it.

The growth of the coppice can be judged by the table below, which is the abstract of measurements taken when the coppice

was five years old. It however remains to be seen which treatment will give the greatest money yield at the end of the rotation (thirty years):—

Treatment.	Number of shoots per stool left.	Type of shoot considered.	Number of stems.	Average height in feet.	Average diameter in inches.
A	1	Biggest	35	18·4	2·8
B	2	Do.	34	21·1	3·1
		Second biggest ..	34	15·6	1·9
C	4	Biggest	33	20·3	3·1
		Second biggest ..	33	16·6	2·1
		Remainder ..	62	12·2	1·1
D	Unthinned.	Biggest ..	33	22·8	3·5
		Second biggest ..	33	17·8	2·1
		Remainder ..	160	10·3	1·1

(iii) Seed.

26. *Seed pre-treatment.*—Routine seed pre-treatment tests were made with 27 species, the treatments used being cold, hot and boiling water, with an untreated control in each case. Seed purity percentage and seed weights were also recorded.

27. The germinative capacity of seed of the following species was not apparently improved by any of the treatments used:—

Acacia ferruginea.
Acacia leucophloea.
Acacia melanoxylon.
Acacia mollissima.
Acacia planifrons.
Acacia sundra.
Aerocarpus frazinifolius.
Albizzia amara.
Albizzia lebbek.
Anacardium occidentale.
Azadirachta indica.
Calophyllum elatum
Cassia auriculata.
Cassia fistula.
Cassia marginata.
Cassia siamea.
Chlorophora excelsa.
Chloroxylon swietenia.
Dalbergia latifolia.
Dalbergia sissoides.
Dendrocalamus strictus.
Dolichandrone crispa.
Gmelina arborea.
Harrisonia bennettii.
Juniperus procera.
Lagerstroemia lanceolata.
Leucaena glauca.
Mahonia leschenaultii.
Meliosma wightii.
Palaquium ellipticum.
Pinus insignis.
Pithecolobium dulce.
Prosopis juliflora.
Pterocarpus dalbergioides.
Pterocarpus marsupium.
Schleichera trijuga.
Soymida febrifuga.
Tectona grandis.
Terminalia chebula.
Terminalia crenulata.
Terminalia paniculata.
Wrightia tinctoria.
Zizyphus incurva.
Zizyphus jujuba.

28. Treatment with boiling water (water twenty times the volume of the seed used is brought to the boil taken off the fire, the seed immediately put in and left till cold) appears to increase the germination of *Acacia auriculiformis*, *Acacia baileyana*, *Acacia decurrens*, *Bauhinia purpurea*, *Pinus longifolia*, *Acacia cyanophylla* and *Acacia dealbata*, the latter two species being very marked.

29. Soaking in cold water for twenty-four hours was beneficial in the cases of *Gluta travancorica*, *Pterocarpus santalinus*, *Vitex littoralis and Xylia xylocarpa* being very marked in the case of *Pterocarpus* (Red sanders). It is again brought to notice that the pre-treatment of teak seed by soaking it in cold water neither increases nor accelerates its germination.

30. The results of pre-treatment tests are summarized in the table below. Generally 100 seeds for each treatment were used in each test though in a few cases 200 or 50 seeds were used. The results of previous year's tests are included.

Species.	Number of tests made.	Average germinative capacity with				Remarks.
		Untreated.	Cold water.	Hot water.	Boiling water.	
Acacia auriculiformis	6	14	14	19	22	Boiling water best in five out of six tests.
Acacia baileyana	2	4	4	26	31	Boiling water best in eight out of nin tests.
Acacia cyanophylla	9	11	14	17	35	
Acacia dealbata	6	46	68	60	87	
Acacia decurrens	2	1	1	8	11	
Acacia ferruginea	6	55	49	53	51	
Acacia leucophlœa	10	19	9	14	24	
Acacia melanoxylon	1	83	81	91	90	
Acacia mollissima	2	13	4	9	9	
Acacia planifrons	1	22	14	12	8	
Acacia sundra	10	34	28	30	25	
Aerocarpus frazinifolius	25	8	8	9	6	
Albizzia amara	78	42	37	30	38	
Albizzia lebbek	1	20	13	10	11	
Anacardium occidentale	6	70	58	54	24	Untreated seed consistently best.
Azadirachta indica	6	44	40	30	9	
Bauhinia purpurea	8	12	11	10	17	
Calophyllum elatum	5	17	16	13	0	
Cassia auriculata	10	2	1	1	2	
Cassia fistula	13	11	11	8	7	
Cassia marginata	12	17	22	13	5	
Cassia siamea	13	52	36	46	3	
Chlorophora excelsa	15	18	15	12	0	
Chloroxylon swietenia	11	14	12	11	1	
Dalbergia latifolia	22	31	26	29	5	
Dalbergia sissoides	30	26	26	32	5	
Dendrocalamus strictus	5	33	22	22	0	
Dolichandrone crispa	1	14	7	6	4	
Gluta travancorica	6	23	29	28	21	
Gmelina arborea	25	20	19	18	6	
Harrisonia bennettii	4	10	14	7	2	
Juniperus procera	2	6	8	10	2	
Lagerstroemia lanceolata	30	6	4	4	0	
Leucaena glauca	10	24	27	38	35	
Mahonia leschenaultii	2	49	12	3	0	
Meliosma wightii	1	14	8	0	0	
Palaquium ellipticum	10	47	49	40	0	
Pinus longifolia	2	15	62	2	80	
Pinus insignis	2	4	13	4	0	
Pithecolobium dulce	8	43	72	38	5	
Prosopis juliflora	5	71	18	61	54	
Pterocarpus dalbergioides	12	17	71	14	5	
Pterocarpus santalinus	12	25	40	33	19	Seed coat removed.
Pterocarpus santalinus	1	24	30	33	10	
Pterocarpus marsupium	82	39	27	31	14	
Pterocarpus trijuga	12	30	3	24	0	
Schleichera trijuga	10	1	27	1	0	
Soymida febrifuga	40	28		24	8	
Tectona grandis	10	18	12	21	3	
Terminalia chebula—						
(1) (whole fruit)	3	4	6	5	7	
(2) (fleshy covering removed)	4	6	1	2	0	Damaged by white ants.
(3) (Kernel)						
Terminalia crenulata—	72	30	33	29	6	
(1) Fresh seed ..	10	9	8	7	8	
(2) Stored 14 months ..	20	7	4	5	0	
Terminalia paniculata	2	30	38	11	0	
Vitex littoralis	1	11	9	5	3	
Wrightia tinctoria	42	20	26	25	13	
Xylia xylocarpa	3	36	25	31	25	
Zizyphus incurva	11	15	20	8	13	
Zizyphus jujuba						

31. *Seed pre-treatment—Obdurate species.*—Five species which usually give a very low germination per cent were experimented on with special tests to try and increase their germination.

The treatments used were (A) control, (B) soaking in lime water for twenty-four hours, (C) soaking in cold water for forty-eight hours and then keeping moist in straw out of free air circulation (fermenting), (D) scorching over a fire, (E) soaking in concentrated sulphuric acid and (F) exposing to the sun and watering on alternate days.

Results including those of previous years are seen in the table below :—

Species.	Number of tests.	Control.	Lime water.	Fermenting.	Scorching.	Sulphuric acid.	Weathering
Acacia auriculiformis	20	8	*	8	*	5	8
Acacia leucophloea	30	14	*	15	0	13	9
Acrocarpus fraxinifolius	19	9	0	8	*	*	*
Cassia auriculata	10	7	*	8	*	25	7
Cassia fistula	30	10	9	7	0	30	5
Cassia marginata	11	22	13	10	0	36	*
Pterocarpus santalinus	30	27	*	22	2	9	11
Terminalia chebula	30	15	9	30	16	0	6

* Test not done.

32. Concentrated sulphuric acid hastened and greatly improved the germination of *Cassia auriculata*, *Cassia fistula* and *Cassia marginata*, while fermenting greatly improved that of *Terminalia chebula*.

33. *Seed—Seasonal collection within the fruiting season.*—Tests were made of seed collected at fortnightly intervals throughout the fruiting season of ten species, *Acacia leucophlœa*, *Artocarpus hirsuta*, *Cassia fistula*, *Cassia marginata*, *Mesua ferrea*, *Pterocarpus santalinus*, *Shorea talura*, *Swietenia macrophylla*, *Terminalia chebula* and *Terminalia paniculata*. In each case these seed collections covered a period of six weeks to two months but in no case were there any definite variations in germinative capacity throughout the fruiting season.

With each species and each date of collection ten separate tests of 100 seeds each were done.

34. *Method of sowing—Hopea parviflora.*—*Hopea* seed was sown (i) with the wings vertical (in the position it falls through the air), (ii) on its side (in the position it normally lies on the ground) and covered with earth to a depth of ½ inch and (iii) on its side but well covered with ½ inch of soil. Including previous years' results the average germination of 26 tests is (i) 1 per cent, (ii) 11 per cent and (iii) 13 per cent. It therefore appears that *Hopea* seed should be sown on its side and well covered with earth to get the best results.

35. *Seed, locality test—Santalum album.*—Sandal seed was collected from both the spring and autumn crops from five localities, Coorg, Javadis, North Coimbatore Division, North Salem Division and the Nilgiris. This seed was tested by monthly sowings.

The spring crop seed (collected in March) was found slightly better in germinative capacity than autumn seed (collected in November). Both seed crops kept equally well in air-tight jars or in gunny bags for eight months but after this very quickly lost their vitality.

36. *Weathering of seed—Teak.*—Experiments were carried out at three centres in the weathering of teak seed. At each centre ten tests of 100-seed each were carried out for each of four treatments (A) seed exposed to sun and rain for six weeks, (B) as (A) but watered once a week in dry weather, (C) seed buried in pits in wet straw, (D) control. The treatments produced no appreciable difference in germination percentage.

37. *Method of collection—Swietenia macrophylla.*—An experiment was done at Kannoth in which mahogany seed was collected at three intervals of a fortnight in the fruiting season in the following ways (A) capsule obviously unripe, (B) capsules ripe on the tree, (C) capsules which had started to open, half the seed being collected off the ground and the other half from the capsule. All the seed was sown on the dates of collection. There was no appreciable difference in germination percentage between any dates or any treatments.

38. *Seed storage.*—Routine storage tests were made with 33 species with different methods of storage. Results showing the lengths of time that seed of the different species remains fertile are given in the table in paragraph 329 in which previous years' results are included. It should be noted that the table gives indications of the probable longevity of the seed but many more tests are necessary before reliable results can be obtained.

39. *Seed weighments.*—Routine seed weighments, germination tests, etc., were carried out. The results are given in paragraph 328 in the form given in the "Note on the Weight of seed (Revised)" by S. H. Howard and H. G. Champion.

(Forest Bulletin No. 41—1928.)

40. *Sorting seed according to size—Teak.*—Previous years' experiments were repeated both for germination and planting out tests and results are confirmed.

Seed was selected in the following four groups (A) district random sample, (B) selected biggest seed, (C) selected medium seed and (D) selected smallest seed.

Results were as follows :

Locality.	Year.	Average germination percentage of 1,000 seed in ten tests of 100 each.			
		District sample.	Selected biggest.	Selected medium.	Selected smallest.
Begur Experimental Garden Experiment 94	1937	23	26	24	19
Dhoni Experimental Garden Experiment 151	1937	43	56	52	20
Topslip Experimental Garden Experiment 163	1937	66	72	58	38
Average of 1937 experiments ..	..	44	51	44	26
Do. 1936 do. ..	..	40	40	37	26
Do. 1935 do. ..	..	53	63	55	38
Do. 1934 do. ..	..	44	49	49	30
Do. 1933 do. ..	..	41	36	..	24
Do. 1933, 1934, 1935, 1936 and 1937 experiments ..	..	44	48	46	29

41. A short term planting out test (Begur Experimental Garden Experiment 25 of 1934) was observed and measurements at the end of the fourth growing season after planting showed no significant difference in mean height growth between the plants resulting from the various types of seed used. This crop was raised by direct dibbling of seed in 1934.

Abbreviated results are—

Type of seed used.	Mean height growth in feet.
District sample	10·76
Selected biggest	11·70
Do. medium	10·72
Do. smallest	10·86

Thus the sorting out and rejection of teak seed on account of size appears to be an unjustified expense.

42. *Size, age and condition of seed bearers Teak.*—Seed was collected separately from large overmature trees (13 feet to 15 feet girth) middle sized trees approaching maturity (4½ feet to 6 feet girth) and small immature trees (below 3 feet girth). The seed was collected from ten trees of each class at each centre.

Each germination test of each class at each centre consisted of five sets of 100 seeds. Germination results were as follows :—

Locality.	Germination percentage of seed from		
	Overmature.	Mature.	Undermature.
Begur	30	33	30
Dhoni	56	60	51
Topslip	67	56	52
Average of 1937 experiments	—	—	—
1936 do.	51	50	44
1935 do.	37	27	21
1935, 1936 and 1937 experiments ..	35	35	32
Average survival percentage of ten short term planting out tests by dibbling and transplanting done in 1933 and 1934	41	37	32
	73	72	75

43. The above figures afford strong evidence that so far as germination and early development is concerned seed from both overmature and undermature teak trees is just as good as that from mature trees provided of course that the tree is old enough to produce fertile seed. In order to test whether this holds good in the later development of the plants three large scale long term planting out experiments have been started at Begur, Dhoni and Topslip. The abbreviated results of these experiments so far are as follows :—

Experiment.	Year of experiment.	Survival percentage.			Mean height in inches.		
		Overmature.	Mature.	Undermature.	Overmature.	Mature.	Undermature.
Wynaad Experimental Plot 35	1937	98	100	96	25·9	21·6	19·1
Palghat Experimental Plot 155	1936	93	92	92	124·8	126·2	146·4
Topslip Experimental Garden Experiment 130 ..	1936	87	86	79	84·2	88·9	82·2
Average ..		93	93	89	77·3	78·9	82·6

(For full experimental data see paragraph 330.)

44. *Dalbergia latifolia.*—Similar germination tests were done at Begur with this species with ten sets of 100 seeds each.

Results were—

Locality.	Germination per cent of seed collected from		
	Overmature.	Mature.	Undermature.
Begur Experimental Garden Experiment 96	21	8	8
Average of 1936 experiments	30	29	33
Average of 1935 experiments	25	34	29
Average of 1935, 1936 and 1937 experiments	25	24	23
Average survival percentage of six short term planting out tests by dibbling and transplanting done in 1933 and 1934 ..	72	73	70

45. For *Dalbergia latifolia* there are thus strong similar indications as for teak and in order to test whether these indications hold good in the later development of the plants three large scale long term planting out experiments have been started at Begur, Dhoni and Topslip. The abbreviated results so far are as follows :—

Experiment.	Year of experiment.	Survival percentage.			Mean height in inches.		
		Overmature.	Mature.	Undermature.	Overmature.	Mature.	Undermature.
Palghat Experimental Plot 157 ..	1936	89	89	91	51·0	47·9	35·8
Topslip Experimental Garden Experiment 182 ..	1936	48	56	80	21·4	25·2	22·5
Wynaad Experimental Plot 36	1937	93	93	95	7·9	8·3	7·9
Average ..		77	79	89	26·8	27·1	22·1

(For full experimental data see paragraph 331.)

46. *Pterocarpus marsupium.*—Similar germination tests were done at Begur, Dhoni and Topslip with *Pterocarpus marsupium.*

Results were—

Locality.	Germination percentage of seed collected from		
	Over-mature.	Mature.	Under mature.
Begur	49	30	24
Dhoni	40	33	24
Topslip	30	46	26
Average of 1937 experiments	40	38	27
1936 do.	52	48	35
1935 do.	59	74	64
1935, 1936 and 1937 experiments ..	50	53	42

47. Three large scale long term planting out experiments have now been started at Begur, Dhoni and Topslip to determine whether the condition of the seed bearers has any effect in the development of the resulting trees.

Abbreviated results so far are—

Experiment.	Year of experiment.	Survival percentage.			Mean height in inches.		
		Overmature.	Mature.	Under-mature.	Overmature.	Mature.	Under-mature.
Wynaad Experimental Plot 31	1936	97	98	98	65·3	62·1	57·6
Palghat Experimental Plot 156	1936	84	87	84	98·4	96·2	93·8
Topslip Experimental Garden Experiment 131 ..	1936	30	69	35	31·4	33·6	36·3
Average ..		70	85	72	65·0	64·0	62·6

(For full experimental data see paragraph 332.)

48. *Terminalia crenulata.*—One set of ten germination tests was done with this species in this subject at each of three centres.

Results were—

Locality.	Germination per cent of seed collected from		
	Over-mature.	Mature.	Under-mature
Begur	12	30	18
Dhoni	2	13	25
Topslip	2	7	8
Average of 1937 experiments	5	17	27
Do. 1936 do.	42	44	48
Do. 1935 do.	25	19	24
Do. 1935, 1936 and 1937 experiments	24	27	33
Average survival percentage of 5 short term planting out tests by dibbling and transplanting done in 1933 and 1934 ..	57	57	65

49. To test the further development of the plants from seed from these types of seed bearers three large scale long term planting

out experiments have been started at Begur, Dhoni and Topslip. The abbreviated results so far are as follows :—

Experiment.	Year of experiment.	Survival percentage.			Mean height in inches.		
		Overmature.	Mature.	Under-mature.	Overmature.	Mature.	Under-mature.
Wynaad Experimental Plot 37	1937	92	89	86	23·3	22·8	21·9
Palghat Experimental Plot 158	1936	95	98	89	136·8	128·4	135·6
Topslip Experimental Garden Experiment 159.	1937	88	80	77	20·0	21·7	19·8
Average ..		92	89	84	60·0	57·6	59·1

(For full experimental data see paragraph 333.)

50. *Seed origin—All-India teak seed origin plots.*—We have now two well established long-term plots (Experimental Plot 129 Nilambur Division and Experimental Plot 59 South Coimbatore Division), each four years old. The Nilambur plot has six origins, Nilambur, Anamalais, Travancore, South Bombay, South Burma and North Burma, and consists of 10·2 acres in 24 randomised blocks, each block containing approximately 520 plants at 6 feet by 6 feet espacement and there are four blocks to each origin.

During the year all the origins except that of North Burma were given a 50 per cent mechanical thinning and sample plots were laid out in each sub-plot. The remaining origin will probably be similarly treated next year. It is at present rather behind the rest.

The South Coimbatore plot has four origins, Nilambur, Anamalais, Mysore and South Burma, and consists of 4 acres in sixteen randomised blocks, four per origin. All origins were roughly 90 per cent at the end of the third year and the mean height varied from 16·3 feet to 21·6 feet. The order of origins in this plot in height growth is given below. This plot will be measured each year until the time of the first thinning when permanent sample plots will be laid out in each origin.

The following table shows the order of origins in mean height growth expressed as percentages of the best origin :—

South Coimbatore Experimental Plot 59—Three years old.

Mount Stuart	100
Mysore	89
Nilambur	86
South Burma	75

The above table shows that there is comparatively little difference in mean height growth of the various origins with the exception of South Burma.

(iv) Nursery Work.

Effect of shade and shelter on germination, survival and growth in nursery beds.

51. *Hopea parviflora* and *Cedrela toona*. Experiments on the effect of shade on the germination of these two species were done at Karian shola. Treatments consisted of (A) 100 per cent thatched shade, (B) 50 per cent reed shade and (C) open-control.

Neither species showed any preference for any of the three treatments.

52. *Artocarpus hirsuta*.—This species suffers in the nursery from the very heavy rain of the south-west monsoon and later from the hot sun after the monsoon. Experiments were therefore done at Chandanathode firstly to try and increase the germination of the species and secondly to try and minimize losses at a later stage.

The effect of shade on germination was tried by four treatments: (A) the open control beds, (B) side shades of woven reed 18 inches high, (C) complete top shade 2 feet from the ground and (D) top and side shade [(B) and (C) combined].

The effect of shading in any form was slightly but definitely beneficial, complete top shading giving the best results as is seen from the germination percentages (A) 43 per cent, (B) 39 per cent, (C) 55 per cent and (D) 54 per cent.

The above figures include the results of previous years and total sixteen tests.

53. The experiment was further extended for *Hopea parviflora*, *Dysoxylum malabaricum* and *Cedrela toona* by trying the effect of three kinds of shading during the hot weather on the mortality and development of seedlings. The three treatments were (A) control—open, (B) 50 per cent top shade at 3 feet from the ground and (C) 100 per cent top shade at 3 feet from the ground. The arrangement was that of a latin square, there being eight replications in each of three repetitions of each treatment.

Results show that shade is very beneficial indeed in both saving of mortality and increase in growth for all these species.

Treatments were applied from mid-November 1936 to late May 1937.

Treatment.	*Hopea parviflora.*		*Cedrela toona.*		*Dysoxylum malabaricum.*	
	Mortality.	Height increment.	Mortality	Height increment.	Mortality.	Height increment.
	Per cent.	Inches.	Per cent.	Inches.	Per cent.	Inches.
(A) Open	62	1·85	47	4·80	95	2·20
(B) 50 per cent shade.	12	1·69	38	5·10	..	2·02
(C) 100 per cent shade.	6	2·80	25	7·41	..	2·11

The experiment was started *after* germination was complete and the figures therefore show the effect of shading on survivals only and not on germination.

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Chandanathode Experimental Garden Experiments 132, 133 and 134.

54. *Nursery watering experiment*.—An experiment was done at Emmanur Experimental Garden nursery to endeavour to determine the amount and periodicity of watering necessary in a nursery to give the best results in germination and survivals. Three species were experimented with *Albizzia amara*, *Azadirachta indica* and *Prosopis juliflora* and three treatments tried—(A) beds watered daily with ten gallons of water, (B) beds watered on alternate days with ten gallons of water and (C) beds watered on alternate days with five gallons of water. The "bed" referred to is a standard nursery bed 40 feet by 4 feet.

Results are—

Species.	Treatment.	(A) 10 gallons daily.	(B) 10 gallons on alternate days.	(C) 5 gallons on alternate days.
Albizzia amara ..	Germination per cent.	0·1	1·0	0·4
	Mean height in inches in February 1937.	19	10	11
Azadirachta indica.	Germination per cent.	20	20	18
	Mean height in inches in Febuary 1937.	11	13	23
Prosopis juliflora ..	Germination per cent.	3	2	1
	Mean height in inches in February 1937.	24	27	23

The above figures show that within the range of these experiments, watering has very little effect on germination but that after germination *Albizzia amara* does best with a lot of water but *Azadirachta indica* and *Prosopis juliflora* will do as well with much less watering.

55. *Effect of repeatedly using the same nursery beds—Teak.*—A set of experiments has been started in four centres to determine the effect of repeatedly using the same nursery beds for the production of teak stumps and also to see whether the fertility of the beds can be kept up by artificial manure or green manure crops.

In each experiment there are sixteen standard beds each 40′ × 4′ which are allotted to four treatments on the basis of their outturn of the best size of stumps in the first year. The treatments are (A) beds sown each year—no manuring, (B) beds to be left fallow in alternate years, (C) a green manure crop to be grown in the beds and dug in, in alternate years and (D) beds to be sown each year but manured with wood ash and leaf mould.

The experiment at Nilambur was started in 1935 and those at Regur, Dhoni and Topslip in 1936.

56. At the end of the first year the average outturn of stumps per standard 40′ × 4′ bed sown with 10 lb. of seed was as follows :—

Date.	Centre.	Number of usable stumps 0·3 inch to 0·8 inch.	Average diameter of usable stumps, inch.	Percentage of stumps usable.	Number of unusable stumps less than 0·3 inches diameter.
April 1936	Nilambur ..	1,353	0·43	34	2,676
April 1937	Begur ..	2,405	0·41	40	3,533
	Dhoni ..	1,847	0·39	51	1,820
	Topslip ..	1,145	0·46	42	1,565
	Average ..	1,688	0·42	42	2,398

The above average figures representing the sowing of 2,560 lb. of seed in 64 standard nursery beds (40′ × 4′) in four different places give an idea of the general production of stumps in current nursery practice. It is to be noted that each bed produces enough stumps of the best size to plant up one acre of plantation at 6 × 6′ espacement and still leaves a reserve for casualty replacement. *It is particularly to be noted that at the end of one year only 42 per cent of the stumps produced are of the best size.*

57. At the end of the second year stump production was as follows (per standard 40′ × 4′ bed) :—

Date.	Centre.	(A) treatment. Number of usable stumps per bed.	(A) treatment. Average diameter of usable stumps, inch.	(D) treatment. Number of usable stumps, per bed.	(D) treatment. Average diameter of usable stumps, inch.
April 1937	Nilambur ..		0·43	2,593	0·42
April 1938	Begur ..	2456	0·37	255	0·38
April 1938	Dhoni ..	138	0·46	876	0·46
April 1938	Topslip ..	726	0·42	678	0·48
		420			
	Average ..	935	0·41	1,101	0·44

When compared with the first year's results it is seen that production has very considerably fallen off but that manuring with wood ash and leaf mould has helped to alleviate this reduction of output. The exceedingly low production at Begur is largely due to cockchafer damage.

58. The Nilambur experiment has now reached the end of its third year and the results of these three years for this centre are recapitulated to show the general trend of the experiment.

Number of usable stumps per standard bed—

	A	B	C	D
1st year	1,353	1,353	1,353	1,353
2nd year	2,456	..	..	2,593
3rd year	925	1,708	2,035	1,509

Average diameter of usable stumps produced—

	A	B	C	D
1st year	0·43	0·43	0·43	0·43
2nd year	0·43	..	..	0·42
3rd year	0·43	0·44	0·47	0·44

The preliminary indication is therefore that it is not advisable to use the same nursery beds year after year without manuring in some form as apart from the liability of pests (such as the cockchafer) to come in, production definitely falls off.

In the couse of the next few years of this set of experiments much more evidence will be obtained—

Nilambur Division Experimental Plot ...	136
Wynaad Division Experimental Plot	34
Palghat Division Experimental Plot	152
South Coimbatore Division Experimental Plot.	68

59. *Nursery methods for the production of teak stumps.*—The work of 1933 and 1934 (reported in the 1934–35 Annual Report, paragraphs 36 to 40) compared (A) dense sowing of about 80 lb. of seed ped 40′ × 4′ nursery bed, (B) transplanting very small seedlings at 4″ × 4″, (C) notching germinating seed at 4″ × 4″ and (D) sowing soaked seed at 3″ × 1½″ (about 15 lb. of seed per 40′ × 4′ bed). The results of this work showed that dense sowing gave much the greater number of usable stumps (over 0·3″ diameter) but was wasteful of seed. The next best treatment was sowing seed at 3″ × 1½″, i.e., a very light sowing but this tended to give poorly stocked beds although it gave the greatest economy of seed.

60. During 1935, three experiments were done at Dhoni, Topslip and Begur and four treatments used : (A) sowing seed at the rate of 60 lb. per 40′ × 4′ bed ; (B) sowing seed at 60 lb. per standard bed and pricking out seedlings into (E) beds at 3″ × 3″ leaving the original (B) beds spaced 1″ × 1″ ; (C) sowing seed at 40 lb. per standard bed and (D) sowing seed at 20 lb. per bed. Each treatment consisted of four sub-beds 10′ × 4′ the arrangement being randomised. In mid April 1936 the outturn of stumps per treatment was enumerated as (i) unusable stumps under 0·3″ diameter and (ii) usable stumps over 0·3″ diameter. This experiment was repeated in 1936 and 1937. The results of the 1937 experiment are as follows :—

Data for a standard 40′ × 4′ nursery bed—

Locality.	Number of usable stumps per treatment A	B	C	D	E
Begur	2,044	985	2,075	1,753	2,920
Dhoni	1,287	1,315	1,363	1,125	6,102
Topslip	1,499	648	809	1,078	1,172
Average ..	1,610	983	1,416	1,319	3,398 *
Average number of unusable stumps below 0·3 inch diameter.	1,917	579	1,474	1,457	1,408 †

* In six standard beds or 566 per bed.
† In six standard beds or 235 per bed.

Locality.	Average diameter of usable stumps per treatment				
	A	B	C	D	E
Begur	0·45	0·47	0·45	0·45	0·45
Dhoni	0·51	0·52	0·49	0·48	0·52
Topslip	0·48	0·49	0·46	0·48	0·45
Average ..	0·48	0·49	0·47	0·47	0·47

61. The results of the last three years are recapitulated below :—

Data for a standard 40′ × 4′ nursery bed -

Year of experiment.	Number of usable stumps per treatment				
	A	B	C	D	E
1937	1,640	983	1,416	1,319	3,398
1936	2,120	1,069	1,832	1,915	4,295
1935	1,815	1,124	1,573	1,553	7,491
Average of 9 experiments over 3 years at 3 centres.	1,848	1,059	1,607	1,596	5,061*

* In seven standard beds or 723 per bed.

Year of experiment.	Average diameter of usable stumps per treatment in inches				
	A	B	C	D	E
1937	0·48	0·49	0·47	0·47	0·47
1936	0·42	0·46	0·41	0·45	0·44
1935	0·44	0·44	0·43	0·44	0·43
Average of 9 experiments over 3 years at 3 centres.	0·45	0·46	0·44	0·45	0·45

Year of experiment.	Average number of unusable stumps per treatment.				
	A	B	C	D	E
1937	1,917	579	1,474	1,457	1,608
1936	3,333	277	2,536	1,268	869
1935	3,031	679	2,687	1,550	1,635
Average of 9 experiments over 3 years at 3 centres.	2,760	509	2,232	1,125	1,304*

* In 7 standard beds or 435 per bed.

62. Thus (i) the average diameter of usable stumps produced was practically the same with all treatments;

(ii) in treatments (A), (C) and (D) (sowing with 60, 40 and 20 lb. of seed per bed) the average number of usable stumps produced was greatest for (A) but not very different from (C) and (D). The quantity of seed used in (A) and (C) was out of all proportion to the number of good stumps produced;

(iii) treatment (B) in which after dense sowing, seedlings were pricked out into (E) beds showed the poorest outturn in the original beds. A large number of seedlings were pricked out into seven (E) beds in each experiment each year. Although these (E) beds produced a fair number of seedlings of the right size they

were in general badly grown with bushy root systems and some 60 per cent were not fit to be made into stumps on this account. Further the cost of the extra beds and the labour of pricking out was great and was not justified by the results.

The indication is therefore that the best procedure is to sow evenly about 20 to 30 lb. of seed per standard bed and do no pricking out of seedlings at all. This is most economical in both cost and quantity of seed.

63. *This one bed sown with 20 to 30 lb. of seed produces enough good stumps of usable size to plant 1 acre at 6′ × 6′.* The plants that are too small in the first year can be left to the second year and there is also a certain amount of seed that has lain dormant in the first year that will germinate in the second year.

The results of these experiments thus substantially confirm the work which has previously been done in this subject.

Begur Experimental Garden Experiment ...	87
Dhoni Experimental Garden Experiment ...	146
Topslip Experimental Garden Experiment ...	160

64. *Experiments on attempting to produce usable stumps in the second year from undersized plants of the first year—Teak.*— It has been repeatedly pointed out that in current nursery work, at the end of the first year more than 50 per cent of the plants produced are not big enough to make stumps of a really suitable size (0·3″ to 0·8″ diameter). It has also been demonstrated (vide the Annual Report for 1935–36—paragraph 15) that leaving a nursery bed untouched for two years does not increase materially the number of good stumps produced because by such treatment the undersized plants merely disappear.

It has been suggested that at the end of the first year the bigger plants should be pulled out and stumped and the remainder left to grow for the second year. This remainder is also greatly aided by germination of dormant seed in the second year. This is current practice in some divisions and has been very successful.

Other divisions have raised objection to this practice and state that the complete nursery bed must be pulled to pieces at the time of planting. In consequence a further suggestion was made that when such a bed is completely dug up the undersized plants should be put back and allowed to grow for the second year.

65. Experiments have been done during the past two years at three centres to demonstrate the practicability of this suggestion. At Begur, Dhoni and Topslip when the nursery beds were dug up, at each centre 1,000 very undersized plants were selected and put back into nursery beds at an espacement of 4″ × 4″, 500 of them as stumps and 500 as transplants.

The outturn of these plants in the 1935 experiments at the end of the second year is as follows :—

(i) *Plants put back as transplants.*

Centre.	Number of transplants put in.	Number of usable stumps produced.	Average diameter of usable stumps.	Percentage of plants that produced usable stumps
Begur	500	91	0·45	18
Dhoni	500	269	0·44	54
Topslip ..	500	219	0·56	44
Average ..	500	193	0·48	39

(ii) *Plants put back as stumps.*

Centre.	Number of stumps put in.	Number of usable stumps produced.	Average diameter of usable stumps.	Percentage of plants that produced usable stumps.
Begur	500	222	0·58	44
Dhoni	500	337	0·54	67
Topslip	500	248	0·54	50
Average ..	500	269	0·55	54

The results of the past two years recapitulated are :—

Year of experiment.	Plants put back as transplants.		Plants put back as stumps.	
	Average percentage of plants that produced usable stumps.	Average diameter of usable stumps.	Average percentage of plants that produced usable stumps.	Average diameter of usable stumps.
		INCHES		INCHES
1937	39	0·48	54	0·55
1936	48	0·52	65	0·49
Average ..	44	0·50	60	0·52

The above figures show that if undersized plants are to be put back in the nursery for a second year they should be put back as stumps and not as transplants. If this is done, instead of wasting some 50 per cent of the material at the end of the first year, only twenty per cent is eventually wasted.

These preliminary results need confirmation by repetition.

66. These usable stumps obtained from material normally wasted were planted out last year to compare them with normal

fresh and full sized one-year old stumps. Their growth and survivals after one growing season are given in the following tables :—

Survival percentage.

Locality.	Fresh one year old stumps.	Plants put back for second year as transplants and then stumped.	Plants put back as stumps for second year and then re-stumped.
Begur	97	100	100
Dhoni	95	98	99
Topslip	72	72	88
Average ..	88	90	96

Mean height growth in inches.

Begur	20·6	30·2	31·9
Dhoni	47·2	49·8	51·1
Topslip	Heights not taken.		
Average .	33·9	40·0	41·5

67. It is thus seen that putting undersized stumps back in the nursery for a second year produces plants at the end of the second year which when stumped and planted out are in no way inferior in their early development but in fact rather better than normal one year old fresh stumps.

It is of course to be noted that in years when seed and stumps are both plentiful it is probably best to throw away the undersized stumps but these experiments show that in years of shortage a great deal of unusable material can be easily made usable.

It is of interest that two of the last four years have been very poor seed years indeed for teak and there has been great seed shortage in consequence.

It is therefore advisable for district nurseries in any year to endeavour to have sufficient plants for two years planting. This will mean that they have a reserve in case of a calamity of any sort and also will have sufficient plants to tide them over a bad seed year. It is obvious from the seed and stump indents that are received, that at present, in general, District Forest Officers do not use sufficient foresight in this direction.

(v) Artificial Regeneration.

(a) *Mixed deciduous timber forests.*

68. *Development of artificial regeneration in gaps.*—Gap regeneration in this type of forest is still being fairly extensively practised. The idea underlying this method of regeneration is that such gaps can be left to themselves after they have been regenerated and intensively tended for two years. Whether this is really the case is not known and in consequence in September 1935, two experiments (Experimental Plot 64, South Coimbatore

division, and Experimental Plot 28, V[illegible]ision) were started in which ten to fifteen typical gaps of [illegible]generated with teak and tended by the districts concerned w[illegible]aken over and enumerated. No tending at all is being done and their development and ultimate fate is being observed.

Each gap is approximately 30′ × 30′ thus containing roughly twenty-five plants at 6′ × 6′ espacement if fully stocked. Each gap will be successful if ultimately one good tree as it comes to maturity and therefore the best tree per gap is considered. The average height of the best tree in each gap was as follows :—

		Increment
	FT.	FT.
Wynaad Division—		
January 1936 at three years old	12·07	
January 1938 at five years old	19·60	7·53
South Coimbatore Division—		
January 1936 at three years old	3·06	
January 1938 at five years old	12.10	9·04

It is thus seen that the teak in the gaps is growing very slowly when compared with teak in plantations. Even after five years they are still within the reach of lantana and climbers and their fate remains to be seen.

In this type of forest in which only small patches are probably fit for clear felling and burning and regeneration with teak "gap" regeneration has definitely failed.

69. In consequence of this failure an investigation has been started to try and raise a valuable crop under the canopy of the comparatively worthless crop.

In Experimental Plot 39, Wynaad division, at Begur an area definitely not fit for teak was selected and the undergrowth up to 20′ felled and burned. Attempts to regenerate it with nine different species by various methods were made. At the end of the first year there is a definite indication that sowing is not likely to succeed as the very young plants will not stand the drip during the monsoon. On the other hand stumping or transplanting according to species holds out good prospects of success and results are so far encouraging. It remains to be seen how the plants already established progress.

The species tried are :—

Lagerstræmia flos reginæ, *Lagerstræmia lanceolata*, *Terminalia paniculata*, *Artocarpus hirsuta*, *Dalbergia sissoides*, *Pterocarpus marsupium*, *Terminalia crenulata*, *Swietenia macrophylla* and *Chloroxylon swietenia*.

70. *Camparison of direct sowing, entire transplanting and stump planting—Teak.*—No experiments have been done with teak during the past two years as it was considered that the superiority of stump planting over direct sowing and entire transplanting as a method of regenerating this species had been sufficiently well demonstrated during the previous five years.

71. *Dalbergia latifolia.*—An experiment at Kanmoth was done during the year with rosewood and confirmed previous years' results that stump planting is the best of the three methods of regeneration for this species.

The result of this experiment is given below and in addition for comparison the results of the previous four years are also shown :—

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1937	6	70	79	9·2	13·1	11·4	One experiment at one centre.
1936	25	97	95	6·1	7·9	8·5	Do.
1935	54	63	88	7·7	8·3	10·2	Four experiments at four centres averaged.
1934	58	58	80	6·8	6·2	15·6	Three experiments at four centres averaged.
1933	77	68	97	11·2	7·5	15·5	Do.
Average of 1933, 1934, 1935, 1936 and 1937 experiments.	44	71	86	8·2	8·6	12·2	Average of twelve experiments over five years at four centres.

(For full experimental data see paragraph 334.)

72. *Pterocarpus marsupium.*—An experiment was done at Kanmoth during the year with this species.

The result of this experiment is given below together with the results of the previous four years for comparison :—

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1937	35	85	40	5·4	11·6	9·9	One experiment at one centre.
1936	62	77	95	4·3	12·4	10·6	Do.
1935	59	65	79	7·7	5·8	10·3	Four results at four centres averaged.
1934	68	82	90	10·1	7·3	16·2	Three results at three centres averaged.
1933	86	82	79	14·2	10·9	19·5	Do.
Average of 1933, 1934, 1935, 1936 and 1937 experiments.	62	78	77	8·3	9.6	13·3	Average of twelve experiments over five years at four centres.

(For full experimental data see paragraph 335.)

73. *Pterocarpus dalbergioides*—(*Andaman padauk*). An experiment with this species was done at Kanmoth. Sowing was a complete failure and stump planting very poor indeed while

transplanting gave very fair results as is seen from the table below. The results of the previous two years are included for comparison :—

Year.	Survival percentage.			Mean height in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
1937	..	93	6	..	44·7	14·0
1936	6	51	16	6·5	24·3	11·8
1935	..	59	2	..	14·0	6·5
Average of 1935, 1936 and 1937	2	69	8	2·5	27·7	10·8

(For full experimental data see paragraph 336.)

74. A further experiment (No. 52) was done with this species also at Kannoth in a ponam crop of hill paddy in which the results from transplants (A) 33 inches, (B) 50 inches, (C) 80 inches, (D) 100 inches high were compared. As is seen from the table below which gives the results in January 1938 the transplants of 33 inches and 50 inches height have done the best. This confirms previous years results.

Treatment.	Survival percentage.	Mean height in inches.
(A) 33-inch transplants	90	37·1
(B) 50-inch transplants	93	52·1
(C) 80-inch transplants	100	79·3
(D) 100-inch transplants	99	89·8

75. *Terminalia crenulata.*—Four experiments with *Terminalia crenulata* were done at four centres. Three of these experiments confirmed previous years results that stump planting is the best method for the species and in one experiment (at Topslip) transplanting showed the best results.

The averaged results of these four experiments are shown below together with the results of the previous four years for comparison :—

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1937	55	89	98	13·3	19·7	29·9	Four results at four centres averaged.
1936	48	53	71	21·0	18·8	26·2	Do.
1935	35	61	50	13·8	13·8	22·3	Do.
1934	36	56	86	16·4	13·0	27·7	Three results at three centres averaged.
1933	65	86	75	20·7	20·5	29·7	Do.
Average of 1933, 1934, 1935, 1936 and 1937.	48	70	76	17·0	17·2	27·2	Average of eighteen experiments at four centres over five years.

(For full experimental data see paragraph 337.)

76. *Xylia xylocarpa.*—No new experiments have been done with this species during the last two years. The averaged results of the work of the previous three years are given below for comparison. Direct sowing is the best of the three methods of regeneration for *Xylia xylocarpa.*

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
Average of 1933, 1934 and 1935.	77	15	52	6·5	4·2	3·8	Average of eight experiments at three centres over three years.

77. *Artocarpus hirsuta.*—An experiment was done with this species at Kannoth after clear felling and burning mixed deciduous forest.

Results are given below together with those of the previous three years, for comparison.

Stump planting is the best method for this species.

Year.	Average survival percentage.			Mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1937	65	34	78	6·7	7·5	7·1	
1936	99	45	83	8·3	5·3	5·7	
1935	54	26	82	5·6	6·5	6·4	
1934	12	2	33	11·2	12·0	14·9	
Average of 1934, 1935, 1936 and 1937.	58	27	69	8·0	7·8	8·5	

(For full experimental data see paragraph 338.)

78. *Terminalia paniculata.*—Two experiments were done in this subject with this species but in one of the experiments (at Dhoni) stumping was not done owing to lack of stock. These preliminary experiments show that stump planting is the best method for the species. This result of course needs confirmation by repetition.

Locality.	Survival percentage.			Mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
Dhoni ..	41	44	*..	6·3	8·9	*..	
Kannoth	53	87	..	8·8	12·7		

* Not done due to lack of stock.

(For full experimental data see paragraph 339.)

79. *Schleichera trijuga.*—Two experiments at two centres were done with this species. These preliminary results indicate that stump planting is probably the best method to use for this species but they need confirmation by repetition.

Locality.	Survival percentage.			Mean height in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
Begur	37	32	90	40·6	31·9	38·8	
Dhoni	43	60	37	6·8	3·6	14·4	
Average ..	40	46	64	23·7	17·8	26·6	

(For full experimental data see paragraph 340.)

80. *Premonsoon stump planting—General.*—The majority of the investigations into the best date of stump planting our principal species (most of which stump well) which have been going on during the past six years at five centres have now been concluded. The investigations with teak at Dhoni, Begur and Topslip, short summaries of which were given in paragraphs 81 to 84 of last year's report, have now been written up and are being published as an Indian Forest Record.

81. The general conclusions of these investigations are :—

(*a*) In districts having a west coast type of climate, our principal species such as *Tectona grandis*, *Dalbergia latifolia* and *sissoides Pterocarpus marsupium* and *Terminalia crenulata* can be stump-planted before the monsoon breaks.

(*b*) Except in unusually hot and dry seasons, such as have not been experienced during the six years of these investigations this early stump planting gives a sufficiently good stocking (often much better than early June planting) and a great gain in height growth as compared with normal early June monsoon planting.

(*c*) Success is not dependent on what is generally considered "good planting weather."

(*d*) The great advantage given by the start the teak or other species get over weeds or field crops more than outweighs any risk of poor stocking due to an exceptionally dry or hot season or other causes and this risk can be insured against by providing a reserve of plants for stumping in early June if the necessity should arise. The extent of this gain by the start the teak gets over a field crop is shown by the fact that in the experiments at Kannoth the average mean height growth over the four years of experiment of stumps planted on April 15th was 19.5 6.2 inches, *an increase of* 215 *per cent.*

(*e*) The best dates of planting each species at each centre are shown in the table below. Many of the results are provisional and will be confirmed by further experiment.

Species.	Begur.	Dhoni.	Kannoth.	Topslip.	Walayar.
Tectona grandis ..	Mid-April ..	Mid-April ..	Late April.	Early May.	Mid-April.
Dalbergia latifolia and *sissoides* ..	Early May ..	Late April Early May	Mid-May.	Mid-May.	
Pterocarpus marsupium ..	Late April ..	Late April ..	Mid-May.	Late May.	
Terminalia crenulata	Early May .. Late April ..	Mid May ..	Early-May.	Mid-May.	
Artocarpus hirsuta.	Late May .. Early June ..	Early June.	Mid-May.	Mid June.	

It is to be noted that at Topslip and Walayar which do not have quite the typical west coast climate, in years which are good climatically all species can be safely planted much earlier than the dates shown.

As each of these investigations is essentially a local problem the results so far obtained are given below for each centre and each species separately.

82. *Begur—Wynaad division—Annual rainfall* 67 *inches, elevation*, 2,000 *feet—Teak (Tectona grandis).*—As reported in full last year, the middle of April is the best date for stump planting this species at this centre. Planting on this date gives less chance of poor stocking and twice the height growth at the end of the first growing season when compared with normal early June planting.

83. *Dalbergia sissoides.*—Experiments at this centre with this species have been done since 1933 but no experiment was done in 1934 due to lack of stock. The results of these four years experiments at the end of the first growing season after planting are given below in an abbreviated form :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937 ..	95	48	98	92	76
1936 ..	95	94	87	97	95
1935 ..	65	48	66	60	6
1934 ..	No experiment due to lack of stock.				..
1933 ..	60	56	74	60	76
Average ..	79	62	81	77	63

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	11·8	11·2	10·6	9·3	8·2
1936	10·1	11·2	11·5	9·9	9·0
1935	9·5	9·9	7·6	8·3	4·8
1934	No experiment due to lack of stock.				..
1933	17·7	18·1	14·1	12·2	10·6
Average ..	12·3	12·6	11·0	9·9	8·2

From the above figures it is seen that at Begur early May is the best time for stump planting *Dalbergia sissoides*. Planting at this time gives less chance of poor stocking (as is shown by the complete failure of normal June planting in 1935) and an increase in height growth of 35 per cent over *normal* early June planting. Planting can be done as early as early April in good years climatically but the chance of poor stocking is considerable.

(For full experimental data see paragraph 343.)

84. *Pterocarpus marsupium*.—Experiments with this species at Begur have been carried out since 1933 but no experiment was done in 1934 due to lack of stock. The results of the four years experiments at the end of the first growing season after planting are given below in an abbreviated form :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937 ..	91	88	88	91	75
1936 ..	57	67	98	100	98
1935 ..	76	86	78	61	32
1934 ..	No experiment due to lack of stock.				..
1933 ..	94	82	84	100	86
Average ..	80	81	87	88	73

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	21·7	21·6	15·4	14·4	12·4
1936	12·6	14·1	17·2	15·6	13·6
1935	12·5	13·4	12·1	10.5	7·9
1934	No experiment due to lack of stock.				..
1933	Height measurements unreliable due to insect attack.				..
Average ..	15·6	16·4	15·0	13.5	11·3

From the above figures it is seen that at Begur the best time for stump planting *Pterocarpus marsupium* is late April or very early May. Planting at this time gives in general less chance of poor stocking and an increase in mean height growth of approximately 39 per cent over normal early June planting. It is only apparently in exceptional years that planting can be done earlier than mid-April on account of the danger of poor stocking.

(For full experimental data see paragraph 343.)

85. *Terminalia crenulata*.—Experiments at Begur with this species have also been done since 1933 but no experiment was

done in 1934 owing to lack of stock. The results of the four years experiments at the end of the first growing season after planting are given below in an abbreviated form :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	85	87	93	94	88
1936	81	96	85	99	89
1935	44	56	62	78	64
1934	No experiment due to lack of stock.				
1933	42	48	48	50	48
Average ..	63	72	72	80	72

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	26·2	24·6	21·0	18·4	16·0
1936	32·2	31·5	28·5	26·5	17·1
1935	24·4	25·7	25·0	26·7	23·6
1934	No experiment due to lack of stock.				
1933	47·3	35·2	40·6	30·7	29·3
Average ..	32·5	29·3	28·8	25·6	21·5

From the above figures it is thus seen that at Begur the best date of stump planting *Terminalia crenulata* is late April. Planting at this time gives no more risk of poor stocking and an increase in mean height growth of 11 per cent over normal early June planting.

(For full experimental data see paragraph 343.)

86. *Artocarpus hirsuta*.—Experiments in the best date of stump planting *Artocarpus hirsuta* at Begur have been done for the last three years. Abbreviated results are given below for these experiments showing data up to the end of the first growing season after planting :—

Year of experiment.	Survival percentage of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1937	83	85	68	90	78
1936	78	94	88	98	86
1935	18	18	14	86	..
Average ..	60	66	57	91	..

Year of experiment.	Mean height growth in inches of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1937	6·7	6·2	4·4	4·4	3·2
1936	8·4	8·2	6·5	6·8	4·7
1935	4·0	4·6	3·1	3·7	..
Average ..	6·4	6·3	4·7	5·0	..

From the above figures it is seen that *Artocarpus hirsuta* can only be stump-planted for a few days before the break of the monsoon and that the best date for the stump planting is very late May or early June. This best date is determined by the date

at which the monsoon breaks and the species should be planted with the first heavy rain that breaks. Even this short period of about ten to fifteen days has produced an increase of height growth of 35 per cent over normal early June planting during the three years of the experiments.

(For full experimental data see paragraph 343.)

87. *Dhoni—Palghat division—Annual rainfall 111 inches—Elevation 300 feet—Teak (Tectona grandis).*—As reported in full last year the middle of April is the best time for stump planting this species at this centre. Planting on this date gives practically no risk of poorer stocking and an increase in mean height growth of approximately 80 per cent when compared with normal early June stump planting.

88. *Dalbergia latifolia.*—Experiments at this centre with this species have been done for the last five years. The results of this investigation up to the end of the first growing season after planting are given below in an abbreviated form :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	48	63	86	89	87
1936	48	30	71	95	95
1935	51	51	61	89	51
1934	18	64	84	64	48
1933	96	96	91	93	98
	—	—	—	—	—
Average ..	52	61	79	86	76
	—	—	—	—	—

Year of experiment.	Mean height growth of stumps in inches planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	21·6	22·5	17·6	17·0	18·9
1936	13·5	12·6	13·4	15·4	13·4
1935	17·2	15·0	12·0	16·1	9·7
1934	20·1	27·3	20·7	20·0	15·9
1933	31·9	32·6	27·3	30·1	28·2
	—	—	—	—	—
Average ..	20·9	22·0	18·2	19·7	17·2
	—	—	—	—	—

It is thus seen from the above figures that the best time for stump planting *Dalbergia latifolia* at Dhoni is late April or early May. By planting at this time slightly less risk of poor stocking is run and an increase in mean height growth of between 20 per cent and 30 per cent is obtained when compared with normal early June planting.

(For full experimental data see paragraph 342.)

89. *Pterocarpus marsupium.*—Experiments with this species have been done at Dhoni for the last five years. Their results up

to the end of the first growing season after planting are given in abbreviated form below :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	58	87	86	78	73
1936	92	69	75	100	92
1935	38	58	79	82	68
1934	7	90	48	26	76
1933	96	81	77	92	82
	—	—	—	—	—
Average ..	58	77	73	76	78
	—	—	—	—	—

Year of experiment.	Mean height growth of stumps in inches planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	13·3	14·6	21·8	12·1	13·0
1936	35·2	28·5	29·6	38·0	30·6
1935	20·4	21·2	14·4	12·1	10·4
1934	42·9	27·1	19·8	17·5	17·5
1933	26·4	23·3	17·8	16·8	16·0
	—	—	—	—	—
Average ..	27·6	22·9	20·7	19·3	17·5
	—	—	—	—	—

From the above figures it is seen that the best date for stump planting *Pterocarpus marsupium* at Dhoni is the second half of April. Planting at this time gives no more risk of poor stocking and an increase in mean height growth of 20 per cent to 30 per cent when compared with normal early June planting.

(For full experimental data see paragraph 342.)

90. *Terminalia crenulata.*—Experiments with *Terminalia crenulata* at Dhoni have only been done in 1936 and 1937 as in the three years previous to this, experiments were not possible owing to lack of stock. Abbreviated results up to the end of the first growing season after planting are given below :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	73	89	35	19	54
1936	21	9	34	96	68
	—	—	—	—	—
Average ..	47	49	35	58	61
	—	—	—	—	—

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15.	June 1st.
1937	31·7	30·6	18·1	15·1	12·0
1936	49·1	45·8	42·6	51·9	35·1
	—	—	—	—	—
Average ..	40·4	38·2	30·4	33·5	23·6
	—	—	—	—	—

If extensive planting of this species at Dhoni is contemplated further research experiments by the district are obviously needed but these preliminary figures show that the middle of May is the best time for stump planting *Terminalia crenulata* at this centre. Planting at this time gives a very fair stocking and an increase in mean height growth of approximately 40 per cent when compared with normal early June planting.

(For full experimental data see paragraph 342.)

91. *Artocarpus hirsuta*.—Experiments in the stump planting of *Artocarpus hirsuta* at Dhoni have been done for the last two years. The results as judged at the end of the first growing season after planting are given in an abbreviated form below :—

Year of experiment.	Survival percentage of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1937	63	51	60	82	82
1936	5	77	89	82	66
Average ..	34	64	75	82	74

Year of experiment.	Mean height growth in inches of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1937	15·7	17·6	14·4	15·8	13·6
1936	7·6	15·0	14·7	9·9	9·0
Average ..	11·7	16·3	14·6	12·4	11·3

Further experiments are needed but these preliminary figures show that the best date of stump planting *Artocarpus hirsuta* at Dhoni is in very early June only a few days before the monsoon breaks. From the figures however it is seen that putting forward the date of planting only a few days produces an appreciable increase in the resulting mean height growth.

(For full experimental data see paragraph 342.)

92. *Topslip—South Coimbatore division—Annual rainfall* 67 *inches—Elevation* 2,500 *feet—Teak* (*Tectona grandis*).—As reported in full last year the best date for stump planting teak at Topslip is early May. In good years climatically however, planting can be done as early as the middle of April but the risk of poor stocking is great. Planting in early May gives no more risk of poor stocking and an increase in mean height growth of 40 per cent when compared with normal early June planting.

93. *Dalbergia latifolia*.—Early stump planting experiments with this species have been done at Topslip for the last five years. The results of these experiments as judged at the end of the first growing season after planting are given in an abbreviated form below :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	92	32	71	80	95
1936	72	57	36	91	89
1935	0	3	3	12	29
1934	43	52	79	75	57
1933	86	96	84	92	88
Average ..	59	54	55	70	72

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	8·1	7·4	6·2	6·3	7·5
1936	11·4	9·9	10·2	12·8	10·0
1935	0	6·1	5·0	5·8	5·0
1934	22·7	17·4	18·0	13·7	12·0
1933	16·5	15·2	13·0	13·2	12·2
Average ..	11·7	11·2	10·5	10·3	9·3

The above figures show that the best date for stump planting *Dalbergia latifolia* at Topslip is the middle of May. Planting at this time gives generally a slightly better stocking and an increase in mean height growth of 11 per cent when compared with normal early June planting.

(For full experimental data see paragraph 344.)

91. *Pterocarpus marsupium*.—Experiments with this species at Topslip have been done for the last five years. Results as judged at the end of the first growing season after planting are given in an abbreviated form in the tables below :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	62	90	90	90	97
1936	26	8	7	74	91
1935	32	40	42	19	25
1934	72	87	81	85	85
1933	90	89	85	72	89
Average ..	56	63	61	68	77

Year of formation.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	6·9	6·0	6·7	5·7	6·4
1936	7·2	6·5	8·7	7·0	6·2
1935	11·2	7·8	7·3	7·0	5·9
1934	13·1	15·3	10·7	9·2	9·1
1933	Height measurements unreliable owing to insect attack.				
Average ..	9·6	8·9	8·4	7·2	6·9

The above figures show that the second half of May is the best time for stump-planting *Pterocarpus marsupium* at Topslip. Planting at this time gives roughly the same stocking but an increase in mean height growth of approximately 5 per cent. This is the *safest* date for planting but in years good climatically the species can be planted as early as mid-April but as is seen in the figures for 1936 and 1935 the risk of poor stocking is great.

(For full experimental data see paragraph 344.)

95. *Terminalia crenulata*.—Experiments with this species at Topslip have been done for the last two years. They were not started before 1936 owing to lack of stock. Results as judged at the end of the first growing season after planting are as follows :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	81	85	61	80	40
1936	33	7	20	84	92
Average ..	57	46	41	82	66

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	27·1	23·4	21·5	20·9	19·7
1936	38·5	26·1	32·2	30·2	28·0
Average ..	32·8	24·8	26·9	25·6	23·9

Although if extensive planting of this species is contemplated at Topslip, further experiments are necessary, yet the above preliminary figures show that *Terminalia crenulata* is stump-planted most safely in mid-May. Planting at this time gives an increased stocking and an increase in mean height growth of 12 per cent. As with other species at this centre it is seen that in years which are climatically good, this species can be stump planted a month earlier than the "safest" date but the danger of poor stocking is great.

(For full experimental data see paragraph 344.)

96. *Artocarpus hirsuta*.—Experiments in the early stump planting of *Artocarpus hirsuta* have been done at Topslip during the past two years. The results of these two experiments as judged at the end of the first growing season after planting are as follows :—

Year of experiment.	Survival percentage of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1937	12	42	54	89	74
1936	0	45	56	72	64
Average ..	6	44	55	81	69

Year of experiment.	Mean height growth in inches of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1937	7·0	5·0	6·4	7·7	5·9
1936	0	4·6	4·5	3·7	3·3
Average ..	3·5	4·8	5·5	5·7	4·6

The above preliminary figures show that the best date for stump-planting *Artocarpus hirsuta* at Topslip is mid-June, i.e., just about the time the monsoon breaks. This time gives the highest survival percentage and also the greatest mean height growth.

(For full experimental data see paragraph 344.)

97. *Kannoth—Wynaad division—Annual rainfall 73 inches—Elevation 300 feet—Teak (Tectona grandis)*.—Experiments in the early planting of teak at Kannoth have been carried out at Kannoth during the last four years. The results of the experiments as judged at the end of the first growing season after planting are given below in an abbreviated form :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	79	100	96	84	84
1936	85	93	96	96	96
1935	41	85	84	85	81
1934	37	75	87	93	88
Average ..	61	88	91	90	87

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	37·6	37·5	18·0	10·2	6·1
1936	21·7	17·4	16·2	9·9	7·6
1935	11·7	9·4	8·7	9·4	4·7
1934	11·9	13·7	11·4	10·9	6·5
Average ..	20·7	19·5	13·6	10·1	6·2

From the above figures it is seen that the best time for stump planting teak at Kannoth is the second half of April.

It should be noted that all the experiments with all species at this centre were done in a taungya crop of hill paddy and under these conditions a great advantage is obtained if the forest crop is put in and gets started before the root competition of the taungya crop starts. This is demonstrated by the fact that April 15th planting and May 1st planting with teak have shown increases in mean height growth over normal June 1st planting of 215 per cent and 120 per cent respectively.

(For full experimental data see paragraph 345.)

98. *Dalbergia sissoides*.—This species has been experimented with at Kannoth for the last four years. The results of the experiments as judged at the end of the first growing season after planting are given in an abbreviated form in the tables below :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	38	34	96	98	96
1936	94	80	26	94	94
1935	44	54	90	80	92
1934	74	98	88	96	92
Average ..	63	62	75	92	94

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	15·9	14·9	16·7	14·2	9·4
1936	11·0	10·7	10·0	11·1	9·9
1935	16·8	13·8	16·4	14·4	11·4
1934	23·4	26·2	23·2	25·1	19·3
Average ..	16·8	16·4	16·6	16·2	12·5

The above figures show that mid-May is the best time for stump planting *Dalbergia sissoides* at Kannoth. Planting at this time gives roughly the same stocking as normal early June planting but it gives an increased height growth of 30 per cent.

(For full experimental data see paragraph 345.)

99. *Pterocarpus marsupium.*—Experiments in the early stump planting of this species at Kannoth have been done for the last four years. The results as judged at the end of the first growing season after planting in an abbreviated form are as follows :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	2	4	52	64	62
1936	46	64	52	92	96
1935	86	60	82	74	82
1934	38	70	88	100	96
Average ..	43	50	69	83	84

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	27·0	31·0	15·0	16·1	10·4
1936	12·6	14·1	17·2	15·6	13·6
1935	7·6	6·7	7·1	6·2	4·4
1934	29·0	46·6	54·1	54·8	44·4
Average ..	19·1	24·6	23·4	23·2	18·2

The above figures show that the best date for stump planting *Pterocarpus marsupium* at Kannoth is the middle of May. Planting on this date gives roughly the same stocking and an increased height growth of 28 per cent when compared with normal early June planting.

(For full experimental data see paragraph 345.)

100. *Terminalia crenulata.*—Experiments with this species at Kannoth have been done for the last three years. Results as judged at the end of the first growing season after planting are given in an abbreviated form as follows :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	12	64	82	74	58
1936	78	88	84	94	88
1935	62	48	92	64	72
Average ..	51	67	86	77	73

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	30·7	29·2	28·5	20·3	16·2
1936	27·6	24·8	24·9	19·8	18·1
1935	14·8	16·2	15·4	14·3	10·0
Average ..	24·4	23·4	22·9	18·1	14·8

The above figures show that very early May is the best time for stump planting *Terminalia crenulata* at Kannoth. Planting at this time gives less chance of poor stocking and an increased height growth of 55 per cent when compared with normal early June planting.

(For full experimental data see paragraph 346.)

101. *Artocarpus hirsuta.*—Experiments in the early stump planting of this species have been done at Kannoth for the last four years. Results as judged at the end of the first growing season after planting are as follows :—

Year of experiment.	Survival percentage of stumps planted on				
	April 15th.	May 1st.	May 15th.	June 1st.	June 15th.
1937	22	50	66	52	50
1936	10	22	99	90	56
1935	8	42	58	20	70
1934	0	6	20	31	48
Average ..	10	30	59	48	56

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 15th.	May 1st.	May 15th.	June 1st.	June 15th.
1937	7·0	8·7	7·7	6·5	5·3
1936	8·6	5·6	7·6	7·5	4·9
1935	3·5	5·6	6·4	5·8	4·7
1934	0·0	12·4	17.6	14·2	15·4
Average ..	4·8	8·1	9·8	8·5	7·6

The above figures show that the best time for stump planting *Artocarpus hirsuta* at Kannoth is the middle of May. Planting on this date gives less chance of poor stocking and an increase in mean height growth of 18 per cent when compared with normal early June planting.

(For full experimental data see paragraph 345.)

102. *Walayar—Palghat division—Annual rainfall* 54 *inches—* ***Elevation*** 300 *feet.*—Experiments in the early stump planting of

teak at Walayar have been done for the last four years. Results as judged at the end of the first growing season after planting are given below in an abbreviated form :—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	92	96	87	72	92
1936	70	53	69	93	67
1935	22	40	29	32	58
1934	83	80	86	95	94
Average ..	67	67	68	73	78

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1937	40·0	41·8	23·4	17·7	19·3
1936	35·9	30·0	26·2	33·1	20·3
1935	14·6	14·9	14·0	13·7	10·7
1934	16·6	13·3	16·1	11·9	11·2
Average ..	26·8	25·0	19·9	19·1	15·4

The above figures show that stump planting of teak at Walayar is best done in mid-April. Planting at this time gives a slightly greater risk of poorer stocking but an increased height growth of 63 per cent when compared with normal early June planting.

(For full experimental data see paragraph 317.)

103. *Pre-monsoon stump planting—District work—Kurnool West Division.*—An interesting set of experiments has been in progress in Kurnool West Division in this subject for the past three years. This division has *not* got a West Coast type of climate. It has a hot hot weather with a lack of early showers and the main steady rains do not start until about the middle of July. (In the past three years this date has varied from the 7th July to the 15th July.)

In these experiments stumps have been planted at fortnightly intervals from mid-April to the 1st July. Abbreviated results are as follows :—

Year of experiment.	Survival percentage of stumps planted on					
	April 15th.	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1935	67	79	81	93	100	95
1936	84	100	99	100	94	81
1937	91	70	90	97	99	89
Average ..	81	83	90	97	98	88

Year of experiment.	Mean height growth in inches of stumps planted on					
	April 15th.	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1935	6·4	5·9	6·1	7·3	9·6	3·9
1936	19·0	22·2	20·4	22·6	12·0	8·8
1937	28·2	17·5	10·7	11·1	16·5	7·2
Average ..	17·9	15·2	12·4	13·7	12·7	6·6

The experiments need further repetition for confirmation but at present there is a very definite indication that planting in the first half of June gives the best results. This date is three weeks to a month before the setting in of the really steady rains. It is particularly noticeable in this set of experiments that although planting earlier than this best date gives very reasonable survivals it only gives a very small increase in height growth and is therefore probably not worth while.

Planting in early June (about a month earlier than normal) gives an increase in survivals of about 10 per cent and of mean height growth of 100 per cent.

104. *Stump planting—Effect of age and diameter of stumps—Teak.*—Three experiments were done in three centres in continuation of the work of previous years. Considering both survival percentage and mean height growth, the work done so far shows that stumps do best if within the diameter range of 0·4″ to 0·8″. Three year old stumps have not done well but within the diameter range mentioned it does not appear to matter whether the stumps are one year or two years old.

The falling off of survival percentage and mean height growth of stumps below this range of size is much more marked than that of stumps above this range, except in the case of three-year old stumps.

Abbreviated results are as follows :—

Survival percentage after one season.

Locality.	Age of stumps.	Diameter of stumps in inches.							
		0·3 — 0·4	0·4 — 0·5	0·5 — 0·6	0·6 — 0·7	0·7 — 0·8	0·9 — 1·0	1·0 — 1·1	1·2 — 1·4	1·8 — 2·0
Dhoni	One year ..	92	..	98	..	96	..	..	..	..
	Two years ..	..	..	..	..	98	96	..	91	..
Topslip	One year ..	..	88	93	87	..	..	..	..	..
	Two years ..	..	90	97	99	94	..	..	..	..
Begur	One year ..	93	..	97	..	93	..	98	..	..
	Two years ..	..	..	..	..	89	..	87	84	..
	Three years ..	..	..	..	..	..	..	..	..	77

Locality.	Age of stumps.	Mean height after one season in inches.								
		0·3	0·4	0·5	0·6	0·7	0·9	1·0	1·2	1·8
		0·4	0·5	0·6	0·7	0·8	1·0	1·1	1·4	2·0
Dhoni	One year ..	41·6	..	45·6	..	45·2	..	..	..	..
	Two years ..	..	..	..	..	38·6	43·1	..	34·8	..
Topslip	One year ..	..	..	13·5	14·4	14·1	..	..	..	..
	Two years ..	..	..	17·3	15·4	13·5	13·4	..	..	..
Begur	One year ..	13·9	..	17·5	..	19·3	..	15·0	..	..
	Two years ..	..	..	..	..	..	13·4	..	12·4	11·8
	Three years ..	..	..	..	..	..	..	..	..	7·6

(For full experimental data see paragraph 347.)

105. *Dalbergia latifolia*.—Experiments were done at Begur, Dhoni and Topslip with this species. One and two year old stumps were used within a range of diameter of stumps from 0·1″ to 0·7″. Results show that the best range of diameter is from 0·2″ to 0·6″. Within this range it does not matter whether the stumps are one year or two years old but of course only a small proportion of one-year old stumps are big enough to be within this range.

Stumps over this maximum diameter although showing good height growth tend to result in a much smaller survival percentage.

Abbreviated results are as follows :—

Locality.	Age of stumps.	Diameter of stumps in inches.					
		0·1 — 0·2	0·2 — 0·3	0·3 — 0·4	0·4 — 0·5	0·5 — 0·6	0·6 — 0·7
Survival per cent after one season.							
Begur	One year	94	96	96			
	Two years	..	88	94	74	72	43
Dhoni	One year	90	89	90	..	..	..
	Two years	..	..	..	86	91	65
Topslip	One year	57	74	..	..	..	..
	Two years	..	73	88	82	66	..
Mean height growth in inches after one season.							
Begur	One year	12·3	12·0	14·1	..	..	..
	Two years	..	9·4	11·0	10·1	9·5	10·2
Dhoni	One year	14·9	19·2	19·6	..	..	..
	Two years	..	..	..	20·4	18·6	24·1
Topslip	One year	7·3	7·8	..	..	..	..
	Two years	..	8·2	8·2	8·3	8·7	..

(For full experimental data see paragraph 348.)

106. *Pterocarpus marsupium*.—Three experiments were done at three centres. Results show that stumps from 0·4″ to 1·0″ diameter do best and that within this range it does not matter whether the stump is one year or two years old. Generally the

older and bigger the stump the better the result. The falling off of survivals and height growth above this range is much slower than it is below this range.

Abbreviated results are—

Locality.	Age of stumps.	Diameter of stumps in inches.						
		0·3 — 0·4	0·4 — 0·5	0·5 — 0·6	0·6 — 0·7	0·7 — 0·8	0·9 — 1·0	1·0 — 1·2
Survival percentage after one season.								
Begur ..	One year	74	96	96	98	..	..	..
	Two years	..	..	96	..	86	80	78
Dhoni ..	One year	80	..	92	..	99	..	..
	Two years	..	..	92	..	89	81	..
Topslip ..	One year	46	73	60	..	..	..	..
	Two years	..	66	76	83	..	..	..
Mean height growth in inches after one season.								
Begur ..	One year	14·5	13·3	13·8	16·7	..	..	..
	Two years	..	..	12·9	..	13·6	15·3	13·0
Dhoni ..	One year	16·9	..	23·1	..	26·4	..	..
	Two years	..	..	29·2	..	28·5	24·8	..
Topslip ..	One year	5·8	7·4	8·2	..	..	..	..
	Two years	..	5·5	6·2	7·3	..	..	..

(For full experimental data see paragraph 349.)

107. *Terminalia crenulata*.—Results with this species showed that stumps from 0·4″ to 0·8″ diameter do best and within this range there is little difference between one year and two years old stumps.

Smaller and larger diameters than this range gave poorer results either in survival per cent or in mean height growth or in both.

Abbreviated results are—

Locality.	Age of stumps.	Diameter of stumps in inches.						
		0·2 — 0·3	0·3 — 0·4	0·4 — 0·5	0·5 — 0·6	0·6 — 0·7	0·7 — 0·8	0·9 — 1·0	1·2 — 1·4
Survival percentage after one season.									
Begur ..	One year	44	66	88	..	70	..	42	..
	Two years	..	..	..	..	88	..	58	8
Dhoni ..	One year	..	68	..	73	..	68	..	..
	Two years	51	61	..	85	..	65	34	..
Topslip ..	One year	..	..	..	73	80	..	..	..
	Two years	..	..	..	70	..	..	28	..
Mean height growth in inches after one season.									
Begur ..	One year	20·7	21·4	23·1	..	22·4	..	18·2	..
	Two years	..	..	..	..	18·6	..	15·0	15·5
Dhoni ..	One year	..	26·7	..	22·8	..	21·3	..	..
	Two years	..	..	..	22·2	..	19·6	18·4	..
Topslip ..	One year	22·8	24·8	..	25·2	25·5	..	..	..
	Two years	..	..	..	24·4	..	..	15·5	..

(For full experimental data see paragraph 350.)

108. *Artocarpus hirsuta.*—Experiments were done at four centres with this species. Results so far show that stumps between 0·3″ and 1·0″ diameter do best and within this range it does not matter whether the stumps are one year or two years old. It should be noted however that only a small percentage of one year old stumps are big enough to come within this range.

Abbreviated results are—

Locality.	Age of stumps.	Diameter of stumps in inches. 0·2–0·3	0·3–0·4	0·4–0·5	0·5–0·6	0·6–0·7	0·7–0·8	0·8–0·9	0·9–1·0	1·0–1·2	1·2–1·4
Survival percentage after one season.											
Begur ..	One year ..	90	92	..	90	..	..	..	..	..	..
	Two years ..	76	78	..	88	..	82	..	..	..	54
Kannoth ..	One year ..	80	92	..	..	..	..	..	..	..	..
	Two years ..	..	62	..	88	70	..	..	90	..	..
Dhoni ..	One year ..	20	..	38	..	60	..	..	..	..	..
	Two years ..	..	..	..	..	53	..	61	..	50	..
Topslip ..	One year ..	27	42	71	..	..	..	..	..	..	..
	Two years ..	..	45	51	..	..	61	..	..	..	..
Mean height growth in inches after one season.											
Begur ..	One year ..	5·8	6·0	..	5·6	..	..	..	..	..	..
	Two years ..	4·0	5·5	..	6·8	..	7·8	..	..	..	6·4
Kannoth ..	One year ..	7·3	9·1	..	..	..	..	..	..	..	..
	Two years ..	..	8·4	..	12·0	10·6	..	..	14·8	..	..
Dhoni ..	One year ..	11·2	..	12·9	..	19·3	..	..	..	..	..
	Two years ..	..	..	..	..	15·9	..	15·8	..	15·0	..
Topslip ..	One year ..	5·0	6·5	6·6	..	..	..	..	..	..	..
	Two years ..	..	4·1	5·1	..	..	6·0	..	..	..	..

(For full experimental data see paragraph 351.)

109. *Stump planting in pits and crowbar holes—District work—Kurnool West Division—Teak (Tectona grandis).*—An interesting set of experiments has been done in Kurnool West Division in this subject during the past three years. This division has *not* got a West Coast type of climate as it has a hot hot weather and a lack of early showers. The main rains set in steadily about mid July.

These experiments have shown that planting in pits as compared with crowbar holes gives no advantage in survival per cent but an increase in mean height growth of 30 per cent at the end of the first growing season after planting. This result has been consistent throughout the experiments. As pitting for planting is much more expensive than making crowbar holes it is for consideration whether the increase in height growth obtained (and hence smaller weeding costs) is commensurate with the extra expense involved.

Abbreviated results are as follows :—

Year of experiment.	Survival percentage. Pits.	Survival percentage. Crowbar holes.	Mean height in inches. Pits.	Mean height in inches. Crowbar holes.
1937	99	99	15·2	12·4
1936	96	93	18·6	14·8
1935	97	98	11·9	7·9
Average ..	97	97	15·2	11·7

110. *Stump planting—Teak—Effect of depth of planting.*—The experiments in this subject were continued and were done at five centres during the year. Four treatments were applied (A) planted on 1st April 1937 normally, (B) planted on 1st April 1937 buried, (C) planted on 1st June 1937 normally and (D) planted on 1st June 1937 buried. In treatments (B) and (D) the stumps were made normally with 1″ of stem and 9″ of root and planted in the ground 1″ lower than they were originally in the nursery, i.e., planted with the top of the stem flush with the ground.

In the late planting (June) the treatment produced no appreciable difference in survival percentage or in mean height growth from the control but the small differences that did occur were all in favour of deep planted stumps.

With the early planted stumps however differences were much greater and in four out of five cases reached significance. We have now done nine experiments in this subject and the averaged results for the early planted stumps show an increase in survival percentage of 14 per cent and in mean height growth of 8 per cent. It therefore appears that it is decidedly beneficial to plant the stumps with the top of the 1″ shoot flush with the ground when doing early planting.

Abbreviated results are as follows :—

Locality.	Survival percentage of stumps planted on 1st April 1936. Buried.	Survival percentage of stumps planted on 1st April 1936. Normal.	Survival percentage of stumps planted on 1st June 1936. Buried.	Survival percentage of stumps planted on 1st June 1936. Normal.	Mean height growth in inches of stumps planted on 1st April 1936. Buried.	Mean height growth in inches of stumps planted on 1st April 1936. Normal.	Mean height growth in inches of stumps planted on 1st June 1936. Buried.	Mean height growth in inches of stumps planted on 1st June 1936. Normal.
Begur	97	93	94	92	25·2	16·5	6·8	6·9
Dhoni	95	48	99	96	58·2	47·5	26·4	22·5
Walayar	92	87	90	82	42·6	36·6	18·1	21·2
Topslip	77	79	95	93	17·9	20·6	11·4	9·5
Kannoth	71	43	98	97	29·8	29·2	10·4	9·9
Average	86	70	95	92	34·7	30·1	14·6	14·0
Average of 1936 experiments.	68	55	91	86	32·1	31·4	18·1	17·9
Average of 1936 and 1937 experiments.	77	63	93	89	33·4	30·8	16·4	16·0

The above figures also give another example of the results of extreme early planting compared with normal monsoon planting. The ratio of the mean height growth of early planting to that of late planting is 2·0 : 1.

(For full experimental data see paragraph 352.)

111. It should be noted however that a practical difficulty arises with this method of burying stumps. After planting and before the sprouting of the stumps, an inspecting officer, to make sure that stumps have really been planted, has seriously to disturb them in order to see them. In consequence of this recently in one regeneration area a portion was completely missed out in the original planting and it was not discovered until the replacement of casualities was done.

112. *Stump planting—Storage of stumps—Teak.* In each of three centres, two experiments on the storage of teak stumps were done. In all these experiments teak plants were dug up in the nursery at intervals of five days, made into stumps, tied into bundles and stored in well ventilated rooms. The period of storage ranged from 0 to 35 days. In one set of experiments the stumps were dug up before the plants had sprouted in the nursery and were planted on 10th April 1937 and in the other set the plants were dug up after they had sprouted and were planted on 5th May 1937.

The stumps dug up before sprouting took place stored well for fifteen days except in one case and then very rapidly deteriorated, while those dug up after sprouting, deteriorated much less, storing well for twenty to twenty-five days. There was practically no difference at all in the resulting height growth of all survivals of all periods of storage.

This investigation has been going on for five years and is now concluded. The five years have not been normal and two of them have been very abnormally dry and hot hot weathers.

113. The investigation has conclusively shown—

(i) that teak stumps keep much longer without deterioration if they are dug up after sprouting in the nursery,

(ii) there is no appreciable deterioration in mean height growth due to storage,

(iii) that even in bad years climatically they will keep for two to three weeks without deterioration.

This indicates that even under exceptionally adverse weather conditions they will keep long enough to be sent from any one part of the Presidency to any other without fear of serious deterioration.

(For full experimental data see paragraph 353.)

114. "*Shaving*" *of teak stumps.*—While on tour it was noticed that in some districts while making teak stumps it was the practice carefully to cut off not only strong side roots but also all the small rootlets and root hairs. This besides taking time increases the cost of the stumps. In consequence during the year two experiments were done at Begur and Kannoth comparing the results from such "shaved" stumps with those from which only the strongest of side roots had been cut.

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Results at the end of the first growing season after planting showed that there was no appreciable difference in percentage of survivals and no significant difference in mean height growth between the treatments.

Although these results need confirmation by repetition it appears that the extra care and expense of this operation while making stumps is not economically justified.

115. *Irrigated teak plantations.*—In 1932 experiments were started in the raising of irrigated teak plantations near Mettupalayam after clear felling and burning mixed deciduous forest of poor quality. The area has an average annual rainfall of 56·2″ and most of this comes from North-East monsoon.

Two methods of irrigation have been tried so far (*a*) by flooding (as in paddy cultivation) and (*b*) by percolation from shallow channels, one channel per two rows of teak. The indications so far are that flooding is more difficult and more expensive to do and also uses more water than percolation. There is practically no difference at all in the resulting growth of the teak between the two methods.

116. In the 1936 experiment in one treatment the irrigation was stopped after the first monsoon and the height increments in the second year have been (i) unirrigated 6′·0 and (ii) irrigated 12′.1 thus showing that the effect of irrigation in the second year of the life of a plantation is very marked indeed. It is to be noted that the average height of this plantation at the end of the second growing season after planting is 16′.

117. In the 1937 experiment we are trying the effect of irrigation in the first, second and third years. At the end of the first growing season after planting there was no significant difference in mean height growth between the three treatments so that the experiment has had a promising start.

118. In the 1932 plantation in which irrigation was stopped after two and a half years, it was started again in the fourth year and three treatments applied (*a*) control, (*b*) irrigated by percolation once a week, and (*c*) irrigated by percolation twice a week. During the fifth year the average height increment per tree for the three treatments was (*a*) + 3·18′, (*b*) + 5·68′, (*c*) + 7·12′ and in the sixth year (*a*) 10·6′, (*b*) 11·1′ and (*c*) 9·9′ while the corresponding diameter increment per tree has been in the fifth year (*a*) + 0·65″, (*b*) + 0·76″, (*c*) + 0·79″ and in the sixth year (*a*) + 0·92″, (*b*) + 0·90″ and (*c*) + 0·86″. It thus appears that irrigation is felt in the fifth year but that in the sixth year of the life of the plantation its effect is scarcely felt at all. The indication needs confirmation.

In one irrigation the water is allowed to flow through the area for three hours in the early morning.

119. *Swietenia macrophylla.*—As previous years' work had shown that this species only stumps very poorly, this year's work was confined, to camparing direct sowing with transplanting of various sizes of transplants.

Four experiments were done during the year and in addition four experiments of 1936, three experiments of 1935 and one experiment of 1934 were remeasured.

In general in the 1937 experiments sowing was found to be as good as the results of the best size of transplants and better than the poorer sizes in survival percentage. These excellent results by the direct sowing of mahogany are however abnormal and must be regarded with caution.

120. Comparing, sowing and transplanting, average results in January 1938 are only given for survival percentage as the height growth of transplants largely depends on their initial size.

Year.	Average survival percentage.			Remarks.
	Sowing.	Trans-planting.	Stump-planting.	
1937	75	74	Not done	Four experiments at four centres averaged.
1936	84	53	Do.	Do. do.
1935	36	73	Do.	Do. do.
1934	50	59	8	Two experiments at two centres averaged.
Average ..	61	63	8	Average of fourteen experiments at four centres over four years.

121. Comparing the results of using different sizes of transplants from 3″ to 48″ high it appears that transplants from 18″ to 36″ high do best as far as survival percentage is concerned but their growth shows that they feel the shock of transplanting far more than do the smaller sizes of transplants. The larger sizes of transplants appear to be more susceptible to attacks by both the shoot and collar borers and this is particularly so under evergreen cover. Height increment after the first year is very much the same for all the sizes of transplants.

(For full experimental data see paragraph 311.)

122. *Swietenia macrophylla—Planting in the open.*—Experimental plot 140, Nilambur Division, which was started in 1936 had as its object to determine from the growth and susceptibility to borer attack the best size of transplant and best espacement for mahogany on an area of mixed deciduous forest which had been clear felled and burned. It is a large scale experiment arranged in randomised blocks and consists of espacements of 3′×3′, 6′×6′ and 9′×9′ and three sizes of transplants, 6″ to 12″ and 12″ to 18″ and 3′ to 4′.

At the end of the first year there was very little difference between the treatments but heavy casualities had occurred owing to the exposure of the plot and in consequence a natural shade crop of *Trema orientalis* was allowed to come in.

The plot is now 95 per cent stocked with the *Trema* 16′ high and the mahogany 3′ to 5′ high. It is now a plot of mahogany under a shade crop of *Trema* and looks very promising. Shoot borer attack has almost completely stopped since the shade crop has come in.

123. *Swietenia macrophylla—Planting under an artificial shade crop.*—In Experimental Plot 151, Palghat Division, a shade crop of *Trema orientalis* was raised in 1935 by direct sowing at an escapement of 6′×6′. Owing to monsoon floods and consequent wash of the seeds it developed as a broadcasted crop. In June 1936 the *Trema* was roughly 6 feet high and was underplanted with three sizes of mahogany transplants (i) 5 inches high, (ii) 15½ inches high and (iii) 27 inches high. Results at the end of the first year of transplant however doing slightly the best.

It was obvious during the year that the shade was too heavy for the mahogany, and in May 1937 the *Trema* which was 20 feet high was thinned and reduced to an even 6′×6′ spacing.

Measurement in January 1938 showed the plot to be 94 per cent stocked with mahogany of an average height of 19·1 inches. The *Trema* is also a full crop with an average height of 26 feet. The mahogany is almost entirely free from the shoot borer, in great contrast to the mahogany in the open surrounding the plot which is riddled with the shoot borer.

(For experiments on this pest see paragraphs 147–150.)

124. As a result of the work seen in Bengal three further experiments were initiated during the year in which mahogany is raised simultaneously with the shade crop, and in addition the mahogany is split up into small blocks by other non-meliaceous species. The object is to minimize shoot borer attack by means of the shade crop and to localize collar borer attack by this segregation of the mahogany plots.

These plots are Experimental Plot 40, Wynaad Division, which consists of alternate strips of mahogany and padauk (*Pterocarpus dalbergiodes*) there being five lines of padauk and seven lines of mahogany in the respective strips. The mahogany strips consist alternately of (i) mahogany and *Trema* at alternate stakes and (ii) mahogany and *Trema* in alternate lines. Experimental plot 143, Nilambur Division, is similar but with mahogany and cashew (*Anacardium occidentale*) in alternate strips and Experimental Plot 151, Palghat Division, which is mahogany and teak in alternate strips.

At the end of the year these plots were all fully stocked and looked very promising. The Wynaad Plot was however visited by bison which browsed the *Trema* and by wild elephant which uprooted some of the *Pterocarpus*.

It is too early yet to judge the effect of the shade on the borer pests of the mahogany.

125. *Artificial regeneration of Bambusa arundinacea (in experimental gardens).*—In 1936 experiments were done at Begur and Topslip in which direct sowing planting of one year old transplants

and planting of one and two year old rhizomes were compared. In one experiment transplanting of seedlings gave easily the best results while in the other, rhizome planting proved the superior method.

Two different methods were adopted in the rhizome planting however and further experiments have been started to test these methods. In both cases the seedlings when a few inches high were pricked out at an espacement of 6″×6″ and allowed to develop rhizomes. At Topslip where rhizomes did well, before planting, the shoots were cut off to about 3 inches or less and they were planted deep and if there were a bunch of shoots the small rhizomes were not separated, whereas at Begur where rhizomes did not do well, shoots were left to 6 inches, they were planted at a normal depth and in the case of a clump of shoots the small rhizomes were cut to one piece per shoot.

126. Abbreviated results at the end of the second growing season are as follows:—

Locality.	Treatment.	Survival per cent.	Mean height in feet.
Begur Experimental Garden Experiment 80 ..	.. Sowing	82	11·92
	One-year transplants ..	96	15·38
	One-year rhizomes ..	38	13·30
	Two-year rhizomes ..	45	12·82
Topslip Experimental Garden Experiment 138 ..	.. Sowing	11	9·25
	One-year transplants ..	12	10·50
	One-year rhizomes ..	92	12·75

The experiments were repeated in 1937 with the following results:—

Survival percentage after one season.

Experiment number.	Sowing.	One-year seedlings.	One-year rhizomes split.	One-year rhizomes *not* split.	Two-years rhizomes split.	Two-year rhizomes *not* split.
Begur—107	8	97	80	60	82	42
Topslip—151	17	77	..	86	..	77
167	..	..	..	..	42	43

Mean height growth in inches after one season.

Experiment number.	Sowings.	One-year seedlings.	One-year rhizomes split.	One-year rhizomes *not* split.	Two-year rhizomes split.	Two-year rhizomes *not* split.
Begur—107	11·4	14·5	26·1	22·3	12·2	25·6
Topslip—151	21·2	39·5	..	32·6	..	36·6
167	..	..	..	..	25·5	54·0

It therefore appears that there is very little to choose between transplanting and rhizome planting or between splitting rhizomes and planting them whole. In general it is apparently better to plant whole rhizomes. The result needs confirmation by repetition.

127. *Artificial regeneration of Dendrocalamus strictus (in experimental gardens).*—A similar experiment was done at Begur in 1936 with *Dendrocalamus strictus* and with similar results, i.e., seedlings produced the better result.

Results at the end of the second growing season after planting are as follows:—

One-year seedlings.		One-year rhizomes.	
Survival per cent.	Mean height in inches.	Survival per cent.	Mean height in inches.
69	117·6	46	160·8

128. *Dendrocalamus strictus raising of artificial plantations for study of intensive working.*—In Experimental Plot 160 of Palghat Division an area of half an acre has been raised with this species by the planting of one year old rhizomes. At the end of the first growing season after planting the area is 95 per cent stocked and the plants have an average height of 16·2 inches.

In Experimental Plot 71 of South Coimbatore Division an area of one acre was raised by planting one-year old rhizomes and seedlings in alternate lines. At the end of the first growing season after planting the rhizomes showed a survival percentage of 62 and mean height growth of 15·1 inches while the seedling transplants showed a percentage survival of 43 and a mean height growth of 9·2 inches.

These plantations are being raised for studies of intensive working.

129. *Pterocarpus dalbergioides.*—In 1936 a small plot of this species was raised by transplanting in the ponam working circle of Nilambur Division. (This is in areas unsuited to teak.) At the end of the second growing season after planting the plot showed a survival percentage of 83 and a mean height growth of 6·8 feet. It therefore appears very suitable to these conditions.

130. *Terminalia crenulata—Heredity of "figure."*—For some years we have been trying to collect seed of "figured" *Terminalia crenulata* trees. The procedure has been to blaze all trees of this species in a regeneration area just before felling and collect the seed separately of each tree which from the blaze appeared to be figured. When the tree was felled it was examined for figure.

In this way we have managed to raise a few plants from seed of trees in which the figure went right through from the bark to the heart and from the base to the top. These seedlings were raised in a nursery and stump planted into an experimental plot (No. 38, Wynaad Division) last June. We thus have a plot of one-fourth of an acre of plants grown from the seed of *Terminalia crenulata* trees of proved figure. At the end of their first growing season they averaged 19 inches in height. The object of the experiment is to determine whether the "figure" is transmitted through the seed.

131. *Artificial regeneration of Chloroxylon swietenia.*—The experiments of 1935 and 1936 were observed during the year and

remeasured. In the 1935 experiment casualties have been negligible but the growth is very slow. A number of plants apparently dead last year have put up new shoots from the base. The plot shows a survival percentage of 78 and a mean height growth of 15·3 inches at the end of the third year.

In the further experiment done at Begur in 1936 comparing large and small transplants and large and small stumps of this species, stumps now show a decided superiority over transplants having a survival percentage and mean height growth of 77 per cent and 12·7 inches as against 58 per cent and 12·5 inches.

132. *Castanospermum australe* (*Australian chestnut*).—A small quantity of seed was received from Australia for trial in October 1935. The seed was received too late for direct sowing and in consequence it was raised in a nursery and during the monsoon it was tried by transplanting and stumping.

Stumping failed completely and transplanting has resulted in about 20 per cent survivals with a height growth of 20 inches in two years. Judging by the ease of germination in the nursery it is a species that will do best by direct sowing. The localities of trial were Begur, Kannoth, Nilambur, Dhoni and Topslip.

133. *Araucaria cunninghamii*.—An experiment in the transplanting of this species as one year old transplants 8 inches high in a clear-felled area of mixed deciduous forest gave a survival percentage of 70 with a height growth of 16 inches at the end of the second year.

134. *Lagerstroemia flos reginae*.—An experiment was done at Dhoni during the year comparing direct sowing and transplanting of this species. The result shows that transplanting is very much the more successful method. Stump-planting was unfortunately not done owing to lack of stock.

135. *Terminalia bialata*.—An attempt was made at Kannoth to raise this species by stump-planting. This attempt failed completely as apparently the species does not stump under Kannoth conditions.

136. *Morus indica* and *alba*.—At Nilambur at the request of the Forest Entomologist, Dehra Dun, an attempt was made to raise a plantation of mulberry in order that he might use it to endeavour to establish a colony of *Cedria paradoxa* which is a parasite of the teak defoliator.

As we had no previous experience of mulberry under the climatic conditions of Nilambur various methods were tried. As the plot was in the current district regeneration area it was planted with teak stumps at 6 feet by 6 feet so that if the mulberry failed it would not be a blank in the plantation. In between the teak and also at 6 feet by 6 feet espacement cuttings of *Morus*

indica and *Morus alba* were planted in April 1937. It was anticipated that the mulberry would probably require shade and so in one plot *Trema orientalis* was transplanted in lines 1½ feet away from the mulberry lines and in another plot *Tephrosia candida* was similarly sown. In January 1938 the plot was enumerated and measured and all species were very nearly 100 per cent stocked.

Height growth was as follows:—

Nilambur Experimental Plot No. 111.

Sub-Plot A.		*Sub-Plot C-1.*	
Morus indica	7·6′	*Morus indica*	6·4′
Teak	1·6′	Teak	1·1′
Trema orientalis ..	4·5′		
Sub-Plot B.		*Sub-Plot C-2.*	
Morus indica	6·5′	*Morus alba*	3·3′
Teak	0·9′	Teak	1·7′
Tephrosia candida	7·0′		

It is obvious from this plot that at Nilambur *Morus* can be successfully established with ease and it does not require any shade at all in the first year.

137. *Teak coppice forest Filling in blanks with stumps.*—Observation of Experimental Plot 17, Palghat Division, was continued. In this experiment an attempt was made to fill in fairly small blanks in a teak coppice forest by using teak stumps at the time of felling. This was done in 1926 over one acre. In 1938 after twelve years (i.e., more than one-third of the rotation of thirty years) 55 per cent of the stumps were still surviving but were only approximately three-fourths the girth and three-fourths the height of the coppice poles surrounding them.

Although these stump plants have not taken their place in the crop yet if they survive to the end of the rotation they will coppice and the object of their introduction will have been achieved. This however does not appear likely as they are now very heavily suppressed.

138. *Teak plantation—Casualty replacement—in the second year.*—The investigations into the fate of casualties replaced in the second year of teak plantations in localities having the West Coast type of climate were continued. The indications are that such replacements do not take their place in the crop and are therefore not financially worth while.

The following table shows the results obtained so far. This table shows that many of the replacements die out and that those that survive have not taken their place in the crop at the time of the first thinning which is usually in about the fifth year.

These considerations of course only apply to cases where casualties are comparatively few and not to the wholesale replacement of a failed plantation.

Division.	Experiment number.	Area.	Year of casualty replacement.	Percentage of original plants replaced.	At the end of second year of plantation.		At the end of third year of plantation.		At the end of fourth year of plantation.		At the end of fifth year of plantation.		At the end of sixth year of plantation.	
					Percentage of replacements surviving.	Average height of replacements / Average height of plantation.	Percentage of replacements surviving.	Average height of replacements / Average height of plantation.	Percentage of replacements surviving.	Average height of replacements / Average height of plantation.	Percentage of replacements surviving.	Average height of replacements / Average height of plantation.	Percentage of replacements surviving.	Average height of replacements / Average height of plantation.
		Acs.												
Palghat ..	135		1933	13	77	0·3	62	0·5	50	0·5	43	0·5	13	0·6
Do. ..	140		1934	33	48	0·23	26	0·5	23	0·5	23	0·5	..	..
Coimbatore South ..	61		1934	26	17	0·2	17	0·3	15	0·5	16	0·7	..	..
Palghat ..	145 (1)		1935	19	85	0·2	74	0·5	74	0·3	..	..	..	..
	145 (2)		1935	18	85	0·1	84	0·5	84	0·6	..	..	..	Flat country.
Do	143	3/5	1936	25	99	0·5	67	0·6	..	..	..	..	..	Hilly country.

139. *Casualty replacement—District work.*—Three experiments in Godavari Upper Division have been done and with the same result that the replacements grow up as suppressed stems and never take their place in the main crop.

140. *Effect of taungya (ponam) crops on the growth of teak in a plantation.*—To obtain further evidence of the retarding effect on the height growth of teak of some ponam crops, Experimental Plot 33, Wynaad Division, was started in 1936. This is a repetition of Experimental Plot 17, Wynaad Division, the results of which were reported in the annual reports for the previous two years.

It is a large scale experiment consisting of 28 randomized sub-plots. Four sub-plots to each treatment. In the first year three of the treatments were controls with no taungya crop, three of the treatments were teak with a ponam crop of "ragi" (*Eleusine coracana*) and the seventh treatment was teak with a ponam crop of "dhall" (*Cajanus indicus*).

At the end of the first year results showed that the "ragi" crop had had a retarding effect on the height growth of the teak of 39 per cent while the "dhall" crop had had no effect. There was no difference between treatments in survival percentage.

This substantially confirmed previous years results.

141. The experiment was continued in the second year to see whether this retarding effect of a heavy ponam crop such as ragi (*Crotalaria juncea*) and Boga (*Tephrosia candida*).

Results are best seen from the following table in which the mean height growth of the control is shown as 100 each year :—

	Crop.			Mean height growth.	
	First year.		Second year.	First year.	Second year.
A	Dhall ..	..	Dhall	100	100
B	Ragi ..	..	Sunnhemp ..	59	109
C	Do.	..	Boga .. .. Average 62	89	114
D	Do. ..	..	No crop ..	68	125
E	Control ..	..	Sunnhemp ..	99	101
F	Do. ..	..	Boga .. .. Average 102	97	127
G	Do. ..	..	Control ..	100	100

It should be noted that during the second year when the cultivators were not in the area all the three cover crops attracted game such as deer and bison. All the cover crops were repeatedly browsed down to the ground and much damage was done to the teak by breaking and trampling.

The general result of the experiment is that all the crops used were bad for the teak but of all the crops used the retardation of growth was greatest with a crop of ragi. It is a dense crop and causes intense competition with the teak in the first year.

(For full experimental data see paragraph 351.)

142. *Effect of planting distance on the height growth of the teak and on weeding costs.*—Experimental Plot 21, Wynaad, in which planting at 3 feet by 3 feet is compared with that at 6 feet by 6 feet was remeasured. It is now four years old. There is no appreciable difference in survival percentage but the 6 feet by 6 feet teak is significantly ahead in mean height growth to the extent of 16 per cent. Weeding costs in the 6 feet by 6 feet area are in the proportion of 1·8 : 1 to those in the 3 feet by 3 feet area.

Both sets of plants are now definitely above weed growth except for occasional plants and the indication is that the extra cost of planting at 3 feet by 3 feet is not offset by the saving effected on weeding by the closer planting. The effect on height growth up to four years is small.

It should be noted however that the area is a poor one and growth in the first four years has been slow.

The growth of the teak at four years old is seen from the following figures :—

	Planting distance.	
	3 feet × 3 feet.	6 feet × 6 feet.
Mean height in feet	26·2	17·1
Mean diameter in inches	2·19	3·75

143. *Regeneration of swampy localities.*—In the Plantation Working Circle of Mount Stuart (South Coimbatore division) small swampy areas frequently occur. These are unfit for teak planting and during the year an experiment was started to try and regenerate such areas with *Lagerstroemia flos reginae*. At the end

of the year the plot was 57 per cent stocked and looked quite promising.

III. *Regeneration of semi-evergreens after clearing and burning what is now deciduous forest.*—In Experimental Plots II, Wynad Division, and 153, Palghat division, an attempt was made on the lines of Bengal practice to raise evergreens after clear-felling and burning the secondary regrowth resulting from old shifting cultivation. This secondary regrowth is deciduous on areas that were originally probably evergreen. The localities were Kannoth and Dhoni.

In both the experiments *Hopea parviflora*, *Mesua ferrea* and *Artocarpus hirsuta* were raised (i) under a cover crop of *Tephrosia candida*, and (ii) under a shade crop of *Trema orientalis*.

The tentative conclusions from these experiments at the end of the first year are:—

(i) *Artocarpus hirsuta* grows best without such a cover or shade crop.

(ii) Both *Hopea* and *Mesua* can probably be raised in such localities under a cover crop of *Tephrosia candida*.

(iii) The shade crop of *Trema orientalis* is however not sufficient in the first year and it is unlikely that species such as *Hopea* and *Mesua* will survive in this way.

145. *Mixed deciduous forest of good quality—Entomological work*—(i) *Teak defoliators.*—The Forest Entomologist, Dehra Dun, maintained an insectary at Nilambur during the year from 28th April to 1st November 1937, for the purpose of trying to breed and release parasites of the teak defoliators. These attempts were generally successful in the introduction of Indian parasites normally absent at Nilambur but generally unsuccessful in the introduction of parasites from Burma.

146. From the point of view of local officers one of the most interesting results is the listing of plants which are to be desired and which are not to be desired in teak plantations from the point of view of defoliator parasites. They are as follows:—

(*a*) Species of plants that are desirable in teak plantations because they are the food plants of defoliators that are alternative hosts of parasites of *machaeralis* and *puera*—

Achyranthes aspera, *Anthocephalus cadamba*, *Bauhinia racemosa*, *Bahmeria malabarica*, *Bahmeria platyphylla*, *Berhavia diffusa*, *Borassus flabellifer*, *Cascaria graveolens*, *Cascaria tomentosa*, *Cassia fistula*, *Cedrela toona*, *Celastrus paniculata*, *Dalbergia sissoo*, *Diospyros montana*, *Diospyros tupru*, *Ehretia laevis*, *Elæodendron glaucum*, *Eugenia operculata*, *Flemingia*

chappar, ***Flemingia paniculata***, ***Grewia*** sp., ***Helicteres isora***, *Holarrhena anti-dysenterica*, *Homalium tomentosum*, *Jasminum pubescens*, *Lagerstræmia flos reginæ*, *Lagerstræmia lanceolata*, *Lagerstræmia parviflora*, *Leea* spp., *Morus alba* and *Morus indica*, *Ougeinia dalbergioides*, *Pavetta indica*, *Peristrophe bicalyculata*, *Pterospermum rubiginosum* (or *reticulatum*), *Solanum indicum*, and *Solanum torvum*, *Swietenia macrophylla*, *Terminalia belerica*, *Terminalia paniculata*, *Xylia xylocarpa*.

Crops in taungya or neighbouring agricultural land.—Cotton, rice, sugarcane, tobacco.

(*b*) Species of plants that are undesirable in teak plantations because they are alternative food plants of *machaeralis* or *puera* or of other pests of teak—

Callicarpa arborea, *Callicarpa lanata*, *Gmelina arborea*, *Macaranga roxburghii*, *Premna latifolia*, *Vitex negundo*, *Vitex peduncularis*, *Lantana camara*.

(*c*) Of the above species, the potentially most useful plants are those that support defoliators which are alternative hosts of parasites common to both *machæralis* and *puera*, e.g., *Achyranthes aspera*, *Bœrhaavia* sp., *Helicteres isora*, *Holarrhena antidysenterica Morus alba*, *Ricinus communis*, *Xylia xylocarpa*.

147. (ii) *Swietenia macrophylla—Shoot and collar borers.*—A series of twenty-one experiments was continued during the year to endeavour to determine the seasons of infection and the incidence of the two main pests of mahogany, the shoot borer (*Hypsipyla robusta* Moore) and the collar borer (*Pagiophlœus longiclavis*, Mshl.) under different conditions of environment. The experiments are at six centres, two of which are in evergreen forests and the remainder in deciduous forest. The ages of plants experimented with vary from one to five years and the conditions are evergreen top canopy cover, clear-felled evergreen followed by a cover crop, clear-felled deciduous forest, mahogany in the open, under an artificial shade crop of *Trema*, and natural regeneration under the shade of mother trees.

148. At the end of the year these observations were sent to the Forest Entomologist, for his criticisms and deductions which are as follows:—

(*a*) *Hypsipyla robusta (shoot borer).*—The local incidence is less at high elevations (about 2,500 feet) and probably because the life cycles are longer and fewer. There does not appear to be a particularly prolonged cold weather generation below 500 feet.

(*b*) The incidence is definitely minimized by shade, i.e., by

(i) mother trees over natural regeneration,

(ii) closed *Trema* shade,

(iii) evergreen top canopy shade,

(iv) in very young crops by a Boga cover crop which is actually shading the mahogany.

(*c*) the incidence in a two-year old crop is higher than in a one-year old crop irrespective of locality.

(*d*) Pruning attacked shoots did not prevent subsequent attacks on the sample trees, because the borers so destroyed were only a small fraction of the local population.

(*e*) The apparently greater incidence in pruned crops is probably due to the stimulation of new growth as a result of pruning.

Pagiophlaeus longiclavis (*collar borer*).—There are indications that the incidence is minimized by shade and also that the incidence in two to four year old crops is higher than in one-year old crops. (This latter effect is probably due to the size of the plant. In Bengal the collar borer attack falls off after about the 5th year.)

149. *General.*—Difficulty has been experienced during the year in this work as it has been found that the collar borer is also breeding in the shoots and hence differentiation between the attacks of the two pests has not been easy.

Another difficulty we have experienced is that even in stems removed as soon as the first outward signs of collar borer attack at the collar were apparent it has been found that the majority of the borers had already emerged.

150. *Sack banding of mature meliaceous trees.*—Four further experiments were carried out to endeavour to determine the extent of infection of mature meliaceous trees in the neighbourhood of mahogany plantations. This was done by sack banding such trees.

So far although the trees have been observed through two flowering seasons only negative results have been obtained. This year during the flowering season the trees were climbed and the incidence of shoot borer attack was found to be very small indeed.

It thus appears that we must look elsewhere for the breeding material of this pest.

151. (iii) *Phassus malabaricus.*—At the request of the Forest Entomologist, Dehra Dun, three experiments were undertaken to find out the efficacy of a simple control method for this pest. This method consisted in putting a twig with a blob of tar on the end into the hole in the stem made by the insect. In apparently 80 per cent of the cases the insect was killed by this method

The success was probably greater than this as in the rest of the cases the insect was merely unaccounted for.

As the insect is believed to have an annual life cycle with the moths emerging in May/June the method appears cheap and practical.

In Madras however this pest does not attack severely any of our main timber species.

The experiments were done with *Phassus* on *Trema orientalis.*

(*b*) *Evergreen rain forests.*

152. All the artificial regeneration experiments done in evergreen rain forests with the exception of one (Experimental Plot 27, Wynaad, and Experimental Plot 70, South Coimbatore Division—Raising of evergreens after clear felling and burning with and without cover crops) have been planting under shade and are therefore reported in Part (ix) of this chapter "Underplanting" below (paragraphs 221 to 241).

(*c*) *Dry fuel forests.*

153. *Direct sowing in a burned over area—Best season.*—Remeasurement of experiments 84 to 89, Emmanur Experimental Garden, at the end of the second rains showed that the best season for direct sowing in 1936 was June to July, but several species showed a secondary best date in early September though these results were not nearly as good as those from the August sowings in point of view of height growth.

(For full experimental data see paragraph 355.)

154. A repetition of the above experiment was made in 1937 with thirteen species *Acacia arabica*, *Acacia ferruginea*, *Acacia planifrons*, *Albizzia amara*, *Albizzia lebbek*, *Cassia auriculata*, *Pterocarpus santalinus*, *Terminalia chebula*, *Acacia auriculiformis*, *Acacia sundra*, *Prosopis juliflora*, *Azadirachta indica* and *Cassia siamea*. Measurements in January 1938 showed the best date of sowing to be June to July with a secondary best date in early October for some species.

(For full experimental data see paragraph 356.)

155. This best date of direct sowing is one of the most important and most controversial items of district rab work in the dry fuel forests. Experiments in this subject have been done at Emmanur Experimental Garden since 1934 and results up to date are given below in an abbreviated form. The measurements of survival percentage and mean height growth are given for the experiments of 1934, 1935 and 1936 at the end of the second

growing season after sowing. At this stage the plants are established and this time also coincides with the time at which in most districts tending of rab plots is discontinued.

Survival percentage of sowings on

Year of experiment.	April 1st.	May 1st.	June 1st.	July 1st.	August 1st.	September 1st.	October 1st.	November 1st.	Remarks. Average of
1934 ..	..	..	13	16	18	19	30	22	Four species. *
1935 ..	..	12	24	48	60	57	57	50	Five species. *
1936 ..	..	..	13	46	39	55	25	30	Six species. *
Average ..	..	..	27	37	39	37	31	34	Three years work.*
1937 ..	25	25	14	42	38	39	55	41	Thirteen species.†

Mean height growth in inches of sowings on

Year of experiment.	April 1st.	May 1st.	June 1st.	July 1st.	August 1st.	September 1st.	October 1st.	November 1st.	Average of
1934 ..	..	..	6·8	8·7	11·7	12·4	12·9	12·3	Four species. *
1935 ..	..	..	42·3	34·6	35·6	32·2	33·5	18·5	Five species. *
1936 ..	..	66·8	58·7	52·0	48·7	45·2	37·8	34·2	Six species. *
Average ..	..	..	35·9	31·8	32·0	29·9	28·1	21·7	Three years work. *
1937 ..	21·5	12·0	8·8	7·4	6·2	7·4	4·8	2·6	Thirteen species. †

* After two seasons growth.

† After one season growth.

156. The above figures show that the best date of sowing at Emmanur has been very variable during the past four years and was as follows :—

1934—October 1st.

1935—August 1st.

1936—June to July with a secondary best date in early September.

1937—June to July with a secondary best date in early October.

The advantage of early sowing is best seen by the increase in mean height growth obtained. This compared with normal early October north-east monsoon sowing showed an *increase* in mean height growth of—

	PER CENT.	
1934	0	(best date was October 1st).
1935	7	
1936	48	
Average ..	18	at the end of the second season's growth.

This increase in height growth is of great importance in the struggle against weeds and climbers as soon as tending is discontinued. At the end of the first season's growth the increase in height growth is even more striking being—

	PER CENT.	
1935	110	
1936	450	
1937	70	
Average ..	210	at the end of the first season's growth.

This very great increase in height growth in the first year is very important as it means a reduction of tending and hence cost. It is the realization of this fact that has evolved the practice of sowing in May/June and going on resowing at reasonable intervals until full stocking is obtained. This method is followed by most districts doing really successful rab work (vide Annual Report 1935–36 paragraph 99).

157. These results have all been obtained at Emmanur in North Coimbatore Division and in order to give other districts a climatic comparison, below is given the average monthly rainfall of the place for as long as we have records (i.e., 47 years) together with the monthly rainfall during the years in which the experiments have been conducted. It will be seen that the rainfall of Emmanur corresponds very closely with that of many of the dry districts, particularly with Ayyalur in Madura district where a great deal of dry fuel rab-cum-kumri work is being done.—

Month.	Average monthly rainfall of 47 years.	1934.	1935.	1936.	1937.
January	0·62	2·74	0·14	..	..
February	0·59	..	0·25	3·91	2·68
March	0·80	0·71	..	2·51	0·33
April	2·18	1·43	4·06	0·98	4·02
May	3·42	3·43	1·19	2·61	2·56
June	1·42	1·37	1·61	2·04	1·26
July	1·32	0·64	0·10	1·05	1·53
August	2·62	1·46	2·93	1·48	1·74
September ..	3·60	..	1·54	5·57	3·14
October	7·83	8·80	8·52	6·76	6·42
November	4·70	5·49	1·17	2·63	2·91
December	0·72	..	1·53	1·90	0·23
Total ..	29·82	26·07	23·04	31·44	26·82

It is thus seen that the years of the experiments have been reasonably normal being generally slightly less than the normal.

The exception is the drought in September of 1931; a critical month in this work.

158. *Direct sowing—Comparison of dry and watered beds.*—Experiments 90 to 95, Emmanur Experimental Garden, had as their object to see whether the best date of direct sowing was different when the beds were watered. Remeasurement at the end of the second rains confirmed last year's indication that the best date of sowing is the same whether the beds are watered or not. Of course the stocking of beds is improved by watering and many inter-monsoon casualties are saved.

(For full experimental data see paragraph 357.)

159. This experiment was repeated in 1937 in experiments 152 to 163 and 187, Emmanur Experimental Garden, with thirteen species and with a similar result. The species experimented with are—

Acacia arabica, *Acacia ferruginea*, *Acacia planifrons*, *Albizzia amara*, *Albizzia lebbek*, *Cassia auriculata*, *Pterocarpus santalinus*, *Terminalia chebula*, *Acacia auriculiformis*, *Acacia sundra*, *Cassia siamea*, *Prosopis juliflora* and *Azadirachta indica*.

(For full experimental data see paragraph 358.)

160. *Direct sowing—Comparison of (A) not burning but soil working, (B) not burning and no soil working, (C) burning and soil working and (D) burning and no soil working.*

(*Note.*—In the experiments described in this section the soil working is that done before sowing and is not soil working or "soil aeration" done after germination.)

In Experiments 103 to 108, Emmanur Experimental Garden of 1936, four treatments were applied, in two of which the area was burned and the ash worked into the soil before sowing and in the remaining two, no burning was done. In each of these two pairs of treatments in one the soil was worked 9″ × 9″ × 6″ at each patch before sowing and in the other only enough soil working to sow the seed was done.

Remeasurement in January 1938 showed that the percentage survivals and mean height of all six species were much better in the two treatments which were burned than in the two unburned areas, and also similarly the soil working had produced better results than the areas not soil worked. The species concerned are *Acacia leucophloea*, *Acacia planifrons*, *Albizzia amara*, *Cassia siamea*, *Dolichandrone crispa* and *Wrightia tinctoria*.

Results averaged for all six species together with results of previous experiments are given below. These results are up to the end of the second growing season after planting by which time the plants are considered to be established.

Survival percentage at the end of the second growing season after sowing.

Year of experiment.	Number of species averaged.	Area not burned.		Area burned.	
		Marked Worked plots.	No soil working.	Worked pits.	No soil working.
1936	6	18	11	42	41
1935	6	20	7	47	25
1934	4	8	14	29	45
Average ..	..	15	11	39	37

Mean height growth in inches at the end of the second growing season after planting.

Year of experiment.	Number of species averaged.	Area not burned.		Area burned.	
		Worked pits.	No soil working.	Worked pits.	No soil working.
1936	6	15·3	14·7	25·3	25·8
1935	6	14·7	9·3	19·2	17·1
1934	4	13·7	10·1	14·8	10·4
Average ..	..	14.6	11·4	19·8	17·8

(For full experimental data see paragraph 359.)

161. The experiment was repeated in 1937 (Emmanur Experimental Garden Experiments, 171 to 176) with six species. Measurements in January 1938 show that both in percentage of survivals and mean height growth the plants of all six species were better in the burned areas than in the unburned areas.

The species used were *Acacia planifrons*, *Albizzia amara*, *Cassia auriculata*, *Cassia siamea*, *Dolichandrone crispa* and *Zizyphus jujuba*.

Results averaged for all six species are—

	Area not burned.		Area burned.	
	Worked pits.	No soil working.	Worked pits.	No soil working.
Percentage survivals	55	61	54	62
Mean height growth in inches ..	2·5″	2·5″	5·6″	4·7″

(For full experimental data see paragraph 360.)

Combining all the above results we have very definite indications that burning is essential and that soil working before sowing is decidedly beneficial.

162. *Comparison of sowing, entire transplanting and stump planting.*—Experiments 113 to 115, 117, 118, 120, 124 and 126 in which eight species were experimented with by the above three methods of regeneration were remeasured at the end of the second growing season (i.e., January 1938). These were the experiments out of Experiments 109 to 126 of last year in which there was any doubt as to which was the best method of regeneration for the species.

The remeasurement after a further year showed that *Wrightia tinctoria*, *Albizzia lebbek* and *Albizzia amara* were best by sowing but fair by both the other two methods. *Azadirachta indica* was best by sowing but fair by transplanting and *Dolichandrone crispa*, *Feronia elephantum*, *Holoptelia integrifolia* and *Soymida febrifuga* were all best by transplanting but very fair by stump planting.

(For full experimental data see paragraph 361.)

163. The experiment was repeated in 1937 in Emmanur Experimental Garden Experiments 180 to 185 with six species all of which either stump or transplant well or which often do not do well by sowing. Results showed that *Azadirachta indica*, *Hardwickia binata* and *Soymida febrifuga* did best by stump planting and were fair by transplanting and *Dolichandrone crispa* was best by stump planting and also fair by both the other methods. *Wrightia tinctoria* and *Pterocarpus santalinus* were best by transplanting and the former fair by both the other methods and the latter fair by sowing.

164. Considering these indications with those of the past few years we get the general conclusion that in this work direct sowing gives the best results for most species that are being commonly used in district rab work. Transplanting and stump planting are only suitable for a very few species and owing to the vagaries of the climate in these dry districts are unreliable methods.

(For full experimental data see paragraph 362.)

165. *Comparison of stump planting and transplanting.*—Experiments 99 to 101, Emmanur Experimental Garden, had as their objects (*a*) to find the best season for stump planting, (*b*) to compare stump planting and transplanting and (*c*) to compare transplanting at the commencement of the south-west and north-east monsoons.

Three species were experimented with, *Azadirachta indica*, *Feronia elephantum* and *Soymida febrifuga*. These species either transplant or stump well or else give very variable results by sowing.

Remeasurement at the end of the second growing season after planting showed with all species that transplanting in the north-east monsoon in early October was better than transplanting in the south-west monsoon and also better than stump planting on any date from 1st July to 1st October. Two-year old stumps were better than one-year old stumps and that 1st August and 1st October were the best dates for stump planting.

(For full experimental data see paragraph 363.)

166. The experiment was repeated in 1937 (Emmanur Experimental Garden Experiments 177 to 179) with *Soymida febrifuga*, *Pterocarpus santalinus* and *Wrightia tinctoria*. Measurements in January 1938 again showed that transplanting is better

lone in the north-east monsoon than in the south-west monsoon. They also again showed that two-year old stumps are better than one-year old stumps, and that the best time for stump planting is September/October.

(For full experimental data see paragraph 364.)

167. *District work—Rab-cum-kumri* (*taungya*).—This work which consists of rab regeneration combined with the growing of field crops has made great strides and is now standard practice in a number of the dry fuel districts.

It was described in detail in the report for 1936–37, paragraphs 131 to 141. The great advance that has been made in this work is the care taken in piling and burning the slash. In current practice most of the rab lines get a very fair burn and great care is taken not recklessly to burn over stools of good species. In paragraph 136 of the report mentioned above it was stated that 50 per cent of the good stools were killed by the general burn. It is now found that the burn can be done efficiently for both the field crop and also the forest crop with a mortality of good stools of only 10 per cent to 20 per cent.

Another fact that has come up for consideration in detail is the tending (such as climber cutting) that is needed in the third and fourth years. At present this tending has got to be done but it could be avoided by allowing the ryot to cultivate a field crop in the third and fourth years. This they are in general willing to do.

168. *District rab work—Chittoor Division.*—This division reports that in two of its ranges where after some five years' work it is found that early showers are generally absent, it is now finding that the best date of sowing is August and not June, but in the case of these August sowings it has been found that it is very important to do soil working and a mixing of the ash from the burn into the soil in May, June and July in order to make use of and "fix" the rain from any showers that occur in the period before sowing.

169. In Chittoor Division also *Wrightia tinctoria* and *Dolichandrone crispa* have in general not fulfilled their early promise and have been given up in favour of *Pongamia glabra* and *Cleistanthus collinus*. *Acacia ferruginea* is now being used in place of *Acacia sundra*.

Tephrosia purpurea has been introduced very successfully as a shade for *Pterocarpus santalinus* seedlings and also as a soil improver.

170. Marked success has also been obtained in the reclamation of *Strobilanthes* areas in Chittoor Division. The *Strobilanthes* is cut and burned in lines one chain apart in two directions at right angles. This work has been going on for some years now and so far the pest has not reinvaded the areas and *Albizzia lebbek*, *Albizzia odoratissima* and *Hardwickia binata* seedlings are appearing naturally in the interspaces.

171. *Plantations for manure leaves.*—Regeneration of *Poinciana elata* by cuttings. In the past two years some interesting and successful work has been done in the raising of plantations for manure leaves by the use of large cuttings of *Poinciana elata*. This work has resulted in plantations varying from 59 per cent to 71 per cent stocking at the end of the second growing season and looks very promising.

In consequence, during the year at Emmanur Experimental Garden, experiments were started to find out (i) the best date of planting, (ii) the best depth of planting and (iii) the best size of cutting to use. Parallel experiments were also done in the plantations of South Salem Division.

172. In the experiments on the best date of planting, cuttings 3 feet long and 8 inches mid-girth were planted on the 1st of each month from June to October 1937.

Results in January 1938 are as follows :—

Locality.		Survival percentage of cuttings planted on				
		1st June 1937.	1st July 1937.	1st August 1937.	1st September 1937.	1st October 1937.
Emmanur Garden.	Experimental	58	30	62	28	98
South Salem division	..	68	58	72	96	82
	Average ..	63	44	67	62	90

173. In the experiments on the best depth of planting, cuttings 4 feet long and 8 inches mid-girth were planted on 2nd July 1937 to three depths (*a*) 9 inches deep, (*b*) 18 inches deep and (*c*) 3 feet deep. Results in January 1938 are as follows :—

Locality.	Survival percentage of cuttings planted to depths of		
	9 inches.	18 inches.	3 feet.
Emmanur Experimental Garden	14	50	78
South Salem division	58	74	86
Average ..	36	62	82

174. In the experiments on the best size of cutting, cuttings of three sizes (*a*) 6 feet long and $1\frac{1}{2}$ inches mid-girth, (*b*) 3 feet long 8 inches mid-girth and (*c*) $1\frac{1}{2}$ feet long and 6 inches mid-girth were planted to a depth of 1 foot on 5th July 1937. Results in January 1938 were as follows :—

Locality.	Survival percentage of cuttings of the following sizes.		
	Big.	Medium.	Small
Emmanur Experimental Garden	78	14	26
South Salem division	68	53	24
Average ..	73	34	35

All the above results must be regarded with caution as the full effect of the hot weather had not been felt at the time of measurement but the preliminary indications of the experiments are that the bigger the cuttings and the deeper they are planted the better the results. With regard to the best date of planting we cannot judge the results until another year has passed as it is doubtful if all the October plantings are established.

175. Vellore West Division reports the successful raising on very poor areas of plantations for manure leaves of *Cassia siamea* and *Poinciana elata* from direct sowings.

It is important to note that the easiest method of raising this *Poinciana* is by large cuttings (vide paragraph 174) but it is difficult to obtain these cuttings in large quantities, hence the necessity of using sowing and the importance of its success.

176. *Artificial regeneration of Shorea talura.* As the natural reproduction of this species was found almost absent in most of the *Shorea* patches in North Salem Division, experiments were continued during the year to find out the best method of regenerating the species.

During the year the experiment was carried out only in one locality at Deverbetta centre in Thalli Reserved Forest over 6 acres. The following table shows the details of work carried out and results obtained so far :—

Locality.	Nature of sowings.	Date of sowing.	Number of patches sown.	Number of seeds sown.	Number of seedlings germinated.	Percentage of germination.	Number of survivals in March 1938.
Thalli Reserved Forest.	(i) Small patches of 1′ diameter.	18th to 20th May 1937.	2,092	12,552	4,820	38	2,337
	(ii) Big patches. 5′ × 5′.	Do.	378	11,340	4,038	36	2,687

1936 *Shorea talura regeneration plots.*—The results of survivals in each plot at Javalagiri and Thalli are given below :—

Locality.	Nature of survivals.	Date of sowing.	Number of patches sown.	Number of survivals in March 1937.	Number of survivals in March 1938.
Thalli Reserved Forest.	(i) Sowings in rab patches.	14th May 1936.	30 rabs.	204	72
	(ii) Line sowings ..	Do.	17 lines.	216	139
	(iii) Sown in ordinary patches.	Do.	174 patches.	278	92
	(iv) Under mother trees.	Do.	4 trees (160 seeds).	8	4
Javalagiri Reserved Forest.	(i) Sowings in rab patches.	20th May 1936.	50 rabs.	160	65
	(ii) Line sowings ..	Do.	3 lines.	262	152
	(iii) Ordinary patches.	Do.	77 patches.	75	32
	(iv) Under mother trees.	Do.	6 trees (450 seed-).	36	14

The seedlings have passed through two growing seasons and their maximum height at Devarabetta centre (Thalli Reserved Forest and unreserve) is 8 inches and at Javalagiri is 6 inches.

177. *Cassia auriculata (Avaram).*—Guntur, Chittoor, Madura and Vellore East divisions all report success in the introduction of

this species by sowing in very poor areas after a very poor burn. No difficulty is therefore anticipated.

Salem Central reports the successful introduction of *Cassia auriculata* grown in a taungya crop of horsegram (*Dolichos biflorus*).

178. *Santalum album*—*Stump planting*—*General.* At Denkanikota to provide material for the spike disease research works, between May and October 1937, 2,477 sandal stumps were planted and of these 2,328 or 94 per cent stumped successfully. These figures give a general idea of the success of this method of regeneration of this species.

179. *Storage of stumps.*—At Denkanikota last year's experiment to find the best method of storing sandal stumps and the period for which they can be safely kept was repeated.

The experiment was started on 8th June 1937 and 100 stumps were prepared on this date, 50 were kept in air-tight tins and 50 in a gunny bag hung up from the roof of the store shed. On every alternate day, 100 stumps were prepared and packed as detailed above and this was continued till 28th June 1937 for twenty days and on 28th June 1937, all these stumps were planted separately.

Of each set 25 were watered on alternate days and 25 were not watered.

The same experiment was repeated in October 1937 on the same lines.

The results are detailed below :—

Percentage survivals of stumps.

Season when the experiments were done.	Date of stumping.	Date of planting.	Period of storage in days.	Watered		Not watered	
				Kept in tins.	Kept in gunny.	Kept in tins.	Kept in gunny.
June 1937 ..	28th June 1937.	28th June 1937.	..	58	58	36	36
	26th June 1937.		2	92	12	8	..
	24th June 1937.		4	72	48	48	12
	22nd June 1937.		6	72	24	40	..
	20th June 1937.		8	60	48	32	8
	18th June 1937.		10	92	36	15	8
	16th June 1937.		12	88	40	68	..
	14th June 1937.		14	76	8	28	..
	12th June 1937.		16	48	32	28	..
	10th June 1937.		18	88	44	72	4
	8th June 1937.		20	88	16	40	..
October–November 1937.	8th November 1937.	8th November 1937.	..	20	20	20	20
	6th November 1937.		2	24	4	8	
	4th November 1937.		4	16	8	12	..
	2nd November 1937.		6	16	4	8	..
	31st October 1937.		8	52	32	40	24
	29th October 1937.		10	48	..	24	4
	27th October 1937.		12	44	20	24	4
	25th October 1937.		14	20	4	12	..
	23rd October 1937.		16	32	..	12	..
	21st October 1937.		18	44	..	24	..
	19th October 1937.		20	48	..	24	..

180. *Transport of stumps.*—Last year's experiments to test the possibilities of the transport of sandal stumps to different places were repeated and in the south-west and north-east monsoons (24th June 1937 and 10th October 1937) consignments of stumps were sent from Denkanikota to Emmanur. Each consignment consisted of 400 stumps which were as follows :—

(A) one and a half to two years-old packed in tins ;

(B) one and a half to two years old packed in gunny ;

(C) two and a half to three years old packed in tins ; and

(D) two and a half to three years old packed in gunny.

In addition, a parallel control experiment was similarly done in Denkanikota. The results of the experiments are given in the following table :—

Date of making stumps at Denkanikota.	Age of stumps.	Denkanikota.			Emmanur.		
		Date of planting.	Percentage of sprouting of stumps stored in		Date of planting.	Percentage of sprouting of stumps stored in	
			Tins.	Gunny.		Tins.	Gunny
24th June 1937.	Two and a half years.	26th June 1937.	25	16	27th June 1937.	2	..
28th October 1937.	One and a half to two years.	30th October 1937.	48	4	2nd November 1937.	20	12
	Two and a half to three years.		58	8	Do.	26	20

181. The results of the work done so far in this subject indicate (1) that sandal stumps can be safely stored in tins for three weeks before planting and still give nearly as good results as fresh stumps, (2) that stumps stored in gunny deteriorate very rapidly (in less than a week), (3) that watering every alternate day is very beneficial, (4) sandal stumps can be sent to comparatively distant places without serious deterioration, (5) packing in tight tins gives much better results than packing in gunny, (6) two and a half to three-year old stumps give better results than one and a half to two-year old stumps and (7) the north-east monsoon is a better time to send the stumps than the south-west monsoon.

182. *Influence of hosts on the seeding of Santalum album.*—A small scale field experiment was carried out at Denkanikota in the *Melia azadirach*—sandal group plot. Two sandal plants in association with hosts of *Melia azadirach* were kept under observation and seeds from these two sandal plants were daily collected in the spring crop and the yield was $5\frac{1}{2}$ lb. whereas in the autumn when the hosts were completely dead, practically no seed production was seen.

This confirms the results described in last year's report, viz., that sandal deprived of hosts does not seed at all or seeds only once a year and then only sparsely.

183. *Introduction of grasses into poor grazing areas.* Guntur division reports the successful introduction of *Pennisetum cenchroides* (Kolukattai) and *Eschaemum laxum* (Nendra) in poor grass areas.

184. *Soil working.* Experiments in recent years in our good teak areas have shown that soil working by forking (the miscalled soil "aeration") is of great expense and very doubtful utility. In the last few years in the development of "rab work" in dry fuel forests opinions have differed as to the merits of soil working in these dry areas. In 1935, seven experiments were started to test its efficacy and the results of these early experiments are striking.

Two sets of experiments were done. In the first set, plants were raised on a very poor soil without a burn so that they would be small and need all possible efforts to make them survive the hot weather. In the second set plants were raised on an average soil, regeneration being preceded by a burn, so that the plants would be of reasonable size at the end of the north-east monsoon.

Soil working was done once a month from early December onwards. The operation was done in lines between the plants, care being taken that the soil within 3 inches of each plant was not disturbed. The first operation was a scratching of the soil to a depth of about 1 inch to 2 inches and each further soil working proceeded deeper and slightly farther away from the plant line until a depth of about 9 inches had been reached. (This is district practice in some of the districts producing the best "rabs.")

185. In the set of experiments where plants were initially only 2 inches high in December 1935 and it was unlikely that they would survive the hot weather, in January 1937, one year later, in the treatment where soil working was done, *seven times as many plants had survived* as compared with the control.

With regard to mean height growth, the soil worked plants which started 24 per cent smaller than the control, at the end of one year were 310 per cent taller. With all species the final results were very significant.

Abbreviated results are as follows:—

Emmanur Experimental Garden experiments
Nos. 3-A, B and C.

Species.	Treatment.	Initial—18th December 1935.		Final 5th January 1935.	
		Survival per cent.	Mean height in inches.	Survival per cent.	Mean height in inches.
Average for all three species together.	Control ..	51	2·29	4	6·27
	Soil worked ..	50	1·70	28	25·71

The species used were *Acacia ferruginea* *Albizzia amara*, and *Cassia siamea*.

186. In the second set of experiments when soil working was begun in January 1936 the plants were 9 inches high. At

the final measurement in January 1937 (i.e., one year later) in survival percentage the soil worked plants were 15 per cent better than the control. In mean height growth the soil worked plants were 6 per cent poorer than the control to start with and one year later they were 49 per cent better.

Abbreviated results are given in the table below:—

Emmanur Experimental Garden experiments, 78 to 81.

Species.	Treatment.	Initial—27th January 1936.		Final 12th January 1937.	
		Survival per cent.	Mean height in inches.	Survival per cent.	Mean height in inches.
Average of all four species together.	Control ..	79	9·30	53	25·03
	Soil worked ..	80	8·84	68	37·25

The species used were *Acacia ferruginea*, *Anacardium occidentale*, *Cassia siamea* and *Pithecolobium dulce*.

187. In 1936 a further set of experiments was started in this subject and the conditions of these experiments were made to conform as far as possible with district rab practice. *Acacia ferruginea* and *Cassia siamea* were raised by sowing in May 1936 in two large compact blocks each forty lines of fifteen plants. In July 1936 when stocking was fairly complete soil working was started. The soil working was done in blocks of five lines of fifteen plants each and arranged with the control in the order A B B A, etc. The treatment was applied once a month until the middle of January 1937 when a deep soil working was done and the plots left over the hot weather. Measurements in mid January 1937 at the time of this deep soil working showed little difference in survival percentage between the two treatments, but in mean height growth the soil worked plants were significantly 20 per cent better than the control.

Soil working was repeated before the south-west monsoon, between the monsoons and after the north-east monsoon and the plots finally measured in January 1938. This final measurement showed that the soil working had caused an appreciable increase in survival percentage and in mean height growth, the soil worked plots which initially were the same height as the control were 36 per cent better at the end of the second growing season after sowing.

Abbreviated results are given in the following table:—

Emmanur Experimental Garden experiments 82 *and* 83.

Species.	Treatment.	Initial 11th July 1936.		Final 20th January 1938.	
		Survival per cent.	Mean height in inches.	Survival per cent.	Mean height in inches.
Acacia ferruginea ..	Control ..	73	7·19	78	42·80
	Soil worked ..	77	7·51	83	57·80
Cassia siamea ..	Control ..	96	2·20	62	53·80
	Soil worked ..	88	1·90	92	74·20
Average of both species together.	Control ..	85	4·70	70	96·60
	Soil worked ..	83	4·71	88	132·00

With both species differences are significant.

188. In 1936 also a set of experiments were started in which the soil working was started at the end of January 1937 and done once a month during the hot weather until July 1937, a final soil working was done in December 1937, and final measurements taken in January 1938. These experiments showed that the soil working during the hot weather had had very little effect on survival percentage but had caused a significant increase in mean height growth of 16 per cent.

Abbreviated results are given in the following table: —

Emmanur Experimental Garden Experiments 136 *to* 138.

Species.	Treatment.	Initial on 30th January 1937.		Final on 26th January 1938.		
		Survival per cent.	Mean height in inches.	Survival per cent.	Mean height in inches.	
Acacia planifrons ..	Control ..	66	14·15	64	37·80	
	Soil worked ..	63	14·85	63	40·50	N.S.
Acacia smadra ..	Control ..	55	7·12	54	29·40	
	Soil worked ..	53	6·32	51	36·75	S.
Albizzia amara ..	Control ..	71	10·20	69	35·52	
	Soil worked ..	68	10·46	66	42·00	S.
Average of all three species together.	Control ..	64	10·49	63	34·24	
	Soil worked ..	61	10·71	60	39·75	

S = Significant. NS = Not significant.

189. In 1937 a further set of large scale experiments (Emmanur Experimental Garden Experiments 164 to 166) have been started to confirm the above experimental results.

The work done so far thus shows that in dry fuel forests soil working is very beneficial if plants are small (due to late germination or poor burn) at the end of the rains and results in a very much bigger survival percentage and mean height growth than if no soil working is done. If the rab regeneration has proceeded normally the soil working produces a very much quicker early height growth and this is most important as it considerably reduces the amount of tending that has to be done. The above experiments also show very strikingly that in doing the soil working it is that done between germination and the beginning of the hot weather that counts most. If by the beginning of the hot weather the soil working has got down reasonably deeply, further soil working during the hot weather only produces a slightly further increased height growth.

(vi) Afforestation.

190. *Grassland catchment areas—General.*—Experiments to examine the possibility of re-afforesting some of the important catchment areas of the Nilgiris were continued. The indigenous sholas of these areas are rapidly disappearing, chiefly due to fire and grazing, and in many places have completely degenerated to grass land.

These grass land areas are very poor and very exposed, and regeneration is difficult as we get heavy frosts, followed by a severe drought in the hot weather.

191. We have two main experimental gardens at Jacko's Nullah and Brooklands and these have rather different climates. From 1st April 1937 to 31st March 1938, Jacko had a rainfall of 42·07 inches and 117 rainy days while Brooklands had 63·47 inches in 126 rainy days.

The temperature conditions mentioned last year were all the severer this year, as summarized in the following paragraphs:—

The first frosty night in Jacko's Nullah Experimental Garden was on the 2nd December 1937 with a temperature of 30° F. and in Brooklands Experimental Garden on the same night with a temperature of 28° F. The last frosty night in Jacko's Nullah was on the 1st of March 1938 with a temperature of 31° F. and in Brooklands on the 3rd March 1938 with a temperature of 30° F.

During the cold weather Jacko's Nullah had 29 frosty nights, the lowest temperature recorded being 18° F. on the night of 8th December 1937, and Brooklands had 37 frosty nights, the lowest temperature recorded being 14° F. on the night of the 8th December 1937. It will thus be seen that the conditions under which the experiments were carried out were noticeably hard.

192. *Jacko's Nullah Experimental Garden No.* 1.—In paragraph 164 of the Annual Report for 1936–37 work done in previous years was summarized.

Planting of stumps and cuttings of various species was continued, in addition to sowings of *Mahonia leschenaultii, Hakea saligna, Cytisus scoparius, Acacia mollissima, Acacia decurrens, Morus indica*, etc. For stump planting of *Mahonia lescenaultii, Myrsine wightii, Rubus lasiocarpus, Rubus moluccanus, Hypericum mysorense, Acacia melanoxylon, Acacia dealbata, Berberis tinctoria, Casuarina* (from nursery plants), *Eurya japonica, Cytisus scoparius*, and *Cassia tomentosa*, and planting of branch cuttings of *Ligustrum perrottetii*, and *Buddleia variegata*, various dates of planting were tried from early May to late June. The indications are that of the dates tried, the best date in this locality for *Mahonia, Acacia dealbata, Myrsine wightii, Rubus lasiocarpus, Rubus moluccanus, Hypericum mysorense*, and *Berberis tinctoria*, is about the end of June while for *Buddleia, Casuarina, Acacia melanoxylon* and *Eurya japonica* the end of May was the best. *Cytisus scoparius, Dodonea viscosa* and *Cassia tomentosa* have not grown satisfactorily from stumps.

The 20 feet by 16 feet plots planted in 1936 have done very well under a pandal frost protection, in spite of the severe frost.

193. The indications in this garden are (*a*) that it is essential to plant in conveniently large patches, (*b*) that 10 feet by 10 feet is perhaps the largest convenient size for effective frost protection. (*c*) that the soil should be thoroughly worked in these patches to promote the early formation of a sufficiently deep root system,

(d) that all grass and roots should be removed, *(e)* that *Cytisus scoparius* is the best nurse, and can be successfully raised by broadcast sowings in worked patches without frost protection (though frost protection does result in early enhanced height growth), *(f)* that *Dodonea viscosa* and *Cassia tomentosa* are very badly affected by frost in spite of all precautions and even when saved are not sufficient as a frost protection for other species; and should therefore be discontinued, *(g)* that *Hakea saligna*, *Acacia melanoxylon*, *Acacia dealbata*, *Cupressus macrocarpa*, *Cupressus torulosa*, *Eugenia arnottiana*, *Mahonia leschenaultii*, *Ligustrum perrottetii*, can be successfully raised under the protection of the broom and that frost protection in the first two years by a pandal for these species is necessary if the broom is not sufficiently dense and high.

194. *Jacko's Nullah Experimental Garden No. 2.*—During the year a portion of the District Experimental Plot in Jacko's Nullah was taken over by the Research Branch, and fifteen plots each 22 feet by 15 feet were prepared as indicated above, and planted up with the species mentioned below, in June 1937. At the end of April 1938 a high percentage of survivals has been observed. The plots were protected by pandals throughout the cold weather, and in the succeeding drought.

The following is a list of percentage of survivals in April 1938 :—

	Planted on	Survival percentage
1. Transplants—		
Hakea saligna	10th June 1937.	96
Cupressus macrocarpa	Do.	42
Eugenia arnottiana	Do.	52
Acacia melanoxylon	13th June 1937.	43
Acacia dealbata	Do.	73
Cytisus scoparius	13th and 28th June 1937.	68
2. Forest stumps—		
Acacia melanoxylon	6th June 1937.	55
Mahonia leschenaultii	Do.	77
Rubus lasiocarpus	5th June 1937.	36
Hypericum mysorense	Do.	9
Acacia dealbata	6th June 1937.	17
3. Branch cuttings—		
Buddleia variegata	20th June 1937.	26
Tithonia tagitiflora	21st July 1937.	16

(*Note.*—These *Buddleia* and *Tithonia* cuttings were planted between the beds to serve as a frost protection at a future date. All the *Tithonia* was severely affected by the frost down to ground level and the above 16 per cent are sprouts after the frost. The *Buddleias* are frost hardy.)

195. *Brooklands Experimental Gardens.*—The work of previous years is summarized in paragraph 163 of last year's annual report. It was continued in 1937-38. The very severe frost affected most plants seriously but the garden rapidly recovered, and the indications are that for such extremely severe conditions as are characteristic of the locality the following species are best suited :—

Cytisus scoparius, *Buddleia variegata* as nurses; and *Mahonia leschenaultii*, *Ligustrum perrottetii*, and possibly

Photinia notoniana, *Cupressus torulosa*, *Cupressus macrocarpa*, *Callitris rhomboidea*, *Acacia dealbata*, and *Acacia melanoxylon* as tree species.

In the above list some exotics are included. Though the ultimate object is the introduction of indigenous shola species, it appears that these exotics will serve a necessary intermediate function in moderating climatic influences and thus serving as intermediate nurses. But for this consideration, species such as *Acacia dealbata*, *Callitris rhomboidea*, and *Hakea saligna*, would not have been included here.

Protection against fire and grazing have resulted in the appearance of considerable numbers of *Acacia dealbata* root suckers, which now form dense patches with a height of more than 15 feet.

The broom that has been repeatedly sown since 1934 has also now formed a dense cover in many parts of this experimental garden.

196. The problem of frost protection by nurse species has thus been solved here and under these two species, tree species have been planted on a small scale.

Under the broom we have now got 42 per cent *Hakea*, 42 per cent *Cupressus torulosa*, 59 per cent *Callitris rhomboidea*, and 5 per cent *Ligustrum*. However as the *Ligustrum* is continuing sprouting after the frost, its numbers are expected to increase appreciably. The *Ligustrum* holds great promise elsewhere.

Under the *Acacia dealbata* we have 20 per cent *Hakea*, 42 per cent *Cupressus torulosa* and 10 per cent *Ligustrum*. The same remarks as in the sub-paragraph above apply here also to the *Ligustrum*.

It will be observed that the survivals under the *Acacia dealbata* are poorer than under the broom. This probably is the result of root competition, and it is therefore proposed to thin out the *Acacia dealbata* judiciously, and plant more species (preferably shola species) during the current year.

197. The following general observations in these gardens are of interest :—

(a) *Myrsine wightii*, *Litsea wightiana*, *Mahonia leschenaultii*, *Zizyphus incurva*, *Acacia dealbata*, *Acacia melanoxylon*, *Rubus lasiocarpus*, *Rubus moluccanus*, plants raised from stumps, and *Ligustrum perrottetii* nursery plants (transplants) sprout freely even after being apparently severely affected by frost.

(b) *Rhododendron arboreum* can be successfully raised in these frosty localities by planting forest transplants.

(c) *Hakea* does better when transplanted in prepared plot of moderate size (say 20 feet by 20 feet or 10 feet by 10 feet) and protected by a pandal, than when transplanted into prepared pits, and individually protected by the orthodox Bracken fern frost covering. The reasons may probably be (1) removal of root competition of grass, and (2) the freer air circulation under the pandal than through the Bracken fern.

198. *Regeneration of tree species in patches of natural Gaultheria.*—As reported last year, *Gaultheria*, has been found unsatisfactory as a nurse. Consequently attempts have been made with natural broom. In one case where the broom patch was of sufficient extent, it was found to be a good nurse for *Hakea*. It is however difficult to get broom patches of sufficient size to be an effective protection against frost, unless artificially raised. It is proposed to try gorse (*Ulex europeus*) next year as there are big patches of this species available.

199. *Willows.* Experimental planting of willows was continued.

Salix alba var. *caerulea* (cricket bat willow).—The survivals of the cuttings of this species that were got out from England in 1935 have now survived three frost seasons and are going ahead.

200. *Salix babylonica.* All the plants in all the plots are doing well. In addition, a few cuttings 5 to 7 feet in length have been planted during the year to see if they do better than the smaller cuttings we have already used. They have all sprouted, and look healthy, but their further progress is being watched, especially as regards [illegible] pests, the first frost and probably [illegible] progress achieved in initial sprouting.

[illegible] the best willow sets which have been [illegible] in the above two species have been [illegible] noteworthy advantageous feature is that [illegible] new shoots arise from or near ground level, unlike the other two species. Experiments on the depth of planting cuttings are in progress and the preliminary indications are that they should be planted with only about 1 inch above ground level.

202. *Tan bark. Wattle* (*Acacia decurrens*). In view of the importance of the wattle industry and the quantity imported into Madras annually, the cultivation of *Acacia decurrens* is receiving attention. A comparative note on the growth of wattle in South Mysore and in South India and another note attempting to assess the financial aspect of wattle planting in the Nilgiris and a third note on the Silviculture of *Cassia auriculata* have been written. Experiments in raising *Acacia decurrens* and *Acacia mollissima* from extracted seed, by direct sowing, transplanting and stump-planting are in progress.

203. *Mulberry.* The Forest Entomologist, Dehra Dun, advised the preliminary introduction of mulberries in Nilambur Division

to serve as an alternative host for parasites of the teak defoliators that he wished to introduce there as a biological control. Cuttings for this purpose were obtained from the Sericulturist's gardens at Coonoor, and some of these were utilized in the Aramby Shola nursery beds, and in the Jacko's Nullah Experimental Gardens. Seed was also obtained from Changamanga in the Punjab and sown. A very high percentage of sprouting from all origins occurred. The frost of December 1937 affected most of the plants in spite of pandal covering, but after the frost the plants are sprouting again very vigorously, and the outlook is hopeful, especially as mulberry is reputed to be frost hardy from the second season onwards. If the attempt proves a success, the species will also be useful for growing along fishing streams in the Nilgiris.

204. *Frost protection.*—The general remarks made in paragraph 167 of last year's annual report have received further confirmation this year.

It is further a very noteworthy and significant fact that every one of the *Eucalyptus maculata* transplants planted under the artificially raised patch of broom in the Jacko's Nulla Experimental Garden No. 1 has continued unaffected throughout the severe frost even though no other protection has been given. Some *Hakea* planted under the same broom have also thriven well. These normally tender species have thus successfully come through their second frost season and are now reasonably safe.

205. *General.*—As it has been found that (*a*) sowing or planting in lines or in worked pits fail completely or almost completely as judged by survivals after the first frost and the following drought,

(*b*) protection by Bracken fern is ineffective, judged also by the results of repeated experiments,

(*c*) sowing in worked patches about 10 feet square has succeeded very well especially with *Hakea*,

(*d*) transplanting or stump-planting according to the nature of the species in 10 feet square worked patches have also succeeded well with several species,

(*e*) a pandal protection over the 10 feet squares gives better results as judged by survivals and height growth, than covering individual plants by Bracken fern during frost,

(*f*) natural patches of *Gaultheria* are unsatisfactory as they are themselves severely affected by frost, when they should most afford shelter for foster plants.

(*g*) natural patches of broom of sufficient extent are non-existent, or difficult to get where wanted on the grass areas,

(*h*) dense patches of broom are easily established by broadcast sowings in soil worked patches of sufficient extent even under exceptionally severe conditions of frost,

(*i*) such broom if covered by a pandal in the first year is over 4 feet in height in two years, and about 7 feet in height in three years,

(*j*) such artificially raised broom has proved an effective nurse during frost for tender plants such as *Eucalyptus maculata* and *Hakea saligna*, and

(*k*) natural broom patches in open unprotected places are heavily browsed, and also burnt by annual fires.

206. *The indications of our present knowledge are that a possible solution to the problem of afforesting the grass areas is* (*a*) fencing the selected area, and fire protection by a scraped and burnt fire line,

(*b*) selecting 10 feet square patches inside the fenced area,

(*c*) working the soil 1 foot to 1½ feet deep in such patches, and removing all grass and roots,

(*d*) sowing broom seed broadcast in these patches,

(*e*) covering the broom plants in the patches by a pandal in the first year as this has the effect of forcing the height growth of the broom,

(*f*) then leaving the patch for the second year to establish itself, and

(*g*) planting under this broom other frost tender tree species that we wish to raise.

(vii) Tending, Thinning, Cleaning, etc.

207. *Weeding practice—Teak plantations.*—In teak plantations in a West Coast type of climate the fact that weeding by forking is not superior to weeding by scraping and therefore its great extra cost is not economically justified has been conclusively proved by research results of recent years.

The change over that has been effected from the more expensive forking to the cheaper scraping is of great financial importance because in the formation of a plantation it was the custom to do three of these forkings in the first two years. The difference in cost between a forking and a scraping is roughly Rs. 3 per acre and when it is considered that we are making teak plantations at the rate of 1,400 acres per annum it is seen that the annual saving due to this piece of research alone is Rs. 12,600 a considerable sum of money.

The research has consisted of a number of small scale experiments followed by a series of large scale experiments. The final results of two of the large scale experiments were given last year. This year a third large scale experiment at Topslip has been concluded and a similar experiment at Walayar has reached the end of its first year.

These experiments are all arranged in large randomised blocks in the form of latin squares and each covers an area of approximately 2 acres. They are reported in detail below.

208. In the South Coimbatore experiment (Experimental Plot 65) measurements in February 1937, i.e., at the end of the first growing season after planting showed that there was no appreciable difference in percentage of survivals between the five treatments which were (A) Forking in 4 feet strips, (B) scraping in 4 feet strips, (C) clean scraping, (D) hand pulling of weeds and (E) weed cut control. In mean height growth (A), (B), (C) and (D) were all significantly better than the control (E). In this experiment forking in 4 feet strips was slightly but not significantly better than scraping in 4 feet strips.

Detailed measurements were as follows :—

Treatment.	Survival percentage	Mean height in inches.	Difference of means.	Significance.
A. 4′ forking	93	14·15 ± 0·79	+ 5·86 ± 0·89	S } N.S.
B. 4′ scraping	89	12·30 ± 0·61	+ 4·01 ± 0·73	S } control.
C. Clean scraping	92	11·09 ± 0·57	+ 2·80 ± 0·70	S
D. Hand pulling	90	9·85 ± 0·46	+ 1·56 ± 0·62	S
E. Weed cut control ..	83	8·29 ± 0·41	..	

The actual costs of weeding only at the end of the first year were in proportion :—A : B : C : D : E : : 2·5 : 1·4 : 2·5 : 1·8 : 1·0.

209. The above measurements take us to the end of the first growing season after planting. It has been widely believed that a weeding by forking in the middle of the first hot weather after planting was the most beneficial of all weedings and to test this belief, treatments were repeated in mid-April 1937 and measurements again taken in very early July at the commencement of the monsoon.

Detailed measurements are as follows :—

Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A. 4′ forking	89	47·30 ± 1·57	+ 23·50 ± 1·83	S } S.
B. 4′ scraping	92	30·80 ± 1·48	+ 16·00 ± 1·75	S } control.
C. Clean scraping	90	44·30 ± 1·43	+ 29·50 ± 1·71	S
D. Hand pulling	92	32·50 ± 1·23	+ 8·70 ± 1·55	S
E. Weed cut control ..	84	23·80 ± 0·94	Control.	

210. To complete the experiment treatments were repeated in mid-September at the end of the monsoon and final measurements taken at the end of January 1938 at the end of the second growing season after planting. These measurements are as follows :—

Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A. 4′ forking	80	88·20 ± 2·92	+ 30·40 ± 3·56	S } Control
B. 4′ scraping	81	82·00 ± 2·74	+ 24·20 ± 3·42	S } N.S.
C. Clean scraping	76	85·10 ± 2·70	+ 27·30 ± 3·38	S
D. Hand pulling	82	71·00 ± 2·44	+ 13·20 ± 3·18	S
E. Weed cut control ..	67	57·80 ± 2·04	Control.	

The actual cost of weeding only over the two years were in the proportion

A : B : C : D : E : : 2·6 : 1·7 : 2·5 : 2·0 : 1·0.

211. As the main weeding controversy is between the relative merits of 4 feet forking and 4 feet scraping the measurements for these two treatments are repeated for clarity.

Area planted in mid-April 1936—

Date of measurement.	Mean height in inches.		Significance.
	4' forking.	4' scraping.	
February 1937	14·15	12·30	Difference not significant.
July 1937	47·30	39·80	Difference significant.
January 1938	88·20	82·90	Difference not significant.

The above figures show that at no time during the experiment was the extra cost of the weeding by forking economically justified.

212. A further large scale experiment at Walayar (Experimental Plot 161, Palghat Division) similar to the South Coimbatore experiment in all ways was started during the year. Measurements in January 1938 at the end of the first growing season after planting showed no appreciable difference in survival percentage between the treatments which were (A) forking in 4 feet lines, (B) scraping in 4 feet lines, (C) complete scraping and (D) weed cut control. In mean height growth all treatments were significantly superior to the weed cut control. Four feet forking was superior to 4 feet scraping to the extent of 14 per cent but this difference was not significant.

Detailed measurements are as follows :—

Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A. 4' forking	90	24·20 ± 1·18	+ 13·00 ± 1·28	S } Control
B. 4' scraping	91	21·20 ± 1·08	+ 10·00 ± 1·22	S } N.S.
C. Clean scraping	87	22·20 ± 1·11	+ 11·00 ± 1·25	S
D. Weed cut control ..	91	11·20 ± 0·56	Control.	

The actual cost of weeding only were in the proportion—
A : B : C : D : : 2·1 : 1 : 1·2·4 : 1·0.

The above figures again demonstrate that for first year weeding in a teak plantation the extra cost of weeding by forking over weeding by scraping is not justified by results.

213. The above four large scale experiments again clearly demonstrate that for four of our main teak areas the very slight increase (if any) in mean height growth obtained by forking as opposed to scraping as weeding methods in a teak plantation is in no way commensurate with the extra cost of forking. When all previous work is taken into consideration this result may be generalized for our main teak areas which have a West Coast type of climate.

We do not know whether this result applies under exceptional conditions such as swampiness, etc., and such conditions will be the object of further experiment but in general where such conditions apply, the area is not really suited to teak in the first place.

In the Walayar experiment reported above, at the end of the first year the average height of the plants in all treatments is poor (19·7 inches) compared with that obtained in a more propitious

year climatically. In consequence it is being continued through the second year, treatments will be repeated in mid April and measurements taken in early July and after the monsoon, about mid September, a final treatment applied followed by a final measurement in the following February when growth has stopped. This further treatment will give additional confirmation of the effect of a forking as compared with a scraping in the first hot weather after the formation of a plantation.

214. It should be noted that these results on weeding practice showing that the small beneficial effect of forking is not economically justified have all been obtained in clear felled areas in mixed deciduous forest of good quality with a light friable loamy soil and rainfall of 60 to 100 inches per annum. We do not know whether they apply to dry areas with a small rainfall and a prolonged hot weather. Experiments on soil working in dry fuel forests are in progress and their results are given in paragraphs 184 to 189.

When the Walayar weeding experiment is finished next year it is not proposed to do any more of these large scale weeding experiments in these types of conditions as more than sufficient evidence will have been obtained.

215. *Leucaena glauca as a cover crop in a teak plantation.*—In Experimental Plot 25 Wynaad Division, *Leucaena glauca* was tried as a cover crop in the first year of a teak plantation. The teak was stump planted in mid-April 1935 and the cover crop sown in June 1935. The *Leucaena glauca* needed a very great deal of attention to prevent its being smothered by weeds and even by the end of the first year when it was 4½ feet high it had still had no effect as a weed suppressor.

Measurements in January 1936 showed that the *Leucaena* teak was significantly ahead of the control teak in mean height growth to the extent of 34 per cent while there was no appreciable difference between treatments in survival percentage.

In the second year of the experiment the plot was often visited by deer and bison which several times browsed the *Leucaena* right down to the ground.

Measurements in January 1937 still showed no difference between treatments in percentage of survivals but the *Leucaena* teak which at the end of the first year was 34 per cent ahead of the control teak was only 11 per cent better and this difference was not significant.

The plot was remeasured in January 1938 and this showed that the *Leucaena* teak was only 8 per cent ahead of the control teak and this difference was not significant.

During the three years of this experiment the *Leucaena* has had no effect at all as a weed suppressor.

(For full experimental data see paragraph 365.)

216. *Thinning research Teak.*—The plots at Nilambur and the Wynaad the objects of which are to determine (*a*) the best date of first thinning, (*b*) the best intensity of thinning and (*c*) the best periodicity of thinning in teak plantations of different qualities were maintained (vide Annual Report 1935–36, paragraphs 143 to 146).

217. The set of plots established to test whether Dr. Craib's theory of thinning is applicable to teak plantations (vide paragraph 146 of the Annual Report for 1935–36) was observed during the year. This is Experimental Plot 139, Nilambur Division. In this experiment the treated plots were thinned with a 50 per cent mechanical thinning at two years old.

During the two years this experiment has been in progress the height increment of the two sets of plots has been the same but the diameter increment in the early thinned plots has increased considerably. In the coming year both treated and control plots will be further thinned by 50 per cent. This will leave the treated plots with 300 and control plots with 600 stems per acre at four years old.

This thinning of the control plots at four years old instead of at five years old is in accordance with the prescriptions of the New Nilambur Working Plan.

218. *Santalum album—Thinning of natural regeneration.*—In an area in Chittoor division where natural regeneration of sandal has appeared to the extent of many thousand plants per acre an interesting experiment is being done on the thinning out of the sandal and the introduction of host plants.

Three treatments have been applied (A) in which the sandal was thinned to an espacement of 15 feet by 15 feet and *Cassia siamea* introduced at 3 feet by 3 feet, (B) in which no thinning was done and *Cassia siamea* introduced as in (A), (C) control.

219. The results so far show that the sandal has very materially improved in (A) and slightly improved in (B).

219. In addition, in the course of tending the sandal, that was left, the host plants of *Cassia siamea* were pollarded to keep them below the sandal. These pollardings were sold as manure leaves. This operation is most important because if the new hosts can thus be worked at a profit, the expenditure incurred on their introduction is doubly repaid.

220. *Effect of pruning young Swietenia macrophylla.*—An experiment (Experimental Plot 135, Nilambur Division) was started in 1935 to determine whether the prunning of eight-year-old mahogany is beneficial and to see whether applying coal tar to the wounds prevents rot. During the first two and a half years of this experiment 87 per cent of the untarred wounds and 68 per cent of the tarred wounds had closed completely. In both

treatments the remainder of the wounds had closed to approximately one-half of their original size. There is no sign of rot yet at any wound.

This plot at 10 years old has now been heavily thinned and part of it will be converted into a sample plot. It is 0·15 acres in extent and contains 17 stems with an average height of 44 feet and an average diameter at breast height of 5·1 inches.

(viii) MIXTURES—Nil.

(ix) UNDERPLANTING.

(*a*) *Teak plantations.*

221. *Underplanting in teak plantations.*—During the year all old plots were maintained and two new plots established. These two new plots (Experimental Plot 145, Nilambur Division, and Experimental Plot 159, Palghat Division) both consisted of underplanting a teak plantation at the time of its first thinning with *Bambusa polymorpha*.

In the plots so far established the Burma bamboo *Cephalostachyum pergracile* is doing very well indeed and the local bamboo *Bambusa arundinacea* has been found comparatively easy to establish but takes some time to settle down. *Cedrela toona* and *Swietenia macrophylla* are easy to establish but suffer greatly from browsing and bark stripping by deer. Once they are above the reach of browsers they grow well under teak.

Hopea parviflora introduced on a lateritic slope in 1924 under a teak plantation of 1888 which failed and had been replaced by natural *Xylia xylocarpa* is a very successful crop so far.

222. The following table shows the progress made by the plots during the year:—

Experimental plot number.	Species.	Date of underplanting.	Age of teak at underplanting.	Survival per cent of underplanted crop.	Mean height growth in January 1938 in feet.	Increment during the year.
		YEARS.	AGE.	PER CENT.	FEET.	FEET.
	NILAMBUR DIVISION.					
98	*Swietenia macrophylla* ..	1930	37	9	6·1	+ 0·5
102	*Do.* ..	1930	37	9	3·7	+ 1·4
99	*Cedrela toona*	1930	37	25	6·5	+ 0·9
103	*Do.*	1930	37	14	7·1	+ 1·5
101	*Bambusa arundinacea* ..	1930	37	80	12·0	+ 3·5
100	*Cephalostachyum pergracile.*	1930	37	76	34·5	+ 5·8
104	*Do.*	1930	37	55	32·5	+ 4·7
105	*Do.*	1931	38	100	33·8	+ 4·0
106	*Do.*	1931	38	77	34·6	+ 7·5
	WYNAAD DIVISION.					
8	*Do.*	1932	33	88	8·9	+ 4·5
	NILAMBUR DIVISION.					
138	*Hopea parviflora*	1929	..	71	7·4	+ 1·3
145	*Bambusa polymorpha* ..	1937	6	74	0·6	..
	PALGHAT DIVISION.					
159	*Do.* ..	1937	7	75	0·9	..

223. In addition to the above, a further plot was laid out during the year at Nilambur (Experimental Plot No. 146). This is of *Cephalostachyum pergracile* which was raised by the district by direct sowing in 1929 under teak which was at that time 27 years old and varies from first to second quality. The plot is 100 per cent stocked with the bamboo which has an average height of 37·80 feet.

This plot is not only being used to watch the development of the bamboo but also to determine the retarding effect (if any) of the bamboo on the teak. In the next few years as soon as the bamboo produces sufficient really mature culms they will be exploited and used for floating and data collected of the utility of this exotic and its costs by comparing it with the local *Bambusa arundinacea* which is at present used for floating.

(b) Evergreen rain forests.

224. *Underplanting under shade.*—Palghat Division experimental Plots 147 and 148 were remeasured. These plots have for their object the observation of the development from the sapling to the pole stage of *Mesua ferrea and Calophyllum elatum* crops which were raised by transplanting under evergreen forest shade in 1924.

These plots are thus now fourteen years old and measure in mean height, *Mesua* 62·2 inches and *Calophyllum* 62·8 inches showing a height increment during the year of 2·7 inches and 4·6 inches, respectively.

225. Nine similar plots were laid out during the year at Chandanathode (Wynaad division) in old experimental gardens. Details of these plots are as follows :—

Experimental plot number.	Species.	Canopy.	Age.	Average height in inches.
42	*Mesua ferrea*	Full evergreen cover.	6	26·1
43	*Artocarpus hirsuta* ..	Do.	6	25·0
44	*Gluta travancorica*	Do.	5	32·7
45	*Hopea parviflora*	Top canopy only ..	4	64·3
46	*Artocarpus hirsuta* ..	Do. ..	4	46·3
47	*Cedrela toona* ..	Do. ..	4	52·7
48	*Gluta travancorica*	Do. ..	4	45·8
49	*Swietenia macrophylla* ..	Do. ..	3	46·2
50	*Dipterocarpus indicus* ..	Do. ..	4	30·2

226. *Regeneration of evergreens after clear felling.*—A considerable amount of information had been gathered from experiments on regenerating evergreens under various degrees of shade. To complete the series of conditions Experimental Plot 27, Wynaad Division, was started in 1935 and was regenerated in 1936. It has the following treatments for the regeneration of evergreens :—

(A) Clear felling and burning—No cover crop.

(B) Clear felling and burning with cover crop.

(C) Clear felling—No burning—No cover crop.

(D) Clear felling—No burning with cover crop.

(E) Felling all but the undergrowth—No burning.

Measurements at the end of January 1938 at the end of the second-growing season after planting show very fair results with most species and in all treatments but it must be remembered that at the time of measurement the full effect of the second hot weather had not been felt. It has been found that at Chandanathode there is too much rain for the cover crop of *Tephrosia* and its place has been taken by fast growing weeds. It remains to be seen whether these weeds will perform the functions of a cover crop. The species experimented with and the results so far obtained can be seen from the following table :—

			C		A		D		B		E	
			No burn—no cover crop.		Burn—no cover crop.		No burn cover crop.		Burn cover crop.		Natural under growth.	
	Species.	Stock used.	Survival per cent.	Mean height.	Survival per cent.	Mean height.	Survival per cent.	Mean height.	Survival per cent.	Mean height.	Survival per cent.	Mean height.
1	*Artocarpus hirsuta.*	Stumps, 0·3″/0·4″	66	5·47	71	11·30	57	5·13	51	4·45	58	3·12
2	*Swietenia macrophylla.*	Transplants, 22″	56	21·30	50	18·46	64	21·24	66	19·00	65	24·50
3	*Hopea parviflora.*	Sowing	95	12·50	83	8·12	85	6·05	76	6·00	89	6·05
4	*Do.*	Transplants, 22″.	78	25·60	77	25·30	66	24·80	70	25·70	65	31·20
5	*Cedrela toona* ..	Cuttings, 18″ ..	27	14·30	39	11·52	33	12·06	37	9·08	47	19·56
6	*Do.* ..	Stumps, 0·2″/0·3″	26	30·60	35	23·20	10	10·40	23	12·85	48	27·30
7	*Chickrassia tabularis.*	Stumps	34	19·95	29	17·40	9	10·78	27	10·90	25	18·70
8	*Dipterocarpus indicus.*	Transplants, 34″.	23	27·80	21	20·90	6	23·63	11	20·91	21	16·83
9	*Dysoxylum malabaricum.*	Transplants, 13″.	3	10·30	9	15·11	2	13·00	7	10·44	27	13·80
10	*Mesua ferrea* ..	Transplants, 14″.	72	9·21	78	7·88	68	6·32	72	7·02	77	8·05
	Average of all species together.	..	48	17·70	49	15·92	40	13·34	44	12·64	52	16·91

It is to be noted from the above figures that the burn has had no effect at all either beneficial or deleterious. This confirms the results of the expermments done in this subject during the last few years.

227. A similar experiment (Experimental Plot 70, South Coimbatore Division) was started during the year in Karian Shola and promises to be successful. Results are however not given yet as the plants have not yet shown the full effect of the first hot weather after planting.

228. *General.*—The general difficulties experienced in regenerating evergreens under evergreen shade have been found to be (1) generally poor initial stocking, (2) slow initial growth and (3) browsing. In studying the following results it must be remembered that experimental gardens are fenced and browsing is not allowed to occur.

The general results obtained are :—

(1) We definitely can make a success of raising artificially about half a dozen of our valuable evergreens.

(2) The best shade conditions so far indicated are those of top canopy only.

(3) The best method of regeneration is transplanting for most species. For the most tender species transplanting in baskets shows promise.

(4) Sowing generally gives poorer results than transplanting.

(5) Stumping is not a suitable method to use except in the case of *Artocarpus hirsuta, Cedrela toona and Chickrassia tabularis.*

(6) Weeding is worth while as it gives a small gain in initial growth and survival percentage.

(7) Pitting before planting is also worth while as although the beneficial effect is very small in the first year it becomes more prominent in the second year as the roots and their needs both get bigger.

(8) Burning before regeneration is not necessary. It not only produces no beneficial effect but it is found often to kill trees that have been left in the top canopy to give shade.

(9) Regeneration works in this type of forest should be done before or after the very heavy rains of the south-west monsoon (which usually occur in July) as the tender plants appear not to be able to establish themselves under the battering to which the rain subjects them.

229. It should be noted that the two evergreen research centres, Chandanathode (in the Wynaad) and Karian Shola (in the Anamalais) have rather different climates. Chandanathode has an annual rainfall of 153 inches and most of this comes from the south-west monsoon while Karian Shola gets 62 inches each year and this is fairly evenly distributed between the two monsoons (vide paragraph 327 for rainfall statement).

230. *Best light and shade conditions for artificial regeneration.*—Experiments during the past few years have covered all shade conditions for regenerating evergreens from full evergreen shade to full light but these experiments have been done in different places and in different years. To correlate the indications obtained, Experiment 65, Chandanathode Experimental Garden, was started in 1934 in which it was attempted to experiment under all shade conditions in the same experiment and in the same year. Five species were introduced by transplanting nursery seedlings in randomised lines and four shade conditions used for each species as follows :—

I Top canopy only left, II Top canopy and high middle storey left, III. All but undergrowth and low middle storey left and IV. Complete evergreen shade. During the experiment however some of the trees left in the top canopy in shade condition I died and this has affected I and II rendering them as I slightly less than top canopy only (about 75 per cent) II slightly more than top canopy only.

The following list shows the shade preferences indicated by the end of the third year :—

Dipterocarpus indicus I (less than top canopy).

Swietenia macrophylla I and II (top canopy only).

Cedrela toona II (slightly more than top canopy).

Hopea parviflora II (slightly more than top canopy).

Gluta travancorica III (slightly less than full evergreen shade).

231. The experiment was repeated in 1936 using three shade conditions : I. Clear felling, II. Top canopy and III. Full evergreen shade. The following table shows the establishment in January 1938 but it must be remembered that at this time the second hot weather after planting had not had its full effect :—

	Species.	Stock used.		Clear felling.		Top canopy only.		Full evergreen shade.	
				Survival per cent.	Mean height.	Survival per cent.	Mean height.	Survival per cent.	Mean height.
					INCHES.		INCHES.		INCHES
1	*Artocarpus hirsuta*	Stumps, 0·3″/0·4″	..	67	12·6	40	6·0	3	7·8
2	*Hopea parviflora*	Transplants, 15″	..	73	27·8	85	24·6	22	20·5
3	*Do.*	Sowings	..	63	8·2	83	6·3	..	..
4	*Swietenia macrophylla.*	Transplants, 21″	..	25	34·2	3	14·0	..	..
5	*Cedrela toona*	Stumps, 0·3″/0·4″	..	40	52·2	20	36·5	5	13·3
6	*Do.*	Cuttings, 18″	..	55	62·8	60	44·7	18	22·9
7	*Dysoxylum malabaricum.*	Transplants, 15″	..	3	16·5	3	18·5	..	..
8	*Do.*	Sowing	..	17	10·9	13	8·3	2	7·0
9	*Dipterocarpus indicus.*	Transplants, 30″	..	23	36·8	23	34·2	10	31·7
10	*Mesua ferrea*	Transplants, 9″	..	33	20·8	32	25·6	17	16·0

232. *Effect of burning in evergreen forest before artificial regeneration of evergreen species under top canopy shade.*—Chandanathode Experimental Garden (Experiment No. 101) was done under top canopy shade in 1936 in which areas were burned in randomised strips and then artificially regenerated with evergreen species. In this experiment six species were experimented with, *Artocarpus hirsuta, Cedrela toona, Dipterocarpus indicus, Dysoxylum malabaricum, Hopea parviflora, and Swietenia macrophylla,* and they were introduced by sowing, transplanting and stump planting and by cuttings as far as stock was available.

This experiment thus covers 24 sub-experiments and 2,400 plants.

It was remeasured at the end of the second growing season (January 1938) and results show that in general there is no appreciable difference in survival percentage or in mean height growth between the burned and unburned treatments for any species and any method of introduction. The averaged results of these 24 sub-experiments are—

Area burned.		Area not burned.	
Percentage survivals.	Mean height in inches.	Percentage survivals.	Mean height in inches.
54	21·04	50	20·41

It is thus seen that over this large number of plants, various species, and methods of introduction, the burn has had the effect of producing an increased survival percentage and mean height growth of 4 per cent and 3 per cent, respectively.

The above results confirm those of previous years that burning before artificial regeneration under evergreen cover is neither beneficial nor harmful and is therefore not economically justified. There is also a serious drawback to burning under evergreen cover. Experiments have shown that the best shade conditions required for regenerating most of the species tried so far is top canopy only. Many of the top canopy trees in our evergreens are very susceptible to fire and three times in the last three years we have had to abandon areas after the burn as the fire had killed some 40 per cent of the trees intended to be left as the top canopy shade.

No further experiments in this subject will be done as it is considered that sufficient evidence has been obtained.

(For full experimental data see paragraph 366.)

233. *Direct sowing—Best date (under top canopy only).*—Experiments were done at each of two centres. In Chandanathode Experimental Garden Experiments 119, 120 and 121, *Acrocarpus fraxinifolius, Cedrela toona, Swietenia macrophylla* were experimented with.

Acrocarpus showed early June or early August, *Cedrela* showed early June, and *Swietenia* early May as the best dates for sowing. At this centre, however, results were in general very poor owing to the very heavy monsoon. Chandanathode received 100 inches of rain in July.

In Karian Shola Experimental Garden Experiments 90 to 93 *Mesua ferrea, Cedrela toona, Swietenia macrophylla* and *Acrocarpus fraxinifolius* all showed July and early August as the best date of sowing and results were generally fair.

It is to be noted that these results confirm previous years indications that regeneration work in evergreens should be done either before or after the heavy rains of the monsoon which usually occur in early July.

(For full experimental data see paragraph 367.)

234. It is of particular interest that in a similar experiment (Karian Shola Experimental Garden Experiment 50) done in 1935 with *Calophyllum elatum* and which was reported two years ago as a total failure, the seed germinated in October-November 1936 profusely and showed early August as the best date of sowing. The average survival percentage of this experiment in January 1937 was 64. Further germination also occurred in October-November 1937. This also occurred to a similar extent in Experiment 44 of 1935 at the same centre.

235. *Entire transplanting—Best date (under top canopy only).*—Ten experiments with five species were done with the object of finding out the best date for entire transplanting under top canopy only. Transplanting was done once a fortnight from the middle of June until the middle of October.

Results indicate the best time for transplants as—

Chandanathode ..	*Hopea parviflora* mid June and early August to mid September.
	Swietenia macrophylla early August to early September.
	Cedrela toona early August to early September.
	Hardwickia pinnata early August to early September.
	Artocarpus hirsuta mid August to early September.
	Calophyllum elatum mid June and early August.
Karianshola	*Swietenia macrophylla* late June and early October.
	Mesua ferrea late June and early October.
	Calophyllum elatum early October (survivals very few).
	Cedrela toona late June and early October.

It is thus seen that (in confirmation of previous years' results) the heavy rain of the south-west monsoon is a bad time for transplanting. This period is usually in July. In years of an early monsoon, transplanting can be done just before this period but in general the best time for transplanting in evergreen forest under top canopy conditions is just after the period of very heavy rain of the south-west monsoon and this is usually August and early September Chandanathode Experimental Garden Experiments, 122 to 127, Karian Shola Experimental Garden Experiments 94 to 97.

(For full experimental data see paragraph 368.)

236. *Stump planting—Best date (top canopy only).*—Two experiments were done at Chandanathode, and Karian Shola to find the best date for stump planting of *Cedrela toona* and *Artocarpus hirsuta*. These experiments all indicated that the monsoon periods before or just after the really heavy rains of the south-west monsoon are the most suitable. These periods were mid May to early July, August and September.

Chandanathode Experimental Garden Experiments 128, 129, Karian Shola Experimental Garden Experiments 86 and 89.

(For full experimental data see paragraph 369.)

237. *Comparison of sowing, transplanting small medium and large transplants, and stumping with small and large stumps (under top canopy cover).*—Thirty-two experiments were done with nine species to compare these various methods of raising evergreens under evergreen top canopy cover.

Direct sowing was found to be the best of these three methods of regeneration for *Acrocarpus fraxinifolius* and *Artocarpus integrifolia*, stumping was best for *Artocarpus hirsuta* while for *Cedrela toona*, *Swietenia macrophylla*, *Hopea parviflora*, *Calophyllum elatum*, *Mesua ferrea*, and *Araucaria cunninghamii* transplants do best.

238. With regard to the size of transplants to be used the following tentative conclusions are drawn as to the approximate size of transplant likely to do best when percentage of survivals and increase, decrease or maintenance of initial difference in mean height growth of the various sizes of transplants are taken into consideration :—

	INCHES
Araucaria cunninghamii	4
Artocarpus hirsuta	10 (but stumps best)
Acrocarpus fraxinifolius	14 (but sowing best)
Calophyllum elatum	8
Cedrela toona	12
Dysoxylum malabaricum	12
Gluta travancorica (does well if basketed) ..	14
Hopea parviflora	9 to 12
Mesua ferrea	9
Swietenia macrophylla	12 to 18
Artocarpus integrifolia	18 (but sowing best).

(In all cases the larger sizes grew much slower than the smaller ones and suffered many more casualties.)

Previous years' results are included and the figures given are the approximate middle of a small range of size found to be suitable to the species.

(For full experimental data see paragraph 370.)

239. *Transplanting (under top canopy cover)—Comparison of natural forest seedlings and nursery transplants.*—In Experiment 98 of Karian Shola Experimental Garden nursery seedlings of *Hopea parviflora* were compared with two sizes of forest transplants. The nursery transplants succeeded very much better than either size of forest transplants used.

This experiment combined with previous years' results indicates that there is in general with most species no advantage gained by using natural forest plants.

(For full experimental data see paragraph 371.)

240. *Comparison of direct sowing, entire transplanting with naked transplants and basketed plants (under top canopy only).*—In Karian Shola Experimental Garden Experiment 33 started in 1934, naked root transplants and basketed transplants of *Dipterocarpus indicus* of the same age were compared. At the end of four years the basketed plants show a very much higher percentage of survivals. In mean height growth the two treatments are progressing in much the same way. The experiment was repeated in 1936 with *Vateria indica*. In this experiment also the basketed plants are doing very much better than the naked root transplants of all sizes, particularly in survival percentage.

In 1937 experiments were done at Chandanathode and Karian Shola comparing direct sowing, naked root transplanting and basket planting of *Dysoxylum malabaricum*, *Gluta travancorica*, and *Vateria indica*. In all these three experiments the basketed plants are doing much the best.

Thus basketing has proved the more efficient method of regeneration. This method although of course more expensive is likely to be very beneficial in the cases of important evergreen species with which difficulty is experienced in getting good initial stocking.

(For full experimental data see paragraph 372.)

241. *Propagation by cuttings (under top canopy only)—Cedrela toona.*—While making stumps of *Cedrela toona* it was noticed that the top ends of the plants which had been cut off and thrown down on the ground quickly rooted themselves.

Experiment 79 Chandanathode was therefore done in 1935 to see whether this species could be successfully propagated by cuttings. In making stumps, the top end of about 1 foot in length which was cut off was divided into two and the two parts planted. There were four treatments :—

(A) 6 inches shoot cuttings planted vertically.

(B) 6 inches shoot cuttings planted slanting.

(C) 6 inches top ends planted vertically.

(D) 6 inches top ends planted slanting.

The method was found very successful as shown below, the shoot cuttings planted vertically doing the best.

	Treatment.	Survival percentage.	Mean height inches.
A	6 inches cuttings vertical	80	22·8
B	6 inches cuttings slanting	56	19·2
C	6 inches top ends vertical	68	17·9
D	6 inches top ends slanting	72	22·7

* Measurements in January 1938.

This comparatively high percentage of survivals from material which is normally wasted is a valuable asset.

242. In 1937 experiments were done at Chandanathode and Karian Shola comparing the results from stumps, cuttings from nursery plants and cuttings from natural forest trees of *Cedrela toona*. These experiments both showed that stumps and cuttings from nursery plants are preferable to those from natural forest plants.

(For full experimental data, see paragraph 373.)

An experiment done at Chandanathode to try and propagate *Chickrassia tabularis* by cuttings from natural forest trees failed completely.

243. *Introduction of semi evergreens under the shade of undergrowth.*—South Mangalore Division reports the successful introduction of *Artocarpus hirsuta* and *Hopea parviflora* under the shade of undergrowth only.

244. In an experiment done in Mangalore North Division comparing the introduction by direct sowing of *Hopea parviflora* (*a*) under semi-evergreen cover and (*b*) after clearfelling, the District Forest Officer reports that the seedlings on the clearfelled areas are most decidedly better in height and general healthiness than those under the shelterwood. In the clearfelled area *Macaranga* and other fast growing softwoods have come in and afford the necessary protection to the *Hopea* seedlings. Climbers have not appeared in this clearfelled area.

(x) Silvicultural Systems—Nil.

(xi) Miscellaneous.

(a) Sandal spike disease research.

245. *Introduction.*—The investigation was continued during the year by the Research Ranger, Denkanikota, under the directions of the District Forest Officer, North Salem, in consultation with the Conservators of Forests, Working Plans and Salem Circles, with the technical advice and general supervision of the Provincial Silviculturist.

The entomological work was done on the lines suggested by Dr. Beeson, the Imperial Entomologist, Dehra Dun.

246. I. *Nature and spread of the disease.*—It is noteworthy that 1937–38 was almost free from new attacks in North Salem division save in two localities—One isolated attack at Denkanikota Reserved Forest about three-fourths of a mile from the main spike area and another in the Hosur Cattle Farm which is about four miles as the crow flies from the Hosur Kenilworth castle area and about thirteen miles from the Thalli spike area.

The spike area at Hosur Cattle Farm which is really an isolated area is close to patta lands and by the side of a cattle path. The associated hosts are *Dalbergia sissoo*, *Pongamia glabra*, *Pithecolobium dulce*, *Lantana*, which have all been proved as imparting susceptibility to sandal.

The above points, viz.,

(i) proximity to cultivated lands,

(ii) presence of hosts which predispose sandal to spike, and

(iii) proximity to paths,

confirm the factors associated with new infections recorded previously.

The progress of the disease on individual trees in this area shows that the infection took place in 1936, which year was noted for several new outbreaks.

The following are the numbers of new attacks in North Salem division for the past seven years :—

1931—1, 1932—3, 1933—Nil, 1934—3, 1935—3, 1936—10, 1937—2, which indicates a greater amount of infection in alternate years and this indication is further strengthened by 1937 figures.

247. II. *Transmission of the disease*—(i) *Cloth cages.*—In the 6 acre plot Javalagiri, 42 plants which continued healthy inside cloth cages from April 1922 to April 1935 were opened out of the cages in May 1935 to see if they had resisted spike by virtue of their autogenic resistance and not by physical obstruction due to cloth cages; of these three plants manifested the disease in March 1937 and by February 1938, eight more showed the disease, i.e., 11 out of 42 or over 26 per cent in one year thus proving that these plants remained free from "Spike" on account of the effective screening of the vectors by the cloth cages with which these plants were kept covered.

248. (ii) *Experiments to determine the size of the vector.*—The result of the experiments carried out up to 1936–37 showed that the size of the infective vector is above 1/20th of an inch and below half an inch.

During the year, ten plants were caged with three-eighth inch mesh cages after testing the healthiness of the plants by pruning. The details of caging and the results obtained so far are tabulated below :—

Serial number.	Size of cages.	Number of plants caged.	Date of caging.	Number of plants spiked.	Date of spike manifestation of caged plants.
1	Twenty meshes to an inch.	10	Nine in March 1933 and one in December 1933.	Nil ..	These cages were removed in 1936 under the instructions of Dr. Beeson.
2	Ten meshes to an inch.	10	Two in March 1933; seven in December 1933 and one in September 1935.	Nil ..	....
3	Four meshes to an inch.	15	Three in March 1933; six in September 1935 and six in September 1936.	1	One on 11th March 1938.
4	Two meshes to an inch.	10	Six in September 1934 and four in November 1934.	9	One on 18th July 1936; one on 18th March 1937; one on 25th June 1937 and six on 18th December 1937.
5	One mesh to an inch.	10	Ten in September 1934.	7	One in October 1935; one in November 1936; one in December 1936; one in May 1937; one in October 1937 and two in December 1937.
6	Three-eighth inch mesh cage.	10	Four in August 1937 and six in September 1937.	Nil ..	....
7	Not caged—control.	800	March 1933	389	48·5 per cent.

249. From the above it is seen that nine out of ten or 90 per cent of plants in half inch mesh cages and seven out of ten or 70 per cent in one inch mesh cages are spiked though these two sizes were started only in 1934.

During the year one out of ten or 10 per cent of the plants in the quarter inch mesh cages became spiked.

The cages of twenty meshes to an inch were dismantled and removed in October 1936 as they were no longer necessary in accordance with Dr. Beeson's advice. Out of the ten plants which were opened out of these twenty mesh to an inch wire gauze cages in October 1936, five showed the disease in May and June 1937 thus proving that they were also not plants possessing autogenic resistance but had remained free by virtue of the caging done with wire gauze of twenty meshes to an inch. The efficacy of this mesh cage in warding off the spike disease shows definitely that the vector is above 1/20th of an inch in size.

In cages of ten meshes to an inch started in 1933 and 1936 although small types of insects such as Coccids, Chalcids, Caterpillars, Bagworms, etc., had gone in in plenty, none have shown the disease yet. It is too early to judge the efficacy or otherwise of the 3/8th inch mesh cage, introduced recently.

250. This experiment strongly indicates that —

(*a*) The insects of the types found inside twenty mesh to an inch cage are not likely to be vectors,

(*b*) That the vector easily gets into cages of one mesh to an inch and two meshes to an inch and has also gone into a cage of four meshes to the inch and infected the plants, and

(*c*) The probable size of the vector is between 1/40 inch and $\frac{1}{4}$ inch.

These conclusions were borne in mind while selecting types of insects for individual transmission experiments which are detailed elsewhere in this report.

251. *Insect catches on sticky papers.*—In the cage plot, at Noganur, sticky papers 3′ × 3′ were exposed at cage height (about 3 feet to 8 feet above ground level) in accordance with the suggestions of the Forest Entomologist, Dehra Dun, during the months of October 1937 to January 1938, to give an idea of what insects were moving about in a virulently spiked area and they were sent to the Forest Entomologist for identification after a representative catch of insects was obtained each month.

The catches on sticky papers exposed between 1st and 28th October 1937 were examined and the following are the results of identification communicated by the Forest Entomologist.

"Excluding 66 spiders, a total of 1,850 insects has been collected. Of these, 983 are *Thysanoptera* (thrips), 166 *Rhynchota*, 56 *Dermaptera and Orthoptera*, 256 *Coleoptera*, 300 *Hymenoptera* and 89 belong to other orders.

The *Thysanoptera* comprise over 53 per cent of the total collection and they are minute species. The *Rhynchota* comprise only 166, specimens of which 5 are Aphids (*Macrosiphium* sp), 86 are Jassids in nine species including 26 nymphs and 17 are *Fulgorids* including 10 nymphs and three species. The Jassids are very poorly represented but the common species, viz., *Bythoscopus indicus*, *Idiocerus* species. *Jassus indicus*, and *Petalocephala nigrilinea* are present. There is only one specimen each of *Moonia albimaculata*, *Acropona* sp. and *Ledra* sp. in the list."

The list of insects identified in these catches is given in paragraph 374.

The sticky papers exposed between 31st October to 16th November 1937 and between 16th December 1937 to 16th January 1938 in Noganur Reserve Forest were examined and the results are summarized below :—

Excluding 22 spiders, ticks, etc., a total of 3,176 insects has been collected. Of these 1,806 or over 56 per cent are *Thysanoptera* (thrips), 759, *Hymenoptera*, 213 *Diptera*, 188 *Coleoptera*, 175 *Rhynchota* and 35 belong to other orders (the complete list is appended—Vide paragraph 374).

252. Dr. Beeson concludes—

that the entire collections can be divided into two categories; (*a*) the strong flyers or powerful winged insects, and (*b*) the weak flyers or weak winged insects. The majority of the species collected are strong flyers and only a few weak winged species which are dependent for their dispersal on wind have been caught. Amongst the latter category may be included the *Thysanoptera*, members of which are known to be vectors of virus diseases. Most of the thrips in this lot, as also those collected during 1st to 28th October are minute species measuring 1–2 mm. in length and 0·25 to 0·45 mm. in width. These can very easily pass through a wire screen of twenty or less meshes to an inch.

Considering the material collected between October and January as a whole, we find there are 32 specimens of *Aphididae*, distributed in 11 out of 19 sticky papers, but even this small catch is interesting as the *aphididae* are the most efficient insect vectors of virus diseases. They are *Macrosiphum* sp. and are of a size that cannot pass through a wire screen of twenty meshes to an inch but can pass through four or eight meshes to an inch. The Jassid fauna are represented by 14 species of which there are 38 specimens of *Idiocerus sp.* 22 specimens of *Petalocephala nigrilinea*, 15 of *Jassus indicus*, 10 of *Nirvana pallida* and 9 of *Bythoscopus* sp. The other species are represented by singletons or by twos or threes.

The materials obtained in January to February 1938 in the Noganur Reserve Forest cage experimental plot and between October to December 1937 in the Javalagiri Reserve Forest platform experimental area are being examined by Dr. Beeson and the results are awaited.

253. (iii) *Platform experiments.*—These were continued during the year in two localities (at Aiyur and Javalagiri) and plants were exposed only on platforms and not on the ground underneath as well as suggested by the Imperial Entomologist and the period of exposure was limited to one calendar month.

One plant removed from open platforms at Aiyur exposed in March 1937 and one exposed in April 1937 have shown the disease during the year confirming the already recorded indications that March and April are important seasons of infection.

254. We have now the following definitely recorded cases in which the period of infection is known. (It should be noted that the data given is the time of *infection* of the plant and not the time of manifestation of the disease.)

Months.	Years.						Total.
	1932.	1933	1934.	1935.	1936.	1937.	
January	..	..	..	..	..	..	..
February	..	..	..	1	..	..	1
March	..	..	..	..	1	1	2
April	..	2	..	..	..	1	3
May	..	..	..	..	..	..	..
June	..	1	..	1	..	..	2
July	..	..	..	..	..	..	..
August	..	..	1	2	..	..	3
September	..	2	1	..	1	..	4
October	..	..	2	1	1	..	4
November	2	..	..	..	..	2	4
December	..	..	..	..	..	..	..

The above figures show the general season of infection to be August to November with a secondary infective season in March–April.

255. None of the plants exposed in Javalagiri platforms have shown the disease so far since the start of the experiment in 1935. The reasons are probably, (1) the availability of more attractive ground plants in the experimental areas as compared with those on platforms and (2) too frequent disturbance by subordinates and coolies working in the experimental areas and bungalow compound.

256. (iv) *Mass infection cages at Javalagiri and Denkanikota.*—These were discontinued and converted into individual transmission cages in accordance with the advice of the Imperial Entomologist, Dehra Dun.

The plants removed from these cages were defoliated and none gave rise to spiked shoots. The important results obtained in these two cages have been summarised and recorded together with all the climatic and other conditions of the experiments.

It is this experiment that definitely proved that the agency for transmission of spike disease is an insect vector.

257. (v) *Group cages at Kenilworth Castle area.*—The experiments detailed last year were continued.

The plants which were in the cages from 19th October 1936 to September 1937 were removed to the pot culture plot at Denkanikota and kept isolated and fresh plants were put in, as it was decided to renew the plants once a quarter.

The following table gives the total number of insects released in each cage so far :—

Cage number.	Date of start.	Natural orders released in each cage.	Number of insects released till 18th February 1938.
1	9th September 1937	Jassids	325
2	Do.	Pentatomids	1856
3	Do.	Jassids and Pentatomids	2134
4	Do.	Fulgorids	*187
5	Do.	Jassids and Fulgorids	*186
6	Do.	Pentatomids and Fulgorids	1936
7	Do.	Coriedes, Pyrrhocorieds and Chrysomelids	246
8	Do.	All except those released in cages 1 to 7, 9 & 10	1814
9	Do.	Membracids and Curculionids	2534
10	Do.	Locustids and Acridiids	745

* One plant is suspicious.

The sandal plants among the set exposed to insect feeding in cages from October 1936 to September 1937, have not shown "Spike" though many of them showed shortening of internodes and dwindling in size of the leaves. Among the plants experimented since September 1937 one of the plants in the cage in which *Fulgorids and Jassids* were released and one in which *Fulgorids* alone were released became suspicious.

In these two cases the plants were put into the cages on 9th September 1937, they became suspicious in appearance on 23rd January 1938, but returned to normal on 18th March 1938. They were removed from the cages on 26th April 1938 and are continuing normal.

258. (vi) With the object of finding the qualitative and quantitative insect fauna of this compact area of about 40 acres in which the introduced spike infection is spread by the insect fauna present in the area, the collections made during the period October 21st 1936 to December 15th, 1936 were sent to Dr. Beeson who has given his analysis as follows :—

> "In this locality 915 insect specimens have been collected of which 144 are *Rhynchota*, 300 *Coleoptera*, 136 *Orthoptera* and 35 belong to other orders. Among the *Rhynchota* there are 231 *Pentatomids* in 21 species and 114 nymphs, 103 *Membracid* in 6 species, 57 *Lygacids in* 10 species, 41 *Coreids* in 6 species and 23 nymphs. 39 *Fulgorids* in 10 species and 7 nymphs and 25 *Jassids* in 8

species. In the *Pentatomids* there are 57 specimens of *Plautia fimbriata* in the Fulgorids there are 13 specimens of *Eurybrachys tomentosa* and 10 of *Satapa granulosa* and in the *Jassids* there are 8 specimens of *Acropona Walkeri* and 7 of *Moonia albimaculata*.

Amongst the *Coleoptera* there are 140 *Curculionids* in 19 species, 43 *Coccinellids* in 9 species and 40 *Chrysomelids* in 10 species. *Myllocerus discolor* contributed 67 specimens in the *Curculionidae*. Amongst the *Orthoptera* there are 48 *Tettigoniids* in 5 species and 25 nymphs, 39 *Acridiids* in 4 species and 10 nymphs and 32 *Blattids* in 6 species. There are only 3 specimens of *Letana inflata*.

In this collection also the *aphids* and *thrips* are entirely absent. The *Jassids* are very poorly represented forming only 2·7 per cent of the total collection, but the common and easily caught species are present. Excluding the commoner species like *Acropona*, *Bythoscopus*, *Jassus*, *Moonia*, *Petalocephala* and *Jassids* fauna of Kenilworth Castle differs from those of Denkanikota, Pane, and Thalli as stated in the table below :—

—	Kolla unimaculatus.	Ledramutica.	Para holocrates porrectus.	Neodartus Acoce-phaloids.	Phyrno-morphus indicus.
Denkanikota	..	..	..	1	..
Pane	..	1	1	4	..
Thalli	..	1	..	..	..
Kenilworth castle	1	..	3	..	1

P. indicus has been previously collected from Aiyur, Kottur and Uduparani and lives hidden under dry leaves during the day. *P. porrectus* has been collected from Fraserpet and Uduparani. *K. unimaculatus* has been obtained from all the collecting stations during the sandal insect survey.

While in this locality the dominant species of *Pentatomidae* is *Plautia fimbriata* in Pane and Thalli it was *Hotea nigrorufa* and at Denkanikota *Coptosoma cribrarium*."

259. (vii) *Transmission experiments, with individual species of insects.*—A priority list was prepared by Dr. Beeson for these experiments and sent to us. This list was prepared taking into consideration the wide distribution of the species in different spike areas and their quantitative occurrence. Those that occurred in large numbers were given a secondary importance.

These individual insect transmission experiments were carried out in two localities :—

(i) Denkanikota, a spike free area, and

(ii) Javalgiri a spike area.

The cages used were generally 3 feet cube in size but a certain number of original compartment cages were also used for the purpose. At Javalagiri four healthy sandal plants were exposed to

insect feeding in each 3 feet cube cage and a larger number (up to 10) in other compartment cages. As plenty of natural spiked plants were available in the locality the 3 feet cube cages were fixed up close to spiked sandal plants and spiked branches introduced through sleeves into the cages whereas in compartment cages at Javalagiri and in all cages at Denkanikota at least one spiked plant in a pot had to be introduced. These spiked plants or branches were given to allow more chances for the insects to feed on diseased tissues after they had been captured and put into the cages.

The period of exposure was fixed as two months for each experiment for want of enough healthy potted plants though it was originally decided to have it as one month.

260. The list of insects so far tried in both the localities is given in the table below :—

Type number of insect.	Name of insect.	Denkanikota. Number of experiments.	Period of exposure.	Number insects fed.	Number plants used.	Date of defoliation.	Number plants defoliated.	Javalagiri. Number of experiments.	Period of exposure.	Number insects fed.	Number plants used.	Date of defoliation.	Number plants defoliated.
	Family—*Jassidae*—												
18	***Petalocephala nigrilinea.***	4	21st May to 21st July 1937.	128	15	21st February 1938.	15	3	17th May to 17th July 1937.	577	4	18th February 1938.	4
			3rd August to 8th October 1937.	489	17	..	..	..	22nd April to 22nd June 1937.	802	4	23rd February 1938.	4
			10th October to 10th December 1937.	108	10	..	..	..	19th September to 19th November 1937.	119	4	..	..
			11th December 1937 to 13th February 1938.	109	..	..	..	..	..	..	..	—	
18c	***Petalocephala granulosa.***	3	1st June to 1st August 1937.	56	3	..	..	3	22nd April to 22nd June 1937.	640	4	23rd January 1938.	4
			24th August to 25th October 1937.	404	3	..	..	..	9th July to 19th October 1937.	71	14	..	..
			26th October to 26th December 1937.	77	3	..	..	..	26th November 1937 to 26th January 1938.	67	4	..	..
19	***Acropona walkeri***	3	3rd June to 3rd August 1937.	223	6	..	..	3	15th May to 15th July 1937.	841	4	16th February 1938.	..
			4th August to 18th October 1937.	348	6	..	..	..	17th May to 17th July 1937.	751	4	18th February 1938.	..
			26th October to 26th December 1937.	295	3	..	..	..	28th August to 28th October 1937.	174	4	..	..
29	***Neodartus accocephaloides.***	2	31st August to 31st October 1937.	125	3	..	..	2	29th October to 29th December 1937.	120	5	..	..
			2nd November 1937 to 2nd January 1938.	99	3	..	..	..	24th June to 24th August 1937.	242	4	..	..
27	***Idiocerus clypealis.***	2	2nd September to 3rd November 1937.	66	3	..	..	..	..	..	..	..	..
			7th November 1937 to 7th January 1938.	77	3	..	..	..	..	..	..	..	..
21	***Jassus indicus***	2	2nd September to 2nd November 1937.	84	3	..	..	2	24th June to 1st August 1937.	280	4	..	..
			9th November 1937 to 16th January 1938.	26	3	..	..	..	19th September to 19th November 1937.	104	4	..	..
28	***Moonia albimaculata.***	2	14th September to 14th November 1937.	117	3	..	..	7	2nd May to 3rd July 1937.	424	4	3rd February 1938.	3*
			17th November 1937 to 22nd January 1938.	191	7	..	..	..	9th July to 19th October 1937.	110	20	..	..
									30th November 1937 to 30th January 1938.	85		..	..
21	***Jassus pauperculus*** ..	1	19th September to 19th November 1937.	36	3	..	..	3	9th July to 9th September 1937.	118	8	..	..
									26th September to 26th November 1937.	169	4	..	..
									30th November 1937 to 30th January 1938.	165	4	..	..
77	***Ledra mutica*** ..	2	11th September to 11th November 1937.	29	3	..	..	1	2nd May to 3rd July 1937.	166	4	4th February 1938.	4
			14th November 1937 to 14th January 1938.	9	6	..	..	..	..	..	..	..	..
77	***Ledropsis*** spp. ..		Nil	..	..	..	..	1	10th May to 3rd July 1937.	19	4	4th February 1938.	4
20	***Bythoscopus indicus.***	2	21st September to 21st November 1937.	35	3	..	..	1	30th November 1937 to 30th January 1938.	187	4	..	..
			4th December 1937 to 4th February 1938.	98	3	..	..	..	..	..	..	..	..
	Family—*Pentatomidae*—												
1	***Catacanthus incarnatus.***	..	..	..	..	..	..	1	22nd April to 22nd June 1937.	1,070	4	23rd February 1938.	4
51	Nymphs of *Chrysocoris* sp.	3	10th October to 10th December 1937.	186	9	..	..	3	11th June to 11th August 1937.	520	4	..	..
			2nd June to 2nd August 1937.	303	6	..	..	..	14th September to 14th November 1937.	328	4	..	..
			5th August to 5th October 1937.	151	6	..	..	..	2nd December 1937 to 2nd February 1938.	100	4	..	..

* One plant showed spike like appearance (detailed below).

Type number of insect.	Name of insect.	Denkanikota. Number of experiments.	Period of exposure.	Number of females leased.	Number of exposed plants.	Date of foliation.	Number of defoliated plants.	Javajagiri. Number of experiments.	Period of exposure.	Number of females leased.	Number of exposed plants.	Date of foliation.	Number of defoliated plants.
71	*Chrysocoris Stockerus.*	1	24th May to 24th July 1937.	351	11	..	..	4	17th May to 16th July 1937.	656	4	17th February 1938.	4
			4th August to 5th October 1937.	354	12	..	..	..	30th April to 22nd June 1937.	727	4	23rd January 1938.	4
			10th October to 10th December 1937.	322	7	..	..	..	22nd October to 22nd December 1937.	157	6	..	..
									15th August to 23rd October 1937.	298	6	..	..
152	*Nezara viridula* ..	4	24th May to 24th July 1937.	284	6	..	..	2	17th June to 17th July 1937.	52	4	..	..
			27th July to 7th October 1937.	264	6	..	..	..	10th November 1937 to 10th January 1938.	158	19 *	..	..
			10th October to 10th December 1937.	338	7	..	..	..	..	..	..	..	..
152	*Nezara viridula*		11th December 1937 to 13th February 1938.	232	5	..	..	.	..	..	..	..	..
152*a*	*Nezara viridula* var *torquata.*	..	..	..	..	..	..	1	6th November 1937 to 1th January 1938.	90	4	..	..
80	*Coptosoma siamicum.*	3	24th June to 24th August 1937.	286	3	..	..	4	17th June to 16th August 1937.	819	4	..	..
			26th August to 28th October 1937.	746	3	..	..	..	17th August to 21st October 1937.	427	4	..	..
			30th October to 30th December 1937.	659	3	..	..	..	25th August to 25th October 1937.	432	4	..	..
									10th November 1937 to 10th January 1938.	260	4	..	..
25	*Coptosoma cribarium.*	1	27th July to 1st October 1937.	75	3	..	..	2	12th November 1937 to 12th January 1938.	106	4	..	..
188	Nymphs of *Hotea* sp..	3	22nd July to 25th September 1937.	126	3	..	..	..	..	..	..	..	..
			26th September to 26th November 1937.	210	3	..	..	..	..	..	..	..	..
			4th December 1937 to 4th February 1938.	98	3	..	.	..	..	..	..	..	..
4	*Plautia fimbriata* ..	2	18th August to 25th October 1937.	731	3	..	..	3	17th August to 21st October 1937.	138	4	..	..
			26th October to 26th December 1937.	527	3	..	..	..	12th October to 12th December 1937.	115	4	..	..
									14th July to 14th September 1937.	115	4	..	..
14	*Manida labacula* ..	2	19th August to 24th October 1937.	87	3	..	..	2	30th June to 21st October 1937.	74	7		..
			27th October to 27th December 1937.	39	3	..	..	..	18th November 1937 to 18th January 1938.	91	4	..	..
182	*Hotea nigrorufa* ..	2	20th August to 25th October 1937.	261	3	..	..	..	..	..	..	..	..
			26th October to 26th December 1937.	142	3	..	..	1	26th October to 26th December 1937.	75	7		
248	*Hotea curculionides* ..	2	20th August to 25th October 1937.	179	3	..	..	1	5th December 1937 to 5th February 1938.	71	4	..	..
			26th October to 26th December 1937.	77	3	..	..	..	..	..	..	..	..
186	*Dalpada clavata* ..	2	21st August to 24th October 1937.	155	3	..	..	2	30th June to 21st October 1937.	74	7		..
			27th October to 27th December 1937.	56	3	..	..	..	24th November 1937 to 24th January 1938.	64	4	..	..
251	Nymphs of *Plautia* sp.	2	9th September to 9th November 1937.	301	3	..	..	..	..	..	..	..	..
			19th November 1937 to 19th January 1938.	275	3	..	..	..	..	..	..	..	..
130	*Dolicoris indicus* ..	2	11th September to 11th November 1937.	99	3	..	..	..	..	..	..	..	..
			19th November 1937 to 22nd January 1938.	18	3	..	..	..	..	..	..	..	..
2	*Rhynchocoria plagiata.*	2	21st September to 24th November 1937.	125	3	..	..	..	..	..	..	..	..
			4th December 1937 to 4th February 1938.	12	3	..	..	..	..		..	..	..
185	*Hotea* sp.	2	22nd September to 22nd November 1937.	146	3	..	..	..	..	..	..	..	..
			24th November 1937 to 23rd January 1938.	87	3	..	..	..		..	..	..	..

REMARKS AND CONDITION OF PLANTS—* Two plants at Denkanikota are suspicious.

Type number of insects.	Name of insect.	Denkanikota. Number of experiments.	Period of exposure.	Number insects fed.	Number plants used.	Date of foliation.	Number plants foliated.	Javalagiri. Number of experiments.	Period of exposure.	Number insects fed.	Number plants used.	Date of foliation.	Number plants foliated.
263	*Sastragala heterospila*	1	23rd September to 23rd November 1937.	419	3	..	..	..	..	..	..	..	..
3	*Halyomarpha Picus.*	2	3rd October to 4th December 1937.	42	3	..	..	1	30th November 1937 to 30th January 1938.	62	4	..	..
			7th December 1937 to 7th February 1938.	21	3	..	..	..	..	..	..	..	..
186A	*Canthecona fercellata.*	..	..	..	..	..	..	1	5th December 1937 to 5th February 1938.	80	4	..	..
96	Family—*Fulgoridæ*—*Eurybrachys tomentosa.*	3	25th May to 25th July 1937.	445	6	26th February 1938.	6	3	11th June to 11th August 1937.	166	4	..	..
			13th August to 17th October 1937.	233	6	..	..	..	11th September to 10th November 1937.	189	4	..	..
			24th October to 24th December 1937.	204	3	..	..	..	10th November 1937 to 10th January 1938.	164	4	..	..
23	*Sarima nigroclypeata.*	4	17th July to 17th September 1937.	130	3	..	..	3	2nd May to 24th June 1937.	538	4	25th January 1938.	4
			13th September to 19th November 1937.	178	3	..	..	..	17th June to 17th August 1937.	205	5	..	..
			24th October to 24th December 1937.	204	3	..	..	..	18th December 1937 to 18th February 1938.	85	4	..	
			23rd November 1937 to 23rd January 1938.	69	3	..	..	..	..	..	..	..	..
23A	*Coimquinda nigroclara.*	2	20th August to 25th October 1937.	55	3	..	..	1	26th November 1937 to 26th January 1938.	82	4	..	..
			26th October to 26th December 1937.	45	3	..	..	..	..	..	..	..	..
	Flatta ferrugata ..	1	11th September to 11th November 1937.	10	3	..	..	3	11th June to 11th August 1937.	37	4	..	..
									12th July to 21st October 1937.	95	7	..	..
									24th November 1937 to 24th January 1938.	91	4	..	..
								..	..	..	..	..	..
112	*Satapa granulosa*	1	12th September to 12th November 1937.	23	3	..	..	..					
150	*Saturnia margivellus.*	2	16th September to 16th November 1937.	69	3	..	..	2	2nd May to 3rd July 1937.	121	4	4th February 1938.	4
			11th December 1937 to 11th February 1938.	10	3	..	..	..	30th November 1937 to 30th January 1938.	125	4	..	..
175	*Nymphs of Fulgorid* sp.	1	26th October to 26th December 1937.	33	3	..	..	..	..	..	..	..	..
92A	*Centromaria* sp. ..	..	..	..	..	..	..	2	30th June to 20th October 1937.	85	6	..	..
									30th October to 31st December 1937.	74	4	..	..
92	*Dictyophara* sp. ..	..	..	..	..	..	..	2	23rd October to 23rd December 1937.	145	4	..	..
									24th June to 24th August 1937.	89	4	..	..
197	*Ricania fanestrata* ..	..	..	..	..	..	..	3	25th July to 21st October 1937.	33	4	..	..
									17th August to 21st October 1937. ..	50	10	..	..
									24th November 1937 to 24th January 1938.	79	4	..	..
187	*Forculus viridis* ..	..	..	..	..	..	..	3	24th November 1937 to 24th January 1938.	40	4	..	..
									11th June to 11th August 1937.	80	4	..	..
									17th August to 21st October 1937.	16	4	..	..
	Family—*Lygæidæ*—												
69	*Graptostethus servus.*	3	5th June to 5th August 1937.	45	3	..	..	4	17th May to 17th July 1937.	744	4	..	..
			12th September to 13th November 1937.	181	3	..	..		30th April to 22nd June 1937.	725	4	23rd January 1938.	4
			19th November 1937 to 19th January 1938.	334	3	..	..		5th October to 5th December 1937.	116	4	..	..
									28th August to 28th October 1937.	174	4	..	..

Jalalagiri.

Type number of insect.	Name of insect.	Number of experiments.	Period of exposure.	Number of insects tested.	Number of plants exposed.	Date of foliation.	Number of plants defoliated.
42	Family—*Tettigoniidæ*—Nymphs of *Letana inflata.*	4	27th November 1937 to 27th January 1938.	120	4	..	..
		..	30th April to 24th June 1937.	752	4	..	..
		..	1st September to 30th October 1937.	139	11	..	..
		..	17th May to 17th July 1937.	652	7	..	..
		2	25th July to 16th October 1937.	64	4	..	..
		..	12th October to 12th December 1937.	144	4	..	..
75	*Adults of Letana inflata.*	2	11th September to 11th November 1937.	13	4	..	..
			28th November 1937 to 28th January 1938.	54	4	..	..
		2	12th July to 21st October 1937.	163	7	..	..
		..	22nd October to 22nd December 1937.	203	6	..	..
		..	22nd October to 22nd December 1937.	166	7	..	..
		..	24th June to 24th August 1937.	375	4	..	..
75A	*Xiphidiopsis dramimula.*	..	..	..	..	..	..
74	*Orthacris* spp.	..	..	..	..	..	..
	Family—*Membracidæ*—*Oxiodus enervatus*	1	27th October to 27th December 1937.	166	7	..	..
24A	*Leptocentrus taurus.*	..	..	..	..	..	..
24	*Cocostophus tuberculatus.*	1	2nd December 1937 to 2nd February 1938.	85	4	..	..
22	Family—*Coriidæ*—*Homoeocerus* sp.	2	28th August to 28th October 1937.	110	4	..	..
5		..	30th October to 30th December 1937.	122	4	..	..
163	*Lucinatus punctatus.*	..	..	..	..	..	..
26	Family—*Cerioidæ*—*Peophilus costalis*	..	..	..	..	..	..
		1	30th October to 31st December 1937.	129	6	..	..

Denkanikota.

Type number of insect.	Name of insect.	Number of experiments.	Period of exposure.	Number of insects tested.	Number of plants exposed.	Date of foliation.	Number of plants defoliated.
42	Family—*Tettigoniidæ*—Nymphs of *Letana inflata.*	3	5th June to 5th August 1937.	35	3	..	..
			26th August to 31st October 1937.	206	3	..	..
			2nd November 1937 to 2nd January 1938.	104	3	..	..
75	*Adults of Letana inflata.*	2	19th September to 19th November 1937.	124	3	..	..
			23rd November 1937 to 23rd January 1938.	80	3	..	..
74	*Orthacris* spp.	..	..	..	..	..	..
	Family—*Membracidæ*—*Oxiodus enervatus*	2	2nd September to 3rd November 1937.	294	3	..	..
24A	*Leptocentrus taurus.*	..	..	..	..	..	..
22	*Cocostophus tuberculatus.*	2	26th August to 27th October 1937.	445	3	..	..
			28th October to 28th December 1937.	280	3	..	..
5	Family—*Coriidæ*—*Homoeocerus* sp.	..	4th December 1937 to 4th February 1938.	46	3	..	..
163	*Lucinatus punctatus.*	..	..	..	..	..	..
26	Family—*Cerioidæ*—*Peophilus costalis*	1	7th December 1937 to 7th February 1938.	17	3	..	..

261. The following table shows the types of insects which have been given a fair trial and those that have to be experimented with again. These latter insects have not yet had a fair chance at both Denkanikota and Javalagiri.

Denkanikota.		Javalagiri.	
Type number of insects that have been given a fair trial so far (February 1938).	Insects that are tried so far but need trial again (Type numbers, of insects).	Type number of insects that have been given a fair trial so far (February 1938).	Insects that are tried so far but need trial again. (Type numbers, of insects).
18, 18 (c), 19, 29, 27, 51, 71, 80, 188, 4, 182, 186, 248, 251, 185, 96, 23, 23-A, 89, 42, 75, 24-A, 22.	21,77, 28, 21 A, 20, 26, 25, 14, 130, 2, 263, 246, 152, 70, 112, 150, 175, 5, 168.	18, 18 (c), 19, 29, 21-A, 51, 168, 71, 14, 186, 80, 4, 23, 150, 96, 70, 92, 187, 197, 148, 75-A, 75, 42, 72, 24-A, 22, 89-A.	77-A, 77, 20, 28, 1, 3, 248, 152, 182, 152-A, 25, 186-A, 23-A, 92-A and 24.

The months in which these above insects have had a fair trial can be seen in the detailed table given previously.

262. None of the plants exposed to individual insect feeding have manifested the disease so far though two cases of suspicion have occurred among plants fed by *Nezara virdula a Pentatomid* at Denkanikota. They were in the cage with this species from 27th July 1937 to 7th October 1937 and became very suspicious on 20th January 1938. By the middle of March the apparent symptoms of spike had so increased that on 14th March 1938, two healthy plants and on 2nd April 1938, a further eight healthy plants were grafted with leaf tissue from these *Nezara* fed plants. At the same time a similar number of control grafts were made. Although sufficient time (up to 5th May) has not elapsed for the grafts to have taken, these do not appear to be cases of genuine spike as the *Nezara* fed plants although still very suspicious in appearance appear to be very slowly progressing towards normal.

This insect therefore deserves more trials in the coming year especially in both the important seasons of infection.

263. (2) *Moonia albimaculata.*—The spike-like appearance reported by Dover with this species in the Indian Forest Record, Volume XX, Part I, "Studies on Insect Transmission" was reproduced in one of the plants fed by *Moonia*. The experiment was conducted at Javalagiri in a 3-feet cube cage. Four healthy plants, Nos. A-3864, A-100, A-3849 and 3584 were kept in the cage on 2nd May 1937, and release of insects started from the same date. These plants remained in the cage till 3rd July 1937, by which time 424 insects were released in the cage. On 4th July 1937 they were removed and transported to Denkanikota and kept in the Denkanikota Pot culture plot a spike-free area.

One of the plants No. A-3849 showed the peculiar formation of spike-like appearance on 21st September 1937.

Six healthy potted sandal plants were grafted with the leaves of Plant No. A-3849 at four leaves to each and at the same time

as controls, six healthy potted sandal plants were grafted with the leaves of genuine spike at four leaves to each on 6th November 1937.

The *Moonia* fed plant was given fresh hosts of *Mundulea suberosa* and *Acacia farnesiana*, after top dressing the pot with fresh soil and manure on 6th November 1937.

The results of grafting experiments are given below :—

Nature of material.	Number of plants grafted.	Dosage.	Number fused.	Number that manifested the disease.	Date of defoliation.	Number that manifested the disease.
Moonia fed spike-like plants.	6	Four leaves of each.	23/24	..	4th January 1938.	..
Genuine spike plant (Control).	6	Do.	23/24	..	4th January 1938.	Two on 20th January 1938.

The *Moonia* fed plant is returning to normal after it has been provided with new hosts. As the plant is returning to normal and the grafts have not taken it is clear that the spike-like appearance produced by *Moonia albimaculata* is not genuine spike. It is to be noted that the three other healthy plants which were in the cage along with this did not show this symptom at all but this was the only one which lost its hosts.

As in the case of Dover's plant referred to above, the suspicious symptoms were associated with the death of the hosts and recovery was associated with the provision of new hosts and manured soil. Experiments with this insect are still in progress to see if such symptoms can be repeatedly got and on plants having good hosts.

264. (viii) *Experiments with Aphids, Thrips and Red Spider.*—These were done during 1937–38 in the all cellophane cages as reported in 1936-37. None of the plants experimented with have manifested the disease. The mortality in these cages was high due to (i) congestion, (ii) lack of enough material of sandal leaves for feeding, (iii) scarcity of light and air, (iv) formation of fungus diseases. The remedy for the fungus disease is periodical cleaning with carbon-di-sulphide. Therefore, the experiment is designed for repetition in a better type of cage in 1938–39.

265. (ix) *Food plant experiments.*—The experiments so far done indicate that the following species of insects generally thrive well on the species of plants noted against each :—

Name of insects.	Food plants.
Catacanthus incarnatus ..	*Santalum album, lantana, Ixora parviflora, Strychnos nux-vomica.*
Plautia fimbriata ..	Dhall, *Dodonea viscosa.*
Myllocerus viridianus ..	*Mundulea suberosa* and Dhall.
Chrysocoris stockerus ..	*Breynia rhamnoides, Ixora parviflora, Azadirachta indica.*
Otinotus oneratus ..	*Mundulea suberosa, Cajanus indicus, Acacia suma.*
Nezara viridula ..	*Breynia rhamnoides, Santalum album,* and Dhall.
Eurybrachys tomentosa ..	*Acacia sundra, Leucaena glauca.*

These plants are being raised in the nursery now laid out in one part of the potculture plot to facilitate easy introduction of such hosts.

266. III. *Experiments to find out at which period of the day the infection is effected.*—The experiment described last year was continued with three times of exposure, i.e., (*a*) day, (*b*) night and (*c*) dusk and dawn.

During the year, one plant exposed during the night between 8 p.m., and 5 a.m., between 29th September 1936, and 30th November 1936, and another during night time between 1st October 1937 to 30th November 1937, manifested the disease in July 1937, and January 1938, respectively, thus giving two more definite instances of infection at night.

Including last year's infection at night, three definite instances of infection at night have been obtained indicating the importance of this experiment.

267. IV. *Experiments to find out why pot plants are less susceptible to infection.*—The experiments to find out why pot plants are less susceptible to infection started in 1935–36 was continued during the year and the results obtained so far are tabulated :—

Set number.	Nature of plant.	Number of plants experimented.	Number manifested the disease so far (February 1938).	Remarks.
1	Plants buried with pots right up to rim.	100	3	Manifested the disease in February 1938.
2	Plants taken out of pots and planted.	100	17	Eight showed the disease in February 1938
3	Planted with pots kept above ground.	10	7	....

The results are getting more and more striking and are proceeding in the direction of observations already recorded. The experiment is being continued. The points to be noted are—

(i) Plants taken out of the pots and planted in the ground have generally grown much bigger and look more sappy and attractive, whereas in pots they are not so,

(ii) The plants have all got more or less browsed by deer and sambhur which accounts for the high manifestation of the disease within the last two months. This browsing amounts in practice to a natural lopping and forcing out of masked disease.

268. V. *Control operations.*—These are dealt with under two main heads, viz. (i) prevention, and (ii) cure.

Under prevention, the work consists of isolating a resistant strain of sandalwood as detailed below.

269. *(a) Acquired resistance.* The sandal plants growing with the various combinations of host plants detailed last year were only grafted during the year to a limited extent. Reinfection of sandal with *Wrightia tinctoria* combinations was carried out and 8 out of 30 showed the disease indicating that the percentage of resistance imparted by this species is about 70 per cent.

270. *(b) Mound experiments.*—The new set of mound experiments started in 1935-36 is continued. Only one combination of sandal and *Premna tomentosa* is spiked so far. Sandal is not yet well established in many of the mounds.

271. *(b) Autogenic resistance.* (i) Seventy-five plants tested to resist three artificial infections were planted in the heavily spiked area at Javalagiri reserve forest in 1932; of these, 48 died naturally and five got spiked. The remaining 22 plants are continuing healthy and have started to yield fruits.

Ten similar plants planted in Samanayu reserve forest as controls to these are perfectly healthy. These have also yielded seeds which have been collected and will be sown in the pot culture plot for raising plants and testing their immunity by artificial grafts.

During the year, 75 more plants tested to resist four artificial infections were planted in the Javalagiri reserve forest, a virulent spike area.

272. (ii) *Four venated sandal plants.*—Ten sandal plants raised from seeds of four venation were grafted during the year and none showed the disease and other plants are not yet big enough for artificial infections.

273. *The Noganur reserve forest peculiar sandal tree.*—The peculiar sandal referred to in 1936-37 report gave fruits for the first time in November 1936. One hundred and ninety-three seeds were collected and seed tests were made with the following results :—

Seed weight with pulp, 51 to the ounce.
Seed weight without pulp, 240 to the ounce.
The seeds were sorted.
Good seeds, 175; bad seeds, 18.
Purity per cent is 91.
Seed weight of good seeds, 190 to the ounce.

One hundred and seventy-five seeds were sown on 23rd November 1936. Germination started on 7th January 1937, and completed by 31st March 1937. Thirty-four seedlings germinated of which seven looked like the parent and the rest looked like normal healthy sandal plants. The growth of the seedlings looking like the parent is slow and a high mortality was noticed among them.

On 24th February 1938, the height measurements recorded among the survivals were found to be as follows :—

Peculiar type.		Normal looking plants.	
Number	Height. INCHES.	Number.	Height. INCHES.
1	7	1	7
2	9	2	15
3	7	3	9
		4	7
		5	17
		6	7
Average	8		10

274. The tree started seeding again in the month of October 1937, which was heavier than the seeding of November 1936 above. Two hundred and ninety seeds were collected, 35 were pressed into the soil under the mother tree.

Two hundred and fifty-five seeds were used for seed tests with the following results :—

Seed weight, 132 per ounce.
Good seeds, 165; bad or immature, 90.
Seed weight of good seeds, 97 per ounce (with pulp).
Purity per cent by cutting test, 90.
These 165 seeds were sown on 3rd November 1937.

Germination started on 28th December 1937, and was complete by 15th March 1938. Twenty-four seedlings came up of which nine looked like the parent, and fifteen like the normal sandal plant. Survivals on 2nd May 1938, were, four like the parent and five normal.

Out of 35 seeds pressed into the soil under the parent tree, ten seedlings have come up of which five look like the parent and five normal. Those similar to the parent have been kept protected by small cages of wire netting to protect them from browsing by hares.

275. Dr. Bor, Forest Botanist, Forest Research Institute, Dehra Dun, inspected the peculiar sandal tree on 10th November 1937, and suggested an analysis of the roots and stems and leaves to detect fungal attack, if any. Samples of leaves and twigs were sent to Dehra Dun, and the results of the analysis are detailed as follows :—

"The roots are found to be free from fungus infection.

The young tender shoots are infected with a fungus apparently of a parasitic nature.

The leaves show an infection of *Gloeosporium* sp. and the fungus has formed pinkish fruit bodies on the surface of the leaves.

The flower buds are also heavily infested with the same fungus.

So, the fungus *Glocosporium* sp. has attacked the flower buds, leaves and most likely the tender shoots as well.

Several species of *Glocosporium* are important plant pathogens and some are known to cause " Witches' brooms " on plants.

Starch test for spike diseases gave *negative results*."

The " peculiar " appearance of this tree may therefore have a fungal origin.

276. Due to the remaining healthy in the spike area for a period of about eleven years functioning like a young normal healthy tree, except for its peculiar foliage and lack of fruit it was considered possibly to be a strain immune to spike. Therefore in order to propagate it, the following pollination experiments were suggested :—

(i) Select branches without open flowers, i.e., in branches where a few flowers have opened out, remove the open flowers and sleeve the twigs with buds only;

(ii) keep flowering sandal plants in pots on platforms close to the peculiar sandal and enclose twigs containing unopened buds of the potted sandal and the twigs containing unopened buds of the peculiar sandal together in sleeves, the twigs of both the plants touching each other; and

(iii) repeat item (ii) but in mature buds of the potted sandal clip off the anthers by carefully opening the buds, so that the potted sandal may get fertilized by the pollen of the peculiar sandal flowers.

Since 21st November 1937, the above experiments are being carried out, the clipping of anthers being done daily as buds get mature.

So far, no formation of fruits is noticed.

277. Since 19th December 1937, the tree appears to have got genuine spike but the spike leaves have not developed to facilitate leaf grafts nor have the leaves remained to reach maturity. The twigs showing genuine spike are withering and dying. Samples have been collected and sent to Dehra Dun on 24th February 1938

This phenomenon of shedding affected portions is not noticed on trees of genuine spike or normal healthy sandal. This peculiarity is perhaps an attempt to overcome the disease, such as occurs in the case of some sugarcane mosaic.

Bark grafts are being carried out.

A root sucker similar to the parent was obtained by trenching and cutting of the roots in May 1932, and it is now about three feet high.

To keep this free from browsing and from " spike " for further experiments and as a possible seed bearer for the future it has been enclosed in a twenty mesh to an inch wire gauze cage of 3′ × 3′ × 5′ size which is proved to ward off the infected vector.

278. (iii) *Introduction of sub-lethal doses of infective material to induce immunity.*—Till February 1938, six doses have been given to 11 sandal plants and all are continuing healthy. Twenty-six plants have now been added to this experiment and one dose has been given so far.

279. (iv) *Prevention of infection by spraying with insect repellant sprays.*—As detailed last year the insect repellants detailed below were sprayed on healthy sandal in diseased areas once in a month and the results are tabulated :—

Locality.	Repellants used.	Date of start.	Number of plants sprayed.	Number of plants spiked till February 1938.	Percentage.
Javalagiri ..	Lead arsenite ..	March 1935..	108	..	..
	Copper arsenite ..	Do. ..	108	1	1
	Nicotine	Do. ..	108	5	5
	Derrisol	Do. ..	108	1	1
	Cinchona	Do. ..	108	3	3
	Controls water ..	Do. ..	108	10	9
Aiyur ..	Lead arsenite ..	August 1933.	50	3	6
	Copper arsenite ..	Do.	50	4	8
	Nicotine	Do.	50	6	12
	Asafœtida	Do.	50	3	6
	Cinchona	Do.	50	5	10
	Controls water ..	Do.	50	11	22

The spraying experiments were started in August 1933 and the spike incidence recorded above is the total incidence of infection for a period of four years and seven months in Aiyur and three years in Javalagiri. This result (as stated in the last year's report) as compared with the total incidence among the controls and the normal annual incidence in other spike areas of this division is striking.

The Imperial Entomologist gave his opinion in September 1936, that " present indications are that the vector is a sap sucker and, therefore, the spray should be a mechanical film and not a stomach poison." In view of this and also of the results obtained after such a long period, and in consideration of Dr. Beeson's suggestions to start a new series of experiments introducing more contact poisons, these experiments will be summarized and closed and new experiments started.

280. (v) *Lopping and spraying.*—The experiments initiated in Noganur reserve forest in 1935-36 to test, if re-infection on lopped healthy trees in newly affected localities, can be prevented by spraying them with a composite spray of lead and copper arsenites were continued during the year. So far (February 1938), re-infection appears to have been prevented by such sprays and 39 trees out of 2,670 or 8·6 per cent of the unsprayed controls showed spike up to February 1938, against none out of 500 sprayed.

This experiment has been going on for the past three years and the above results are very striking. Repetition of spraying in newly infected isolated areas will next be done in order to confirm the above indications.

281. (vi) *Injection experiments.*—Minute doses of certain elements which are usually found in healthy plants and whose presence in the plant body either repels insect vectors or neutralizes the virus introduced by insects in the plant itself were injected into healthy sandal plants. The table given below shows the dosage and results so far :—

Serial number and name of chemical.	Nature of chemical.	Proportion of dosage.	Number of plants injected.	Number spiked.	Remarks.
1 Aluminium sulphate.	Resistance builder.	1 : 250	50	12	..
2 Zinc sulphate ..	Do.	1 : 250	50	10	..
3 Manganese chloride.	Do.	1 : 250	50	9	Worth continuing.
4 Pyridine	Insect repellant.	1 : 2500	50	9	Do.
5 Strychnine ..	Do.	1 : 2500	50	9	Do.
6 Formalin	Resistance builder.	1 : 50	50	3	Appears to be effective.
7 Nicotine	Insect repellant.	1 : 2500	50	10	..
8 Water-controls ..	..	..	50	11	..
9 Ordinary controls.	..	..	50	16	..

So far the indication is that formalin is useful. The experiment is continued but still it is doubtful if the plants have absorbed enough of the chemicals to produce the desired effect.

The dosage of all the chemicals except formalin is being increased until the plants show signs of withering.

282. (ii) *Cure and control of spike.*—The results of control operations applied to new spike areas in various localities are detailed below :—

A. *Old areas where control operations were instituted immediately the disease was noticed.*

283. (1) *Noganur reserve forest—Solitary spike tree area* (spike area No. 2).—A solitary spiked tree was observed on 30th June 1934 in Noganur reserve forest. The tree was treated with atlas. All apparently healthy trees around the area to a distance of 100 feet were lopped.

Result.—Only one tree out of 62 lopped trees showed the disease and the locality is free from spike (3¾ years). The results are striking.

284. (2) *Denkanikota reserve forest—Fuel coupe spike area.*—This is situated about four furlongs east of the Denkanikota reserve forest spike area and only one tree was found spiked in December 1934. The tree was girdled and killed with atlas, and control operations carried out in the area.

Result.—None of the lopped trees showed the disease (3¼ years) and there is no further spread.

285. (3) *Gudigunta spike area.*—This lies about two miles as the crow flies from the nearest spike area. At the start a clump of seven trees was found spiked and these trees were carefully uprooted and removed.

A belt of 100 yards all round the infected group was demarcated and all apparently healthy trees amounting to 68 were lopped in June 1935.

Result.—No further recrudescence is noticed so far (2½ years).

286. (4) *Jogyenka area.*—A solitary spiked tree, 19 inches in girth was found on 3rd October 1935, and it was immediately killed with atlas. The area was demarcated by a 100 yards belt all round and all apparently healthy trees amounting to 88 were lopped in October 1935.

Result.—No spread is noticed so far (2 years and 4 months).

287. (5) *Denkanikota reserve forest 1936 area.*—This is situated at a distance of two miles as the crow flies from the nearest spike area. Spike was noticed on 10th October 1936, and four trees were found affected which were girdled and treated with atlas. The area was demarcated by a 100 feet belt all round and all apparently healthy trees amounting to 73 were lopped in October 1936.

Result.—One out of the 73 lopped trees manifested the disease and this was killed with atlas and there is no recrudescence in the area so far (1 and 1/3 years).

288. (6) *Devasthanam Kothanur spike area.*—This lies about two miles north of Denkanikota reserve forest spike area right in the middle of patta lands. Eleven trees were found spiked in January 1936. All these were killed with atlas treatment. One hundred and ninety apparently healthy trees found in the area within a radius of 100 yards all round were lopped after taking the consent of the pattadar. Only 17 of the lopped trees manifested the disease and they were killed with atlas.

Result.—No spread is noticed outside the demarcated limits and no recrudescence in the area now so far (2 years).

289. (7) *Rangasandiram area.*—This lies about two miles north-north-east of Noganur spike area and one and a half miles to the west of Denkanikota town.

Six trees were found affected on 18th November 1936. They were girdled and treated with atlas and all apparently healthy trees amounting to 90 were lopped. Nineteen trees were found affected till April 1937, within the locality and all these were girdled and treated with atlas.

Result.—There is no spread outside the area so far.

290. (8) *Gandaganahalli spike area.*—Spike was first noticed in Gandaganahalli patta lands on 18th November 1936. The area is about two miles from Rangasandram area and one and a half miles from Noganur reserve forest spike area.

Four sandal trees were found spiked and also a stump of 12 inches girth. They were killed with atlas solution and all apparently healthy trees lopped.

Result.—No spike recrudescence in the area is noticed so far.

The results obtained from the above eight areas definitely prove that *spike can be eradicated effectively by the control operations now in vogue if the affected locality is found out when there are only a few trees affected.*

291. (b) *New areas dealt with in* 1937-38.—(i) *Denkanikota reserve forest.*—One tree was reported spiked in Denkanikota reserve forest in a locality about three-quarter of a mile from the main spike area on 27th November 1937. The spiked tree was inspected and girdled and treated with atlas on 1st December 1937. The area was demarcated and all apparently healthy trees amounting to 390 were lopped by the end of December 1937. The pattadar of the land close to the above spike area was found and a statement was obtained from him stating his willingness for our carrying out spike control operations in his lands.

Lopping of trees in the lands adjacent to the above spike area was started on 18th April 1938 and completed by 20th April 1938. One hundred and seventy-five trees in the patta lands and 158 trees in the unreserve have been lopped.

Two of the lopped trees out of 390 in the reserve forest portion lopped in December 1937, manifested the disease in March 1938, and they have been girdled and treated with atlas.

292. (ii) *Hosur Cattle Farm area.*—A spike outbreak was reported in this locality which is about four and a half miles as the crow flies from the Kenilworth castle and thirteen miles from Thalli spike area.

Ninety trees were found spiked in the locality which were treated with atlas solution and then uprooted completely. Five hundred and six apparently healthy trees found in the area within a belt of 300 yards were lopped in the cattle farm limits and 256 trees found in the patta lands near by within 200 yards were also lopped after getting the necessary permission from the pattadar.

293. (c) *Old areas in which spike control operations were instituted after allowing the disease to spread for a period.*—The control operations instituted over large isolated areas extending over 300 acres in Denkanikota reserve forest and Manchi unreserve have prevented further spread, but the disease is not rooted out

of the areas. The reasons why such areas were dealt with are given below :—

(i) The object in doing the control operations in these large areas is to see if by constantly keeping out the two sources of infection, i.e., the diseased and disease masking trees we can gradually eradicate the disease out of such large areas, by giving no opportunity for insects to become infectious.

(ii) The spike control areas are selected on the western side of large blocks of healthy sandal areas so as to protect the latter by controlling the disease in the former areas.

(iii) As spike is still prevalent in the area, if any unknown factors suddenly become favourable to the insect vectors there may be an outburst of spike. If the operations now being carried out keep the situation well in hand, the subsequent results will enable us to isolate the factor and indirectly the nature of the vector.

294. It is very satisfactory to note that in these three cases (Denkanikota reserve forest, Manchi and Kodagarai) although large areas, such as 400 acres (in difficult country) are concerned and although the disease had been allowed to spread for some time uncontrolled *the effect of the control measures since they have been adopted has been to confine the outbreaks to their original limits.*

The above are experimental applications of control measures. In recent years many spike outbreaks have been dealt with by the methods outlined in the "Standing orders for the control of spike" by the districts concerned. These have been strikingly successful and the only cases which have not proved completely satisfactory are those in which the control measures have not been properly carried out. In these cases, once mistakes have been rectified the measures have been successful.

295. VI. *Technique to find out if an area is susceptible to infection or not and how far the environmental factors influence the resistance or susceptibility.*—The experiment started last year is continued and plants from different localities are being raised for infection purposes.

296. VII. *General.*—(i) The periodical insect collections for ten days in the month in each of the areas (*a*) Denkanikota newly infected spots in the midst of field crops, (*b*) Thalli healthy area, and (*c*) Pane spike resistant area with the object of comparing the insect fauna and deducing the vector and also to get evidence if the field crops in any way influence the fauna containing the vector, were continued. One set of insects collected during the period from October 1936 to January 1937, has been identified and further work is in progress.

(iii) Fifty types of insect, out of the remaining 105 not yet identified have been despatched during the year to the Forest Entomologist, Dehra Dun, for his identification. These are the remainder of the types which were liberated in the mass infection cages previously mentioned.

(iv) In order to work out correctly the annual infection incidence of spike disease each year, Dr. Beeson suggested the selection of 100 plants in different localities in February each year, their defoliation, rejection of those that manifest spike immediately and keeping of the rest exposed to infection from April onwards. Early in April, the following year all the plants will again be defoliated to bring out the masked symptoms. The number of plants spiked in these sets will give the annual infection incidence. So far (i.e., till May 31st, 1938), 31 at Javalagiri and 6 at Aiyur have shown the disease which indicates a much higher infection at Javalagiri than at Aiyur. The infection incidence at Javalagiri may be taken as final but at Aiyur as the new leaf flush is not complete still more plants may yet manifest the disease.

297. VIII. *Summary of the important results of the year.*—
(1) Further indications of night infection.
(2) Definite range regarding the size of the vector (1/20" to 1/4").
(3) One main season for infection (August to November) with a secondary season (March to April).
(4) Effective eradication of spike by control measures in newly affected areas if detected early.
(5) Promising results in preventing re-infection by sprays of lead and copper arsenites.
(6) Promising results in isolating resistant strains.

(b) Periodicity of height growth.

298. *General.*—Measurements were continued weekly at all centres for a number of species to determine the active growing and resting periods of young trees.

Results during the year show the following.

299. (A) *Evergreen forest.*—(i) *Chandanathode.*—All species grew throughout the year very slowly and steadily but with an appreciably increased rate from the middle of February to the middle of May and from early September to the end of November. The middle of May to early September was a period of comparative quiescence, and December to February were months of comparatively slow growth.

Species.—*Hopea parviflora*, *Dysoxylum malabaricum*, *Dipterocarpus indicus*, *Cedrela toona*, and *Swietenia macrophylla*.

(ii) *Karian Shola.*—In the Karian Shola Experimental Garden No. 1 *Hopea parviflora* and *Mesua ferrea* grew from March 1937 to the end of May and from August 1937 to the beginning of 1938. The rest of the year, the growth was extremely slow.

Swietenia macrophylla exhibited similar growth but with an extra period of accelerated growth from the middle of June 1937 to the middle of July.

In the Karian Shola Experimental Garden No. 2, all species grew slowly during the year, with retardation in growth towards the end of May, the end of September, and February. *Artocarpus hirsuta*, exhibited particularly rapid growth in May, and *Swietenia macrophylla* towards the end of October.

Species.—*Swietenia macrophylla*, *Hopea parviflora*, *Cedrela toona*, *Dipterocarpus indicus* and *Artocarpus hirsuta*.

300. *B. Mixed deciduous forest.*—(i) *Nilambur.*—Teak and Andaman Padauk (*Pterocarpus dalbergioides*) grew steadily in height from the end of March 1937 to the end of January 1938. *Swietenia macrophylla* exhibited a period of rapid growth in April, and another prolonged period of sustained growth from the end of May 1937 to the end of December 1937.

(ii) *Kannoth.*—All species grew steadily throughout the year without any marked rest periods. The growth of teak has again been found most active from the middle of May to the end of November.

Species.—Teak, *Terminalia crenulata*, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Pterocarpus dalbergioides*, *Artocarpus hirsuta*, *Swietenia macrophylla*.

(iii) *Begur.*—With the two exceptions of *Chloroxylon swietenia* and *Castanospermum australe* all species started growing about the middle of February 1937 and this growing season lasted until the beginning of December 1937, when they again started a period of rest. The growth of *Bambusa arundinacea* and *Dendrocalamus strictus* was very rapid during the period July to November. The growth of *Chloroxylon swietenia* from Ceylon and *Castanospermum australe* was exceedingly slow during the year, appreciable growth being confined to the months of July and August 1937 and also early November.

Species.—*Artocarpus hirsuta*, *Bambusa arundinacea*, *Castanospermum autrale*, *Chloroxylon swietenia*, *Dalbergia latifolia*, *Dendrocalamus strictus*, *Pterocarpus marsupium*, *Schleichera trijuga*, *Swietenia macrophylla*, *Tectona grandis* and *Terminalia crenulata*.

(iv) *Dhoni.*—All species grew rapidly from the beginning of April 1937 to the beginning of December 1937 when growth though continued was apparently retarded.

Species.—*Dalbergia latifolia*, *Pterocarpus marsupium*, *Swietenia macrophylla*, *Tectona grandis*, *Terminalia crenulata* and *Xylia xylocarpa*.

(v) *Topslip.*—Teak (of South Burma, Mount Stuart, Mysore and Nilambur origins) and *Terminalia crenulata* exhibited active growth from the middle of March to early December 1937. This

growth was however retarded during a very short period at the end of May 1937, and during October 1937. From December 1937 to March 1938 was a period of comparative rest.

Xylia xylocarpa exhibited active growth from March to the end of May 1937, from the middle of June to the end of July 1937, and in the latter half of October 1937.

Pterocarpus marsupium grew rapidly from the middle of April to the middle of May, and from the middle of August to the end of November 1937.

Dalbergia latifolia grew slowly but steadily from March to the middle of July, and mid August to mid November.

Species. Tectona grandis (of four origins), *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Xylia xylocarpa*.

304. *C. Dry fuel forests—Emmanur.* All species exhibited two periods of active growth between March 1937 and January 1938. These periods were apparently from early March to the middle of May 1937 and from early October to the end of January 1938. The period from the middle of May to early October was a period of comparative rest though occasionally slight growth was observed.

Species.—*Acacia auriculiformis*, *Acacia ferruginea*, *Acacia sundra*, *Albizzia amara*, *Anacardium occidentale*, *Azadirachta indica*, *Cassia siamea* and *Prosopis juliflora*.

(c) *Weeds—Lantana Eradication.*

302. (i) *Germination tests.*—In connection with the *Lantana* seed fly investigation *Lantana* seeds were collected and despatched to Dehra Dun and at the same time a parallel germination experiment was carried out at Denkanikota. The results are tabulated below :—

Seeds sown without pulp.			Seeds sown with pulp.		
Test number.	Number of seeds sown.	Number germinated.	Test number.	Number of seeds sown.	Number germinated.
1	100	3	1	100	2
2	100	4	2	100	..
3	100	4	3	100	..
4	100	3	4	100	..
5	100	5	5	100	..
6	100	5	6	100	1
7	100	3	7	100	1
8	100	3	8	100	1
9	100	2	9	100	..
10	100	2	10	100	1
Total ..		34 out of 1,000 or 3·4 per cent.			7 out of 1,000 or 0·7 per cent.

The results indicate that seeds without pulp give a higher percentage of germination than those with pulp (as in the case of sandal seeds) and that the percentage of germination of *lantana* seeds is very low.

303. (ii) *Eradication of lantana*—(*a*) *Biological methods.*—*Lantana* berries were collected from Noganur Reserved Forest, Sanamavu Reserved Forest, Denkanikota Reserved Forest, Denkanikota, Noganur road sides and Galigattam Reserved Forest and spread in insect breeding glass cages to watch for the emergence of *lantana* seed flies. In the batch of berries of Noganur Reserved Forest, Sanamavu Reserved Forest, Denkanikota Reserved Forest, and Denkanikota-Noganur road sides, plenty of *lantana* seed flies emerged thus showing their presence in these localities whereas in Galigattam Reserved Forest which is at a distance of eighteen miles from Denkanikota they were absent. Seeds from various other localities are also being collected to note the presence or absence of these flies. These flies destroy a certain amount of *lantana* fruits before they are ripe and thus lessen the chances for profuse regeneration.

Mauve colour flowered *lantana* appears to support the flies better than the pink colour flowered variety.

304. (*b*) *Chemical methods.*—(i) A thick *lantana* area (density of *lantana* 10,000 per acre) 2 acres in extent was selected and divided into 25 strips in Noganur Reserved Forest. In August 1937, 32 gallons of sodium chlorate solution was sprayed on the *lantana* and between 30th November 1937 and 3rd December 1937, repetition of spraying with 20 gallons was carried out. The *lantana* is all dead now and has been burned. Sowings of *Cassia siamea*, etc., will be done early in May 1938.

Cost of operation.

	Rs.	A.	P.
Cost of 32 gallons of sodium chlorate solution for first spray.	9	4	0
Cost of 20 gallons of sodium chlorate solution for second spray	5	12	6
Cost of burning	3	0	0
Total ..	18	0	6
	or 9	0	3 per acre

(ii) *One acre plot.*—One acre of *lantana* area (density 10,000 per acre) was demarcated in Noganur Reserved Forest and spraying was carried out between the 15th and 18th January 1938 with sixteen gallons of sodium chlorate solution the strength used being ½lb of sodium chlorate to every two gallons of water instead of ¾ lb the old strength. The *lantana* plants have shed their leaves and in some cases the top twigs also dried up by 28th January 1938. Some of the plants started shooting on 16th February 1938. Re-spraying for the second time was done in March 1938 with ten gallons of solution.

Cost.

		Rs.	A.	P.
Cost of 16 gallons of sodium chlorate solution for first spray	..	4	10	0
Cost of 10 gallons of sodium chlorate solution for second spray	..	2	14	3
Total	..	7	8	3

305. (iii) *Regeneration in lantana destroyed areas.* (*a*) Over an area of two acres in which *lantana* was destroyed in 1936 by cutting and burning and spraying the regrowth, 150 *Cassia siamea* stumps were planted in October 1936. Of these, 398 have come up very well and the maximum height is 12 feet.

In October 1937, the spacing of *Cassia siamea* was considered insufficient and 1,300 stumps more were planted at a 6 feet spacing. Among these 15 per cent are dead and the rest are living and the maximum height is 2 feet.

Noganur four-acre plot. The plot was regenerated after uprooting and burning *lantana* and sowing *Cassia siamea* seeds on 1st June 1934. The plot is stocked with *Cassia siamea* plants and the maximum height is 18 feet and average height 12 feet.

Nyamasandiram agraharam one acre *lantana* killed plot regenerated with *Bambusa arundinacea* :—

On 26th August 1935 and 30th August 1935, two-year old *Bambusa arundinacea* rhizomes were planted in 322 pits. An enumeration done in March 1936 gave 185/322 survivals. The casualties were replaced in August 1936. Again in October 1937, 150 pits were planted with 300 seedlings as they were all blank. The seedlings are coming up well now though only 62 are alive now (March 1938).

306. *Effect of sodium chlorate spray on young Cassia siamea plants.*—Only two age classes were sprayed with the usual strength of sodium chlorate used for *lantana* eradication. One year and six months old plants. In both these cases the foliage was killed out by the spray but stems remained green.

The spray killed plants were below 6 inches in height but plants over this height merely shed their leaves.

This result is important as in the regeneration of *Cassia siamea* in *lantana* areas, the best and cheapest method of preventing the re-invasion of the plots by *lantana* until the *Cassia siamea* is high enough to take care of itself is probably spraying.

307. (*c*) *Silvicultural.*—Experiments started in 1933 in introducing *Bambusa arundinacea* and *Dendrocalamus strictus* under *lantana* without clearing lantana were continued.

During the year 1937–38, a plot of five acres of dense *lantana* was selected in Nyamasandiram Agraharam Reserved Forest and bamboo seedlings were planted under *lantana* as detailed in the table below. No clearing was carried out.

In the three-acre plot opened in 1936–37 in which bamboo rhizomes from Wynaad were planted in 1936–37 the seedlings all died out. Re-planting of bamboo seedlings were done during 1937–38 as detailed below.

The results of enumeration carried out in March 1938 are tabulated :—

Plot number.	Date of planting.	Number of seedlings planted.	Survivals in March 1938.	Percentage of survivals.
Three acre plot ..	11th October 1937 ..	865	271	31
Five acre plot ..	30th September to 12th October 1937.	3,822	948	25

308. The results of survivals in the plots opened since 1933–34 are tabulated below :—

Locality :—Nyamasandiram Agraharam Reserved Forest.

Plot number.	Extent.	Nature of sowings or plantings.	Date of start.	Number of plants in the plot.	Number surviving in March 1938.	Percentage of survivals.
A-1 ..	¼ acre ..	Direct sowings on mounds.	September 1933.	366	148	40
A-2 ..	Do. ..	Do.	Do.	308	125	41
B-1 ..	Do. ..	Direct sowings in patches.	Do.	326	202	62
B-2 ..	Do. ..	Do.	Do.	240	225	94
D-1 ..	Do. ..	Planting one-year old rhizomes.	October 1934.	328	187	57
D-2 ..	Do. ..	Do.	Do.	203	107	53
	Two-acre plot.	Do.	Do.	644	448	69
A-1 ..	¼ acre ..	Direct sowings on mounds.	August 1935.	337	37	11
A-2 ..	Do. ..	Do.	Do.	300	97	32
B-1 ..	Do. ..	Direct sowings in patches.	Do.	324	141	47
B-2 ..	Do. ..	Do.	Do.	308	180	58
	Two-acre plot.	Planting two-year old rhizomes.	Do.	628	187	30

309. These older areas in which the *lantana* is 6 to 10 feet high have been carefully enumerated and it is found that the percentage of plants that have come through the *lantana* or that are just coming through the *lantana* in each case is as follows :—

Year of planting.	Area in acres.	Number of plants surviving.	Number of plants that have come through the lantana or are just coming through the lantana.	Percentage.
1933	¾	384	115	30
1934	2¾	811	192	24
1935	3	136	27	20

310. In order to test the capability of *Bambusa arundinacea* to suppress *lantana* in mixed deciduous forest of good quality four experiments have been started. (Experimental plot 32, Wynaad Division, Experimental Plot 67, South Coimbatore Division, and Experimental Plot 150 A and B in Palghat Division). In each experiment, plots of about one acre each were selected where *Lantana* had come in and almost completely defeated the natural forest. *Bambusa* was established by coolies crawling under this dense *lantana* growth and planting one year old transplants and

rhizomes at 15 feet into 15 feet espacement in alternate lines. No cutting of *lantana* at all was done and it was as little disturbed as possible.

At the end of the second year the establishment is as follows :—

Division.	Experimental Plot number.	Transplants. Survival per cent.	Transplants. Mean height in inches.	Rhizomes. Survival per cent.	Rhizomes. Mean height in inches.
Wynaad	32	78	41·2	53	32·7
Coimbatore South ..	67	43	20·6	39	38·9
Palghat	150 A	83	45·5	87	55·2
	150 B	46	18·2	73	36·7
Average ..		63	31·4	63	40·9

The above figures show that there has been very little difference in survival percent between the transplants and rhizomes, but in mean height growth at the end of second growing season after planting, the rhizomes are 30 per cent ahead.

311. The planting of cuttings of fast growing species with the idea of causing shade and thus suppressing the growth of *lantana* was undertaken. A plot of one acre was selected in Noganur Reserved Forest and 23 lines at a spacing of 15 to 10 feet were cut and the following cuttings were planted in July 1937.

The results are tabulated below :—

Species.	Number planted.	Number sprouted.
Ficus Bengalensis	53	26
Ficus mysorensis	28	5
Ficus glomerata	30	..
Ficus retusa	28	3
Erythrina indica	17	11
Thespesia populnea	14	6
Cassia siamea	7	1
Albizia amara	5	3

The results cannot be judged until the cuttings grow into big trees and cast a heavy shade. The object is to regenerate *lantana* areas with better species and at the same time to see if the *lantana* will be killed out by the heavy shade cast by these species.

312. *Climber eradication by poisoning.*—Vellore West Division reports on two experiments in the eradication of climbers with a solution of arsenious oxide. The species experimented with were *Pterolobium indicum*, *Zizyphus oenoplia* and *Acacia intsia* and the percentages of success in the two experiments with these species were 75 per cent, 76 per cent and 92 per cent; and 85 per cent, 66 per cent and 87 per cent respectively.

In most of the failures the climbers were killed back to ground level but produced strong basal shoots.

313. *Strobilanthes eradication.*—Experimental plots 1, 2 and 22, Wynaad Division, have as their object the eradication of *Strobilanthes*. The first two of these plots were initiated in 1932, one year after the *Strobilanthes* flowering and the last one in 1934, i.e., three years after. The following four treatments were applied : (A) Control—nothing done, (B) cutting above the aerial root,

(C) cutting flush with the ground and (D) pulling out by hand. So far practically no *Strobilanthes* plants have appeared in the treated plots.

The species is suspected to be *Strobilanthes reticulatus* but this can only be confirmed at the next flowering.

314. *Attempted suppression of Eupatorium in the Nilgiris.*—The weed *Eupatorium* is seriously invading grazing ground in the Nilgiris. Kikiyu grass (*Pennisetum clandestinum*) has been introduced in a series of plots after pulling up the *Eupatorium* to see whether the grass so established will keep out the weed. The grass is now well established and its "runners" have penetrated well into the *Eupatorium*, but a few plants of the weed have appeared in the grass but look sickly. The struggle between the two is still in progress and after four years the method looks very promising. In consequence a large-scale experiment was started last year to endeavour to get a reliable estimate of the costs of such work. It is of course too early to judge the results of this large-scale experiment but it looks promising. In addition it is to be noted that the *Eupatorium* thus uprooted is a good base for making "compost" for nursery manure.

II. WORKING PLANS AND STATISTICS.

(i) Working Plans.

315. The Provincial Silviculturist continued to be in touch through the Conservator of Forests, Working Plans Circle, with the Working Plans officers in the various districts. He was largely consulted with regard to proposed prescriptions on silvicultural matters and statistical work. The experience gained and the results obtained in this branch were availed of by the Working Plans officers and District Forest officers.

316. The following statement shows the working plans under preparation in the Working Plans Circle at the beginning of the year under review, those completed during the year, and the new ones undertaken :—

Number of division.	Working plans under preparation at the beginning of the year.	Working plans completed during the year.	New working plans commenced during the year.	Remarks.
I	Nilambur division.	Vellore East division (*a*).	..	(*a*) Pending sanction during the year.
	....	Vellore West division (*b*).	..	(*b*) Under compilation.
II	Anantapur and Chittoor divisions.	Cuddapah South division (*c*).	..	(*c*) Pending sanction of the Chief Conservator.
III	Wynaad division.	....	..	....
IV	The Nilgiris division.	The Nilgiris division (*d*).	Kurnool East division.	(*d*) Pending sanction of Chief Conservator of Forests.
V	Godavari Upper division.	Godavari Upper division (*e*).	Guntur division.	(*e*) Under compilation.

The Working Plan for the Walayar, Bolampatti, and Thadagam valleys of Palghat Division was sanctioned during the year.

The cost per acre of Working Plans completed during the year were as follows :—

(a) Vellore East Division 3·9 annas.

(b) Cuddapah South Division 1·5 annas.

(c) The Nilgiris Division 1·2 annas.

(iii) Yield, Volume, and Form Factor Tables.

317. *Yield tables.* During the year the Central Silviculturist, Dehra Dun, has prepared new yield tables for Nilambur teak. These are a great advance on Bourne's tables (good though they were) which were prepared over 20 years ago for temporary sample plots.

The great point that has emerged from the preparation of these new tables is that when plotted against "top height" (height of dominant trees) instead of against age, the number of stems per acre, basal area per acre and volume per acre are independant of age and quality.

This has thus given us a guide to thinnings by which any thinning can be readily checked without reference to the age or quality of the plantation.

Below is given a table showing the approximate number of stems per acre and spacing in the crop for a series of top heights.

Top height in feet.	Number of stems per acre in the main crop.	Approximate espacement in feet.
30	560	..
35	465	9 × 9
40	385	10 × 10
45	315	11 × 11
50	260	12 × 12
55	210	..
60	165	15 × 15
65	130	..
70	105	..
75	85	20 × 20
80	70	..
85	60	25 × 25
90	52	..
100	40	30 × 30
110	83	..
		36 × 36

318. *Samples plots.*—One hundred and forty-five plots in six divisions representing sixteen species were maintained. The difference in numbers between last year and this year is due to transfer on further scrutiny of some plots from sample plots to Tree increment plots. Twenty new teak sample plots in the Nilambur Division to compare teak growth from different origins, and five new teak sample plots in the Wynaad Division were opened during the year. In addition twenty-one sample plots in the Nilambur Division, two in the Wynaad Division, and five in the Nilgiri Division were remeasured.

A sectional ladder in seven sections of 6 feet each has been constructed and brought into use for sample tree measurements as an adjunct to the swing seat paraphernalia already reported.

319. *Permanent Preservation plots.*—Ten files have been opened with complete information, and for five more plot files are awaited from concerned District Forest Officers. Two more files for single trees for permanent preservation have also been opened.

320. *Tree Increment plots.*—Including six *Chloroxylon swietenia* Tree Increment Plots in the Upper Godavari Division we have now 36 Tree Increment Plots. Of these the area or length of base line for Chittoor Tree Increment Plot No. 4 and Upper Godavari Tree Increment Plot Nos. 1 to 4 are yet to be ascertained. The remaining 31 plots are composed of 5 plots with a total base line length of 4·91 miles, and 26 plots of an aggregate area of 327·30 acres.

III. MISCELLANEOUS.

321. *Tours, records and staff.*—The Provincial Silviculturist and the Assistant Silviculturist toured for 190 and 189 days, respectively, during the year under report.

The sandal spike disease research works in North Salem Division were inspected by the Provincial Silviculturist and also by the Forest Botanist, Dehra Dun.

The Provincial Silviculturist was deputed to the "Research Demonstration Course" held at Dehra Dun in October 1937. The course was interesting and instructive and on account of its advantages the Assistant Silviculturist has been selected for the next course to be held in 1938–39. A note on the "demonstration course" was written and submitted to the Chief Conservator of Forests.

For the better identification of evergreens in the Presidency the Forest Botanist, Dehra Dun, visited all the four linear tree increment plots which were opened during the year (i.e.), at Staircase Shola in the Nilgiris division, (2) Karian Shola in Coimbatore South Division, (3) Neelikal in the Palghat Division and (4) Chandanathode in the Wynaad Division, and he started the work of identification in all these places.

On his return from Coorg the Central Silviculturist, Dehra Dun, also visited and inspected the Research Experimental Works at Chandanathode, Kannoth, Nilambur, Nilgiris, Emmanur, Walayar, Dhoni, the irrigated teak plantations at Hulical drug and the district rab and kumri works in the Ayyalur range of Madura district.

The Provincial Silviculturist accompanied these officers throughout their tours in the Presidency.

322. *Books and publications.*—" The note on a tour in South Bengal " referred to in paragraph 266 of the last year's report has been sanctioned by the Government to be printed, and its publication is awaited.

The following pamphlets were written during the year by the Assistant Silviculturist and submitted to the Chief Conservator of Forests, Madras :—

(1) A note on the cultivation of the Green wattle (*Acacia decurrens*) in South Africa and South India.

(2) A short note on *Cassia auriculata*.

(3) A note on the financial aspect of planting wattle (*Acacia decurrens*) in the Nilgiris.

The results of some of the closed investigations were summarized and written up as pamphlets by the Provincial Silviculturist during the year.

They are—

(1) An investigation into the best date of stump planting teak (*Tectona grandis*) at Begur, Dhoni and Topslip.

(2) An investigation into the relative merits of planting teak (*Tectona grandis*) stumps in pits and crowbar holes in areas having a west coast type of climate.

(3) An investigation into the best root lengths of stumps to use when stump planting teak (*Tectona grandis*).

All the above three investigations are being published as " Indian Forest Records " by the Forest Research Institute, Dehra Dun.

Besides the above, two sets of research experiments on soil working in dry fuel forests (Emmanur) in Coimbatore North Division as detailed below were also summarized and submitted to the Chief Conservator of Forests who had them distributed to all the Forest Officers in the Presidency—

First set.—The effect of soil working by forking on the survival per cent and height growth in the first year of " rab " regeneration raised under the poorest conditions, of *Acacia ferruginea*, *Albizzia amara*, and *Cassia siamea*.

Second set.—The effect of soil working by forking on the survival per cent and height growth in the first year of " rab " regeneration raised under fairly good conditions, of *Acacia ferruginea*, *Anacardium occidentale*, *Cassia siamea*, and *Pithecolobium dulce*.

323. *Office inspection.*—The three research range offices of the division were inspected by the Provincial Silviculturist during the year.

The half-yearly inspections of the ledger files and the annual office inspection were made by the Conservator of Forests Working Plans Circle, Ootacamund, during the year.

324. *Records.*—The specific and general ledger files now number 436 and 156, respectively, seven new specific and four new general ledger files having been opened during the year.

Fourty-one new experimental plots and 192 new experimental garden experiments were opened and 11 experimental plots and 151 experimental garden experiments were closed during the year. In consequence 106 experimental plots and 328 experimental garden experiments were open at the close of the year.

One hundred and seventy-six photographs were added to the collection during the year and the total number of photographs now ledgered is 636 under specific and 320 under general ledger files.

A proposal to establish a Central Library of all forest literature in the Provincial Silviculturist's office was made during the year, and to initiate this scheme the library registers of the District and Circle Offices in the Presidency were perused. The listing of books is in progress.

325. *Staff.*—The Extra Assistant Conservator of Forests remained in the division as Assistant throughout the year.

The subordinate staff consisted of three Research Rangers, nine Foresters and one Forest Guard.

One Ranger, Sri S. G. Venkatramanan, was deputed to foreign service (as Forest Superintendent, Vizianagram Estate) and the Forest Guard was deputed to " The Forest Guards School " at Nilambur during the year.

The office establishment consisted of one head clerk, two clerks and one typist.

326. *Discipline.*—The general discipline of the staff was satisfactory.

OOTACAMUND,
14th June 1938.

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Silviculturist

PART II

EXPERIMENTAL DATA.

327. *Rainfall in inches and number of rainy days* (vide paragraph 8).

Locality.	April 1937.	May 1937.	June 1937.	July 1937.	August 1937.	September 1937.	October 1937.	November 1937.	December 1937.	January 1938.	February 1938.	March 1938.	April 1938.	May 1938.	Total for year from 1st April 1937 to 1st April 1938.	Average of years.	
																INCHES	YRS.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Evergreen forests.																	
Topslip (Karianshola) ..	5·65	1·00	6·60	16·90	2·95	1·45	9·15	6·25	1·60	..	1·00	1·20	4·85	3·00	53·75	61·66	14
Chandanathode ..	8 5·30	2 7·30	15 36·50	27 96·30	8 36·90	4 11·60	14 20·80	11 2·05	1 ..	..	2 ..	3 1·30	5 10·70	2 7·00	95 218·05	103* 156·45	21
	9	14	25	31	27	18	18	6				2	10	12	150	144	
Mixed deciduous forests.																	
Nilambur	3·48	3·66	19·08	30·93	9·54	2·59	16·32	3·98	..	..	0·02	1·22	2·11	6·42	90·82	112·21	63
Begur	8 2·00	10 3·40	26 6·29	31 13·65	18 5·27	11 2·52	21 5·33	13 1·92	..	..	2 0·15	3 1·28	9 4·20	11 0·94	143 41·81	112 71·49	21
Kannoth	11 5·24	10 4·06	23 24·86	30 55·81	17 17·87	10 7·36	15 12·75	9 1·73	..	..	1 ..	3 2·38	9 4·58	4 8·53	129 132·06	77 76·40	19
Dhoni	9 6·28	10 0·76	24 17·07	31 27·93	17 12·29	13 4·43	13 23·25	7 3·20	0·35	..	0·61	5 1·98	12 0·95	12 4·32	129 98·15	136 104·72	11
Walayar	8 1·80	4 1·80	26 5·30	31 13·30	16 4·80	12 1·50	23 5·70	9 4·00	1 0·40	..	3 0·10	4 0·50	9 0·40	8 0·30	137 39·20	136* 52·75	18
	5	2	14	24	7	5	13	8	1		1	2	2	2	82	82	

* Average of two years only.

Locality (1)	April 1937. (2)	May 1937. (3)	June 1937. (4)	July 1937. (5)	August 1937. (6)	September 1937. (7)	October 1937. (8)	November 1937. (9)	December 1937. (10)	January 1938. (11)	February 1938. (12)	March 1938. (13)	April 1938. (14)	May 1938. (15)	Total for year from 1st April 1937 to 1st April 1938. (16)	Average of years. INCHES. (17)	Average of years. YEARS. (18)
Dry fuel forests.																	
Ermanur	4·54	3·08	0·76	1·06	1·11	4·00	7·86	8·04	..	..	..	0·38	6·50	2·13	30·83	29·88	2
Satyamangalam ..	10 4·02	15 2·56	5 1·26	4 1·53	3 1·74	6 3·14	16 6·42	17 2·91	0·23	..	0·16	2 0·45	14 1·58	4 0·29	75 24·42	79 29·74	44
Denkanikota	8 9·19	12 10·30	3 3·25	6 1·95	4 4·47	5 6·43	14 7·42	11 3·57	3 0·75	..	1 0·11	3 0·41	7 0·34	1 6·08	70 47·80	55 34·44	15
	12	11	7	10	8	5	16	11	3		1	2	2	8	86	70	
High elevation forests.																	
Jacko's nullah . ..	5·82	3·06	2·97	8·54	4·07	3·16	8·25	5·55	0·20	..	..	0·43	2·79	3·31	42·07	43·21	2
Brooklands	15 7·06	12 6·75	16 9·74	26 8·93	11 4·43	8 5·40	12 10·80	13 9·30	2 [illegible]	..	..	2 0·76	8 4·68	6 4·63	117 63·47	125 63·47	4
Windy Corner (Yemmakal).	14 4·09	13 3·14	19 4·97	28 8·28	11 3·82	9 2·77	14 5·65	13 4·95	5 0·35	0·03	0·04	2 [illegible]	10 2·65	8 2·75	126 57·81	126 57·61	
	17	14	not known*	30	21	16	23	18	12	5	4	4	12	12	162 + X*	X*	

* Could not be determined due to instrument not functioning one month.

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328. Seed weighments (Vide paragraph 39)—For germinative capacity and plant per cent the maxima are given.

Species (Botanical names). (1)	Month in which to collect seed. (2)	Number of seeds per Ounce. (3)	Number of seeds per Lb. (4)	Number of weighments. (5)	Plant per cent. (6)	Germinative capacity. (7)	Number of tests. (8)	Number of seeds tested. (9)	Plants per lb. of seed. (10)
Acacia arabica ..	II–III	151	2,416	10	75	75	2	4,000	*1,820
Acacia auriculiformis.	III–IV	1,197	19,152	12	59	67	26	10,000	9,900
Acacia baileyana ..	..	795	12,720	2	11	31	2	500	1,780
Acacia cyanophylla ..	IV	2,010	32,160	5	93	94	12	4,300	29,900
Acacia dealbata ..	I–IV	2,313	37,008	4	33	45	12	1,200	12,180
Acacia decurrens ..	..	1,550	24,800	2	11	11	2	1,000	2,728
Acacia ferruginea ..	III	165	2,640	20	80	90	20	6,500	2,112
Acacia leucophloea ..	III–IV	1,115	17,840	20	28	28	19	3,100	4,950
Acacia melanoxylon.	IV	2,023	32,368	4	78	83	12	1,200	25,000
Acacia mollissima ..	..	1,600	25,600	2	8	13	2	1,000	2,048
Acacia planifrons ..	VI	709	11,344	5	18	22	4	4,000	2,040
Acacia sundra ..	II–V	730	11,680	12	90	90	30	8,000	10,512
Acrocarpus fraxinifolius	III–IV	929	14,864	40	21	25	50	48,000	3,130
Albizzia amara ..	II–IV	386	6,176	22	74	79	32	50,000	4,550
Albizzia lebbek ..	II–III	315	5,040	25	24	27	8	1,800	1,208
Albizzia stipulata ..	..	1,997	31,952	2	1	8	10	1,000	320
Anacardium occidentale.	III–V	5·3	85	10	98	98	35	7,000	83
Artocarpus hirsuta ..	IV–VI	60	960	85	81	97	65	45,000	776
Azadirachta indica ..	III–VII	132	2,112	12	40	14	14	15,000	845
Bambusa arundinacea.	IV	2,303	36,848	15	37	38	7	2,500	13,600
Bambusa polymorpha.	III	1,326	21,216	3	32	40	22	3,000	6,750
Bauhinia racemosa ..	IV	217	3,472	4	12	17	4	3,000	417
Callitris rhomboidea.	IV–VI	4,856	77,696	4	18	22	5	500	13,960
Calophyllum elatum.	V–VI	5	83	22	67	89	23	7,800	55
Canthium didymum.	IV	360	5,760	10	2	42	3	3,000	115
Cassia auriculata ..	I	199	3,184	2	19	25	4	4,000	602
Cassia fistula ..	III–V	180	2,880	16	33	44	40	15,000	950
Cassia marginata ..	II–V	133	2,128	13	47	65	21	8,800	997
Cassia siamea ..	III–IV	1,060	16,960	20	87	98	24	5,500	14,680
Cassia tomentosa ..	II–IV	1,033	16,528	4	8	13	15	1,500	1,320
Castanospermum australe	IV	1	15	3	53	56	4	350	8
Casuarina montana ..	..	39,900	638,400	2	5	15	2	1,000	31,920
Cedrela odorata ..	III	2,104	33,664	2	15	27	2	10,000	5,040
Cedrela toona ..	V	5,486	87,776	25	62	82	28	18,000	54,100
Chlorophora excelsa ..	..	8,900	142,400	2	29	31	4	50,000	41,400
Chloroxylon swietenia.	III–VIII	2,538	40,608	40	64	69	54	38,000	25,900
Chloroxylon swietenia (Ceylon) .. .	III–X	1,406	22,496	48	58	73	35	35,000	13,100
Citysus scoparius ..	III–IV	3,188	51,008	2	24	30	5	500	12,200
Cupressus macrocarpa.	IV–VI	4,363	69,708	4	8	8	6	1,000	5,577
Cupressus torulosa ..	V–VI	3,840	61,440	1	5	9	5	500	3,072
Dalbergia latifolia ..	I–III	520	8,320	20	55	65	63	43,000	4,580
Dalbergia sissoides ..	III	516	8,256	60	50	65	60	30,000	4,128
Daphniphyllum glaucescens	V–VI	143	2,288	4	5	8	10	1,000	114
Dendrocalamus brandisii	II	3,475	55,600	1	1	2	2	1,000	556
Dendrocalamus strictus.	IV	1,269	20,304	15	47	48	5	1,500	9,580
Dipterocarpus indicus.	III–V	5	78	6	20	41	6	3,000	16
Dodonea viscosa ..	II–IV	3,220	54,520	2	12	12	5	500	6,150
Dolichandrone crispa.	III–IV	846	13,536	10	30	32	8	4,800	4,061
Dysoxylum malabaricum	VII–VIII	3	50	4	85	85	32	2,435	43
Eucalyptus maculata.	..	6,112	97,792	2	12	13	2	200	11,730
Eugenia arnottiana ..	VI–VII	†120	2,064	6	71	73	22	3,000	†1,465
Erythroxylon monogynum	I–II	895	14,320	12	2	2	4	1,600	286
Feronia elephantum.	IV	1,408	22,528	6	1	1	4	4,000	225
Givotia rottleriformis.	..	16·5	264	5	..	..	..	..	..
Glochidion neilgherrense	III–IV	1,400	23,840	1	..	3	1	100	..
Gluta travancorica ..	V–VIII	1·9	30	5	90	96	32	6,255	27
Gmelina arborea ..	V–VI	42	672	3	56	64	25	8,500	375
Hakea saligna ..	IX–X	2,445	39,120	6	68	78	14	1,200	26,500
Hardwickia binata ..	V	‡134	2,144	5	..	..	..	..	..
Hardwickia pinnata.	..	4·6	74	1	80	85	5	500	59
Harrisonia bennettii.	I	269	4,304	5	8	12	3	300	344

* Best results are with seed navigated through goats.

† With pulp ; without pulp 164 to the ounce. ‡ Kernel only. Pods 88 per ounce.

Species (Botanical names).	(1)	Months in which seed is available.	Number of seeds per		Number of weighments.	Plants per lb. of seed.	Grains per plant.	Yield per lb. of seed.	Number of seed.	Plants per lb. of seed.
		(2)	(3) Ounce.	(4) Lb.	(5)	(6)	(7)	(8)	(9)	(10)
Holoptelia integrifolia			1,080	17,280						INCHES.
Hopea parviflora		V VII	84	1,344					100	2,500
Jacaranda mimosifolia			1,320	60,120					10,000	728
Juniperus procera			1,384	22,144					1,000	4,147
Lagerstroemia reginæ										
Lagerstroemia lanceolata		I III	2,980	47,680					1,200	1,107
Lantana camara		III	2,592	29,472					20,000	21,400
Leucæna glauca		VIII	*1,302	20,832						
Ligustrum perrotetii		I	866	13,856					61,000	8,947
Mahonia leschenaultii		I III	†812	12,992					2,000	117
Melicoma wightii		III IV	1,875	30,000					1,000	1,560
Mesua ferrea		III	127	1,952					1,000	8,510
Michelia nilagirica		III & IX	30	480					500	14,400
Morus alba		VI	332	5,312					100	
Nouhtsa sedanica			26,015						8,000	326
Pelagonium elipticum		V VI	172	2,752					1,000	1,220
Pinus insignis		V-VIII	76	1,216					5,000	20,800
Pinus longifolia			1,326	21,216					200	404
Pithecolobium dulce			223	3,568					7,000	77
Prosopis julifloa			186	2,976					1,000	849
Prosopis spicigera		V	926	14,816					1,000	143
Pterocarpus dalbergioides		III IV	569	9,204					1,200	980
Pterocarpus marsupium		III IV	50	800					87,000	11,560
Pterocarpus santalinus		I IV	59	944					2,400	8,000
Santalum album		II IV	59	944						
Schleichera trijuga		X & III-IV	30	472					14,000	**232
Shorea talura		II VI	‡141	2,256					38,000	850
Soymida febrifuga		V	53	848					20,000	300
Swietenia macrophylla		V	832	510					24,000	880
Tamarindus indica		XII III	378	6,048					7,500	609
Tectona grandis		II III	59	944					4,500	280
Terminalia chebula		I III	47	752					9,000	1,512
Terminalia crenulata		XI II	50	800					35,000	670
Terminalia paniculata		I IV	16	257						
Trema orientalis		II IV	23	368					68,000	464
Valeria indica		I VI	939	15,024					16,000	§129
Viburnum erubescens		VIII	6,040	96,640					55,000	212
Vitex altissima			1	18					1,50,000	300
Vitex littoralis		XII I	942	15,072					15,000	1,832
Vitex peduncularis		V-VII	313	5,008					500	14
Wrightia tinctoria		VIII	88	1,408					1,000	603
Xylia xylocarpa			280	4,480					230	
Zizyphus incurva		V	809	12,944					3,000	45
Zizyphus jujuba		I-V	85	1,360					4,000	1,036
		I	¶116	1,856					35,000	1,075
		III	45	720					7,000	709
									8,000	70

* With pulp; 2,092 per ounce without pulp.

† Without pulp; with pulp 508 to the ounce.

‡ With pulp; without pulp 203 per ounce.

§ Without wing. With wings 15 per ounce.

‖ Kernel. Best results are obtained with fermented seed.

¶ Without pulp. With pulp 80 to the ounce.

NOTE.—Seed of *Acrocarpus fraxinifolius*, *Calophyllum elatum*, *Mesua ferrea*, and *Dysoxylum malabaricum* very often only germinates to a small extent in the first year, the main germination often being in the second year.

** Seed from the Andamans.

329. Seed Storage (Vide paragraph 38).

Tests made at intervals with seed from the same sample gave the following indications of the length of time the seed remains fertile. Previous years' results are included in the table.

Species (Botanical names).	Method of storage.	Number of individual tests.	Number of series of the same sample of seed.	Remarks.
(1)	(2)	(3)	(4)	(5)
Acacia auriculiformis.	(1) Stoppered bottle	22	7	No falling off up to nine months.
	(2) Earthen pot.	26	7	
	(3) Gunny bag ..	26	7	
	(4) Air tight tins.	28	6	No falling off up to eight months.
Acacia cyanophylla ..	(1) Stoppered bottle.	21	6	Do.
	(2) Earthen pot.	21	6	
	(3) Gunny bag ..	21	6	
	(4) Air tight tins.	28	8	Seed ten months old only slightly less fertile than fresh seed.
Acacia ferruginea ..	(1) Stoppered bottle.	22	7	Seed good up to eight months and then rapidly deteriorates.
	(2) Earthen pot.	26	7	
	(3) Gunny bag ..	26	7	
	(4) Air tight tins.	24	6	
Acacia leucophloea ..	(1) Air tight tins.	8	4	Seed good after six months.
Acacia sundra ..	(1) Stoppered bottle	19	7	Seed good after nine months.
	(2) Earthen pot.	23	7	
	(3) Gunny bag ..	23	7	
	(4) Mud pot with wood ash.	41	7	Seed good after eight months falling off slightly by twelve months.
Acrocarpus fraxinifolius.	(1) Gunny bags.	113	25	Seed after nineteen months as good as fresh seed.
	(2) Air tight tins.	20	4	
Albizzia amara ..	(1) Air tight tins.	15	12	Seed good up to eighteen months but does not keep for two years, keeps best in (1).
	(2) Mud pot with wood ash.	47	20	
	(3) Gunny bag ..	15	12	
Anacardium occidentale.	(1) Air tight tins.	24	12	Seed good up to eight months. Keeps best in (1) or (3).
	(2) Gunny bag ..	44	12	
	(3) Earthen pot.	24	12	
Artocarpus hirsuta ..	(1) Gunny bag ..	47	12	Seed good up to two months and then rapidly deteriorates, keeps best if in pit covered with two inches of dry earth or in puddled mud.
Calophyllum elatum.	(1) Gunny bag ..	3	7	Keeps for at least one year. In the seed bed it often only germinates in the second year.
Cassia fistula ..	(1) Air tight tins.	34	12	Seed good up to sixteen months except in (1).
	(2) Earthen pots.	14	12	
	(3) Gunny bag ..	14	12	
Cassia marginata ..	(1) Air tight tins.	16	8	Seed good after eight months.
Cassia siama ..	(1) Air tight tins.	18	12	Seed good after eighteen months but does not keep for two years; keeps best in (1).
	(2) Mud pots with wood ash.	38	12	
	(3) Gunny bag ..	18	12	
Cedrela toona ..	(1) Gunny bag.	28	6	Seed good up to eight weeks falling to 50 per cent at ten weeks.
Chloroxylon swietenia.	(1) Air tight tins.	66	12	Good up to three months and then rapidly deteriorates.
	(2) Earthen pots.	12	12	No difference between Ceylon and Madras seed.
	(3) Gunny bags	48	12	
Dalbergia latifolia ..	(1) Gunny bag.	140	20	Good up to five months.
	(2) Air tight tins.	58	15	No seed has given any result after one year.
	(3) Earthen pot.	10	7	Good up to four months.
Dalbergia sissoides ..	(1) Gunny bag ..	8	8	Good up to three months and then rapidly deteriorates.
	(2) Air tight tins.	8	8	Best kept in tins.
	(3) Wood ash ..	8	8	
Dysoxylum malabaricum.	(1) Dry gunny bag.	8	4	Seed good up to six weeks. Keeps in wet gunny bag but not in dry gunny bag.
	(2) Wet gunny bag.	8	4	
Gluta travancorica ..	(1) Gunny bag ..	40	6	Seed good up to four months dropping to 50 per cent at six months.
Gmelina arborea ..	(1) Gunny bag ..	75	15	Variable. Seed usually good up to six or eight weeks.
Hopea parviflora ..	(1) Gunny bags.	47	6	Seed good after twenty days falling to 0 after forty days.

Species. (Botanical names).	Method of storage.	Number of individual tests.	Number of series of the same sample of seed.	Remarks.
(1)	(2)	(3)	(4)	(5)
Lagerstroemia flos reginae.	(1) Gunny bags.	50	10	Seed good up to six months by all three method and then rapidly deteriorates.
	(2) Gunny bag with wood ash.	50	10	
	(3) Air tight tins.	50	10	
Lagerstroemia lanceolata.	(1) Gunny bags.	34	6	Seed good up to four months.
	(2) Air tight tins.	34	6	Seed good up to six months.
	(3) Wood ash	10	6	Seed good up to three months.
Mesua ferrea ..	(1) Gunny bags.	17	6	Seed good up to four months dropping to 50 per cent at six months.
Palaquium ellipticum	(1) Gunny bags.	20	5	Variable usually good up to about two months.
Prosopis juliflora ..	(1) Stoppered bottle	20	8	Seed good after seven months.
	(2) Earthen pot.	24	8	
	(3) Gunny bag .	24	8	
	(4) Air tight tins.	24	6	
Pterocarpus dalbergioides.	(1) Gunny bags.	11	8	Seed good up to twenty-six months.
Pterocarpus marsupium.	(1) Gunny bags.	155	18	Variable, usually good up to six months, sometimes good up to one year.
	(2) Air tight tins.	14	12	
Pterocarpus santalinus.	(1) Gunny bags ..	32	7	Good up to six months, indications are that it is good up to ten months.
	(2) Earthen pot.	25	7	
	(3) Stoppered bottle.	25	7	
Santalum album ..	(1) Air tight tins.	26	15	Seed good up to eighteen months. Keeps best in gunny.
	(2) Gunny bags.	16	14	
Schleichera trijuga ..	(1) Gunny	5	6	Seed kept by all methods for five months without any deterioration.
	(2) Gunny with wood ash.	5	6	
	(3) Air tight tin.	5	6	
Swietenia macrophylla.	(1) Gunny bags.	60	10	Seed good up to 5 months falling to 0 at seven months.
Tectona grandis ..	(1) Gunny bags.	198	26	Seed good up to one year but falls to 30 per cent after two years. It keeps much better in (1) than in (2).
	(2) Air tight tins.	83	10	
Terminalia chebula ..	(1) Gunny bags.	40	10	Seed good up to eight months falling to about 50 per cent after twelve months.
	(2) Stoppered bottle.	16	10	
	(3) Earthen pots.	16	10	
Terminalia crenulata (tomentosa).	(1) Gunny bags	163	22	Seed good up to five months, deteriorates to 50 per cent by 9 months.
	(2) Stoppered bottle.	38	6	
	(3) Air tight tins.	33	4	
Terminalia paniculata.	(1) Gunny bags.	43	10	Seed good up to five months.
	(2) Stoppered bottle.	33	10	
	(3) Air tight tins.	13	10	
Trema orientalis ..	(1) Gunny bags.	60	6	Seed kept by all methods for six months and then rapidly deteriorated.
	(2) Gunny bags with wood ash.	55	6	
	(3) Air tight tins.	55	6	
Vateria indica ..	(1) Gunny bags	5	6	Seed kept for two weeks and then rapidly deteriorated.
Vitex peduncularis ..	(1) Gunny bags.	4	4	We have not been able to keep this seed at all. Its germination is very poor and it must be sown at once.
	(2) Air tight tins.	4	4	
Xylia xylocarpa ..	(1) Gunny bags.	160	20	Very variable usually good up to three months.
	(2) Stoppered bottle.	45	12	
	(3) Air tight tins.	45	12	

Notes.—(1) The above results are indications of the probable longevity of the seed. Many more tests are necessary in most cases before reliable results can be obtained.

(2) The periods in column (5) are the times between collection and sowing and not between collection and germination which are often much longer.

(3) Generally 100 seeds were used for each treatment, date and test.

(4) In many cases the remark is given as "Seed good up to X months." Often this is the maximum period tested and not necessarily the maximum period the seed remains fertil.

330. *Size, age and condition of seed bearers—Teak* (vide paragraph 43)—

Wynaad Division Experimental Plot 35.—*Arrangement*—Six blocks of 10 × 10 stakes each 6′ × 6′ arranged $\frac{A|B|C}{C|B|A}$ *Soil preparation*—Crowbar holes. *Stock used*—One year old stumps 0·3″ to 0·9″ diameter from Begur Experimental Garden Experiment 68 of 1936. *Treatment*—(*a*) Stumps 0·50″ average diameter for seed of 10 healthy mature trees of 4′ to 6′ G.B.H., (*b*) Stumps 0·50″ average diameter for seed of 10 healthy immature trees under 3′ G.B.H. and (*c*) Stumps 0·46″ average diameter for seed of ten healthy over mature trees over 8′ G.B.H. *Date of stump planting*—16th April 1937.

Palghat Experimental Plot 155.—*Arrangement*, etc., as above. *Stock used*—(A) (B) (C) stumps 0·4″ to 0·5″ diameter as above from Dhoni Experimental Garden Experiment 92 of 1935. *Date of stump planting*—4th April 1936.

Topslip Experimental Garden Experiment 130.—*Arrangement*, etc., as above. *Stock used*—(A) (B) (C) stumps 0·3″ to 0·8″ diameter as above from Topslip Experimental Garden Experiment 110 of 1935. *Date of stump planting*—13th April 1936.

Measurements in January 1938.

Locality.		Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Wynaad Experimental Plot.	35	Over mature ..	98	25·90 ± 1·42	+ 4·30 ± 1·74	S.
		Mature	100	21·60 ± 1·01	Control.	
		Under mature ..	96	19·10 ± 1·07	— 2·50 ± 1·47	N.S.
Palghat Experimental Plot.	155	Over mature ..	93	121·80 ± 3·48	— 4·44 ± 5·04	N.S.
		Mature	92	126·24 ± 3·84	Control.	
		Under mature ..	92	146·40 ± 3·24	+ 19·16 ± 4·92	S.
Topslip Experimental Garden Experiment.	130	Over mature ..	87	84·20 ± 4·05	— 4·70 ± 5·22	N.S.
		Mature	86	88·90 ± 3·30	Control.	
		Under mature ..	79	82·20 ± 2·39	— 6·70 ± 4·07	N.S.

331. *Dalbergia latifolia* (vide paragraph 45)—

Palghat Experimental Plot 157.—*Arrangement*, etc., as above. *Stock used*—(A) (B) (C) stumps 0·2″ to 0·4″ diameter as above from Dhoni Experimental Garden Experiment 93 of 1935. *Date of stump planting*—17th May 1936.

Topslip Experimental Garden Experiment 132.—*Arrangement*, etc., as above. *Stock used*—(A) (B) (C) stumps 0·2″ to 0·3″ diameter as above from Topslip Experimental Garden Experiment 113 of 1935. *Date of stump planting*—13th April 1936.

Wynaad Experimental Plot 36.—*Arrangements*, etc., as above. *Stock used*—(A) (B) (C) stumps 0·1″ to 0·2″ diameter as above from Begur Experimental Garden Experiment 69 of 1936. *Date of*

Measurements in January 1938.

Locality.		Treatment.	Survival per-centage.	Mean height in inches.	Difference of means.	Signifi-cance.
Palghat Experimental Plot.	157	Over mature ..	89	51·00 ± 1·93	+ 3·40 ± 2·85 Control.	N.S.
		Mature	89	47·90 ± 2·10		
		Under mature ..	91	35·80 ± 1·46	— 12·10 ± 2·52	S. **
Topslip Experimental Garden Experiment.	132	Over mature ..	48	21·40 ± 1·15	— 2·80 ± 1·50 Control.	S.
		Mature	56	25·20 ± 0·97		
		Under mature ..	80	22·48 ± 0·80	2·72 ± 1·26	S. **
Wynaad Experimental Plot.	36	Over mature ..	93	7·87 ± 0·27	— 0·45 ± 0·38 Control.	N.S.
		Mature	93	8·32 ± 0·26		
		Under mature ..	95	7·86 ± 0·25	0·46 ± 0·36	N.S. **

332. *Pterocarpus marsupium* (vide paragraph 47)—

Wynaad Experimental Plot 31.—*Arrangement*, etc., as above. *Stock used*—(A) (B) (C) stumps 0·40″ average diameter as above from Begur Experimental Garden Experiment 48 of 1935. *Date of stump planting*—17th May 1936.

Palghat Experimental Plot 156.—*Arrangement*, etc., as above *Stock used*—(A) (B) (C) stumps 0·55″ average diameter as above from Dhoni Experimental Garden Experiment 90 of 1935. *Date of stump planting*—4th April 1936.

Topslip Experimental Garden Experiment 131.—*Arrangement* etc., as above. *Stock used*—(A) (B) (C) stumps 0·3″ to 0·7 diameter as above from Topslip Experimental Garde Experiment 112 of 1935. *Date of stump planting*—13t April 1936.

Measurements in January 1938.

Locality.		Treatment.	Survival per-centage.	Mean height in inches.	Difference of means.	Signifi-cance.
Wynaad Experimental Plot.	31	Over mature ..	97	65·30 ± 1·78	+ 3·20 ± 2·44 Control.	N.S.
		Mature	98	62·10 ± 1·68		
		Under mature ..	98	57·50 ± 1·52	1·50 ± 2·14	S. **
Palghat Experimental Plot.	156	Over mature ..	84	98·40 ± 3·84	+ 2·16 ± 4·44 Control.	N.S.
		Mature	87	96·24 ± 2·52		
		Under mature ..	84	93·84 ± 2·88	2·40 ± 3·84	N.S.
Topslip Experimental Garden Experiment.	131	Over mature ..	30	31·37 ± 1·76	— 2·23 ± 2·22 Control.	N.S.
		Mature	69	33·60 ± 1·36		
		Under mature ..	35	36·30 ± 2·48	+ 2·70 ± 2·83	N.S.

333. *Terminalia crenulata* (vide paragraph 49)—

Wynaad Experimental Plot 37.—*Arrangement*, etc., as abo *Stock used*—(A) (B) (C) stumps 0·56″ average diameter above from Begur Experimental Garden Experiment of 1936. *Date of stump planting*—9th May 1937.

Palghat Experimental Plot 158.—*Arrangement*, etc., as abo *Stock used*—(A) (B) (C) stumps 0·2″ to 0·9″ diameter above from Dhoni Experimental Garden Experiment 9 1935. *Date of stump planting*—17th May 1936.

Topslip Experimental Garden Experiment 159 *of* 193 *Arrangement*, etc., as above. *Stock used*—(A) (B) stumps 0·2″ to 0·6″ diameter as above from Begur Exp mental Garden Experiment 70 of 1936. *Date of stump planting*—20th May 1937.

Measurements in January 1938.

Locality.		Treatment.	Survival per-centage.	Mean height in inches.	Difference of means.	Signifi-cance.
Wynaad Experimental Plot.	37.	Over mature ..	92	23·30 ± 0·64	+ 0·50 ± 0·87 Control.	N.S.
		Mature	89	22·80 ± 0·59		
		Under mature ..	86	24·90 ± 0·68	— 0·90 ± 0·90	N.S.
Palghat Experimental Plot.	158.	Over mature ..	95	136·80 ± 1·92	+ 8·40 ± 3·60 Control.	S.
		Mature	98	128·40 ± 2·04		
		Under mature ..	89	135·60 ± 2·88	+ 7·20 ± 2·88	S. **
Topslip Garden Experimental Experiment.	159.	Over mature ..	88	20·02 ± 0·77	— 1·68 ± 1·08 Control.	N.S.
		Mature	89	21·70 ± 0·76		
		Under mature ..	77	19·83 ± 0·85	— 1·87 ± 1·14	N.S.

334. *Comparison of direct sowing, entire transplanting and stump planting—Dalbergia latifolia* (vide paragraph 71)—

Kannoth Experimental Garden Experiment 45.—*Arrangement*, DTS STD repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—6′ × 3′. *Soil preparation—Sowing* patches 1′ diameter and 6″ deep. *Transplanting*—1′ cube pits. *Stump planting*—Crowbar holes. *Stock used—Sowing* ten sections of broken pods per patch. *Transplants*—Two years old 12″ to 18″ high. *Stumps*—Two years old 0·2″ to 0·3″ diameter. *Date of sowing*—16th May 1937. *Transplanting*—19th June 1937. *Stumping*—20th May 1937. *Treatment*—Normal district weeding.

This experiment was done in a Ponam crop of hill paddy sown on 12th May 1937.

Treatment.	Date of measure-ment.	Survival percen-tage.	Mean height in inches.	Difference of means.	Significance.
Sowing	27th January 1938.	6	9·17 ± 4·11	Control	..
Transplanting ..	..	70	13·10 ± 0·67	+ 3·93 ± 4·16	N.S.
Stumping	..	70	11·38 ± 0·77	+ 2·21 ± 4·18	N.S.

335. *Pterocarpus marsupium* (vide paragraph 72)—

Kannoth Experimental Garden Experiment 46.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used—Sowing* ten seeds per patch. *Transplanting*—Two years old 12″ to 18″ high. *Stumps*—Two years old 0·4″ to 0·5″ diameter. *Date of sowing*—5th June 1937. *Date of transplanting*—19th June 1937. *Date of stumping*—20th May 1937.

This experiment was done in a Ponam crop of hill paddy sown on 14th May 1937.

Treatment.	Date of measure-ment.	Survival percen-tage.	Mean height in inches.	Difference of means.	Significance.
Sowing .. .	27th January 1938.	35	5·38 ± 0·46	Control	..
Transplanting ..	..	85	11·60 ± 0·64	+ 6·22 ± 0·79	S.
Stumping ..	..	40	9·93 ± 0·97	+ 4·55 ± 1·07	S.

336. *Pterocarpus dalbergioides* (Andaman padauk) (vide paragraph 73)—

Kannoth Experimental Garden Experiment 49.—*Arrangement* etc., as for *Dalbergia latifolia*. *Stock used—Sowing* ten seed per patch. *Transplanting*. Two—years old and 37″ high *Stumps*.—Two years old and 0·5″ to 0·6″ diameter. *Date o*

sowing 16th May 1937. *Transplanting*—19th June 1937. *Stumping* 20th May 1937.

Treatment.	Date of measurement.	Survival percentage.	Mean height in inches	
owing	28th January 1938.	..	..	Too few survivals for calculation of significance.
Transplanting	..	93	14·70	..
Stumping	..	6	14·00	..

337. *Terminalia crenulata* (vide paragraph 75.)

Dhoni Experimental Garden Experiment 143. *Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used Sowing* ten seeds per patch. *Transplanting* Transplants three months old 6″ to 9″ high. *Stumps* One year old and 0·4″ to 0·5″ diameter. *Date of sowing* 26th April 1937. *Transplanting*- 30th June 1937. *Stumping* 26th April 1937.

Topslip Experimental Garden Experiment 149. *Arrangement*, etc., as above. *Stock used Sowing* ten seeds per patch. *Transplants*—Three months old and 9″ to 12″ high. *Stumps* —One year old and 0·4″ to 0·9″ diameter. *Date of sowing* —1st May 1937. *Transplanting* —1st July 1937. *Stumping* —1st May 1937.

Begur Experimental Garden Experiment 93. *Arrangement*, etc., as above. *Stock used Sowing* ten seeds per patch. *Transplants* One year old and 18″ to 24″ high and *Stumps* —One year old and 0·5″ to 0·6″ diameter. *Date of sowing* —*ing*—7th May 1937. *Transplanting*—18th June 1937. *Stumping*—7th June 1937.

Kannoth Experimental Garden Experiment 48. *Arrangement*, etc., as above. *Stock used Sowing* ten seeds per patch.—*Transplanting*—One year old and 12″ to 18″ high. *Stumps*—One year old 0·5″ to 0·8″ diameter. *Date of sowing*—16th May 1937. *Transplanting* 19th June 1937. *Stumping*—20th May 1937.

This experiment was done in a Ponam crop of hill paddy sown on 18th May 1937.

Experiment number.	Treatment.	Date of measurement.	Survival percent.	Mean height (in inches).	Difference of means.	Significance.
Dhoni Experimental Garden Experiment 143.	Sowing ..	5th February 1938.	65	11·95 ± 0·93	Control ..	..
	Transplanting.	..	10	10·90 ± 1·05	− 1·05 ± 1·40	N.S.
	Stumping ..	..	71	27·80 ± 2·03	+ 15·85 ± 2·23	S.
Topslip Experimental Garden Experiment 149.	Sowing ..	19th January 1938.	56	15·20 ± 0·63	Control ..	..
	Transplanting.	..	95	17·82 ± 0·60	+ 2·62 ± 0·87	S.
	Stumping ..	..	67	19·80 ± 0·63	+ 4·60 ± 0·89	S.
Begur Experimental Garden Experiment 93.	Sowing ..	26th January 1938.	52	8·50 ± 0·38	Control ..	..
	Transplanting.	..	55	14·70 ± 0·88	+ 6·20 ± 0·05	S.
	Stumping ..	..	87	19·70 ± 0·75	+ 11·20 ± 0·84	S.
Kannoth Experimental Garden Experiment 48.	Sowing ..	28th January 1938.	3	4·33 ± 0·59	Control ..	..
	Transplanting.	..	77	15·60 ± 0·84	+ 11·27 ± 1·03	S.
	Stumping ..	..	70	22·44 ± 1·21	+ 18·11 ± 1·37	S.

338. *Artocarpus hirsuta* (vide paragraph 77)—

Kannoth Experimental Garden—Experiment 47.—*Arrangement* etc., as for *Dalbergia latifolia*. *Stock used—Sowing* ten seeds per patch. *Transplants*—One year old and 12″ to 18″ high. *Stumps*—Two years old and 0·3″ to 0·4″ diameter. *Date of sowing*—15th May 1937. *Transplanting*—19th June 1937. *Stumping*—8th June 1937.

Treatment.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Sowing	27th January 1938.	65	6·66 ± 0·34	Control ..	..
Transplanting	..	34	7·52 ± 0·60	+0·86 ± 0·69	N.S.
Stumping	..	78	7·12 ± 0·34	+0·46 ± 0·47	N.S.

339. *Terminalia paniculata* (vide paragraph 78)—

Kannoth Experimental Garden—Experiment 53.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ½ ounce per patch. *Transplanting* Transplants one year old and 12″ to 24″ high. *Stumps*—One year old and 0·4″ to 0·7″ diameter. *Date of sowing*—16th May 1937. *Transplanting*—15th June 1937. *Stumping*—20th May 1937.

Dhoni Experimental Garden Experiment 136.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* 200 seeds per patch. *Transplanting*—Transplants two months old and 5″ to 8″ high. *Date of sowing*—23rd April 1937. *Transplanting*—2nd July 1937.

Note.—In this experiment stump planting was not done owing to lack of stock.

Experiment number.	Treatment.	Date of measurement.	Survival percentage.	Mean height of inches.	Difference of means.	Significance.
Kannoth Experimental Garden Experiment 53.	Sowing ..	27th January 1938.	..	....	....	
	Transplanting.	..	53	8·81 ± 0·80	−3·91 ± 1·08	S.
	Stumping ..	..	87	12·72 ± 0·74	Control	
Dhoni Experimental Garden Experiment 136.	Sowing ..	5th February 1938.	41	6·33 ± 0·83	Control	
	Transplanting.	..	44	8·92 ± 0·99	+ 2·59 ± 1·29	S.

340. *Schleichera trijuga* (vide paragraph 79)—

Begur Experimental Garden Experiment 84 *of* 1936.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—Transplants four months old and 4″ to 8″ high. *Stumps*—Four months old and 0·2″ to 0·3″ diameter. *Date of sowing*—4th June 1936. *Transplanting*—6th June 1936. *Stumping*—6th June 1936.

Dhoni Experimental Garden Experiment 145 *of* 1937.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—Transplants one year old and 4″ to 6″ high. *Stumps*—One year old and 0·6″ to 0·9″ diameter. *Date of sowing*—16th June 1937. *Transplanting*—2nd October 1937. *Stumping*—7th May 1937.

Experiment number.	Treatment.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance
Begur Experiment 84/1936	Sowing ..	13th January 1938	37	40·60 ± 2·41	Control ..	S
	Transplanting ..	..	32	31·90 ± 2·71	−8·70 ± 3·62	NS
	Stumping ..	..	90	38·80 ± 1·58	−1·80 ± 2·87	NS
Dhoni Experiment 145/1937	Sowing ..	6th February 1938	43	6·78 ± 0·95	Control ..	S
	Transplanting.	..	60	3·58 ± 0·30	−3·20 ± 1·00	S
	Stumping ..	..	37	14·37 ± 1·62	+ 7·59 ± 1·88	S

341. *Comparison of direct sowing with transplanting different sizes of transplants. Switenia macrophylla* (see paragraph 121)

Begur Experimental Garden Experiment 92 of 1937. *Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—Four months old 10" high; one year old 21" and 36" high. *Date of sowing*—7th June 1937. *Transplanting*—16th June 1937.

Dhoni Experimental Garden Experiment 141 of 1937.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—One year old and 7½", 15" and 22½" high. *Date of sowing*—23rd April 1937. *Transplanting*—30th June 1937.

Topslip Experimental Garden Experiment 150 of 1937.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—One year old 7½", 21" and 35" high. *Date of sowing*—1st May 1937. *Transplanting*—2nd July 1937.

Kannoth Experimental Garden Experiment 51 of 1937.—*Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—Three months old and 7½" high; one year old and 15" and 35" high. *Date of sowing*—15th May 1937. *Transplanting*—19th June 1937.

Dhoni Experimental Garden Experiment **117** *of* **1936.** (Second year measurements). *Arrangement*, etc., as for *Dalbergia latifolia*. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—Two months old 15" high and one year old 21" and 36" high. *Date of sowing*—19th May 1936. *Transplanting*—12th June 1936.

Topslip Experimental Garden Experiment **137** *of* **1936.** (Second year measurements).—*Arrangement*, etc., as above. *Stock used*—*Sowing* ten seeds per patch. *Transplanting*—Transplants three months old 6", 13" and 26" high. *Date of sowing*—3rd April 1936. *Transplanting*—27th May 1936.

Begur Experimental Garden Experiment 66 *of* 1936. (Second year measurements).—*Arrangement*, etc., as above. *Stock used*—*Sowing* ten seeds per patch. *Transplants*—(i) and (ii) one year old 15" and 33" high, (iii) three months old and 7½" high. *Date of sowing*—28th May 1936. *Transplanting*—16th June 1936.

Kannoth Experimental Garden Experiment 33 *of* 1936. (Second year measurements).—*Arrangement*, etc., as above. *Stock used*—*Sowing* ten seeds per patch. *Transplants*—(i) four months old 10½" high, (ii) one year old and 25" high, (iii) one year old and 42" high. *Date of sowing*—19th May 1936. *Transplanting*—18th June 1936. This experiment was done in a Ponam crop of hill paddy sown on 29th May 1936.

Kannoth Experimental Garden Experiment 20 *of* 1935. (Third year measurements).—*Arrangement*, etc., as above. *Stock used*—*Sowing* ten seeds per patch. *Transplants*—(i) six

months old 6" to 9" high, (ii) six months old 12" to 18" high and (iii) six months old 30" to 36" high. *Date of sowing*—25th May 1935. *Transplanting*—5th July 1935. This experiment was done in a Ponam crop of hill paddy sown on 15th May 1935.

Dhoni Experimental Garden Experiment No. 79 *of* 1935. (Third year measurements).—*Arrangement*, etc., as above. *Stock used*—*Sowing* fifteen seeds per patch. *Transplants*—Two months old 2" to 5" high. *Date of sowing*—21st May 1935. *Transplanting*—22nd June 1935.

Begur Experimental Garden Experiment No. 45 *of* 1935. (Third year measurements).—*Arrangement*, etc., as above. *Stock used*—*Sowing* ten seeds per patch. *Transplants*—(i) one year old 21" high and (ii) four months old 5½" high. *Date of sowing*—20th June 1935. *Transplanting*—27th June 1935.

Kannoth Experimental Garden Experiment No. 7 *of* 1934. (Fourth year measurements).—*Arrangement*, etc., as above. *Stock used*—*Transplants*—(i) three months old 9" high, (ii) one year old 18" high and (iii) one year old 30" high. *Date of transplanting*—1st July 1934. This experiment was done in a Ponam crop of hill paddy sown on 22nd May 1934.

First year measurements.

Experiment number.	Treatment.	Survival percentage.	Initial height in inches.	Height after one year.	Increment first year.
				INCHES.	INCHES.
Begur Experimental Garden Experiment No. 92.	Sowing ..	67	..	7·9	+7·9
	Transplanting (i)	86	10	11·8	+ 1·8
	(ii)	92	21	22·2	+ 1·2
	(iii)	93	36	31·5	− 4·5
Dhoni, Experimental Garden Experiment, No. 141.	Sowing ..	90	..	19·3	+19·3
	Transplanting (i)	52	7·5	17·5	+10·0
	(ii)	68	15·0	21·6	+ 6·6
	(iii.)	70	22·5	28·2	+ 5·7
Topslip Experimental Garden Experiment No. 150.	Sowing ..	68	..	12·8	+12·8
	Transplanting (i)	53	7·5	10·8	+ 3·3
	(ii)	76	21·0	20·2	− 0·8
	(iii)	42	35·0	21·4	− 13·6
Kannoth Experimental Garden Experiment No. 51.	Sowing ..	73	..	12·4	+ 12·4
	Tran-planting (i)	82	7·5	15·0	+ 7·5
	(ii(	78	15·0	19·6	+ 4·6
	(iii)	93	35·0	31·5	− 3·5

Note.—Negative increment is due to shoot borer attack or dying back.

Third year measurements.

Experiment number.	Treatment.	Survival percentage.	Initial height.	Height after			Increment.		
				One year.	Two years.	Three years.	First year.	Second year.	Third year
			INCHES.	INCHES.	INCHES.	INCHES.	INCHES.	INCHES.	INCHES.
Kannoth No. 20.	Sowing ..	32	..	9·3	25·8	41·2	+ 9·3	+16·5	+15·4
	Transplanting. (i)	62	7·5	11·8	35·4	48·8	+4·3	+13·6	+13·4
	(ii)	83	15	18·6	37·0	50·4	+ 3·6	+18·4	+13·4
	(iii)	38	33	29·8	41·0	55·2	— 3·2	+11·2	+14·2
Dhoni No. 79.	Sowing ..	49	..	12·8	53·1	81·1	+12·8	+40·3	+28·0
	Transplanting.	53	3·5	15·3	56·3	88·2	+11·8	+41·0	+31·9
Begur No. 45.	Sowing ..	26	..	9·5	36·1	79·2	+ 9·5	+26·6	+43·1
	Transplanting. (i)	565	5·5	10·6	40·6	79·0	+ 5·1	+30·0	+38·4
	(ii)	85	21·1	24·3	50·0	88·7	+ 3·2	+26·7	+38·7

Fourth year measurements.

Experiment number.	Treatment.	Survival percentage.	Initial height.	Height after				Increment.			
				One year.	Two years.	Three years.	Four years.	First year.	Second year.	Third year.	Fourth year.*
			INCHES.	INCHES.	INCHES.	INCHES.	INCHES.	INCHES.	INCHES.	INCHES.	INCHES.
Kannoth No. 7.	Transplants.										
	(i)	50	9	15·8	54·4	89·2	133·6	+ 6·8	+ 30·6	+ 34·8	+ 44·4
	(ii)	49	15	19·8	53·9	84·4	133·2	+ 1·8	+ 34·1	+ 30·5	+ 44·8
	(iii)	50	30	25·8	61·0	105·3	156·8	+ 1·2	+ 34·2	+ 44·3	+ 51·5

Note.—Negative increment is due to shoot borer attack or dying back.

Second year measurements.

Experiment number.	Treatment.	Survival percentage.	Initial height.	Height after		Increment.	
				One year.	Two years.	First year.	Second year.
			INCHES.	INCHES.	INCHES.	INCHES.	INCHES.
Dhoni Experimental Garden Experiment No. 117.	Sowing	95	...	20·8	50·3	+ 20·8	+ 29·5
	Transplanting (i)	41	15	19·3	49·5	+ 4·3	+ 30·2
	(ii)	71	21	25·7	52·5	+ 4·7	+ 26·8
	(iii)	67	30	34·4	57·0	+ 4·4	+ 12·6
Topsilp Experimental Garden Experiment No. 137.	Sowing	78	...	12·40	45·6	+ 12·4	+ 33·2
	Transplanting (i)	32	6	11·3	41·7	+ 5·3	+ 30·4
	(ii)	29	12·5	14·6	39·2	+ 2·1	+ 24·6
	(iii)	67	26	24·0	50·6	− 2·0	+ 26·6
Kannoth Experimental Garden Experiment No. 33	Sowing	80	...	9·6	31·8	+ 9·5	+ 22·2
	Transplanting (i)	53	10·5	12·3	32·5	+ 1·8	+ 20·2
	(ii)	59	25	19·4	36·2	− 5·6	+ 16·8
	(iii)	73	42	32·3	44·9	− 9·7	+ 12·6
Begur Experimental Garden Experiment No. 66.	Sowing	87	...	12·20	47·8	+ 12·20	+ 35·6
	Transplanting (i)	35	7·5	11·6	40·6	+ 4·1	+ 38·0
	(ii)	19	15·0	15·0	40·6	+ 0·0	+ 31·6
	(iii)	84	33	22·6	57·8	− 10·4	+ 35·2

Note.—Negative increment is due to shoot borer attack or dying back.

342. *Premonsoon stump planting—Dhoni Experimental Garden* (vide paragraphs 88 to 91)—

Experiment No. 132 *of* 1937.—*Species—Dalbergia latifolia. Arrangement*—ABCDE EDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—6′ × 3′. *Soil preparation*—Crowbar holes. *Stock used*—Stumps from one year old nursery plants. *Date of stump planting*—Fortnightly from 1st April 1937 to 1st June 1937. *Size of stumps*—0·1″ to 0·2″ diameter. *Tending*—Normal district weeding.

Experiment No. 135 *of* 1937.—*Species—Pterocarpus marsupium. Arrangement*, etc., as above. *Stock used*—Stumps 0·3″ to 0·4″ diameter made from one year old plants.

Experiment No. 131 *of* 1937.—*Species—Terminalia crenulata. Arrangement*, etc., as above. *Stock used*—Stumps 0·5″ to 0·8″ diameter made from one year old plants.

Experiment No. 137 *of* 1937.—*Species—Artocarpus hirsuta. Arrangement*, etc., as above. *Stock used*—Stumps 0·4″ to 0·5″ diameter made from one year old plants. *Date of stump planting*—Fortnightly from 1st May 1937 and 1st July 1937.

Dhoni Experimental Garden—Growth data after one season.

Experiment number and species.		Date of planting.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Experiment, 132—*Dalbergia latifolia.*	A	1st April 1937.	4th February 1938.	48	21·60±1·06	+2·70±2·32	N.S.
	B	15th April 1937.	Do.	63	22·50±1·73	+ 3·60±2·14	N.S.
	C	1st May 1937.	Do.	86	17·60±1·29	−1·30±1·79	N.S.
	D	15th May 1937.	Do.	89	16·95±1·26	−1·95±1·78	N.S.
	E	1st June 1937.	Do.	87	18·90±1·25	Control.	..
Experiment, 135—*Pterocarpus marsupium.*	A	1st April 1937.	5th February 1938.	58	13·25±0·84	+0·27±1·25	N.S.
	B	15th April 1937.	Do.	87	14·62±0·80	+1·64±1·22	N.S.
	C	1st May 1937.	Do.	86	21·80±1·51	+8·82±1·77	S.
	D	15th May 1937.	Do.	78	12·10±1·42	−0·88±1·69	N.S.
	E	1st June 1937.	Do.	73	12·98±0·92	Control.	..
Experiment, 131—*Terminalia crenulata.*	A	1st April 1937.	4th February 1938.	73	31·70±2·33	+19·75±2·60	S.
	B	15th April 1937.	Do.	89	30·60±2·06	+18·65±2·37	S.
	C	1st May 1937.	Do.	35	18·10±1·67	+6·15±2·04	S.
	D	15th May 1937.	Do.	19	15·05±2·28	+3·10±2·56	N.S.
	E	1st June 1937.	Do.	54	11·95±1·17	Control.	..
Experiment, 177—*Artocarpus hirsuta.*	A	1st May 1937.	4th February 1938.	63	15·70±1·11	+0·23±1·50	N.S.
	B	15th May 1937.	Do.	51	17·60±1·04	+3·18±1·45	S.
	C	1st June 1937.	Do.	60	14·42±1·01	Control.	..
	D	15th June 1937.	Do.	82	15·80±0·81	+1·38±1·29	N.S.
	E	1st July 1937.	Do.	82	13·55±0·58	−0·87±1·16	N.S.

343. *Premonsoon stump planting—Begur Experimental Garden* (vide paragraphs 83 to 86).—

Experiment No. 88 *of* 1937.—*Species—Dalbergia sissoides. Arrangement*—ABCDE EDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—6′×3′. *Soil preparation*—Crowbar holes. *Stock used*—Stumps from one year old nursery plants. *Dates of stump planting*—Fortnightly from 1st April 1937 to 1st June 193′. *Size of stumps*—0·1″ to 0·2″ diameter. *Tending*—Normal district weeding.

Experiment No. 90 *of* 1937.—*Species—Pterocarpus marsupium. Arrangement*, etc., as above. *Stock used*—Stumps 0·4″ to 0·5″ diameter made from one year old plants.

Experiment No. 89 *of* 1937.—*Species—Terminalia crenulata. Arrangement*, etc., as above. *Stock used*—Stumps 0·5″ to 0·6″ diameter made from one year old plants.

Experiment No. 91 *of* 1937.—*Species*—*Artocarpus hirsuta. Arrangement*, etc., as above. *Stock used*—Stumps 0·3" to 0·4" diameter made from one year old plants. *Dates of stump planting*—Fortnightly from 1st May 1937 to 1st July 1937.

Begur Experimental Garden—Growth after one season.

Experiment number and species.	Date of planting.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Experiment, 88 *Dalbergia sissoides.*	A 1st April 1937.	27th January 1938.	[illegible]	11·[illegible]	[illegible]·03 ± 0·65	S.
	B 15th April 1937.	Do.	18	11·[illegible]	[illegible]·00 ± 0·79	S.
	C 1st May 1937.	Do.	98	10·[illegible] ± 0·40	+2·55 ± 0·58	S.
	D 15th May 1937.	Do.	92	9·[illegible]	+1·40 ± 0·54	S.
	E 1st June 1937.	Do.	76	[illegible]·20 ± 0·42	Control.	..
Experiment, 90—*Pterocarpus marsupium.*	A 1st April 1937.	27th January 1938.	[illegible]	[illegible]·70 ± 1·13	+9·30 ± 1·29	S.
	B 15th April 1937.	Do.	[illegible]	21·6[illegible]	+9·20 ± 1·04	S.
	C 1st May 1937.	Do.	[illegible]	1[illegible]·38 ± 0·72	+2·98 ± 0·96	S.
	D 15th May 1937.	Do.	91	11·40 ± 0·71	+2·00 ± 0·95	S.
	E 1st June 1937.	Do.	75	12·40 ± 0·63	Control.	..
Experiment, 89 *Terminalia crenulata.*	A 1st April 1937.	27th January 1938.	85	26·20 ± 1·05	+10·20 ± 1·21	S.
	B 15th April 1937.	Do.	87	21·60 ± 0·99	+8·60 ± 1·16	S.
	C 1st May 1937.	Do.	93	21·00 ± 0·95	+5·00 ± 1·13	S.
	D 15th May 1937.	Do.	94	18·40 ± 0·67	+2·40 ± 0·91	S.
	E 1st June 1937.	Do.	88	16·00 ± 0·64	Control.	..
Experiment, 91—*Artocarpus hirsuta.*	A 1st May 1937.	28th January 1938.	83	6·68 ± 0·37	+2·28 ± 0·45	S.
	B 15th May 1937.	Do.	85	6·18 ± 0·32	+1·78 ± 0·40	S.
	C 1st June 1937.	Do.	68	4·40 ± 0·24	Control.	..
	D 15th June 1937.	Do.	90	4·36 ± 0·19	−0·04 ± 0·32	N.S.
	E 1st July 1937.	Do.	78	3·18 ± 0·15	−1·18 ± 0·28	S.

344. ***Premonsoon stump planting—Topslip Experimental Garden*** **(vide paragraphs 93 to 96)**—

Experiment No. 145 *of* 1937.—*Species*—*Dalbergia latifolia. Arrangement*—ABCDE EDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—6' × 3'. *Soil preparation*—Crowbar holes. *Stock used*—Stumps from one year nursery plants. *Date of stump planting*—Fortnightly from 1st April 1937 to 1st June 1937. *Size of stumps*—0·2" to 0·3" diameter. *Tending*—Normal district weeding.

Experiment No. 147 *of* 1937.—*Species*—*Pterocarpus marsupium. Arrangement*, etc., as above. *Stock used*—Stumps 0·3" to 0·5" diameter made from one year old plants.

Experiment No. 146 *of* 1937.—*Species*—*Terminalia crenulata. Arrangement*, etc., as above. *Stock used*—Stumps 0·4" to 0·9" diameter made from one year old plants.

Experiment No. 148 *of* 1937.—*Species*—*Artocarpus hirsuta. Arrangement*, etc., as above. *Stock used*—Stumps 0·3" to 0·6" diameter made from one year old plants. *Date of stump planting*—Fortnightly from 1st May 1937 to 1st July 1937.

Topslip Experimental Garden—Growth data after one season.

Experiment number and species.	Date of treatment.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means. INCHES.	Significance.
Experiment No. 145. *Dalbergia latifolia*	A 1st April 1937.	19th January 1938.	92	8·12 ± 0·31	+0·60 ± 0·48	N.S.
	B 15th April 1937.	Do.	32	7·42 ± 0·77	−1·10 ± 0·84	N.S.
	C 1st May 1937.	Do.	71	6·22 ± 0·27	−1·30 ± 0·42	S.
	D 15th May 1937.	Do.	80	6·26 ± 0·28	−1·26 ± 0·44	S.
	E 1st June 1937.	Do.	95	7·52 ± 0·33	Control.	..
Experiment No. 147. *Pterocarpus marsupium*	A 1st April 1937	19th January 1938.	62	6·90 ± 0·41	+0·53 ± 0·43	N.S.
	B 15th April 1937.	Do.	90	5·96 ± 0·26	−0·41 ± 0·33	N.S.
	C 1st May 1937.	Do.	90	6·71 ± 0·27	+0·34 ± 0·33	N.S.
	D 15th May 1937.	Do.	90	5·72 ± 0·20	−0·65 ± 0·28	S.
	E 1st June 1937.	Do.	97	6·37 ± 0·21	Control.	..
Experiment No. 146. *Terminalia crenulata.*	A 1st April 1937.	19th January 1938.	81	27·10 ± 1·21	+7·37 ± 1·61	S.
	B 15th April 1937.	Do.	85	23·40 ± 1·03	+3·67 ± 1·48	S.
	C 1st May 1937.	Do.	61	21·50 ± 0·97	+1·77 ± 1·44	N.S.
	D 15th May 1937.	Do.	80	20·91 ± 0·85	+1·18 ± 1·36	N.S.
	E 1st June 1937.	Do.	40	19·73 ± 1·07	Control.	..
Experiment No. 148. *Artocarpus hirsuta.*	A 1st May 1937.	19th January 1938.	12	7·00 ± 0·88	+0·61 ± 0·94	N.S.
	B 15th May 1937.	Do.	42	5·04 ± 0·44	−1·35 ± 0·56	S.
	C 1st June 1937.	Do.	54	6·39 ± 0·34	Control.	..
	D 15th June 1937.	Do.	89	7·71 ± 0·24	+1·32 ± 0·42	S.
	E 1st July 1937.	Do.	74	5·85 ± 0·26	−0·54 ± 0·44	N.S.

345. ***Premonsoon stump planting—Kannoth Experimental Garden*** **(vide paragraphs 97 to 101).**—

Experiment No. 39 *of* 1937.—*Species*—*Tectona grandis. Arrangement*—ABCDE EDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—6' × 6'. *Soil preparation*.—Crowbar holes. *Stock used*—Stumps from one year nursery plants. *Dates of stump planting*—Fortnightly from 1st April 1937 to 1st June 1937. *Size of stumps*—0·5" to 0·6" diameter. *Tending*—Normal district weeding.

Experiment No. 40 *of* 1937.—*Species*—*Dalbergia sissoides. Arrangement*, etc., as above. *Espacement*—6' × 3'. *Size of stumps*—0·2" to 0·3" diameter.

Experiment No. 41 *of* 1937.—*Species*—*Pterocarpus marsupium. Arrangement*, etc., as above. *Size of stumps*—0·4" to 0·5" diameter.

Experiment No. 43 *of* 1937.—*Species*—*Terminalia crenulata. Arrangement*, etc., as above. *Size of stumps*—0·5" to 0·6" diameter.

Experiment No. 42 of 1937. Species Artocarpus hirsuta. Arrangement, etc., as above. *Size of stumps* 0·5″ to 0·6″ diameter. *Date of stump planting* Fortnightly from 15th April 1937 to 15th June 1937.

NOTE. All the above experiments were done in a Control crop of hill paddy sown on 18th May 1937.

Kannoth Experimental Garden—Growth data after one season.

Experiment number and species.	Date of treatment.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Experiment No. 39. *Tectona grandis* ..	A 1st April 1937.	27th January 1938.	78	37·90 ± 1·14	+ 31·17 ± 1·88	S.
	B 15th April 1937.	Do.	100	37·13 ± 0·85	+ 31·36 ± 1·60	S.
	C 1st May 1937.	Do.	96	18·00 ± 0·92	+ 11·87 ± 1·00	S.
	D 15th May 1937.	Do.	84	10·90 ± 0·62	+ 4·07 ± 0·73	S.
	E 1st June 1937.	Do.	84	6·45 ± 0·40	Control.	..
Experiment No. 40. *Dalbergia sissoides*.	A 1st April 1937.	27th January 1938.	38	13·90 ± 1·37	+ 6·52 ± 1·51	S.
	B 15th April 1937.	Do.	51	14·90 ± 2·52	+ 5·52 ± 2·60	S.
	C 1st May 1937.	Do.	96	16·70 ± 0·91	+ 7·32 ± 1·12	S.
	D 15th May 1937.	Do.	98	14·20 ± 0·87	+ 4·82 ± 1·09	S.
	E 1st June 1937.	Do.	96	9·38 ± 0·46	Control.	..
Experiment No. 41. *Pterocarpus marsupium*.	A 1st April 1937.	27th January 1938.	2	27·00 ±	+ 16·57 ±	.. *
	B 15th April 1937.	Do.	4	31·00 ± 8·27	+ 20·57 ± 8·33	S.
	C 1st May 1937.	Do.	92	14·95 ± 2·15	+ 4·52 ± 2·36	N.S.
	D 15th May 1937.	Do.	64	16·08 ± 1·50	+ 5·65 ± 1·78	S.
	E 1st June 1937.	Do.	62	10·43 ± 0·96	Control.	..
Experiment No. 43. *Terminalia crenulata*.	A 1st April 1937.	28th January 1938.	42	30·70 ± 6·54	+ 14·53 ± 6·72	S.
	B 15th April 1937.	Do.	61	29·20 ± 2·23	+ 13·03 ± 2·72	S
	C 1st May 1937.	Do.	82	28·50 ± 2·11	+ 12·33 ± 2·68	S.
	D 15th May 1937.	Do.	74	20·25 ± 1·61	+ 4·08 ± 2·24	N.S.
	E 1st June 1937.	Do.	88	16·17 ± 1·57	Control.	..
Experiment No. 42. *Artocarpus pirsuta*.	A 15th April 1937.	28th January 1938	32	7·00 ± 1·08	+ 0·50 ± 1·23	N.S.
	B 1st May 1937.	Do.	50	8·70 ± 0·91	+ 2·20 ± 1·10	N.S.
	C 15th May 1937.	Do.	66	7·70 ± 0·62	+ 1·20 ± 0·85	N.S.
	D 1st June 1937.	Do.	52	6·50 ± 0·58	Control.	..
	E 15th June 1937.	Do.	50	5·30 ± 0·59	+ 1·20 ± 0·88	N.S.

* Too few survivals to calculate significance.

346. *Premonsoon stump planting—Walayar Experimental Garden Experiment No. 6 of* 1937.—*Species—Tectona grandis. Arrangement*—ABCDEF FEDCBA repeated ten times in lines of ten plants (i.e., 100 plants per treatment). *Espacement*—6′ × 6′. *Soil preparation*—Crowbar holes. *Stock used*—Stumps from one year nursery plants. *Dates of stump planting*—Fortnightly from 2nd April 1937 to 17th June 1937. *Size of stumps*—0·5″ to 0·7″ diameter. *Tending*—Normal district weeding.

Walayar Experimental Garden—Growth data after one season.

Experiment number and species.	Date of treatment	Date of measurement.	Survival per centage.	Mean height in inches.	Difference of means.	Significance.
Experiment No. 6. *Tectona grandis*.	A 2nd April 1937.	13th January 1938.	92	39·95 ± 1·96	+ 20·63 ± 2·21	S.
	B 17th April 1937.	..	96	41·80 ± 1·96	+ 22·48 ± 2·21	S
	C 2nd May 1937.	..	87	23·40 ± 1·19	+ 4·08 ± 1·56	S.
	D 17th May 1937.	..	72	17·70 ± 1·15	− 1·62 ± 1·16	N.S.
	E 2nd June 1937.	..	92	19·32 ± 1·02	Control.	
	F 17th June 1937.	..	99	16·95 ± 0·77	−2·37 ± 1·10	S.

347. *Stump planting—effect of age and diameter of stumps—Teak*—(vide paragraph 104).—

Dhoni Experimental Garden Experiment No. 129.—*Arrangement*—ABCDEF FEDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—6′ × 6′. *Soil preparation*—Crowbar holes. *Stock used*—Stumps one year old and 0·3″ to 0·4″, 0·5″ to 0·6″ and 0·7″ to 0·8″ diameter, and two years old 0·7″ to 0·8″, 0·9″ to 1·0″ and 1·2″ to 1·4″ diameter. *Date of stump planting*—19th April 1937. *Tending*—Normal District Practice.

Begur Experimental Garden Experiment No. 99.—*Arrangement*, etc., as above only for eight treatments. *Stock used*—Stumps one year old 0·3″ to 0·4″, 0·5″ to 0·6″, 0·7″ to 0·8″ and 1·0″ to 1·1″ diameter, stumps two years old 0·7″ to 0·8″, 1·0″ to 1·1″, 1·2″ to 1·4″ diameter and stumps three year sold 1·8″ to 2·0″ diameter. *Date of stump planting*—19th April 1937.

Topslip Experimental Garden Experiment No. 152.—*Arrangement*, etc., as above only for seven treatments. *Stock used*—Stumps one year old 0·4″ to 0·5″, 0·5″ to 0·6″ and 0·6″ to 0·7″ diameter and stumps two years old 0·4″ to 0·5″, 0·5″ to 0·6″, 0·6″ to 0·7″ and 0·7″ to 0·8″ diameter. *Date of stump planting*—29th April 1937.

Experiment number.	Age of stumps.	Diameter of stumps.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
				92	41·60 ± 2·25	− 4·00 ± 3·10	N.S.
Dhoni Experimental Garden—Experiment No. 129.	One year.	0·3″–0·4″	4th February 1938.	98	45·60 ± 2·16	Control.	
		0·5″–0·6″	Do.	96	45·20 ± 2·44	− 0·40 ± 3·26	N.S.
		0·7″–0·8″	Do.	98	38·60 ± 1·85	− 7·00 ± 2·85	S.
	Two years.	0·7″–0·8″	Do.	96	43·10 ± 2·00	− 2·50 ± 2·94	N.S.
		0·9″–1·0″	Do.	91	34·80 ± 1·84	− 10·80 ± 2·84	S.
		1·2″–1·4″	Do.	93	13·90 ± 1·02	− 3·60 ± 1·65	S.
Begur Experimental Garden—Experiment No. 99.	One year.	0·3″–0·4″	28th January 1938.	97	17·50 ± 1·30	Control.	
		0·5″–0·6″	Do.	96	19·30 ± 1·69	+ 1·80 ± 2·14	N.S.
		0·7″–0·8″	Do.	98	15·90 ± 1·33	− 1·60 ± 1·86	N.S.
		1·0″–1·1″	Do.	89	13·40 ± 0·95	− 4·10 ± 1·61	S.
	Two years.	0·7″–0·8″	Do.	87	12·10 ± 0·73	− 5·40 ± 1·52	S.
		1·0″–1·1″	Do.	81	11·82 ± 0·89	− 5·68 ± 1·58	S.
		1·2″–1·4″	Do.	77	7·60 ± 0·47	− 9·90 ± 1·38	S.
	Three years.	1·8″–2·0″	Do.	88	13·53 ± 0·75	− 0·83 ± 1·04	N.S.
Topslip Experimental Garden—Experiment No. 152.	One year.	0·4″–0·5″	18th January 1938.	93	14·36 ± 0·73	Control.	
		0·5″–0·6″	Do.	87	14·13 ± 0·66	− 0·23 ± 0·98	N.S.
		0·6″–0·7″	Do.	90	17·26 ± 0·99	+ 2·90 ± 1·23	S.
	Two years.	0·4″–0·5″	Do.	97	15·35 ± 0·74	+ 0·99 ± 1·04	N.S.
		0·5″–0·6″	Do.	99	13·45 ± 0·51	− 0·91 ± 0·89	N.S.
		0·6″–0·7″	Do.	94	13·37 ± 0·49	− 0·59 ± 0·88	N.S.
		0·7″–0·8″					

348. *Dalbergia latifolia* (vide paragraph 105).

Begur Experimental Garden Experiment No. 100.—*Arrangement*, etc., as for teak but for eight treatments. *Espacement* 6′ × 3′. *Stock used*—Stumps one year old 0·1″/0·2″, 0·2″/0·3″, and 0·3″/0·4″ diameter and two years old 0·2″/0·3″, 0·3″/0·4″, 0·4″/0·5″, 0·5″/0·6″, 0·6″/0·7″ diameter. *Date of stump planting*—27th April 1937.

Dhoni Experimental Garden Experiment No. 139.—*Arrangement*, etc., as above but for six treatments. *Stock used*—one year old 0·1″/0·2″, 0·2″/0·3″ and 0·3″/0·4″ diameter and two years old 0·4″/0·5″, 0·5″/0·6″ and 0·6″/0·7″ diameter. *Date of stump planting*—27th April 1937.

Topslip Experimental Garden Experiment No. 153.—*Arrangement*, etc., as above. *Stock used*—Stumps one year old 0·1″/0·2″ and 0·2″/0·3″ diameter and stumps two years old 0·2″/0·3″, 0·3″/0·4″, 0·4″/0·5″ and 0·5″/0·6″ diameter. *Date of stump planting*—30th April 1937.

Experiment number.	Age of stumps.	Diameter of stumps.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Begur Experimental Garden Experiment No. 100.	One year.	0·1″-0·2″	29th January 1938.	91	12·28 ± 0·59	± 0·28 ± 0·87	N.S.
		0·2″-0·3″	Do.	96	12·00 ± 0·64	Control.	
		0·3″-0·4″	Do.	96	14·10 ± 0·82	+ 2·10 ± 1·04	S.
	Two years.	0·2″-0·3″	Do.	88	9·38 ± 0·59	− 2·62 ± 0·87	S.
		0·3″-0·4″	Do.	94	11·00 ± 0·73	1·00 ± 0·95	N.S.
		0·4″-0·5″	Do.	74	10·10 ± 0·67	0·10 ± 0·93	N.S.
		0·5″-0·6″	Do.	72	9·48 ± 0·67	− 0·52 ± 0·95	N.S.
		0·6″-0·7″	Do.	42	10·20 ± 0·90	0·20 ± 1·10	N.S.
Dhoni Experimental Garden Experiment, No. 139.	One year.	0·1″-0·2″	5th February 1938.	90	14·86 ± 1·11	+ 4·34 ± 1·87	S.
		0·2″-0·3″	Do.	80	10·20 ± 1·51	Control.	
		0·3″-0·4″	Do.	90	10·63 ± 1·60	+ 0·43 ± 2·20	N.S.
	Two years.	0·4″-0·5″	Do.	86	20·41 ± 1·62	+ 1·21 ± 2·22	N.S.
		0·5″-0·6″	Do.	91	18·80 ± 1·41	− 0·40 ± 2·07	N.S.
		0·6″-0·7″	Do.	65	21·10 ± 1·74	+ 1·90 ± 2·51	S.
Topslip Experimental Garden Experiment No. 153.	One year.	0·1″-0·2″	19th January 1938.	57	7·30 ± 0·34	− 0·45 ± 0·49	N.S.
		0·2″-0·3″	Do.	74	7·75 ± 0·34	Control.	
	Two years.	0·2″-0·3″	Do.	73	8·15 ± 0·40	+ 0·40 ± 0·53	N.S.
		0·3″-0·4″	Do.	88	8·15 ± 0·32	+ 0·40 ± 0·47	N.S.
		0·4″-0·5″	Do.	82	8·28 ± 0·33	+ 0·53 ± 0·48	N.S.
		0·5″-0·6″	Do.	65	8·70 ± 0·42	+ 0·95 ± 0·55	N.S.

349. *Pterocarpus marsupium* (vide paragraph 106).—

Begur Experimental Garden Experiment No. 102.—*Arrangement*, etc., as for teak but for eight treatments. *Espacement*—6′ × 3′. *Stock used*—Stumps one year old 0·3″/0·4″, 0·4″/0·5″, 0·5″/0·6″, 0·6″/0·7″ diameter and stumps two years old 0·5″/0·6″, 0·7″/0·8″, 0·9″/1·0″ and 1·0″/1·2″ diameter. *Date of stump planting*—30th April 1937.

Dhoni Experimental Garden Experiment No. 130.—*Arrangement*, etc., as above but for six treatments. *Stock used*—Stumps one year old 0·3″/0·4″, 0·5″/0·6″ and 0·7″/0·8″ diameter and two years old 0·5″/0·6″, 0·7″/0·8″ and 0·9″/1·0″ diameter. *Date of stump planting*—30th April 1937.

Topslip Experimental Garden Experiment No. 155.—*Arrangement*, etc., as above. *Stock used*—Stumps one year old 0·3″/0·4″, 0·4″/0·5″ and 0·5″/0·6″ diameter and two years old 0·4″/0·5″, 0·5″/0·6″ and 0·6″/0·7″ diameter. *Date of stump planting*—30th April 1937.

Experiment number.	Age of stumps.	Diameter of stump.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Begur Experimental Garden—Experiment No. 102.	One year.	0·3″-0·4″	29th January 1938.	46	11·52 ± 0·75	± 1·52 ± 1·02	N.S.
		0·4″-0·5″	Do.	96	13·30 ± 0·69	Control.	
		0·5″-0·6″	Do.	96	14·82 ± 1·05	+ 0·52 ± 1·26	N.S.
		0·6″-0·7″	Do.	98	16·50 ± 1·00	+ 3·20 ± 1·22	S.
	Two years.	0·5″-0·6″	Do.	96	12·57 ± 0·87	0·43 ± 1·11	N.S.
		0·7″-0·8″	Do.	96	14·00 ± 0·80	+ 0·30 ± 1·06	N.S.
		0·9″-1·0″	Do.	94	14·32 ± 0·97	+ 2·03 ± 1·19	N.S.
		1·0″-1·2″	Do.	78	13·00 ± 1·07	0·30 ± 1·27	N.S.
Dhoni Experimental Garden—Experiment No. 130.	One year.	0·3″-0·4″	4th February 1938.	80	16·94 ± 1·00	− 0·46 ± 1·51	S.
		0·5″-0·6″	Do.	92	23·40 ± 1·17	Control.	
		0·7″-0·8″	Do.	90	26·40 ± 1·22	+ 3·0 ± 1·72	N.S.
	Two years.	0·5″-0·6″	Do.	92	20·20 ± 1·57	+ 0·10 ± 1·96	S.
		0·7″-0·8″	Do.	89	28·50 ± 1·41	+ 5·40 ± 1·86	S.
		0·9″-1·0″	Do.	84	24·80 ± 1·65	+ 1·70 ± 2·02	N.S.
Topslip Experimental Garden—Experiment No. 155.	One year.	0·3″-0·4″	18th January 1938.	46	5·80 ± 0·28	− 1·60 ± 0·47	S.
		0·4″-0·5″	Do.	73	7·40 ± 0·38	Control.	
		0·5″-0·6″	Do.	60	8·18 ± 0·43	+ 0·78 ± 0·57	N.S.
	Two years.	0·4″-0·5″	Do.	66	5·52 ± 0·21	− 1·88 ± 0·45	S.
		0·5″-0·6″	Do.	76	6·15 ± 0·31	− 1·25 ± 0·49	S.
		0·6″-0·7″	Do.	52	7·30 ± 0·43	− 0·10 ± 0·57	N.S.

350. *Terminalia crenulata* (vide paragraph 107)—

Begur Experimental Garden Experiment No. 101.—*Arrangement*, etc., as for teak but for eight treatments. *Espacement*—6′ × 3′. *Stock used*—Stumps one year old 0·2″/0·3″ 0·3″/0·4″, 0·4″/0·5″, 0·6″/0·7″, 0·9″/1·0″ diameter and stumps two years old 0·6″/0·7″, 0·9″/1·0″ and 1·2″/1·4″. *Date of stump planting*—1st May 1937.

Dhoni Experimental Garden Experiment No. 133.—*Arrangement*, etc., as above but for six treatments. *Stock used*—Stumps one year old and 0·3″/0·4″, 0·5″/0·6″ and 0·7″/0·8″ diameter and two years old 0·5″/0·6″, 0·7″/0·8″ and 0·9″/1·0″ diameter. *Date of stump planting*—26th April 1937.

Topslip Experimental Garden Experiment No. 154.—*Arrangement*, etc., as above. *Stock used*—Stumps one year old and 0·2″/0·3″, 0·3″/0·4″, 0·5″/0·6″, 0·6″/0·7″ diameter and two years old 0·4″/0·7″ and 0·7″/1·2″ diameter. *Date of stump planting*—16th May 1937.

Experiment number.	Age of stumps.	Diameter of stumps.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Begur Experimental Garden—Experiment No. 101.	One year.	0·2″-0·3″	29th January 1938.	44	20·70 ± 1·48	− 2·40 ± 1·94	N.S.
		0·3″-0·4″	Do.	66	21·40 ± 1·38	− 1·70 ± 1·87	N.S.
		0·4″-0·5″	Do.	88	23·10 ± 1·26	Control.	
		0·6″-0·7″	Do.	70	22·40 ± 1·26	− 0·70 ± 1·78	S.
		0·9″-1·0″	Do.	42	18·24 ± 1·62	− 4·86 ± 2·06	S.
		0·6″-0·7″	Do.	88	18·60 ± 1·01	− 4·50 ± 1·61	S.
	Two years.	0·9″-1·0″	Do.	58	14·95 ± 1·51	− 8·15 ± 1·97	S.
		1·2″-1·4″	Do.	8	15·50 ± 3·44	− 7·60 ± 3·66	S.

Experiment number.	Age of stumps.	Diameter of stumps.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Dhoni Experimental Garden Experiment No. 133.	One year.	0·3″–0·4″	4th February 1938.	68	26·70 ± 2·50	+ 3·90 ± 3·44	N.S.
		0·5″–0·6″	Do.	74	22·80 ± 2·37	Control.	...
		0·7″–0·8″	Do.	68	21·80 ± 1·83	1·50 ± 2·99	N.S.
	Two years.	0·5″–0·6″	Do.	85	22·20 ± 1·91	0·50 ± 3·20	N.S.
		0·7″–0·8″	Do.	65	19·60 ± 1·75	3·20 ± 2·66	N.S.
		0·9″–1·0″	Do.	31	18·10 ± 2·67	4·70 ± 3·51	N.S.
Topslip Experimental Garden Experiment No. 151.	One year.	0·2″–0·3″	10th January 1938.	54	22·80 ± 1·65	2·10 ± 1·54	N.S.
		0·3″–0·4″	Do.	64	24·80 ± 1·06	0·10 ± 1·35	N.S.
		0·5″–0·6″	Do.	73	25·20 ± 0·84	Control.	...
		0·6″–0·7″	Do.	80	27·19 ± 1·08	1·99 ± 1·37	N.S.
	Two years.	0·4″–0·5″	Do.	70	24·13 ± 1·01	0·77 ± 1·31	N.S.
		0·7″–1·2″	Do.	28	15·53 ± 2·46	9·67 ± 2·82	S.

351. *Artocarpus hirsuta* (vide paragraph 108)

Kannoth Experimental Garden Experiment No. 50. *Arrangement*, etc., as for teak but for six treatments. *Espacement*—6′ × 3′. *Stock used*—Stumps one year old 0·2″/0·3″, 0·3″/0·4″ diameter and two years old 0·3″/0·4″, 0·5″/0·6″, 0·6″/0·7″ and 0·9″/1·0″ diameter. *Date of stump planting*—8th June 1937.

Note. This experiment was done in a taungya crop of hill paddy sown on 17th May 1937.

Begur Experimental Garden Experiment No. 103.—*Arrangement* etc., as for teak but for eight treatments. *Stock used*—Stumps one year old 0·2″/0·3″, 0·3″/0·4″ and 0·5″/0·6″ diameter and two years old 0·2″/0·3″, 0·3″/0·4″, 0·5″/0·6″, 0·7″/0·8″ and 1·2″/1·4″ diameter. *Date of stump planting*—7th June 1937.

Dhoni Experimental Garden Experiment No. 138.—*Arrangement*, etc., as above but for six treatments. *Stock used*—Stumps one year old 0·2″/0·3″, 0·4″/0·5″ and 0·6″/0·7″ diameter and two years old 0·6″/0·7″, 0·8″/0·9″ and 1·0″/1·2″ diameter. *Date of planting*—1st June 1937.

Topslip Experimental Garden Experiment No. 156.—*Arrangement*, etc., as above. *Stock used*—Stumps one year old 0·2″/0·3″, 0·3″/0·4″ and 0·4″/0·5″ diameters and stumps two years old 0·3″/0·4″, 0·4″/0·5″ and 0·7″/0·9″ diameters. *Date of stump planting*—19th May 1937.

Experiment number.	Age of stumps.	Diameter of stumps.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Kannoth Experimental Garden—Experiment No. 50.	One year.	0·2″–0·3″	29th January 1938.	80	7·28 ± 0·39	− 1·82 ± 0·61	S.
		0·3″–0·4″	Do.	92	9·10 ± 0·40	Control.	...
	Two years.	0·3″–0·4″	Do.	62	8·38 ± 0·62	− 0·72 ± 0·80	N.S.
		0·5″–0·6″	Do.	88	12·02 ± 0·61	+ 2·92 ± 0·79	S.
		0·6″–0·7″	Do.	70	10·62 ± 0·74	+ 1·52 ± 0·89	N.S.
		0·9″–1·0″	Do.	90	14·81 ± 0·87	+ 5·71 ± 1·00	S.
Begur Experimental Garden—Experiment No. 103.	One year.	0·2″–0·3″	27th January 1938.	90	5·75 ± 0·30	− 0·21 ± 0·79	N.S.
		0·3″–0·4″	Do.	92	5·96 ± 0·33	Control.	...
		0·5″–0·6″	Do.	90	5·58 ± 0·30	− 0·38 ± 0·79	N.S.
	Two years.	0·2″–0·3″	Do.	76	4·02 ± 0·28	− 1·94 ± 0·78	S.
		0·3″–0·4″	Do.	78	5·49 ± 0·53	− 0·47 ± 0·93	N.S.
		0·5″–0·6″	Do.	88	6·80 ± 0·35	+ 0·84 ± 0·82	N.S.
		0·7″–0·8″	Do.	82	7·78 ± 0·57	+ 1·82 ± 0·95	N.S.
		1·2″–1·4″	Do.	54	6·43 ± 0·65	+ 0·47 ± 0·99	N.S.

Experiment number.	Age of stumps.	Diameter of stumps.	Date of measurements.	Survival percentage.	Mean height in inches.	Difference of means. INCHES.	Significance.
Dhoni Experimental Garden—Experiment No. 138.	One year.	0·2″–0·3″	5th February 1938.	20	14·15 ± 1·25	Control.	
		0·4″–0·5″	Do.	38	12·86 ± 1·52	+ 1·71 ± 1·97	N.S.
		0·6″–0·7″	Do.	60	19·27 ± 1·18	+ 8·12 ± 1·72	S.
	Two years.	0·6″–0·7″	Do.	53	15·92 ± 1·06	+ 4·77 ± 1·63	S.
		0·8″–0·9″	Do.	61	15·83 ± 1·30	+ 4·68 ± 1·80	S.
		1·0″–1·2″	Do.	56	14·95 ± 1·02	+ 3·80 ± 1·61	S.
Topslip Experimental Garden Experiment No. 156.	One year.	0·2″–0·3″	19th January 1938.	27	5·85 ± 0·48	− 0·65 ± 0·63	N.S.
		0·3″–0·4″	Do.	42	6·50 ± 0·41	Control.	...
		0·4″–0·5″	Do.	71	6·58 ± 0·37	+ 0·08 ± 0·56	N.S.
	Two years.	0·3″–0·4″	Do.	45	4·08 ± 0·28	− 2·42 ± 0·50	S.
		0·4″–0·5″	Do.	51	5·08 ± 0·35	− 1·42 ± 0·54	S.
		0·7″–0·9″	Do.	81	6·00 ± 0·46	− 0·50 ± 0·62	N.S.

352. ***Effect of depth of stump planting—Teak*** (vide paragraph 110)—

Begur Experimental Garden—Experiment No. 106 *of* 1937.—*Arrangement*—ABCD DCBA repeated ten times in single lines of ten plants, i.e., 100 per treatment. *Espacement*—6′ × 6′. *Treatment*—(*a*) planted on 1st April 1937 buried, (*b*) planted on 1st April 1937 normal, (*c*) planted on 1st June 1937 buried and (*d*) planted on 1st June 1937 normal. *Stock used*—One year old stumps 0·5″ to 0·6″ diameter. *Weeding*—Normal district practice.

Dhoni Experimental Garden—Experiment No. 140 *of* 1937.—*Arrangement*, etc., as above. *Stock used*—Stumps one year old 0·4″ to 0·7″ diameter.

Walayar Experimental Garden—Experiment No. 7 *of* 1937.—*Arrangement*, etc., as above. *Stock used*—One year old stumps 0·4″ to 0·7″ diameter.

Topslip Experimental Garden—Experiment No. 158 *of* 1937.—*Arrangement*, etc., as above. *Stock used*—One year old stumps 0·5″ to 0·8″ diameter.

Kannoth Experimental Garden—Experiment No. 44 *of* 1937.—*Arrangement*, etc., as above. *Stock used*—One year old stumps 0·5″ to 0·6″ diameter.

NOTE.—This experiment was done in a taungya crop of hill paddy sown on 13th May 1937.

Locality.	Date of planting.	Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Begur Experimental Garden—Experiment No. 106.	1st April 1937.	Buried ..	97	25·20 ± 1·66	+ 8·74 ± 2·24	S.
		Normal ..	93	16·46 ± 1·51	Control.	
	1st June 1937.	Buried ..	94	6·78 ± 0·20	− 0·10 ± 0·37	N.S.
		Normal ..	92	6·88 ± 0·27	Control.	
Dhoni Experimental Garden—Experiment No. 140.	1st April 1937.	Buried ..	95	58·20 ± 2·47	+ 10·70 ± 4·02	S.
		Normal ..	48	47·50 ± 3·17	Control.	
	1st June 1937.	Buried ..	99	26·40 ± 1·36	+ 3·90 ± 1·76	S.
		Normal ..	96	22·50 ± 1·11	Control.	
Walayar Experimental Garden—Experiment No. 7.	1st April 1937.	Buried ..	92	42·60 ± 1·80	+ 6·00 ± 2·60	S.
		Normal ..	87	36·60 ± 1·88	Control.	
	1st June 1937.	Buried ..	90	18·06 ± 0·82	− 3·14 ± 1·34	S.
		Normal ..	82	21·20 ± 1·07	Control.	

Locality.	Date of planting.	Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Topslip Experimental Garden Experiment No. 158.	1st April 1937.	Buried ..	77	17·86 ± 1·17	2·74 ± 1·66	N.S.
		Normal ..	79	20·60 ± 1·18	Control.	
	1st June 1937.	Buried ..	95	11·35 ± 0·59	1·85 ± 0·70	S.
		Normal ..	92	9·50 ± 0·37	Control.	
Kanoth Experimental Garden Experiment No. 44.	1st April 1937.	Buried ..	71	20·80 ± 1·01	+ 0·60 ± 2·84	N.S.
		Normal ..	43	29·20 ± 2·08	Control.	
	1st June 1937.	Buried ..	98	10·43 ± 0·63	1·05 ± 0·81	N.S.
		Normal ..	97	9·85 ± 0·50	Control.	

353. *Stump planting—Storage of stumps—Teak* (vide paragraph 113)—

Begur Experimental Garden Experiment No. 104.—*Arrangement*—ABCD DCBA repeated ten times in single lines of ten—plants (i.e., 100 plants per treatment). *Espacement*—6′ × 3′. *Soil preparation*—Crowbar holes. *Treatment*—Stumps were prepared on 5th March 1937, 15th March 1937, 25th March 1937, 10th April 1937 and planted on 10th April 1937. *Stock used*—One year old stumps 0·5″ to 0·6″ diameter. *Tending*—Normal district weeding.

Begur Experimental Garden—Experiment No. 105.—*Arrangements*, etc., as above. *Treatment*—Stumps were prepared on 5th April 1937, 10th April 1937, 15th April 1937 and 1st May 1937 and planted on 1st May 1937. *Stock used*—One year old stumps 0·5″ to 0·6″ diameter.

Topslip Experimental Garden—Experiment No. 157.—*Arrangement*, etc., as above. *Treatment—Set I*—Stumps were prepared on 5th March 1937, 15th March 1937, 25th March 1937 and 10th April 1937 and planted on 10th April 1937 and *Set II*—Stumps were prepared on 5th April 1937, 10th April 1937, 15th April 1937, 1st May 1937 and 5th May 1937 and planted on 5th May 1937. *Stock used*—One year old stumps 0·4″ to 0·8″ diameter.

Dhoni Experimental Garden—Experiment No. 134.—*Arrangements*, etc., as above. *Treatment* as above. *Stock used*—One year old stumps 0·4″-0·7″ diameter.

Experiment number.	Date of stump planting.	Date of measurement.	Days of storage.	Survival percentage.	Mean height in inches.
Begur Experimental Garden—Experiment No. 104	10th April 1937.	27th January 1938.	..	87	20·80
			15	34	19·30
			25	3	16·00
			35	..	..
Do. No. 105	1st May 1937.	Do.	..	94	18·20
			15	84	17·20
			20	74	12·50
			25	47	13·30
Topslip Experimental Garden—Experiment No. 157	10th April 1937.	19th January 1938.	..	92	26·40
			15	83	21·00
			25	58	19·20
			35	2	7·00
	5th May 1937.	Do.	..	91	11·72
			15	84	13·24
			20	74	12·60
			25	42	12·64

Experiment number.	Date of stump planting.	Date of measurement.	Days of storage.	Survival percentage.	Mean height in inches.
Dhoni Experimental Garden—Experiment No. 134	10th April 1937.	5th February 1938.	..	90	52·47
			15	50	54·78
			25	1	68·00
			35	7	37·71
	5th May 1937.	Do.	..	98	23·10
			15	64	17·50
			20	34	17·20
			25	88	33·80

354. *Effect of taungya (ponam) crops on the growth of teak in a plantation* (vide paragraph 141)—

Experimental Plot No. 33, *Wynaad Division.—Arrangement*—The area of 70 × 40 stakes is arranged in 28 randomized blocks of 10 × 10 stakes each, i.e., four repetitions of seven treatments. *Espacement*—6′ × 6′. *Treatment*—First year (A) Dhall, (B), (C) and (D) Ragi. (E), (F) and (G) Control—No crop. Dhall sown in patches on 8th June 1936 and harvested in January 1937. Ragi, broadcast on 19th June 1936 and harvested in November 1936. *Tending*—All plants kept clear of crops in 2′ diameter circles. *Date of planting* of teak 5th April 1936.

Measurements in January 1937.

Sub-plot.	First year treatment.	Survival percentage.	Mean height in inches.	Difference from control.	Significance.
A	Dhall	88	13·50±0·49	0·0±0·66	NS
B	Ragi	100	7·98±0·29	— 5·52±0·52	S
C	,, ...	100	8·03±0.29	— 5·47±0·52	S
D	,, ...	97	9·20±0·37	— 4·30±0·57	S
E	Control	96	13·37±0·55	— 0·13±0·70	NS
F	,, ...	99	14.43±0·56	+ 0·83±0·71	NS
G	,, ...	98	13·80—0·44	Control	..

Treatment 2nd year (A) Dhall (B) Sunnhemp (C) Boga (D) No crop (E) Sunnhemp (F) Boga (G) Control.

Measurements in January 1938.

Sub-plot.	First year treatment.	Second year treatment.	Survival percentage.	Mean height inches.	Difference from control.	Significance.
A	Dhall	Dhall	95	41·70±1·58	0·00±2·23	NS
B	Ragi	Sunnhemp	99	41·50±1·30	— 0·20±2·04	NS
C	,,	Boga	99	46·20±1·40	+ 4·50±2·11	S
D	,,	No crop	95	52·20±1·75	+ 1050±2·36	S
E	Control	Sunnhemp	96	41·10±1·57	— 0·60±2·23	NS
F	,,	Boga	98	52·10±1·61	+ 10·40±2·25	S
G	,,	Control	96	41·70±1·58	Control	..

NOTE.—All cover crops were continually browsed by deer and bison in the second year and al the teak was broken and trampled.

355. *Direct sowing in a burned over area, Best season* (vide paragraph 153)—

Experiments Nos. 84 *to* 89, *Emmanur Experimental Garden.—Species*—As shown in the table below. *Arrangement*—ABCDEF FEDCBA repeated ten times in single lines of

twenty patches, i.e., 200 of each treatment. *Espacement* - 2' × 2'. *Soil preparation* - 9 inches cube pits ash from the burn being worked into each pit. *Stock used*- Ten seeds per patch (*Anacardium occidentale* - Three seeds per patch). *Dates of sowing* - On the first of each month from May to November 1936. *Treatment* - Clean weeded in 1 foot diameter circles round the plants.

Experiment number.	Species.	Measurements on 26th January 1938.	Date of sowing (10 seeds per patch). 1st May 1936.	1st June 1936.	1st July 1936.	1st August 1936	1st September 1936.	1st October 1936.	1st November 1936.
84	*Acacia auriculiformis.*	Percentage survivals.	13	13	6	16	14	10	10
		Mean height in inches.	66·1	64·0	55·7	65·6	58·6	46·6	26·5
85	*Acacia planifrons.*	Percentage survivals.	46	58	57	52	76	55	38
		Mean height in inches.	48·0	43·5	32·4	32·1	32·2	23·3	21·6
86	*Acacia sundra.*	Percentage survivals.	12	41	52	31	74	20	11
		Mean height in inches.	58·1	56·2	45·8	33·8	32·5	30·5	40·4
87	*Albizzia amara.*	Percentage survivals.	46	75	61	51	46	3	37
		Mean height in inches.	53·3	41·4	34·8	32·2	29·5	28·2	28·6
88	*Anacardium occidentale.*	Percentage survivals.	5	3	3	2	8	14	11
		Mean height in inches.	19·7	23·5	30·2	21·5	25·8	20·0	20·0
89	*Cassia siamea.*	Percentage survivals.	62	23	51	44	59	23	45
		Mean height in inches.	88·8	65·0	61·0	58·2	47·2	34·2	33·8
	Average survival percentage	..	12	43	46	39	55	25	30
	Average mean height	..	66·8	58·7	52·0	48·7	45·2	37·8	34·2

356. *Experiments Nos.* 140 *to* 151 *and* 186. *Emmanur Experimental Garden* (vide paragraph 154)—

Species—As shown in the table below. *Arrangement*, etc., as above. *Dates of sowing*—On the 1st of each month from April to November 1937.

Experiment number.	Species.	Measurements on 13th January 1938.	Date of sowing (10 seeds per patch). 1st April 1937.	1st May 1937.	1st June 1937.	1st July 1937.	1st August 1937.	1st September 1937.	1st October 1937.	1st November 1937.
140	*Acacia arabica.*	Survival percentage.	48	71	81	89	81	77	83	92
		Mean height in inches.	28·2	12·2	13·0	13·8	13·8	12·4	11·6	7·1
141	*Acacia ferruginea.*	Survival percentage.	3	2	4	2	3	3	34	32
		Mean height in inches.	31·2	25·7	15·0	11·8	8·0	7·3	5·9	3·9
142	*Acacia planifrons.*	Survival percentage.	57	51	69	29	47	78	65	48
		Mean height in inches.	28·8	10·0	8·9	10·1	8·8	9·1	5·7	3·6
143	*Albizzia amara.*	Survival percentage.	38	9	18	34	34	32	51	53
		Mean height in inches.	27·0	18·8	3·2	5·1	2·2	2·3	2·3	1·7
144	*Albizzia lebbek.*	Survival percentage.	21	24	64	86	61	73	83	94
		Mean height in inches.	17·4	8·7	3·1	2·9	2·4	2·2	2·1	1·7
145	*Cassia auriculata.*	Survival percentage.	35	25	62	49	27	20	36	16
		Mean height in inches.	37·5	19·2	12·9	5·4	3·0	4·8	1·8	1·

Experiment number.	Species.	Measurements on 13th January 1938.	Date of sowing (10 seeds per patch). 1st April 1937.	1st May 1937.	1st June 1937.	1st July 1937.	1st August 1937.	1st September 1937.	1st October 1937.	1st November 1937.
146	*Pterocarpus santalinus.*	Survival percentage.	..	2	10	12	13	29	4	26
		Mean height in inches.	..	3·3	3·4	3·7	3·1	3·4	3·0	1·5
147	*Terminalia chebula.*	Survival percentage.	2	11	20	4	9	3	0	0
		Mean height in inches.	1·7	1·2	3·1	1·4	1·1	1·2	0	0
148	*Acacia auriculiformis.*	Survival percentage.	*	27	42	3	36	23	75	25
		Mean height in inches.	*	3·3	4·1	3·2	2·8	3·0	3·1	1·7
149	*Acacia sundra.*	Survival percentage.	*	26	31	44	38	35	66	23
		Mean height in inches.	*	10·8	10·2	5·2	3·9	4·2	4·0	2·2
150	*Cassia siamea.*	Survival percentage.	*	51	63	61	70	59	86	50
		Mean height in inches.	*	18·6	9·1	8·6	6·2	5·6	4·9	1·9
151	*Prosopis juliflora.*	Surveyed percentage.	*	*	66	62	72	67	84	77
		Mean height in inches.	*	*	18·9	17·4	15¾	16·0	15·4	4·6
186	*Azadirachta indica.*	Survival percentage.	*	*	*	*	2	1	47	2
		Mean height in inches.	*	*	*	*	10·0	25·0	2·4	2·3
	Average survival percent	..	25	25	44	42	38	39	55	41
	Average mean height	..	21·5	12·0	8·8	7·4	6·2	7·4	4·8	2·6

* Not done owing to late ripening of seed.

357. *Direct sowing in a burned over area—comparison of dry and watered beds* (vide paragraph 158)—

Experiments Nos. 90 *to* 95, *Emmanur Experimental Garden* (Supplementary to experiments Nos. 84 to 89).—*Species*—As shown in the table below. *Arrangement*—One nursery bed for each species, each bed divided into twelve parts ABCDEF FEDCBA each sowing of 100 seeds repeated once. *Soil preparation*—Soil worked 18 inches deep and smoothed, bed raised 3 inches above ground level. *Stock used*—Two hundred seeds for each treatment. *Date of sowing*—On the 1st of each month from May to November 1936. *Treatment*—Clean weeded throughout. *Watering*—Five gallons per day per bed for the watered beds, dry beds no watering.

Experiment number and species.	Bed treatment.	Percentage survivals on 2nd February 1938 of seed sown on 1st May 1936.	1st June 1936.	1st July 1936.	1st August 1936.	1st September 1936.	1st October 1936.	1st November 1936.
90 *Acacia auriculiformis* ..	Watered ..	4	10	7	1	1	1	2
	Dry ..	5	2	2	5	3	2	2
91 *Acacia planifrons*	Watered ..	16	7	10	9	10	5	16
	Dry ..	14	19	23	20	11	7	14
92 *Acacia sundra*	Watered ..	23	11	2	1	4	1	13
	Dry ..	18	17	13	8	5	3	5
93 *Albizzia amara*	Watered ..	27	24	21	12	6	2	9
	Dry ..	35	25	13	9	2	1	7
94 *Anacardium occidentale* ..	Watered ..	10	0	1	0	7	1	6
	Dry ..	7	2	1	0	7	6	14
95 *Cassia siamea*	Watered ..	15	9	6	7	6	3	7
	Dry ..	24	15	4				5

358. *Experiments Nos.* 152 *to* 163 *and* 187, *Emmanur Experimental Garden* (vide paragraph 159)

(Supplementary to experiments Nos. 140 to 151 and 186). *Species*—As shown in the table below. *Arrangement*, etc., as above. *Dates of sowing*—1st of each month from April to November 1937.

Experiment number.	Species.	Bed treatment.	Percentage survivals on 2nd February 1938 of seed sown on 1st April 1937.	1st May 1937.	1st June 1937.	1st July 1937.	1st August 1937.	1st September 1937.	1st October 1937.	1st November 1937.
152	*Acacia arabica* ..	Watered ..	14	17	11	27	40	51	26	39
		Dry	14	9	13	19	16	17	21	18
153	*Acacia ferruginea* ..	Watered ..	0	0	0	1	0	14	44	38
		Dry	0	1	1	1	0	4	7	24
154	*Acacia planifrons* ..	Watered ..	16	9	15	16	16	25	10	16
		Dry	25	13	22	11	19	10	10	9
155	*Albizzia amara* ..	Watered ..	2	3	8	7	18	23	14	12
		Dry	2	3	16	12	13	15	5	10
156	*Albizzia lebbek* ..	Watered ..	2	3	8	15	13	31	21	20
		Dry	3	3	16	18	23	7	18	25
157	*Cassia auriculata* ..	Watered ..	14	7	11	6	8	27	13	90
		Dry	8	5	6	3	5	3	2	2
158	*Pterocarpus santalinus.*	Watered ..	0	1	4	8	9	16	15	15
		Dry	0	2	6	5	2	17	2	23
159	*Terminalia chebula* ..	Watered ..	4	27	3	7	5	10	0	0
		Dry	4	3	27	20	28	3	3	0
160	*Acacia auriculiformis.*	Watered ..	*	21	36	46	49	36	7	12
		Dry	*	2	10	11	10	13	33	4
161	*Acacia sundra* ..	Watered ..	*	3	23	18	19	25	35	32
		Dry	*	2	2	10	10	9	22	13
162	*Cassia siamea* ..	Watered ..	*	6	19	16	30	41	51	59
		Dry	*	3	3	8	6	5	20	40
163	*Prosopis juliflora* ..	Watered ..	*	*	23	40	56	38	33	41
		Dry	*	*	8	11	8	7	62	23
187	*Azadirachta indica* ..	Watered ..	*	*	*	*	1	28	0	1
		Dry	*	*	*	*	0	0	19	0

* Test not done due to late ripening of seed now.

359. *Direct sowing—comparison of burning and no burning, soil working and no soil working before sowing* (vide paragraph 160) *Experiments Nos.* 103 *to* 108, *Emmanur Experimental Garden.*—*Species*—As shown in the table below. *Arrangement*—Plot in the open five 100′ strips side by side, the first and last 6′ wide and the middle three strips 12′ wide. The second and fourth strips burned 4′ buffer lines left between burned and unburned strips. 50 stakes per line in each treatment for each species (i.e., 200 per species per treatment). *Espacement*—2′ × 2′. *Soil preparation*—In soil worked area, 9″ × 9″ × 6″ ash mixed with the soil in non-soil worked area, just enough soil working to be able to sow. *Stock used*—Ten seeds per patch. *Date of sowing*—10th July 1936. *Treatment*—Kept clean weeded throughout.

Note.—In the burned areas brushwood was piled 6 feet high and beaten down to 4 feet high before burning.

Experiment number.	Species.	Measurements on 24th January 1938.	Area not burned. Worked pits.	Area not burned. No soil working.	Area burned. Worked pits.	Area burned. No soil working.
103	*Acacia leucophloea* ..	Percentage survivals	10	8	21	31
		Mean height growth in inches.	4·3	2·9	16·1	15·8
104	*Acacia planifrons* ..	Percentage survivals	27	14	39	35
		Mean height growth in inches.	17·1	19·2	38·3	38·0
105	*Albizzia amara* ..	Percentage survivals	40	22	57	44
		Mean height growth in inches.	17·9	13·0	30·6	31·7
106	*Cassia siamea*	Percentage survivals	14	9	36	26
		Mean height growth in inches.	32·1	35·4	36·9	33·7
107	*Dolichandrone crispa* ..	Percentage survivals	6	4	30	29
		Mean height growth in inches.	7·3	5·8	13·4	15·9
108	*Wrightia tinctoria* ..	Percentage survivals	9	9	69	83
		Mean height growth in inches.	13·2	11·8	16·2	19·8
	Average for all species.	Percentage survivals	18	11	42	41
		Mean height growth in inches.	15·3	14·7	25·3	25·8

360. *Experiments Nos.* 171 *to* 176, *Emmanur Experimental Garden* (vide paragraph 161)—

Species.—As shown in the table below. *Arrangement*—A plot 120′ × 120′ divided into thirty sub-plots of which ten were burned and ten were not burned arranged 1, 2, 2, 1, etc., with 4′ buffer line between treatments. Treatments A and B to be randomized in the unburned strips and C and D in the burned strips. A and B not burned. A and C worked pits 9″ cube. C and D burned. B and D soil loosened just enough to sow seed. *Espacement*, etc., as above. *Date of sowing*—3rd July 1937.

Experiment number.	Species.	Measurement on 19th January 1938.	Area not burned. Worked pits.	Area not burned. No soil working.	Area burned. Worked pits.	Area burned. No soil working.
171	*Acacia planifrons* ..	Percentage survivals	65	49	60	55
		Mean height growth in inches.	4·1	4·0	8·3	8·1
172	*Albizzia amara* ..	Percentage survivals	23	52	42	72
		Mean height growth in inches.	2·0	2·0	4·5	3·2
173	*Cassia auriculata* ..	Percentage survivals	57	59	59	67
		Mean height growth in inches.	2·2	2·1	8·5	4·5
174	*Cassia siamea*	Percentage survivals	63	59	63	57
		Mean height growth in inches.	2·0	2·1	4·1	3·4
175	*Dolichandrone crispa* ..	Percentage survivals	25	51	15	31
		Mean height growth in inches.	1·4	1·7	1·9	2·6
176	*Zizyphus jujuba* ..	Percentage survivals	95	95	85	91
		Mean height growth in inches.	3·1	2·9	6·5	6·1
	Average for all species.	Percentage survivals	55	61	54	62
		Mean height growth in inches.	2·5	2·5	5·6	4·7

361. *Comparison of sowing, entire transplanting and stump planting* (vide paragrahp 162).

Experiments Nos. 113 *to* 115, 117, 118, 120, 124, *and* 126, *Emmanur Experimental Garden.*—*Species.*—As in the table below. *Arrangement.*—ABC CBA repeated ten times in single lines of ten plants, i.e., 100 per treatment per species. *Espacement*—2′ × 2′. *Soil preparation.*—Area burned and ash mixed with the soil, soil worked 9″ × 9″ × 6″ for for sowing 9″ crowbar holes for stumps planting, and sail worked 9″ × 9″ × 6″ for transplanting. *Stock used.*—Sowing ten seeds per patch, transplanting and stump

planting one year old plants from Emmanur nursery. *Date of sowing.*—15th July 1936. *Date of transplanting.*—19th October 1936. *Date of stump planting.*—29th September 1936. *Treatment.*—Clean weeding in one foot diameter circles round the plants.

Measurement in January 1938.

Experiment number.	Species.	Percentage survivals.			Mean height in inches.		
		Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
113	*Albizzia amara*	67	34	22	54·8	21·2	16·5
114	*Albizzia lebbek*	67	57	82	44·5	25·4	28·2
115	*Azadirachta indica* ..	30	39	75	63·8	48·6	54·5
117	*Dolichandrone crispa* ..	82	34	42	27·7	26·1	26·1
118	*Feronia elephantum* ..	4	20	73	16·3	13·6	17·9
120	*Holoptelia integrifolia* ..	2	39	39	43·0	35·2	30·6
124	*Soymida febrifuga*	6	36	69	..	15·1	19·2
126	*Wrightia tinctoria*	69	47	..	26·9	23·9	26·0

362. *Comparison of sowing, entire transplanting and stump planting* (vide paragraph 163)—

Experiments Nos. 180 *to* 185, *Emmanur Experimental Garden*—*Species*—As in the table below. *Arrangement*, etc., as above. *Date of sowing*—23rd July 1937. *Date of transplanting*—8th October 1937. *Date of stump planting*—21st September 1937.

Measurements in January 1938.

Experiment number.	Species.	Percentage survivals.			Mean height in inches.		
		Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
180	*Azadirachta indica*	0	21	56	0	4.5	4·0
181	*Dolichandrone crispa*	38	25	72	2·7	3·1	4·5
182	*Hardwickia binata*	7	14	67	1·4	2·9	2·9
183	*Pterocarpus santalinus*	44	62	4	2·7	2·6	3·3
184	*Wrightia tinctoria*	18	64	39	2·5	4·9	4·3
185	*Soymida febrifuga*	..	14	37	..	2·7	2·3

363. (i) *Stump planting—best date*, (ii) *stump planting and transplanting comparison* and (iii) *comparison of transplanting at the commencement of the south-west monsoon and north-east monsoon* (vide paragraph 165)—

Experiments Nos. 99 *to* 101, *Emmanur Experimental Garden*.—*Species*—As in the table below. *Arrangements*—A-1, A-2, B, C-1, C-2, D-1, D-2, E-1, E-2, F, F, E-2, E-1, D-2, D-1, C-2, C-1, B, A-2, A-1, etc., in single lines of ten plants repeated ten times, i.e., 100 plants per treatment. *Espacement*—2′ × 2′. *Soil preparation*—Crowbar holes for stumps; pits 6″ × 6″ × 12″ for transplants—the area was burned and the ash worked in. *Stock used*—A-1, C-1, D-1, D-2, E-2—Two year old stumps 0·1″ to 0·2″ diameter, A-2, C-2, E-1—One year old stumps 0·15″ to 0·3″ diameter and B and F—One year old transplants 12 inches to 33 inches in height. *Treatment*—Kept clean weeded. *Dates of stump planting*—1st July 1936, 1st August 1936, 1st September 1936, 1st October 1936. *Dates of transplanting*—16th June 1936, 21st October 1936.

Experiment number.	Species.	Measurement on 21st January 1938.	Stump planting on				Transplanting on	
			1st July 1936.	1st August 1936.	1st September 1936.	1st October 1936.	16th June 1936.	21st October 1936.
			A. 1.	A. 2.	D. 1.	D. 2.	E. 1.	E. 2.	B.	F.
99	*Azadirachta indica* ..	Percentage survivals	..	1	..	2	..	11	..	42
		Mean height in inches	..	74·0″	..	75·0″	..	51·9″	..	57·8″
100	*Feronia elephantum* ..	Percentage survivals	..	5	..	..	1	12	..	22
		Mean height in inches	1	19·4″	..	..	13·0″	14·5″	..	15·5″
101	*Soymida febrifuga* ..	Percentage survivals	24·0″	..	14″	1	13″	24	..	69
		Mean height in inches	1	..	9·4″	12·0″	8·5″	13·9″	..	7·6″

364. *Experiments Nos.* 177 *to* 179 *Emmanur Experimental Garden* (vide paragraph 166)—

Species—As in the table below. *Arrangements, etc.*, as above. *Stock used*—As above. *Dates of stump planting*—1st July 1937, 1st August 1937, 1st September 1937 and 1st October 1937. *Dates of transplanting*—29th July 1937 and 7th October 1937.

Experiment number.	Species.	Measurement on 20th January 1938.	Stump planting on				Transplanting on	
			1st July 1937.	1st August 1937.	1st September 1937.	1st October 1937.	29th July 1937.	7th October 1937.
			A. 1.	A. 2.	D. 1.	D. 2.	E. 1.	E. 2.	B.	F.
177	*Pterocarpus santalinus.*	Percentage survivals	3	59	35	49	49	66	42	66
		Mean height in inches	2·3	3·4	5·1	5·3	2·4	3·5	4·6	3·3
178	*Soymida febrifuga* ..	Percentage survivals	3	4·4	21	39	53	35	12	41
		Mean height in inches	2·3	1	1·9	2·2	1·6	1·5	3·8	3·4
179	*Wrightia tinctoria* ..	Percentage survivals	23	4·0	58	87	71	73	40	75
		Mean height in inches	6·9	6·2	5·6	6·5	3·5	3·5	5·7	5·2

365. *Leucaena glauca as a cover crop in a teak plantation* (vide paragraph 215)—

Experimental Plot No. 25, Wynad Division. Arrangement—AB BA, etc., each treatment being four lines of ten plants repeated five times (i.e., 200 plants of each treatment). *Espacement*—6′ × 6′. *Treatment*—Teak was stump planted in April 1935 after clear felling and burning (A) control, (B) *Leucaena glauca* sown on 28th June 1935 in 2′ diameter patches worked 6 inches deep in between the teak. 100 seeds per patch sown. *Tending* (A) Normal district practice and (B) weeded as little as possible as is essential for the teak or *Leucaena*.

Measurements in January 1938.

	Treatment.	Survival percentage.	Mean height in inches.	Difference from control.	Significance.
A	Control ..	100	113·00 ± 1·81		
B	*Leucaena* ..	100	121·00 ± 1·15	Control + 8·00 ± 6·36	NS

366. *Effect of burning in evergreen forest before artificial regeneration of evergreens under top canopy cover* (vide paragraph 232)—

Chandanathode Experimental Garden—Experiment No. 101.—*Arrangement*—ABCDEFGHIJKL LKJIHGFEDCBA repeated nine times in lines of twenty stakes (ten burned and ten unburned), i.e., ninety stakes burned and ninety stakes unburned per species. *Espacement*—3′ × 1½′. *Soil preparation*—Sowing 1′ diameter patches worked 6″ deep. *Transplanting*—1′ cube pits. *Stump planting*—Crowbar holes. *Cuttings*—Crowbar holes.

Species, method and date of introduction.

A. *Artocarpus hirsuta* stumps 0·3″/0·4″ diameter, planted on 17th July 1936.

B. *Swietenia macrophylla* transplants 30″/36″ high, planted on 16th July 1936.

C. *Artocarpus hirsuta* transplants 18″ high, planted on 16th July 1936.

D. *Dipterocarpus indicus* transplants 40″/48″ high, planted on 16th July 1936.

E. *Cedrela toona* cuttings 18″ high, planted on 16th July 1936.

F. *Cedrela toona* stumps 0·7″/0·8″ diameter, planted on 17th July 1936.

G. *Hopea parviflora* sowing 10 seeds per patch, sown on 9th June 1935.

H. *Hopea parviflora* transplants 30″/36″ high, planted on 16th July 1936.

I. *Hopea parviflora* transplants 12″ high, planted on 16th July 1936.

J. *Dysoxylum malabaricum* sowings 5 seeds per patch, sown on 9th August 1936.

K. *Dysoxylum malabaricum* transplants 20″/24″ high, planted on 16th July 1936.

L. *Dysoxylum malabaricum* basketed plants 6″/12″ high, planted on 15th August 1936.

Weeding—Normal district practice.

Data after two seasons growth.

Experimental garden.	Species.	Unburned. Survival per cent.	Unburned. Mean height.	Burned. Survival per cent.	Burned. Mean height.
			INCHES.		INCHES.
Chandanathode Experiment No. 101.	1 *Artocarpus hirsuta* stumps.	44	4·73	61	6·78
	2 *Swietenia macrophylla* transplants.	48	31·40	42	30·80
	3 *Artocarpus hirsuta* transplants.	20	8·70	21	9·30
	4 *Dipterocarpus indicus* transplants.	31	39·00	38	43·20
	5 *Cedrela toona* cuttings.	48	32·00	41	35·10
	6 *Cedrela toona* stumps ..	37	28·50	46	29·00
	7 *Hopea parviflora* sowings.	66	5·39	65	5·38
	8 *Hopea parviflora* transplants.	92	20·20	91	21·20
	9 *Hopea parviflora* transplants.	95	39·00	96	37·50
	10 *Dysoxylum malabaricum* sowings.	14	7·52	16	8·12
	11 *Dysoxylum malabaricum* transplants.	62	19·00	79	17·82
	12 *Dysoxylum malabaricum* transplants.	45	8·58	48	8·30
	Average of all species.	50	20·41	54	21·04

367. *Direct sowing—Best date* (Under top canopy only) (vide paragraph 233)—

Chandanathode Experimental Garden—Experiment No. 119.—*Species—Acrocarpus fraxinifolius. Arrangement*—ABCD DCBA repeated ten times in single lines of ten plants (i.e., 100 per treatment). *Espacement*—3′ × 1½′. *Soil preparation*—Patches 1′ diameter worked 6″ deep. *Stock used*—Ten seeds per patch. *Date of sowing*—(A) 1st May 1937, (B) 1st June 1937, (C) 1st July 1937 and (D) 1st August 1937. *Weeding*—Normal district practice.

Chandanathode Experimental Garden—Experiment No. 120.—*Species—Cedrela toona. Arrangement*, etc., as above.

Chandanathode Experimental Garden—Experiment No. 121.—*Species—Swietenia macrophylla. Arrangement*, etc., as above.

Karianshola Experimental Garden—Experiment No. 90.—*Species—Mesua ferrea. Arrangement*, etc., as above. *Dates of sowing*—(A) 1st July 1937, (B) 15th July 1937, (C) 1st August 1937, (D) 15th August 1937 and (E) 1st September 1937.

Karianshola Experimental Garden—Experiment No. 91.—*Species—Cedrela toona. Arrangement*, etc., as above.

Karianshola Experimental Garden—Experiment No. 92.—*Species—Swietenia macrophylla. Arrangement, etc.*, as above.

Karianshola Experimental Garden—Experiment No. 93.—*Species—Acrocarpus fraxinifolius. Arrangement*, etc., as above.

Survival percentage in January 1938.

Locality.	Species.	Experiment number.	1937. 1st May.	1st June.	1st July.	15th July.	1st August.	15th August.	1st September.
Chandanathode.	*Acrocarpus fraxinifolius.*	119	3	8	4	..	10	..	..
	Cedrela toona	120	14	21	7	..	17	..	..
	Swietenia macrophylla.	121	15	0	1	..	0	..	..
Karianshola ..	*Mesua ferrea*	90	..	..	4	2	1	1	0
	Cedrela toona	91	..	..	70	29	13	5	3
	Swietenia macrophylla.	92	..	..	19	8	47	41	27
	Acrocarpus fraxinifolius.	93	..	..	20	46	43	53	32

Mean height growth in January 1938 *in inches.*

Chandanthode.	*Acrocarpus fraxinifolius.*	110	3·3	2·0	2·3	..	2·4	..	..
	Cedrela toona	120	4·0	4·3	4·9	..	3·1	..	..
	Swietenia macrophylla.	121	6·9	..	6·0	..	..	..	..
Karianshola ..	*Mesua ferrea*	90	..	..	6·0	3·5	4·0	4·6	..
	Cedrela toona	91	..	..	6·0	4·8	5·1	2·5	2·7
	Swietenia macrophylla.	92	..	..	8·1	6·6	5·4	5·2	5·5
	Acrocarpus fraxinifolius.	93	..	..	4·5	4·7	4·4	4·4	3·6

368. *Entire transplanting—Best date* (under top canopy only) (vide paragraph 235)—

Chandanathode Experimental Garden—Experiment No. 122.—*Species—Hopea parviflora. Arrangement*—ABCDEFG GFEDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—3′ × 1½′. *Soil preparation*—1′ cube pits. *Stock used*—One year old plants 6″ to 12″ high. *Dates of transplanting*—(A) 15th June 1937, (B) 1st July 1937, (C) 15th July 1937, (D) 1st August 1937, (E) 15th August 1937, (F) 1st September 1937 and (G) 15th September 1937. *Weeding*—Normal district practice.

Chandanathode Experimental Garden—Experiment No. 123.—*Species—Swietenia macrophylla. Arrangement*, etc., as above. *Stock used*—One year old plants 18″ to 24″ high.

Chandanathode Experimental Garden—Experiment No. 124.—*Species—Cedrela toona. Arrangement*, etc., as above. *Stock used*—One year old plants 6″ to 12″ high.

Chandanathode Experimental Garden—Experiment No. 125.—*Species—Hardwickia pinnata. Arrangement, etc.*, as above. *Stock used*—One year old plants 6″ to 12″ high.

Chandanathode Experimental Garden—Experiment No. 126.—*Species—Artocarpus hirsuta. Arrangement*, etc., as above. *Stock used*—One year old plants 6″ to 12″ high.

Chandanathode Experimental Garden—Experiment No. 127.—*Species—Calophyllum elatum. Arrangement*, etc., as above. *Stock used*—Two years old plants 6″ to 12″ high.

Karianshola Experimental Garden—Experiment No. 94.—*Species—Swietenia macrophylla. Arrangement*, etc., as above. *Stock used*—One year old plants 9″ to 16″ high. *Dates of transplanting*—(A) 25th June 1937, (B) 10th July 1937, (C) 25th July 1937, (D) 10th August 1937, (E) 25th August 1937, (F) 1st October 1937 and (G) 15th October 1937.

Karianshola Experimental Garden—Experiment No. 95.—*Species—Mesua ferrea. Arrangement*, etc., as above. *Stock used*—One year old plants 4″ to 10″ high.

Karianshola Experimental Garden Experiment No. 96.—*Species—Cedrela toona. Arrangement*, etc., as above. *Stock used*—One year plants 9″ to 24″ high.

Karianshola Experimental Garden Experiment No. 97.—*Species—Calophyllum elatum. Arrangement*, etc., as above. *Stock used*—Two years old plants 6″ to 18″ high.

Locality.	Experiment number.	Species.	Survival percentage of plants transplanted on								
			15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.	15th August 1937.	1st September 1937.	15th September 1937.	1st October 1937.	15th October 1937.
Chandanathode ..	122	*Hopea parviflora*	97	88	91	96	99	97	58	..	..
	123	*Swietenia macrophylla*	80	41	19	97	98	94	60	..	..
	124	*Cedrela toona*	50	70	87	95	96	98	52	..	..
	125	*Hardwickia pinnata*	50	50	54	72	78	94	40	..	..
	126	*Artocarpus hirsuta*	48	54	44	18	74	74	10	..	..
	127	*Calophyllum elatum*	60	42	40	52	20	22	16	..	..
Karianshola	94	*Swietenia macrophylla*	95	93	..	88	3	..	..	96	91
	95	*Mesua ferrea*	76	48	..	34	49	38	..	68	63
	96	*Cedrela toona*	94	81	..	64	59	24	..	92	96
	97	*Calophyllum elatum*	0	0	..	0	0	0	..	1	0

Locality.	Experiment number.	Species.	Mean height growth in inches of plants transplanted on								
			15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.	15th August 1937.	1st September 1937.	15th September 1937.	1st October 1937.	15th October 1937.
Chandanathode ..	122	*Hopea parviflora*	9·7	7·6	8·2	7·7	[illegible]	7·5	6·7	..	..
	123	*Swietenia macrophylla*	10·8	17·4	19·3	17·1	[illegible]	[illegible]	[illegible]	..	..
	124	*Cedrela toona*	7·7	7·6	7·4	7·3	[illegible]	[illegible]	4·5	..	..
	125	*Hardwickia pinnata*	6·7	4·5	5·2	5·3	4·7	[illegible]	[illegible]	..	..
	126	*Artocarpus hirsuta*	7·5	7·0	7·0	2·7	[illegible]	[illegible]	2·7	..	..
	127	*Calophyllum elatum*	10·1	6·5	6·7	6·4	[illegible]	4·5	2·4	..	..
Karianshola	94	*Swietenia macrophylla*	19·9	21·5	..	21·2	[illegible]	0	..	30·5	[illegible]
	95	*Mesua ferrea*	7·2	6·7	..	6·7	[illegible]	5·5	..	7·1	6·6
	96	*Cedrela toona*	16·9	18·9	..	17·9	10·9	7·4	..	15·7	13·0
	97	*Calophyllum elatum*	0	0	..	0	0	0	..	14·0	0

369. ***Stump-planting—Best date*** **(Under top canopy only) (vide paragraph 236)—**

Chandanathode Experimental Garden—Experiment No. 128.—*Species*—***Artocarpus hirsuta.*** *Arrangement*—ABCDE EDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). ***Espacement*—3′ × 1½′.** ***Soil preparation***—Crowbar holes. ***Stock used***—One year old plants, stumps 0·3″ to 0·5″ diameter. ***Dates of stump planting***—(A) 15th May 1937, (B) 1st June 1937, (C) 15th June 1937, (D) 1st July 1937 and (E) 15th July 1937. *Weeding*—Normal district practice.

Chandanathode Experimental Garden Experiment No. 129.—*Species*—***Cedrela toona.*** *Arrangement*, etc., as above. ***Stock used***—One year old plants, stumps 0·3″ to 0·4″ diameter.

Karianshola Experimental Garden—Experiment No. 86.—*Species*—*Cedrela toona.* ***Arrangement***, etc., as above. ***Stock used***—One year old plants, stumps 0·2″ to 0·7″ diameter. *Dates of planting*—Fortnightly from June 15th to October 15th.

Karianshola Experimental Garden—Experiment No. **89.—** *Species*—*Artocarpus hirsuta.* ***Arrangement***, etc., as above. ***Stock used***—One year old plants, stumps 0·2″ to 0·6″ diameter.

Measurements in January 1937 showed the following :—

Experiment number.	Species.	Survival percentage of stumps planted on						Mean height growth (in inches) of stumps planted on					
		15th May 1937.	1st June 1937.	15th June 1937.	1st August 1937.	15th August 1937.	1st September 1937.	15th May 1937.	1st June 1937.	15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.
123	*Artocarpus hirsuta*	54	62	56	..	..	..	2·4	2·3	1·8	2·2	2·1	..
129	*Cedrela toona*	20	24	29	..	..	..	4·8	5·4	6·0	4·5	4·1	..
86	*Cedrela toona*	..	..	..	23	51	39	..	..	..	4·0	4·0	4·2
89	*Artocarpus hirsuta*	..	..	..	73	94	72	..	..	..	3·2	2·6	3·2

Experiment number.	Species.	Survival percentage of stumps planted on						Mean height growth (in inches) of stumps planted on					
		15th May 1937.	1st June 1937.	15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.	15th May 1937.	1st June 1937.	15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.
123	*Artocarpus hirsuta*	..	..	..	9	73	..	..	..	..	2·2	2·1	..
129	*Cedrela toona*	..	..	..	2	29	..	..	..	..	4·5	4·1	..
86	*Cedrela toona*	..	..	..	48	47	23	..	..	..	4·0	4·0	4·2
89	*Artocarpus hirsuta*	..	..	..	54	67	73	..	..	..	3·2	2·6	3·2

Experiment number.	Species.	Survival percentage of stumps planted on						Mean height growth (in inches) of stumps planted on					
		15th May 1937.	1st June 1937.	15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.	15th May 1937.	1st June 1937.	15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.
123	*Artocarpus hirsuta*	..	..	..	..	..	..	..	..	..	..	..	..
129	*Cedrela toona*	..	..	..	..	..	..	..	..	..	..	..	..
86	*Cedrela toona*	..	..	..	..	..	..	..	..	..	..	..	..
89	*Artocarpus hirsuta*	..	..	..	..	..	..	..	..	..	..	..	..

Experiment number.	Species.	Survival percentage of stumps planted on						Mean height growth (in inches) of stumps planted on					
		15th May 1937.	1st June 1937.	15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.	15th May 1937.	1st June 1937.	15th June 1937.	1st July 1937.	15th July 1937.	1st August 1937.
123	*Artocarpus hirsuta*	..	..	..	..	..	..	..	..	..	..	..	..
129	*Cedrela toona*	..	..	..	..	..	..	..	..	..	..	..	..
86	*Cedrela toona*	..	..	..	..	..	..	..	..	..	..	..	..
89	*Artocarpus hirsuta*	..	..	..	..	..	..	..	..	..	..	..	..

370. *Comparison of sowing, transplanting, small, medium and large transplants and stumping with small and large stumps* (under top canopy cover) (vide paragraph 238)—

Arrangement.—For all experiments ABC, etc., CBA repeated ten times in single lines of ten plants (i.e., 100 per treatment). *Espacement*—For all experiments 3′ × 1½′. *Soil preparation for all experiments—Sowing*—1′ diameter patches worked 6″ deep. *Transplanting*—1′ cube pits. *Stumping*—Crowbar holes. *Weeding for all experiments*—Clean weeding.

1. *Artocarpus hirsuta.*

Chandanathode Experimental Garden—Experiment No. 46.—*Stock used*—

(A) Sowing ten seeds per patch (12th June 1934).
(B) Transplants 6″ high one year old (20th August 1934).
(C) Transplants 12″ high one year old (20th August 1934).
(D) Stumps 0·22″ diameter one year old (20th August 1934).
(E) Stumps 0·10″ diameter one year old (20th August 1934).

Chandanathode Experimental Garden—Experiment No. 67.—*Stock used*—

(A) Sowing ten seeds per patch (10th June 1935).
(B) Transplants 7·6″ high one year old (19th August 1935).
(C) Transplants 16″ high one year old (19th August 1935).
(D) Stumps 0·2″ diameter one year old (19th August 1935).
(E) Stumps 0·45″ diameter one year old (19th August 1935).

Karianshola Experimental Garden—Experiment No. 60.—*Stock used*—

(A) Sowing ten seeds per patch (26th March 1936).
(B) Transplants 7″ high three months old (17th June 1936).
(C) Transplants 25″ high one year old (17th June 1936).
(D) Stumps 0·2″ diameter three months old (17th June 1936).
(E) Stumps 0·4″ diameter one year old (17th June 1936).

Chandanathode Experimental Garden—Experiment No. 111.—*Stock used*—

(A) Sowing ten seeds per patch (4th June 1937).
(B) Transplants 6″ high one year old (14th July 1937).
(C) Transplants 18″ high one year old (14th July 1937).
(D) Transplants 30″ high three years old (14th July 1937).
(E) Stumps 0·2″ to 0·3″ diameter one year old (6th July 1937).
(F) Stumps 0·5″ to 0·6″ diameter three years old (6th July 1937).

Karianshola Experimental Garden– Experiment No. 81.—
Stock used—
(A) Sowing ten seeds per patch (18th June 1937).
(B) Transplants 5″ high two months old (13th August 1937).
(C) Transplants 15″ high one year old (4th August 1937).
(D) Transplants 30″ high one year old (4th August 1937).
(E) Stumps 0·2″ diameter one year old (13th August 1937).
(F) Stumps 0·2″ to 0·4″ diameter one year old (4th August 1937).

II. *Acrocarpus fraxinifolius.*

Chandanathode Experimental Garden– Experiment No. 85.—
Stock used—
(A) Sowing ten seeds per patch (3rd June 1936).
(B) Transplants 7½″ high one year old (6th August 1936).
(C) Transplants 18″ high one year old (6th August 1936).
(D) Stumps 0·6″ diameter one year old (6th August 1936).
(E) Stumps 1·5″ diameter three years old (6th August 1936).

Chandanathode Experimental Garden– Experiment No. 115.—
Stock used—
(A) Sowing ten seeds per patch (4th June 1937).
(B) Transplants 7½″ high one year old (16th May 1937).
(C) Transplants 14″ high one year old (16th May 1937).
(D) Stumps 0·1″ to 0·2″ diameter one year old (22nd July 1937).
(E) Stumps 0·4″ to 1·0″ diameter one year old (22nd July 1937).

Karianshola Experimental Garden—Experiment No. 83.—
Stock used—
(A) Sowing ten seeds per patch (18th June 1937).
(B) Transplants 5½″ high two months old (13th August 1937).
(C) Transplants 21″ high one year old (26th June 1937).
(D) Stumps 0·2″ diameter two months old (13th August 1937).
(E) Stumps 0·2″ to 1·0″ diameter one year old (26th June 1937).

III. *Cedrela toona.*

Chandanathode Experimental Garden– Experiment No. 49.—
Stock used—
(A) Sowing fifteen seeds per patch (12th June 1934).
(B) Transplants 7″ high one year old (1st August 1934).
(C) Transplants 11″ high one year old (1st August 1934).
(D) Stumps 0·46″ diameter one year old (1st August 1934).

Chandanathode Experimental Garden—Experiment No. 69.—
Stock used—
(A) Sowing ten seeds per patch (10th June 1935).
(B) Transplants 8½″ high one year old (18th August 1935).
(C) Transplants 20″ high one year old (18th August 1935).
(D) Stumps 0·5″ diameter one year old (19th August 1935).
(E) Stumps 0·27″ diameter one year old (19th August 1935).

Chandanathode Experimental Garden—Experiment No. 89.—
Stock used—
(A) Sowing ten seeds per patch (3rd June 1936).
(B) Transplants 9″ high one year old (23rd July 1936).
(C) Transplants 30″ high one year old (23rd July 1936).
(D) Stumps 0·25″ diameter one year old (23rd July 1936).
(E) Stumps 0·7″ diameter one year old (23rd July 1936).

Karianshola Experimental Garden—Experiment No. 55.—
Stock used—
(A) Sowing ten seeds per patch (15th June 1936).
(B) Transplants 7″ high three months old (17th September 1936).
(C) Transplants 15″ high one year old (17th September 1936).
(D) Transplants 27″ high one year old (17th September 1936).

Chandanathode Experimental Garden—Experiment No. 118.—
Stock used—
(A) Sowing ten seeds per patch (4th June 1937).
(B) Transplants 11″ high one year old (1st July 1937).
(C) Transplants 30″ high one year old (1st July 1937).
(D) Stumps 0·4″ to 0·5″ diameter one year old (15th June 1937).
(E) Stumps 0·6″ to 0·7″ diameter one year old (15th June 1937).

Karianshola Experimental Garden—Experiment No. 88.—
Stock used—
(A) Sowing ten seeds per patch (18th June 1937).
(B) Transplants 5″ high two months old (13th August 1937).
(C) Transplants 27″ high one year old (13th August 1937).
(D) Stumps 0·2″ diameter one year old (13th August 1937).
(E) Stumps 0·4″ to 0·7″ diameter one year old (13th August 1937).

IV. *Swietenia macrophylla.*

Chandanathode Experimental Garden—Experiment No. 47.—
Stock used—

(A) Sowing ten seeds per patch (12th June 1934).
(B) Transplants 8½″ high five months old (1st August 1934).
(C) Transplants 16″ high one year old (1st August 1934).

Karianshola Experimental Garden—Experiment No. 32.—
Stock used—

(A) Transplants 36½″ high one year old (17th August 1934).
(B) Transplants 16½″ high one year old (17th August 1934).
(C) Transplants 4″ high two months old (17th August 1934).

Chandanathode Experimental Garden—Experiment No. 68.—
Stock used—

(A) Sowing ten seeds per patch (10th June 1935).
(B) Transplants 6″ high four months old (18th August 1935).
(C) Transplants 18″ high one year old (18th August 1935).
(D) Transplants 35″ high one year old (18th August 1935).

Karianshola Experimental Garden—Experiment No. 45.—
Stock used—

(A) Transplants 8·5″ high five months old (29th August 1935).
(B) Sowing five seeds per patch (1st July 1935).

Chandanathode Experimental Garden—Experiment No. 86.—
Stock used—

(A) Sowing ten seeds per patch (3rd June 1936).
(B) Transplants 6″ high four months old (23rd June 1936).
(C) Transplants 18″ high one year old (23rd June 1936).
(D) Transplants 35″ high two years old (23rd June 1936).

Karianshola Experimental Garden—Experiment No. 59.—
Stock used—

(A) Sowing ten seeds per patch (17th June 1936).
(B) Transplants 7″ high four months old (17th June 1936).
(C) Transplants 14″ high one year old (17th June 1936).
(D) Transplants 30″ high one year old (17th June 1936).

Chandanathode Experimental Garden—Experiment No. 116.—
Stock used—

(A) Sowing ten seeds per patch (4th June 1937).
(B) Transplants 6″ high five months old (13th July 1937).
(C) Transplants 18″ high two years old (13th July 1937).
(D) Transplants 35″ high three years old (13th July 1937).

Karianshola Experimental Garden—Experiment No. 84.—
Stock used—

(A) Sowing ten seeds per patch (18th June 1937).
(B) Transplants 7½″ high five months old (2nd July 1937).
(C) Transplants 21″ high one year old (2nd July 1937).
(D) Transplants 35″ high one year old (2nd July 1937).

V. *Hopea parviflora.*

Chandanathode Experimental Garden—Experiment No. 48.—
Stock used—

(A) Sowing fifteen seeds per patch (12th June 1934).
(B) Transplants 9″ high one year old (16th August 1934).
(C) Transplants 20″ high two years old (16th August 1934).

Karianshola Experimental Garden—Experiment No. 48.—
Stock used—

(A) Transplants 7·7″ high one year old (21st July 1935).
(B) Transplants 3·4″ high one year old (21st July 1935).
(C) Transplants 13½″ high two years old (5th July 1937).
(D) Transplants 24″ high two years old (5th July 1937).

Karianshola Experimental Garden—Experiment No. 82.—
Stock used—

(A) Sowing ten seeds per patch (7th June 1937).
(B) Forest transplants 7½″ high (12th August 1937).
(C) Forest transplants 12½″ high (12th August 1937).
(D) Forest transplants 16½″ high (12th August 1937).

VI. *Calophyllum elatum.*

Chandanathode Experimental Garden—Experiment No. 90.—
Stock used—

(A) Transplants 7½″ high two years old (6th August 1936).
(B) Transplants 28″ high two years old (6th August 1936).

VII. *Mesua ferrea.*

Chandanathode Experimental Garden—Experiment No. 88.—
Stock used—

(A) Transplants 7½″ high one year old (6th August 1936).

Chandanathode Experimental Garden—Experiment No. 117.—
Stock used—

(A) Sowing ten seeds per patch (4th June 1937).
(B) Transplants 14″ high two years old (16th July 1937).
(C) Transplants 22″ high two years old (16th July 1937).

Karianshola Experimental Garden—Experiment No. 87.—
Stock used—

(A) Sowing ten seeds per patch (8th June 1937).
(B) Transplants 4″ high three months old (12th August 1937).
(C) Transplants 6″ high six months old (12th August 1937).

VIII. *Araucaria cunninghamii.*

Kariamshola Experimental Garden—Experiment No. 63.—*Stock used.*

(A) Transplants 4″ high eighteen months old (5th July 1936).

IX. *Artocarpus integrifolia.*

Chandanathode Experimental Garden Experiment No. 112.—*Stock used*—

(A) Sowing three seeds per patch (4th June 1937).

(B) Transplants 15″ high three months old (16th July 1937).

(C) Transplants 32″ high three months old (16th July 1937).

(D) Stumps 0·2″ to 0·3″ diameter three months old (16th July 1937).

(E) Stumps 0·4″ to 0·5″ diameter nine months old (16th July 1937).

Species.	Locality.	Experiment number.	Year of formation.	Percentage survivals in January 1937.				Remarks.
				Sowings.	Small transplants.	Medium transplants.	Large transplants.	Large stumps.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)
Artocarpus hirsuta	Chandanathode	46	1934	26	33	55		72	
	Do.	67	1935	94	58	63		53	
	Kariamshola	60	1936	67	6	23		71	Large stumps best.
	Chandanathode	111	1937	7	15	37		84	
	Kariamshola	81	1937	47	0	26		93	
	Chandanathode	85	1936	34	5	26		8	
	Do.	115	1937	26	16	64		21	
Acrocarpus fraxinifolius	Kariamshola	83	1937	52	4	16		57	
	Chandanathode	49	1934	3	46	64		52	
Cedrela toona	Do.	69	1935	25	1	64		39	Trans-planting best although stumpings good.
	Do.	89	1936	10	73	45		17	
	Do.	56	1936	37	63	2		10	
	Kariamshola	115	1937	13	16	92		60	
	Chandanathode	47	1937	34	14	26		61	
Swietenia macrophylla	Kariamshola	32	1934	1	57	5		1	Trans-planting best.
	Chandanathode	68	1935	3	21	41		1	
	Kariamshola	45	1935	28	55	29		1	
	Chandanathode	86	1936	0	26	61		1	
	Kariamshola	59	1936	3	50	72		1	
	Chandanathode	116	1937	0	50	89		1	
	Kariamshola	84	1937	3		33		1	
	Chandanathode	48	1934	0	17	10		1	
Hopea parviflora	Kariamshola	113	1935	13	95	65		1	Trans-planting best.
	Chandanathode	82	1937	37	11	96		1	
	Kariamshola	90	1936	1	6	39		1	
Calophyllum elatum	Chandanathode	50	1936	0	64	40		1	Trans-planting best.
Mesua ferrea.	Do.	117	1937	0	33	53		1	
	Do.	87	1937	89	92	21		11	Sowing best.
Araucaria cunninghamii	Kariamshola	63	1936	44	1	1		1	
Artocarpus integrifolia	Chandanathode	112	1937	44	1	1		1	

371. *Transplanting under top canopy shade—Comparison of natural forest seedlings and nursery transplants* (vide paragraph 239)—

Karianshola Experimental Garden—Experiment No. 98.—*Species*—*Hopea parviflora*. *Arrangement*—ABC CBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—3′ × 1½′. *Soil preparation*—1′ cube pits. *Stock used*—(A) Nursery transplants 3″ high two months old, (B) forest transplants 4½″ high and (C) forest transplants 10½″ high. *Date of planting*—12th August 1937. *Treatment*—Kept clean weeded.

Measurements in January 1938 showed.

	A 3 inches nursery transplanting.	B 4½ inches forest transplants.	C 10½ inches forest transplants.
Survival percentage	22	12	5
Mean height in inches	3·0″	4·3″	10·8″

372. *Comparison of direct sowing, naked root transplanting and basket planting* (vide paragraph 240)—

Karianshola Experimental Garden—Experiment No. 33.—*Species*—*Dipterocarpus indicus*. *Arrangement*—AB BA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—3′ × 1½′. *Soil preparation*—1′ cube pits. *Stock used*—(A) two months old transplants 3·3″ high, (B) one month transplants were basketed on 29th July 1934 and when the baskets were planted the plants were 3·0″ high. *Date of transplanting*—17th August 1934. *Treatment*—Kept clean weeded.

Karianshola Experimental Garden—Experiment No. 73.—*Species*—*Vateria indica*. *Arrangement*—AB BA repeated eleven times in single lines of five plants (i.e., 55 plants per treatment). *Espacement*, etc., as above. *Stock used*—(A) Transplants 7½″ high four months old, (B) transplants 18½″ high four months old and (C) basketed plants 10″ high four months old. *Date of transplanting*—2nd October 1936.

Chandanathode Experimental Garden—Experiment No. 114.—*Species—Dysoxylum malabaricum*. *Arrangement*, etc., as above. *Stock used*—(A) Sowing three seeds per patch (8th August 1937), (B) transplants 7½″ high one year old (22nd July 1937) and (C) transplants 7½″ high one year old basketed on 21st July 1937 (1st September 1937).

Karianshola Experimental Garden—Experiment No. 85.—*Species*—*Gluta travancorica*. *Arrangement*, etc., as above. *Stock used*—(A) Transplants 7½″ high eighteen months old (6th August 1937), (B) Transplants 15″ high eighteen months old (6th August 1937), (C) transplants 30″ high eighteen months old (6th August 1937) and (D) transplants 8″ high eighteen months old, basketed on 12th June 1937 (6th August 1937).

Karianshola Experimental Garden—Experiment No. 102.—*Species*—*Vateria indica*. *Arrangement*, etc., as above. *Stock used*—(A) Sowing two seeds per patch (17th July 1937), (B) transplants 6″ high two months old (14th October 1937) and (C) transplants 6″ high two months old basketed one month old (14th October 1937).

Measurements in January 1938.

Species.	Experiment number.	Treatment.	Survival percentage.	Mean height in inches.
Dipterocarpus indicus	33	Basket planting	37	22·4
		Transplanting	15	20·2
Vateria indica	73	7½″ transplants	29	13·7
		18½″ ,,	40	15·2
		10″ basketed transplants	71	14·1
Dysoxylum malabaricum	114	Sowing.		
		7½″ transplants	2	4·0
		7½″ basketed transplants	26	5·4
Gluta travancorica ..	85	7½″ transplants	93	4·4
		15″ ,,	5	8·2
		30″ ,,	5	11·2
		8″ basketed plants	0	0
Vateria indica	102	Sowing	70	7·6
		6″ transplants	4	3·6
		6″ basketed plants	97	5·7
			97	6·6

373. *Comparison of stumps and cuttings from nursery transplants and natural forest trees* (under top canopy only) (vide paragraph 241)—

Chandanathode Experimental Garden—Experiment No. 130.—*Species—Cedrela toona*. *Arrangement*, etc., as above. *Stock used*—(A) Stumps from nursery seedlings one year old 0·3″/0·4″ diameter, (B) cuttings from nursery seedlings one year old 18″ long and 0·2″ to 0·3″ diameter and (C) cuttings from forest trees 18″ long and 0·3″ to 0·4″ diameter. *Date of planting*—1st July 1937.

Karianshola Experimental Garden—Experiment No. 99.—*Species*—*Cedrela toona*. *Arrangement*, etc., as above. *Stock used*—(A) Stumps from nursery seedlings one year old 0·4″ to 0·8″ diameter, (B) cuttings from nursery seedlings one year old 10″ long and 0·2″ to 0·5″ diameter and (C) cuttings from forest trees 10″ long and 0·3″ to 0·8″ diameter. *Date of planting*—11th August 1937.

Experiment.	Treatment.	Survival percentage.	Mean height in inches.
130	(A) Stumps	15	3·3
	(B) Nursery cuttings	2	9·5
	(C) Forest cuttings	0	0
99	(A) Stumps	29	6·8
	(B) Nursery cuttings	73	13·1
	(C) Forest cuttings	0	0

374. *Spike disease of sandal investigation—Movement of insects in sandal forests.* (Vide paragraph 251).

List of insects caught on sticky papers exposed at cage height in the Noganur Cage Plot between 1st to 26th October 1937.

Species or family.	Sticky papers exposed by the side of cage. No. 530.	No. 532.	No. 530.	No. 526.	No. 525.	Total.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Thysanoptera (adults)	383	123	76	10	382	983
Rhynchota (broken)	..	6	..	5	7	18
Membracidæ	2	..	2	1	..	1
Aphidæ (adults)	..	..	..	..	1	5
Psyllidæ	3	..	2	1	..	1
Jassidæ (nymph)	4	3	4	13	8	26
Idiocerus sp.	6	1	1	..	4	15
Bythoscopus indicus	..	..	..	..	..	7
Acropona sp.	3	3	..	..	1	1
Jassus indicus	1	1	..	1	4	11
Petalocephala nigrilinea	..	1	..	..	5	7
Moonia albimaculata	1	..	..	..	..	1
Neodartus sp.	1	..	..	..	1	2
Ledra sp.	..	..	..	..	..	1
Nirvana suturalis	6	1	..	..	2	[illegible]
Jassids (broken)	1	2	3	..	6	13
Fulgoridæ (nymphs)	..	..	..	4	..	10
Ricania sp.	3	..	..	1	2	3
Sarima sp. (nymphs)	1	..	..	..	..	3
Tambinia sp.	5	2	..	..	..	1
Pentatomidæ	1	..	..	1	3	11
Capsidæ	21	..	..	..	..	1
Coreidæ	3	..	..	..	..	21
Lygæidæ	..	1	..	..	2	5
Orthoptera	1	2	..	..	..	1
Forficulidæ	24	..	..	1	..	4
Blattidæ (A—n)	11	..	..	..	3	27
Acrididæ	7	..	2	..	..	18
Orthæris	..	..	..	..	..	7
Letana inflata	1	..	1	..	..	1
Gryllidæ	1	..	1	..	..	2
Mantidæ	..	11	..	..	..	1
Coleoptera (broken)	15	15	1	11	8	31
Coccinellidæ	1	3	7	6	48	91
Nitidulidæ	..	1	2	1	2	0
Cucujidæ	6	..	1	..	8	10
Anthicidæ	7	..	1	..	..	7
Tenebrionidæ	..	..	..	4	2	13
Cleridæ	3	4	..	..	1	1
Carabidæ	2	1	1	3	6	17
Elateridæ	..	2	..	..	1	4
Histeridæ	1	..	..	..	0	8
Melasidæ	..	3	2	..	8	11
Colydidæ	1	..	..	1	..	4
Bruchidæ	..	2	..	1	1	3
Scolytidæ	1	..	..	..	2	4
Curculionidæ	11	3	..	1	3	5
Chrysomelidæ	..	2	..	4	8	26
Cerambycidæ	1	..	..	..	1	3
Hispinæ	2	..	..	..	..	1
Staphylinidæ	18	10	1	3	2	8
Hymenoptera	53	36	4	2	..	34
Chalcidæ	35	3	29	15	52	185
Formicidæ (adults)	1	1	6	5	8	57
Braconidæ	10	..	..	1	6	0
Sphegidæ	1	..	..	..	4	14
Mutilidæ	18	1	..	..	..	1
Diptera	31	3	5	3	7	34
Culicinæ	1	..	1	4	6	45
Tipulidæ	1	..	..	..	..	1
Collembola	5	..	2	..	..	3
Moths	40	2	1	..	..	6
Spiders	..	..	4	15	5	66
[M]ites			..	..	F..	..
Total ..	754	247	160	127	1625	1,916

Spike disease of sandal investigations, movement of insects in sandal forests.

Insects caught on sticky papers exposed between 31st October to 16th November 1937 and 16th December 1937 to 16th January 1938, at Noganur Reserved Forests, North Salem.

Species.	369	62	15	702	222	868	Number.	532	31	540	524	525	Total.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Thysanoptera (adults)	71	57	75	126	62	83	392	356	101	178	83	222	1806
Rhynchota (broken)	4	1	..	1	..	..	1	7	1	1	3	1	20
Aphidae	1	..	..	2	..	1	2	7	4	3	7	..	27
Psyllidæ	..	..	..	..	..	2	1	..	..	1	..	2	4
Jassidæ (n and broken)	..	..	1	..	..	..	..	2	..	..	..	..	5
Jassidæ (not identified)	..	..	7	..	1	..	6	3	..	9	5	..	31
Kolla sp.	..	1	..	..	..	..	..	..	..	..	..	..	1
Nirvana pillida	1	..	..	1	4	..	..	2	1	1	1	..	10
Nirvana suturalis	..	1	..	..	..	..	..	..	..	..	4	3	2
Petalocephala nigrilinea	..	4	..	..	..	..	..	1	2	1	1	1	16
Jassus indicus	..	..	..	..	..	..	..	1	..	1	..	1	4
Drabescus sp.	..	..	..	..	..	..	..	1	..	..	..	..	1
Penthimia sp.	..	..	..	..	..	..	1	..	..	7	..	..	23
Idiocerus sp.	..	..	..	..	..	..	3	13	..	1	..	1	3
Neodartus accocephaloides	..	..	..	..	..	..	1	..	..	1	..	1	2
Bythoscopus sp.	..	..	..	..	..	..	..	..	..	..	..	..	1
Scaphoideus	..	..	..	..	..	..	..	1	..	..	1	..	5
Fulgoridæ (n and broken adults).	..	..	..	..	..	..	..	4	..	1	..	1	7
Pentatomidæ	1	..	..	..	..	..	2	2	..	..	1	1	11
Lygæidæ	..	1	1	..	2	..	2	2	1	..	..	..	1
Tingitidæ	..	..	1	..	..	..	..	..	..	..	..	..	3
Forficulidæ	..	1	..	..	..	..	..	2	..	..	..	4	9
Blattidæ	..	1	..	..	..	..	1	3	..	..	..	3	7
Acrididæ	..	..	1	..	..	..	1	2	..	..	..	..	1
Letana inflata	..	..	..	..	..	..	..	1	..	..	1	..	2
Tittigonidæ	..	..	..	..	..	..	..	1	..	..	..	..	1
Mantidæ	..	..	..	..	..	..	..	1	..	..	..	..	12
Coleoptera	2	..	1	1	..	..	4	2	2	..	..	2	2
Tenebrionidæ	..	..	..	..	..	..	..	..	..	13	6	5	49
Coccinellidæ	2	..	1	2	6	1	2	10	1	..	..	..	1
Nitidulidæ	..	..	..	..	..	..	..	1	..	..	..	..	5
Anthicidæ	..	1	..	..	1	..	..	3	..	..	..	..	2
Cleridæ	..	..	..	..	..	..	..	2	..	..	..	..	1
Carabidæ	1	..	..	..	..	..	..	..	..	..	..	4	7
Melasidæ	1	2	..	..	..	..	..	..	..	..	..	..	1
Colydidæ	..	..	..	..	..	..	..	1	..	..	..	1	1
Hydrophilidæ	..	..	..	..	..	..	..	..	..				

Insects caught on sticky papers exposed between 31st October to 16th November 1937 and 16th December 1937 to 16th January 1938 at Noganur Reserved Forests, North Salem—*cont.*

Species.	369	62	15	702	222	868	Number.	532	31	540	524	525	Total.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Bruchidæ	1	..	1	..	..	..	1	1	..	..	..	..	4
Scolytidæ	..	1	..	1	..	1	2	1	..	..	..	3	9
Curculionidæ	..	..	..	..	..	..	2	3	1	2	1	1	10
Chrysomelidæ	2	..	..	..	2	..	2	2	1	2	..	1	12
Staphylinidæ	..	..	..	1	..	..	1	2	..	1	..	..	5
Elateridæ	1	..	..	..	..	..	..	..	..	..	..	1	2
[illegible]	..	..	..	..	..	..	..	2	..	..	..	..	2
[illegible]	1	4	5	4	5	1	12	5	1	5	1	1	45
[illegible]	..	..	..	..	..	..	..	1	..	..	..	..	1
Cantharidæ	..	1	..	..	..	..	..	..	..	..	..	..	1
Hymenoptera (broken)	1	1	..	3	..	..	1	7	..	..	1	2	16
Chalcidæ	14	11	23	71	10	13	202	132	44	64	31	60	675
Formicidæ	..	2	3	..	..	..	2	6	3	..	3	..	19
Braconidæ	5	1	1	2	..	..	4	9	3	4	1	2	32
Sphegidæ	..	..	..	..	..	..	..	8	..	1	..	3	12
Ichneumonidæ	..	4	..	..	..	..	..	1	..	..	..	..	5
Apidæ	..	2	..	..	..	..	1	4	..	2	3	4	16
Diptera (broken, etc.)	21	2	9	11	2	1	15	23	6	23	4	19	139
Culicidæ	6	6	6	6	2	1	20	20	5	..	..	1	73
Asilidæ	..	..	..	1	..	..	..	..	..	..	..	..	1
Chrysopidæ	..	..	..	..	..	..	..	1	..	..	..	..	1
Moths	..	..	2	1	..	..	..	5	1	..	..	2	11
Spiders	3	1	..	1	..	1	..	7	..	4	3	..	21
Mites and ticks	..	..	..	..	..	1	..	..	..	..	..	..	1
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