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ANNUAL REPORT ON
SILVICULTURAL RESEARCH
IN THE MADRAS PRESIDENCY
FOR THE YEAR
1938-39

PART I

RESULTS—WORKING PLANS—
STATISTICS—STAFF

PART II

EXPERIMENTAL DATA

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RESULTS—WORKING PLANS—STATISTICS—STAFF.

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ANNUAL REPORT ON SILVICULTURAL RESEARCH IN THE MADRAS PRESIDENCY FOR THE YEAR 1938-39

PART I.

Results—Working Plans—Statistics—Staff.

I. RESULTS AND INDICATIONS.

(i) GENERAL.

As in previous years, a large amount of the work done this year has been small scale [Stage 1 (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 weightment tests.

The year has in general been one in which we have published information rather than undertaken many new lines of research. In the past eighteen months we have prepared for publication five pamphlets and eight Indian Forest Records.

It should also be noted that in the past two years we have had a number of visits by several officers of the Forest Research Institute, Dehra Dun. These visits together with visits of officers of this Presidency to Dehra Dun have been of the greatest value. They were not only very useful at the time but have resulted in a very much closer co-operation with the Forest Research Institute.

2. Some of the most important results obtained recently are the following :—

A. *Mixed deciduous forest of good quality.*

(i) Confirmation of our preliminary indications of the benefits obtained by burying teak stumps flush with the ground when planting them instead of leaving 1" of stem protruding above the ground (i.e., in the position that they occupied in the nursery). This result applies to pre-monsoon planting and not to monsoon planting.

(ii) Demonstration of the fact that the yield of teak stumps of the best size from a given quantity of seed falls off very considerably if the nursery beds are used year after year even if they are manured. This means that it is unlikely to be worth while to raise the teak stumps for the Presidency in a large central nursery.

B. The spike disease of sandal.

(i) In five cases of individual insect transmission cages we have succeeded in transmitting suspicious spike like symptoms to healthy plants. These suspicious symptoms are possibly due to a component of a complex virus and are the subject of intensive experiment.

(ii) The working of the spike control operations in the districts has been studied, the defects listed and the whole subject of control operations written up as an illustrated Indian Forest Record.

(iii) During the year the efficacy of the spike standing orders was well illustrated by the reporting in its initial stages of an outbreak of the disease in Tinnevely district. This is the first outbreak in this district and it is roughly 200 miles from the nearest known spike.

(iv) During the year Dr. Beeson, Forest Entomologist, Forest Research Institute, Dehra Dun, visited the spike research works and during his visit a general stock taking of the work was done which included a careful elimination of many insects and the preparation of a revised list of suspected insects. This list is now small.

(v) Confirmation of the inclusion of a number of the suspected insects by the use of sticky papers in diseased areas. The insect catches on these sticky papers have given us very valuable information.

(vi) Experiments have been started to test the efficacy or otherwise of electroculture in works connected with the disease.

C. Dry fuel forests.

(i) During the year tours of instruction for selected officers were carried out in several districts.

(ii) The whole subject of the regeneration of our dry fuel forests was written up and is being published as an illustrated Indian Forest Record.

(iii) Confirmation of the benefits of early sowing was obtained in an experiment done by the district staff at Ayyalur in Madura district.

D. Lantana areas.

Further progress was made in the eradication of *lantana* by spraying and poisoning and its replacement by such species as *Cassia siamea* and bamboos. In sandal areas these species make good hosts and in addition are profitable in themselves and quickly pay for their introduction.

E. Seed indents.

During the year the Provincial Silviculturist arranged for the collection and supply of 236 seed indents comprising 83 species and 12½ tons of seed, and 17 indents of 11 species totalling 125,000

seedlings and stumps. A large proportion of this stock was collected by the research staff in addition to their ordinary duties.

3. *Financial aspect of silvicultural research.*—In last year's report paragraphs 3 to 7 mention was made of a few examples of the financial benefits obtained in the past few years by silvicultural research.

The irrigated teak plantations at Mettupalayam are a further example worthy of mention.

These plantations have been made by using water from a hill stream to irrigate an area of scrub thorny fuel species. This area in the past has been worked on a 30-year rotation and the coupes fetched about Rs. 10 per acre, i.e., about 5 to 6 annas per acre per year.

The irrigated plantations are expensive and cost Rs. 60 to Rs. 70 per acre to raise but the 1932 plantation has already been cut for poles and fetched Rs. 173 per acre at 6 years old.

Thus an area that was producing a few annas per acre per year has been made to produce Rs. 17-8-0 per acre per year. It must of course be realized that such suitable areas are each small in extent but this is an item of local forestry that can be done in a number of places in the Presidency.

It is a good example of the fact so often forgotten in these present days of stringent economy of expenditure that in general in order to increase the nett revenue of a forest area, expenditure on that area must be increased and not decreased.

4. *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 302. 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.—

10.71 (inches of rain in the month)
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 (April 1st, 1938 to June 1st, 1939) covers all the 1938 experiments. The rainfall is totalled for the year April 1st, 1938 to April 1st, 1939, as this period covers most measurements and is to be compared with the average annual rainfall given in the last column.

(ii) NATURAL REGENERATION.

5. *By seed—Attempts to induce natural regeneration under mother trees—Hopea parviflora.*—In Experimental plot 54, 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 six 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.

6. *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 six years ago.

7. *Mesua ferrea*.—Experimental plot 23, Wynad division, and 55, South Coimbatore division, are similar experiments with *Mesua*. Seed fall with this species has been very slight during the last six years but the treatment has shown no beneficial or deleterious effects.

8. *Dysoxylum malabaricum*.—Experimental plot 23, Wynad division, is a similar plot with *Dysoxylum malabaricum*. There has been very little seed fall during the last six years but the treatment has shown no beneficial or deleterious effect.

9. *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, was started in which burning before and after the seed fall has been added to the above treatments.

Enumerations at the end of February 1938 and 1939 show that burning either before or after seed fall is deleterious.

10. 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. In the first year of the experiment the trees produced a normal quantity of normal seed and this seed germinated and produced seedlings a normal number of which survived the hot weather (162 per tree average).

In order to confirm this normality before proceeding further all this regeneration was pulled up. In the second year the trees flowered fruited and seeded normally again and produced 284 seedlings per tree.

It remains to be seen what happens to this regeneration.

11. *Canopy manipulation over natural regeneration Hopea parviflora*.—Experimental plots 37, 38 and 39, South Coimbatore division, were opened in 1931 in Karian shola to study the effect of canopy manipulation on natural regeneration of *Hopea parviflora* 5'-10' 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 eight years the plots have been open the treatments have shown the following average annual height increment (A) 14.8", (B) 8.4" and (C) 7.7".

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 a fair girth increment but have suffered from bark stripping by deer.

Experimental plots 42 and 43, South Coimbatore division, were opened in 1932 in Karian shola to study the effect of canopy manipulation on established 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 has shown the following average annual percentage increase in the indicator plots :—

	PER CENT.
A-1. Top canopy fenced	177
A-2. Top canopy unfenced	133
B. Full evergreen shade unfenced control	8

In the whole of the plots—and they total 2.7 acres—the established regeneration has shown the following average annual percentage increase :—

	PER CENT.
A. Top canopy only (unfenced)	191
B. Full evergreen shade (control)	29

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

In order to continue this investigation two more sets of plots were opened last year. In the first set (Experimental plots 75 and 76, South Coimbatore division) the progress of established regeneration of *Hopea parviflora* 3' to 8' high is observed under the conditions of (a) clear-felling and (b) top canopy cover.

During the year these plots have shown an average height increment per tree of (a) 1.3' and (b) 0.9'. Thus the beneficial effect of opening the canopy has shown itself even in the first year after the operation.

In the second set (Experimental plots 72, 73 and 74 of South Coimbatore division) opened last year the progress of established regeneration of *Hopea parviflora* 3' to 10' high is observed under the conditions of (a) clear-felling, (b) top canopy and (c) full evergreen cover control. In this set of plots the effect of the three treatments on the unestablished regeneration on the ground is also being watched.

At the end of the first year, the established regeneration has shown a height increment per plant of (a) + 0.46', (b) + 0.41' and (c) + 0.13' while the recruitment to the class of regeneration

3' high has been (a) 36 per cent, (b) 24 per cent and (c) 1 per cent. The small regeneration on the ground has so far not moved at all.

12. *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' to 10' 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 have showed an average annual height increment of (A) 10.2" and (B) 5.3" but the small regeneration on the ground is not quite as good as it was in either plot.

Experimental plots 3 and 4 of Wynad division, were opened in 1932 and two treatments applied (A) cutting undergrowth and (B) control. They show an average annual height increment of (A) 6.1" and (B) 1.3". The state of small regeneration on the ground has not moved.

Experimental plots 5 and 6 of Wynad division were similarly opened in 1932. In these two experiments the treated and control plots have shown movements very similar indeed to those of Experiments 3 and 4 mentioned above.

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'-10' high.

13. *Palaequium ellipticum*.—During last year a set of plots in Palghat division (Experimental plots 163, 164 and 165) were opened to determine the effect of various shade conditions on established regeneration 4' to 6' 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.

Measurements at the end of the first year show that the treatments have produced height increments per tree of (a) 1.24', (b) 0.90' and (c) 0.71'. The young regeneration on the ground has definitely increased in treatments (a) and (b) and has remained stationary in (c). We therefore have the indication that the opening has been beneficial but this remains to be confirmed.

14. *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 had 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 three 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' high) has increased by 417 per cent while the total number of seedlings has decreased due to early dying back of younger seedlings by only 18 per cent. The treatment of opening the canopy by 30 per cent to 50 per cent has thus been markedly successful in the first three years. We must however continue to observe the experiment until it has passed through two consecutive climatically normal years.

15. *By coppice*.—In Experimental plot No. 11 of Chittoor division, three species (*Acacia sundra*, *Albizia 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 was not available and it was considered best to get more reliable results with fewer treatments.

Measurements 4½ 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.
<i>Acacia sundra</i>	5	13	13
<i>Albizia amara</i>	5	12	8
<i>Azadirachta indica</i>	6	9	Treatment omitted owing to insufficient number of stools.
Average for all three species.	5	11	11

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 (1,224 stools) the ordinary operation of coppicing has caused 9 per cent mortality.

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 18 months.

16. A further experiment in this subject was started during the year to determine the mortality of stools in ordinary district work. A coupe of 96 acres at Bennari in Coimbatore North division was completely enumerated before felling. It has been felled by the district and the stools (15,500 in number and of 33 species) are being observed.

17. *Teak coppice—Mortality of stools.*—Last 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" to 12" above the ground stools not trimmed and (D) high cutting 9" to 12" 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 1939 showed that mortality of stools had up to then been negligible [(A) 1.3 per cent, (B) 0.8 per cent, (C) 1.7 per cent and (D) 1.7 per cent] and coppice shoots averaged 11 feet in height.

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 shoot shoots from ground level but a few feeble shoots appear from the cut edge but these die off in the first few months.

18. *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 18 months old and consisted of four treatments,

- (A) reduction to 1 shoot per stool,
- (B) reduction to 2 shoots per stool,
- (C) reduction to 4 shoots per stool and
- (D) control, unthinned.

It was found that 18 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 4 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, 4 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 6 years old. It however remains to be seen which treatment will give the greatest money yield at the end of the rotation (30 years):—

Treatment.	Number of shoots per stool left.	Type of shoots considered.	Number of stems.	Average height in feet.	Average diameter in inches.
A	1	Biggest	35	21.6	3.4
B	2	Biggest	34	23.4	3.4
		Second	..	..	..
		Biggest	34	16.9	2.5
C	4	Biggest	33	24.8	3.5
		Second	..	..	..
		Biggest	33	16.8	2.3
		Remainder.	62	14.9	2.1
D	Unthinned	Biggest	33	25.8	3.9
		Second	..	..	..
		Biggest	33	20.2	2.7
		Remainder.	155	11.7	1.9

19. *Coppicing of Santalum album.*—An experiment by the District Forest Officer, Vellore West division, is in progress in which observations are being made on the coppicing of sandal of different sizes. The experiment is only in its initial stages but so far appears to indicate that the bigger girth classes only coppice to a poor extent.

20. *Natural regeneration by root suckers.*—The District Forest Officer, Anantapur, reports the inducing of profuse natural regeneration by root suckers by wounding the soil and the roots round the tree. The species dealt with were *Azadirachta indica*, *Pongamia glabra* and *Dalbergia sisoo*.

(iii) SEED.

21. *Seed pre-treatment.*—Routine seed pre-treatment tests were made with 54 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.

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

<i>Acacia ferruginea.</i>	<i>Bauhinia purpurea.</i>
<i>Acacia leucophloea.</i>	<i>Bauhinia racemosa.</i>
<i>Acacia melanoxylon.</i>	<i>Berberis tinctoria.</i>
<i>Acacia planifrons.</i>	<i>Calophyllum elatum.</i>
<i>Acacia eundra.</i>	<i>Casia auriculata.</i>
<i>Acrocarpus fraxinifolius.</i>	<i>Cassia fistula.</i>
<i>Albizia amara.</i>	<i>Cassia marginata.</i>
<i>Albizia lebbek.</i>	<i>Cassia siamea.</i>
<i>Anacardium occidentale.</i>	<i>Chlorophora excelsa.</i>
<i>Azadirachta indica.</i>	<i>Chloroxylon swietenia.</i>
<i>Balanocarpus utilis.</i>	<i>Chorisia speciosa.</i>

<i>Cupressus torulosa.</i>	<i>Michelia neilgherrense.</i>
<i>Dalbergia latifolia.</i>	<i>Neolitsea zeylanica.</i>
<i>Dalbergia sissooides.</i>	<i>Pithecolobium dulce.</i>
<i>Dendrocalamus strictus.</i>	<i>Pongamia glabra.</i>
<i>Dolichandrone crista.</i>	<i>Prosopis juliflora.</i>
<i>Dolichandrone falcata.</i>	<i>Pterocarpus dalbergioides.</i>
<i>Eleocarpus oblongus.</i>	<i>Pterocarpus marsupium.</i>
<i>Eugenia arnottiana.</i>	<i>Quercus incana.</i>
<i>Evodia roxburghiana.</i>	<i>Sapindus emarginatus.</i>
<i>Feronia elephantum.</i>	<i>Schleichera trijuga.</i>
<i>Glochidion neilgherrense.</i>	<i>Soymida febrifuga.</i>
<i>Ghuta travancorica.</i>	<i>Tectona grandis.</i>
<i>Gmelina arborea.</i>	<i>Terminalia chebula.</i>
<i>Hakea saligna.</i>	<i>Terminalia crenulata.</i>
<i>Harrisonia bennettii.</i>	<i>Terminalia paniculata.</i>
<i>Lagerstroemia lanceolata.</i>	<i>Trema orientalis.</i>
<i>Ligustrum neilgherrense.</i>	<i>Vateria indica.</i>
<i>Litsea zeylanica.</i>	<i>Vitex peduncularis.</i>
<i>Mahonia leschenaultii.</i>	<i>Wrightia tinctoria.</i>
<i>Markhamia platycalyx.</i>	<i>Zizyphus incurva.</i>
<i>Meliosma wightii.</i>	

22. Treatment with boiling water (water 20 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 cyanophylla*, *Acacia dealbata*, *Acacia decurrens*, *Acacia mollissima* and *Myrsine wightiana*.

23. Soaking in hot water (as hot as the hand can bear) increased the germination of *Juniperus procera*, *Leucaena glauca* and *Strychnos nux vomica*.

24. Soaking in cold water for 24 hours was beneficial in the case of *Palaquium ellipticum*, *Pinus longifolia*, *Pinus insignis*, *Pterocarpus santalinus*, *Vitex littoralis*, *Xylia xylocarpa* and *Zizyphus jujuba*.

The results of pre-treatment tests are summarized in paragraph 304. 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 years' tests are included.

25. *Seed pre-treatment—Obdurate species.*—Eight 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 24 hours, (C) soaking in cold water for 48 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.
<i>Acacia auriculiformis</i>	21	9	X	9	X	6	9
<i>Acacia leucophloea</i>	32	15	X	15	..	16	10
<i>Acrocarpus fraxinifolius</i>	24	11	1	9	X	X	6
<i>Cassia auriculata</i>	10	7	X	8	X	25	7
<i>Cassia fistula</i>	32	15	9	11	..	37	10
<i>Cassia marginata</i>	11	22	13	10	..	36	X
<i>Erythroxylon monogynum</i>	2	4	X	2	X	1	2
<i>Pterocarpus santalinus</i>	32	29	X	25	2	11	13
<i>Terminalia chebula</i>	32	18	9	37	16	6	14
<i>Trema orientalis</i>	2	73	X	X	2	X	X

NOTE.—X test not done.

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*.

26. *Seed—Seasonal collection within the fruiting season.*—Tests were made of seed collected at fortnightly intervals throughout the fruiting season of 10 species, *Acacia leucophloea*, *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.

27. *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 $\frac{1}{8}$ inch and (iii) on its side but well covered with $\frac{1}{2}$ inch of soil. Including previous years' results the average germination of 30 tests is (i) 4 per cent, (ii) 12 per cent, (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.

28. *Seed, locality test—Santalum album.*—Sandal seed was collected from both the spring and autumn crops from five localities, Coorg, Javadi, North Coimbatore division, North Salem division and the Nilgiris.

The spring crop seed (collected in March) was found considerably better in germinative capacity than autumn seed (collected in November). In both the spring and autumn crops, the seed from Coorg, North Salem division and the Javadi gave a much better germination than that from the Nilgiris and North Coimbatore divisions.

The seed was tested by monthly sowings and both autumn and spring crops kept equally well in air-tight tins or in gunny bags. The 1936 crops kept quite well for two years and still gave 75 per cent of the original germination.

29. *Weathering of seed—Teak.*—For the third year, experiments were carried out at three centres in the weathering of teak seed. At each centre 10 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.

30. *Removal of seed coat—Pterocarpus santalinus.*—The removal of the outer seed coat in this year's test was found to increase the germination only slightly and not greatly as has been found previously.

31. *Passage through goats—Acacia arabica.*—Passing *Acacia arabica* seed through goats was tried at two centres. The "goat" seed was found to germinate much quicker but the final resulting germinative capacity was found to be much the same as that of the control seed.

32. *Passage through birds—Azadirachta indica.*—In the annual report for 1936-37, paragraph 139, it was noted that in Madura district they were getting excellent results in their rab work with *Azadirachta indica* seeds that had been passed through birds (crows and pigeons).

In order to test whether this increased germination was due to mere depulping or to passing through the birds, tests were done at two centres.

These two tests both showed that the removal of the pulp very greatly increased germination but whereas in one set of tests the "bird" seed was very much better than the depulped seed, in the other set of tests results were much the same.

Results were—

	Seed with pulp.	Seed without pulp.	Seed passed through birds.
Germination per cent ..	4	11	66
	34	87	89
Average ..	19	49	78

It appears therefore that it is very beneficial to remove the pulp of *Azadirachta indica* seed before sowing.

33. *Covering test—Gluta travancorica.*—Covering the bed of this species with straw after sowing the seed was found to increase the germination per cent from 32 per cent (Control) to 49 per cent (straw covered).

34. *Seed storage.*—Routine storage tests were made with 38 species with different methods of storage. Results showing the lengths of time that seed of different species remains fertile are given

in the table in paragraph 305 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.

35. *Seed weighments.*—Routine seed weighments, germination tests, etc. were carried out. The results are given in paragraph 303 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).

36. *Supplies of seeds, seedlings and stumps.*—As usual the Provincial Silviculturist was in charge of the supplies of seed, seedlings, stumps, etc. of the Presidency. The extent of this routine item of work is not generally appreciated.

During the year arrangements were made for the supply of 236 indents comprising 83 species and 12½ tons of seed and 17 indents of 11 species totalling 125,000 seedlings and stumps. The largest proportion of this stock was collected by the research staff in addition to their ordinary duties.

During the past three years we have been endeavouring to standardise indents in order to reduce the office work, etc., to a minimum and to ensure that supplies are made with the greatest efficiency. The Chief Conservator of Forests has from time to time issued orders on seed supplies and it is here brought to notice that non-adherence to these instructions causes considerable increase in the office work of this division and delays and difficulties in making supplies.

37. The main items which are essential in making indents are—

- indents should be sent in good time (i.e., before 30th November);
- all species should be referred to by their botanical names and under no circumstances by their local names;
- indents should be expressed in lb. and not in indeterminate quantities such as bags, etc.

These points are brought to notice as this office has to know what seed is available, where and when it is available, and how much is required to be collected. The seeding season of the same species often varies considerably from year to year and indents often have to be spread over a number of districts.

A scrutiny of the indents received during the past four years reveals that an appreciable proportion were due to lack of foresight by the district officers concerned and could have been avoided.

38. For the benefit of indenting officers it is again brought to notice that up to date details with regard to seed weights, storage, germinative capacity, etc. of species in common use are recorded year by year in this report.

39. *Sorting seed according to size—Teak.*—The five years investigation on the effect on germination of the sorting of teak seed by size has been concluded. The averages of these 15 tests which were spread over three centres during a period of five years are given below. Each test consisted of 10 randomised sets of 100 seeds each for each of the four kinds of seed. The tests thus represent 60,000 seeds.

District sample.	Average germination percentage		
	Selected biggest.	Selected medium.	Selected smallest.
44	48	46	29

The above figures show that the selection of teak seed by size so far as germination is concerned is not economically justified.

40. In order to determine whether such a selection of seed by size has any effect on later growth and development and particularly whether it would result in the breeding of any particular strains of teak, three large scale planting out experiments have been started. Each of these experiments consists of a latin square of 16 sub plots, each sub plot being 10 × 10 stakes at 6' × 6' espacement. They were raised by stump planting following normal district practice.

Measurements in January 1939 at the end of the first growing season after planting show the following :—

Survival percentage.

District.	Experimental plot number.	District sample.	Selected biggest.	Selected medium.	Selected smallest.
Wynad	55	99	99	98	100
Palghat	166	99	95	100	98
Coimbatore South ..	80	97	97	94	97
Average ..		98	97	97	98

Mean height in feet.

Wynad	55	1.17	0.84	0.89	1.05
Palghat	166	2.36	2.07	2.06	2.37
Coimbatore South ..	80	1.60	1.66	1.57	1.49
Average ..		1.71	1.52	1.51	1.64

The above plots are being kept under careful observation.

41. *The effect of the size, age and condition of seed bearers on germination.*—The investigation in this subject which has been going on during the past five years is now concluded. Seed for test was collected from seed bearers of the following classes (A) old hollow over-mature trees of 13' to 15' girth, (B) well-grown trees approaching maturity 4½' to 6' girth and (C) small immature trees

below 3' girth. Tests were done at each of three centres and at each centre each year seed was collected from 10 seed bearers of each class, the seed was well mixed and random samples taken and tested. Each test was of 10 sets of 100 seeds each.

The averaged figures given below thus represent 15,000 seeds for each species :—

Species.	Germination percentage of seed from.		
	Overmature.	Mature.	Undermature
<i>Tectona grandis</i>	41	37	32
<i>Dalbergia latifolia</i>	25	24	23
<i>Pterocarpus marsupium</i>	50	53	42
<i>Terminalia cremulata</i>	24	27	33

The above figures afford strong evidence that so far as germination is concerned seed from both overmature and undermature 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 large scale long term planting out experiments have been started for each species in each of three centres by stump planting.

In particular, we wish to find out whether by this sorting of seed according to seed bearers we breed particular strains in each species (e.g., we might be segregating undesirable characters like the early flowering of teak).

42. The results so far of these long term plants are given below species by species :—

Teak.

Experiment.	Year of experiment.	Survival percentage.			Mean height in feet.		
		Over-mature.	Mature.	Under-mature.	Over-mature.	Mature.	Under-mature.
Wynad Experimental Plot 35 ..	1937	99	99	95	6.65	6.15	5.77
Palghat Experimental Plot 155 ..	1936	90	94	87	13.67	12.68	15.50
South Coimbatore Experimental Plot 81 ..	1938	90	97	93	1.57	1.58	1.23
Average ..		93	97	92	7.26	6.79	7.50

(For full experimental data see paragraph 306.)

Dalbergia latifolia.

Experiment.	Year of experiment.	Survival percentage.			Mean height in feet.		
		Over-mature.	Mature.	Under-mature.	Over-mature.	Mature.	Under-mature.
Wynad Experimental Plot 36 ..	1937	100	99	97	1.81	2.11	1.95
Palghat Experimental Plot 157 ..	1936	82	85	85	6.43	5.72	4.02
South Coimbatore Experimental Plot 78 ..	1938	71	97	96	1.25	1.21	1.20
Average ..		84	94	93	3.16	3.01	2.76

(For full experimental data see paragraph 307.)

Pterocarpus marsupium.

Experiment.	Year of experiment.	Survival percentage.			Mean height in feet.		
		Over-mature.	Mature.	Under-mature.	Over-mature.	Mature.	Under-mature.
Wynad Experimental Plot 81	1936	97	99	98	7.27	6.77	6.72
Palghat Experimental Plot 156	1936	80	88	88	11.70	12.25	11.38
South Coimbatore Experimental Plot 77	1938	87	91	89	6.45	6.69	6.62
Average ..	..	88	93	92	6.47	6.57	6.24

(For full experimental data see paragraph 308.)

Terminalia crenulata.

Experiment.	Year of experiment.	Survival percentage.			Mean height in feet.		
		Over-mature.	Mature.	Under-mature.	Over-mature.	Mature.	Under-mature.
Wynad Experimental Plot 87	1937	93	95	92	5.97	5.71	5.47
Palghat Experimental Plot 158	1936	97	98	88	16.42	15.37	15.35
South Coimbatore Experimental Plot 79	1938	90	89	77	2.57	2.33	2.39
Average ..	..	93	94	86	8.32	7.80	7.74

(For full experimental data see paragraph 309.)

43. *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 five 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 originally approximately 520 plants at 6' × 6' espacement and there are four blocks to each origin.

During 1937 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 was similarly treated last year. It is at present still rather behind the rest.

The South Coimbatore plot has four origins, Nilambur, Anamalais, Mysore and South Burma, and consists of 4.0 acres in 16 randomised blocks, four per origin. During the year sample plots were laid out in all the sub-plots and they were all given a 50 per cent thinning.

We thus now have 40 sample plots covering over 14 acres and six seed origins. As the two experiments are properly randomised, in the course of time we shall be able to collect comparable growth data.

(iv) NURSERY WORK.

44. *Effect of shade on germination (dry fuel forests).*—Previous years experiments were repeated at Emmanur Experimental Garden with 23 species. With 13 of these species the shade had no effect on germination, with nine species it was increased by shade and one species definitely did better in the open.

The species were —

- (a) Preferring the open—*Acacia planifrons*.
- (b) Preferring the shade—*Acacia auriculiformis*, *Acacia sundra*, *Albizia lebbek*, *Azadirachta indica*, *Cassia marginata*, *Cassia siamea*, *Chloroxylon swietenia*, *Santalum album* and *Canthium didymum*.
- (c) Indifferent to the shade or open conditions—*Acacia ferruginea*, *Acacia leucophloea*, *Albizia amara*, *Bauhinia purpurea*, *Cassia auriculata*, *Cassia fistula*, *Dolichandrone crista*, *Dolichandrone falcata*, *Markhamia platycalyx*, *Pterocarpus santalinus*, *Tamarindus indica*, *Terminalia chebula*, *Prosopis spicigera*.

These results in combination with the results of the past four years show that in general with most of our dry district species germination is not affected by shading the seed patches after sowing.

(NOTE.—This refers to germination only and not to subsequent survivals.)

45. *Effect of shade and shelter on germination survival and growth in nursery beds.*—*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, (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) 53 per cent, (B) 50 per cent, (C) 69 per cent and (D) 61 per cent.

The above figures include the results of previous years and total 16 tests.

46. 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, (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 1938 to late May 1939.

Treatment.	Hopea parviflora.		Cedrela toona.		Dysoxylum malabaricum.	
	Morta- lity.	Height incre- ment.	Morta- lity.	Height incre- ment.	Morta- lity.	Height incre- ment.
	PER CENT.	INCHES.	PER CENT.	INCHES.	PER CENT.	INCHES.
(A) Open	68	1.53	80	4.54	70	4.49
(B) 50 per cent shade	30	1.76	52	4.68	26	4.79
(C) 100 per cent shade	32	1.76	52	5.11	31	5.46

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

(Chandanathode Experimental Garden experiments 160 to 162.)

47. *Nursery watering experiment.*—Experiments were repeated 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. Four species were experimented with *Albizia amara*, *Azadirachta indica*, *Acacia planifrons* 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' × 4'.

Results including those of previous years are —

Species.	Treatment.	A	B	C
		10 gallons daily.	10 gallons on alter- nate days.	5 gallons on alter- nate days.
<i>Albizia amara</i>	Germination per cent	38	34	31
	Mean height in inches in Febru- ary	15	11	11
<i>Azadirachta indica</i>	Germination per cent	11	11	11
	Mean height in inches in Feb- ruary	10	10	16
<i>Prosopis juliflora</i>	Germination per cent	23	20	23
	Mean height in inches in Feb- ruary	24	22	20
<i>Acacia planifrons</i>	Germination per cent	72	58	52
	Mean height in inches in Feb- ruary	18	15	15

The above figures show that within the range of these experi-ments, watering has comparatively little effect on germination but that after germination *Albizia amara* does best with a lot of water, but *Azadirachta indica*, *Acacia planifrons* and *Prosopis juliflora* will do as well with much less watering.

48. *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 16 standard beds each 40' × 4' which were 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, (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 Begur, Dhoni and Topslip in 1936.

49. At the end of the first year the average outturn of stumps per standard 40' × 4' bed sown with 40 lb. of seed for all experi-ments taken together was as follows :—

Number of usable stumps 0.3" to 0.8" diameter.	Average diameter of usable stumps. INCH.	Percentage of stumps usable. PER CENT.	Number of un- usable stumps less than 0.3" diameter.
1,688	0.42	42	2,398

The above average figures representing the sowing of 2,560 lb. of seeds 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 produced enough stumps of the best size to plant up one acre of plantation at 6' × 6' space-ment and still left a reserve for casualty replacement. *It is parti-cularly to be noted that at the end of one year only 42 per cent of the stumps produced were of the best size.*

50. The results up to the end of the third year are best seen in the following tables in which the stump production per standard bed is averaged for all 4 experiments :—

Number of usable (0.3" to 0.8" diameter) stumps per standard bed—

	A	B	C	D
First year ..	1,688	1,688	1,688	1,688
Second year ..	935	..	..	1,101
Third year ..	943	1,092	1,351	1,145

Average diameter of usable stumps produced (in inches)—

	A	B	C	D
First year ..	0.42	0.42	0.42	0.42
Second year ..	0.41	..	..	0.44
Third year ..	0.40	0.40	0.41	0.41

51. The detailed results of stump production at the end of the third year in each of the experiments was as follows:—

Number of usable stumps per standard bed—

Date.	Centre.	A	B	C	D
April 1938 ..	Nilambur ..	925	1,708	2,035	1,509
April 1939 ..	Begur ..	748	835	1,060	793
April 1939 ..	Dhoni ..	1,475	1,368	1,417	1,333
April 1939 ..	Topslip ..	624	458	892	944
	Average ..	943	1,902	1,351	1,145

Average diameter of usable stumps produced (in inches)—

Date.	Centre.	A	B	C	D
April 1938 ..	Nilambur ..	0.43	0.44	0.47	0.44
April 1939 ..	Begur ..	0.37	0.39	0.38	0.38
April 1939 ..	Dhoni ..	0.42	0.40	0.40	0.44
April 1939 ..	Topslip ..	0.38	0.37	0.38	0.38
	Average ..	0.40	0.40	0.41	0.41

52. It is thus seen that after three years the stump production per standard bed for these four treatments has fallen to (A) 56 per cent, (B) 65 per cent, (C) 80 per cent, (D) 68 per cent, in spite of the remedial measures of fallowing, green manuring and artificial manuring in the treatment B, C and D. It is to be noted that the average diameter of usable stumps produced has also fallen off in all four treatments.

It thus appears (as a preliminary indication) that the much talked of raising of teak stumps for the Presidency in a large central nursery is unlikely to be a means of cheapening teak stump production. The above figures show that using the same nursery year after year causes a considerable falling off in production of stumps both in size and number for the same quantity of seed even if expensive manuring is resorted to.

53. The Nilambur experiment has now reached the end of its fourth year and the results of these four 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
First year ..	1,353	1,353	1,353	1,353
Second year ..	2,456	..	..	2,593
Third year ..	925	1,708	2,035	1,509
Fourth year ..	659	..	..	621

Average diameter of usable stumps produced (in inches).—

	A	B	C	D
First year ..	0.43	0.43	0.43	0.43
Second year ..	0.43	..	..	0.42
Third year ..	0.43	0.44	0.47	0.44
Fourth year ..	0.42	..	..	0.41

The preliminary indication is therefore that it is not advisable to use the same nursery beds year after year as even with manuring in some form, apart from the liability of pests (such as cock chafer) to come in, production very definitely falls off.

In the course of the next few years of this set of experiments much more evidence will be obtained.

(Nilambur division Experimental plot 136; Wynad division Experimental plot 34; Palghat division Experimental plot 152; South Coimbatore division Experimental plot 68.)

54. *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 per 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.

55. 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 4" × 4", (C) sowing seed at 40 lb. per standard bed and (D) sowing seed at 20 lb. per bed. Each treatment consisted of 4 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 has been repeated in 1936, 1937 and 1938. The results of the 1938 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	1,492	779	1,835	2,138	6,181
Dhoni	679	518	732	702	4,603
Topslip	1,611	1,044	1,353	1,155	1,558
Average	1,261	780	1,307	1,332	4,081
Average number of unusable stumps below 0.3" diameter	4,854	727	4,223	2,394	†2,469

* In 7 standard beds or 583 per bed.

† In 7 standard beds or 353 per bed.

Average diameter of usable stumps per treatment (in inches).—

Locality.	Number of usable stumps per treatment.				
	A	B	C	D	E
Begur	0.38	0.44	0.35	0.39	0.46
Dhoni	0.40	0.45	0.40	0.41	0.40
Topslip	0.45	0.48	0.46	0.47	0.46
Average	0.41	0.46	0.40	0.42	0.44

56. The results of the last four 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
1938	1,261	780	1,307	1,332	4,081
1937	1,610	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 12 experiments over 4 years at 3 centres. .. .	1,702	989	1,532	1,530	*4,816

* In 7 standard beds or 688 per bed.

Year of experiment.	Average diameter of usable stumps per treatment in inches.				
	A	B	C	D	E
1938	0.41	0.46	0.40	0.42	0.44
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 12 experiments over 4 years at 3 centres. .. .	0.44	0.46	0.43	0.45	0.45

Year of experiment.	Average number of unusable stumps per treatment.				
	A	B	C	D	E
1938	4,854	727	4,223	2,394	2,469
1937	1,917	579	1,474	1,457	1,408
1936	3,333	277	2,536	1,268	869
1935	3,031	670	2,687	1,550	1,635
Average of 12 experiments over 4 years at 3 centres. .. .	3,284	563	2,730	1,667	* 1,595

* In 7 standard beds or 228 per bed.

57. Thus (i) the average diameter of usable stumps produced was practically the same with all treatments. (ii) In Treatment 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 40 to 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.

*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 substantively confirm the work which has previously been done in this subject :—

Begur Experimental Garden Experiment ..	111
Dhoni Experimental Garden Experiment ..	166
Topslip Experimental Garden Experiment ..	183

58. *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 really suitable size (0.3" to 0.8" diameter). It has also been demonstrated (vide the Annual Report for 1935-36, paragraph 45), 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 under-sized plants should be put back again and allowed to grow for the second year.

59. Experiments have been done during the past three years at 3 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 under-sized 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 1938 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.
			INCHES.	
Begur	500	180	0.46	36
Dhoni	500	327	0.52	65
Topslip	500	314	0.54	63
Average ..	500	274	0.51	55

(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.
			INCHES.	
Begur	500	208	0.47	42
Dhoni	500	298	0.55	60
Topslip	500	435	0.53	87
Average ..	500	314	0.52	63

The results of the past three 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.
1938	55	0.51	63	0.53
1937	39	0.48	54	0.55
1936	48	0.52	65	0.49
Average ..	47	0.50	61	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 material at the end of the first year, only 20 per cent is eventually wasted.

60. These usable stumps obtained from material normally wasted have been planted out for the last two years 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	99	83	97
Dhoni	88	93	99
Topslip	84	94	97
Average ..	90	91	98
Average of 1937 experiments ..	88	90	98
Average of 1937 and 1938 experiments ..	89	91	96

Mean height growth in inches.

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	26.6	22.1	19.0
Dhoni	18.6	20.7	18.8
Topslip	22.5	26.8	26.2
Average ..	21.9	23.2	21.3
Average of 1937 experiments ..	33.9	40.0	41.5
Average of 1937 and 1938 experiments ..	27.9	31.6	31.4

It is thus seen that putting undersized seedlings 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 five 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 stumps 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.*

61. *Development of artificial regeneration ingaps.*—Gap regeneration in this type of forest until comparatively recently was being fairly extensively practised. The idea underlying this method of regeneration was that such gaps could be left to themselves after they had been regenerated, and intensively tended for two years. To determine whether this really was the case or not, in September 1935, two experiments (Experimental plot 64, South Coimbatore division, and Experimental plot 28, Wynad division) were started in which 10 to 15 typical gaps of 1933, regenerated with teak and tended by the districts concerned were taken 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 25 plants at 6' × 6' espacement if fully stocked. Each gap will be successful if ultimately one good tree in it comes to maturity and

therefore the best tree per gap is considered. The average heights of the best tree in each gap were as follows :—

			Three years increment.
<i>Wynad division.</i>			
		FT.	FT.
January 1936 at 3 years old	..	12.1	10.2
January 1939 at 6 years old	...	22.3	
<i>Coimbatore South division.</i>			
January 1936 at 3 years old	..	3.1	2.7
January 1939 at 6 years old	..	5.8	

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

62. During the year a further experiment in this subject (Wynad Experimental plot 58) was taken over from the district. In this experiment gaps planted in 1935 were intensively tended for two years and then left to themselves. Half of the gaps were at 3' × 3' espacement and the other half at 6' × 6' espacement.

The average height of the best plant per gap after four growing seasons is (A) 3' × 3'—17.7'; (B) 6' × 6'—16.0'.

The plants in the gaps are struggling against the ravages of elephant, bison, deer, lantana and bamboo.

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.

63. In consequence of this failure an investigation was started in 1937 to try and raise a valuable crop under the canopy of the comparatively worthless crop.

In Experimental plot 39, Wynad division at Begur, an area definitely not fit for teak, was selected and the undergrowth up to 20 feet felled and burned. Attempts to regenerate it with a different species by various methods were made. At the end of the second 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 and the progress they have made so far is seen in the following table :—

Species.	Undergrowth up to 20 feet cut and burned.		Ground fire only.	
	Survival, per cent.	Mean height in inches.	Survival, per cent.	Mean height in inches.
1 <i>Lagerstroemia flos reginas</i> , sowing ..	87	4.1	97	5.8
2 <i>Lagerstroemia lanceolata</i> , sowing ..	85	7.6	96	15.6
3 <i>Terminalia paniculata</i> , sowing ..	40	5.3	4	10.8
4 <i>Artocarpus hisida</i> , stumps ..	97	6.5	86	5.7
5 <i>Dalbergia sisoides</i> , stumps ..	98	12.1	99	18.1
6 <i>Pterocarpus marsupium</i> , stumps ..	97	12.1	95	18.7

* Affected by drip.

Species	Undergrowth up to 20 feet cut and burned.		Ground fire only.	
	Survival, per cent.	Mean height in inches.	Survival, per cent.	Mean height in inches.
7 <i>Terminalia crenulata</i> , stumps ..	77	10.3	92	15.1
8 <i>Swietenia macrophylla</i> , transplants ..	98	38.7	99	38.4
9 Ceylon <i>Chloroxylon swietenia</i> —				
Transplants ..	95	12.7	99	17.0
Stumps ..	95	12.7	96	9.6
10 Madras <i>Chloroxylon swietenia</i> —				
Transplants ..	81	12.7	92	12.8
Stumps ..	69	6.4	70	8.3
Average of all species ..	85	11.8	85	13.8

64. *Comparison of direct sowing, entire transplanting and stump planting—Teak.*—No experiments have been done with teak during the past three years as it is 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.

65. *Dalbergia latifolia.*—An experiment at Kannothe 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 results of this experiment is given below and in addition for comparison the results of the previous five years are also shown :—

Year.	Average survival percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Trans-planting.	Stump-ing.	Sowing.	Trans-planting.	Stump-ing.	
1938 ..	52	94	97	3.7	20.3	10.7	One experiment at one centre.
1937 ..	6	70	79	9.2	13.1	11.4	Do.
1936 ..	25	97	95	0.1	7.9	8.5	Do.
1935 ..	54	63	68	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 three centres averaged.
1933 ..	77	68	97	11.2	7.5	15.5	Do.
Average of six years work.	45	75	88	7.5	10.6	12.0	Average of 13 experiments over six years at four centres.

Work with this species in this subject is now concluded.

66. *Pterocarpus marsupium.*—An experiment was done at Kannothe 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.	
1938	84	98	91	9.3	11.5	9.8	One experiment at one centre.
1937	35	85	40	5.4	11.0	9.9	One experiment at one centre.
1936	62	77	95	4.3	12.4	10.6	One experiment at one centre.
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	Three results at three centres averaged.
Average of six years work.	66	82	79	8.5	9.9	12.7	Average of 13 experiments over six years at four centres.

Work in this subject with this species is now concluded.

67. *Pterocarpus dalbergioides* (Andaman padauk).—An experiment with this species was done at Kannothe. Sowing and stump planting were very poor indeed while transplanting gave very fair results as is seen from the table below. The results of the previous three years are included for comparison.

Year.	Survival, percentage.			Mean height in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
1938	11	94	7	10.0	38.8	20.6
1937	..	93	6	..	44.7	14.0
1936	6	54	16	6.5	24.3	11.8
1935	..	59	2	..	14.0	6.5
Average of four years work.	4	75	8	4.1	30.5	13.2

68. A further experiment (No. 73) was done with this species also at Kannothe in a ponam crop of hill paddy in which the results from transplants (A) 18 inches, (B) 27 inches, (C) 38 inches, (D) 54 inches high were compared. As is seen from the table below which gives the results in January 1939 the transplants of the bigger sizes have done the best. This confirms previous years results.

Treatment.	Survival, percentage.	Mean height in inches.
A. 18-inch transplants	82	29.6
B. 27-inch transplants	98	40.5
C. 38-inch transplants	98	50.5
D. 54-inch transplants	100	62.3

69. *Terminalia crenulata*.—An experiment was done this year at Kannothe with this species in a ponam crop of hill paddy.

This experiment confirmed previous years results that stump planting is the best of the three methods to use for regenerating this species. Results together with those of the previous five years are as follows:—

Year.	Average survival, percentage.			Average mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
1938	50	31	81	10.4	18.3	24.0	One experiment at one centre.
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	64	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 six years work.	48	63	77	15.9	17.4	26.6	Average of 19 experiments at four centres over six years.

Work with this species in this subject is now concluded.

70. *Xylia xylocarpa*.—No new experiments have been done with this species during the past three years as it is considered that the work of the previous three years has amply demonstrated that for regenerating this species direct sowing is the best of the three methods.

71. *Artocarpus hirsuta*.—Four experiments were done with this species at four centres after clear-felling and burning mixed deciduous forests.

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

Stump planting is the best method for this species, sowing is unreliable.

Locality.	Average survival, percentage.			Mean height growth in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
Begur	97	56	78	6.2	10.5	5.8
Kannothe	42	37	74	7.1	7.2	6.8
Dhoni	100	79	37	14.6	6.8	9.7
Topslip	..	20	72	..	4.9	5.0
Average of 1938 experiments	60	48	65	7.0	7.4	6.6
Average of 1937 experiments	65	34	78	6.7	7.5	7.1
Average of 1936 experiments	99	45	83	8.3	5.3	5.7
Average of 1935 experiments	54	26	82	5.6	6.5	6.4
Average of 1934 experiments	12	2	33	11.2	12.0	14.9
Average of five years work	58	31	68	7.8	7.7	8.1

Work in this subject with this species is now concluded.

72. *Terminalia paniculata*.—Four experiments were done in this subject with this species at four centres. Results are given below together with those of last year for comparison.

Results so far indicate that stump planting is the most satisfactory method for this species.

Locality.	Survival, percentage.			Mean height growth in inches.			Remarks.
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.	
Begur	24	84	100	9.6	19.0	19.0	
Kannoth	9	56	60	6.4	7.1	8.9	
Dhoni	65	65	79	7.3	5.2	18.4	
Topslip	4	3	51	9.5	4.0	20.2	
Average of 1938 experiments.	26	52	73	8.2	9.1	16.6	Average of four experiments at four centres.
1937	..	53	87	..	8.8	12.7	Average of two experiments at two centres.
Average of 1937 and 1938 experiments.	13	53	80	4.1	9.0	14.7	Average of six experiments at four centres over two years.

73. *Schleichera trijuga*.—In connexion with lac work regeneration of this species has become important recently. Three experiments were done at three centres. Their results are given below together with those of the last two years for comparison. The indications at present are that stump planting is the best method for this species.

Locality.	Survival, percentage.			Mean height in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
Begur	73	96	99	5.2	12.1	16.7
Dhoni	99	41	53	15.0	10.2	5.9
Average of 1938 experiments	86	69	76	10.6	11.2	11.8
1937	40	46	64	23.7	17.8	26.6
1936	40	40	90	8.5	5.4	7.2
Average of 1936, 1937 and 1938 experiments.	55	53	77	14.3	11.5	15.0

74. *Artocarpus integrifolia*.—Two experiments done with this species at two centres showed that direct sowing is probably the best method to use.

Locality.	Survival, percentage.			Mean height growth in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
Kannoth	99	61	55	36.6	12.5	8.5
Dhoni	100	99	71	44.0	39.0	23.2
Average	100	80	63	40.3	25.8	15.9

75. *Lagerstræmia lanceolata*.—Three experiments were done with this species at three centres and all indicated that stump planting is likely to be the best method. Of course the result needs confirmation by repetition.

Locality.	Survival, percentage.			Mean height growth in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
Begur	82	64	97	15.7	15.4	27.1
Dhoni	84	96	99	17.6	24.8	40.4
Topslip	50	2	56	14.8	12.0	27.2
Average	72	54	84	16.0	17.4	31.6

76. *Lagerstræmia flos reginæ*.—Four experiments were done at four centres with this species. Results were rather variable but in general show that stump planting is likely to be the best of the three methods for this species. This indication however needs confirmation by repetition.

Locality.	Survival, percentage.			Mean height growth in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
Begur	86	95	99	3.9	10.8	16.2
Kannoth	14	96	82	5.2	16.7	14.7
Dhoni	80	88	84	10.9	18.6	28.3
Topslip	84	9	4	14.0	1.7	22.0
Average	66	72	67	8.5	12.0	20.3

77. *Trema orientalis*.—Two experiments at two centres were done with this species and gave the preliminary indication that transplanting is likely to be the best method of regenerating this species. This indication however requires confirmation by repetition.

Locality.	Survival, percentage.			Mean height in inches.		
	Sowing.	Transplanting.	Stumping.	Sowing.	Transplanting.	Stumping.
Begur	14	70	96	30.3	58.7	55.9
Dhoni	93	95	9	45.5	52.2	37.8
Average	54	83	53	37.9	55.5	46.9

78. *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 seven years at five centres have now been concluded. The investigations with teak at Dhoni, Begur and Topslip, have been written up and published as an Indian Forest Record.

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 *sissooides*, *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 seven 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 Kannothe the average mean height growth over the five years of experiment of stumps planted on April 15th was 18.1 inches while that of stumps planted on June 1st was 6.7 inches, an increase of 170 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.

	Begur.	Dhoni.	Kannothe.	Topslip.	Walayar.
<i>Tectona grandis</i> ..	Mid-April ..	Mid-April ..	Late April ..	Early May ..	Mid-April
<i>Dalbergia latifolia</i> ..	Late April ..	Late April ..	Mid-May ..	Mid-May.	
and <i>sissooides</i> ..					
<i>Pterocarpus marsupium</i> ..	Early May ..	Early May.	Mid-May ..	Late May.	
	Late April ..	Late April ..			
<i>Terminalia crenulata</i> ..	Early May.	Mid-May ..	Early May ..	Mid-May.	
<i>Artocarpus hirsuta</i> ..	Late April ..	Mid-May ..	Mid-May ..	Mid-May.	
	Late May ..	Early June			
	Early 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.

79. *Begur, Wynad division*—Annual rainfall 67 inches, elevation 2,000 feet—*Teak* (*Tectona grandis*).—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.

80. *Dalbergia sissooides*.—Early May is the best time for stump planting rosewood at Begur. Planting at this time gives less chance of poor stocking (as was 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 a good year climatically but the chance of poor stocking is considerable.

81. *Pterocarpus marsupium*.—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.

82. *Terminalia crenulata*.—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 41 per cent over normal early June planting.

83. *Artocarpus hirsuta*.—Experiments in the best date of stump planting *Artocarpus hirsuta* at Begur have been done for the last four 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				
	1st May.	15th May.	1st June.	15th June.	1st July.
1938	56	48	74	93	79
1937	83	85	68	90	78
1936	78	94	88	98	86
1935	18	18	14	86	..
Average ..	59	61	61	92	..

Year of experiment.	Mean height growth in inches of stumps planted on				
	1st May.	15th May.	1st June.	15th June.	1st July.
1938	7.0	5.6	6.4	6.6	4.1
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 ..	6.5	6.2	5.1	5.4	..

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 10 to 15 days has produced an increase of height growth of 12 per cent over normal early June planting during the four years of the experiments.

(For full experimental data see paragraph 310.)

84. *Dhoni, Palghat division*—Annual rainfall 111 inches, elevation 300 feet—*Teak* (*Tectona grandis*).—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.

85. *Dalbergia latifolia*.—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.

86. *Pterocarpus marsupium*.—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.

87. *Terminalia crenulata*.—Experiments at Dhoni with this species have only been done for two years.

Therefore, 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.

88. *Artocarpus hirsuta*.—Experiments in the stump planting of *Artocarpus hirsuta* at Dhoni have been done for the last three 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.
1938	59	65	75	63	54
1937	63	51	60	82	82
1936	5	77	89	82	66
Average	42	64	75	76	67

Year of experiment.	Mean height growth in inches of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1938	12.6	10.7	11.9	13.2	9.4
1937	15.7	17.6	14.4	15.8	13.6
1936	7.6	15.0	14.7	9.9	9.0
Average	12.0	14.4	13.7	13.0	10.7

Further experiments are needed but these preliminary figures show that the best date of stump planting *Artocarpus hirsuta* at Dhoni is in late May or 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 311.)

89. *Topslip, South Coimbatore division—Annual rainfall 67 inches, elevation 2,500 feet—Teak (Tectona grandis)*.—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.

90. *Dalbergia latifolia*.—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.

91. *Pterocarpus marsupium*.—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 was seen in the figures for 1936 and 1935 the risk of poor stocking is great.

92. *Terminalia crenulata*.—Experiments with this species at Topslip have been done for two years.

Although if extensive planting of this species is contemplated at Topslip, further experiments are necessary, yet the 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 this "safest" date but the danger of poor stocking is great.

93. *Artocarpus hirsuta*.—Experiments in the early stump planting of *Artocarpus hirsuta* have been done at Topslip during the past three years. The results of these 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.
1938	37	25	91	92	15
1937	12	42	54	89	74
1936	..	45	56	72	64
Average	16	37	67	84	51

Year of experiment.	Mean height growth in inches of stumps planted on				
	May 1st.	May 15th.	June 1st.	June 15th.	July 1st.
1938	4.9	4.6	7.2	6.0	5.1
1937	7.0	5.0	6.4	7.7	5.9
1936	..	4.6	4.5	3.7	3.3
Average	4.0	4.7	6.0	5.8	4.8

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 312.)

94. *Kannoth, Wynad division—Annual rainfall 173 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 five 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.
1938	99	97	98	100	99
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 ..	68	90	92	92	90

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1938	15.3	12.5	11.2	10.3	8.6
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 ..	19.6	18.1	13.1	10.1	6.7

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 170 per cent and 98 per cent, respectively.

(For full experimental data see paragraph 313.)

95. *Dalbergia sissooides*.—This species has been experimented with at Kannoth for the last 5 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.
1938	96	94	100	100	98
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 ..	69	72	80	94	94

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1938	16.5	13.1	14.1	11.3	13.6
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 ..	16.7	15.7	16.1	15.2	12.7

The above figures show that early May is the best time for stump planting *Dalbergia sissooides* at Kannoth. Planting at this time gives roughly the same stocking as normal early June planting but it gives an increased height growth of 24 per cent.

(For full experimental data see paragraph 313.)

96. *Pterocarpus marsupium*.—Experiments in the early stump planting of this species at Kannoth have been done for the last five 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.
1938	100	100	94	96	88
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 ..	54	60	74	85	85

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1938	30.6	24.2	16.0	13.7	9.8
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 ..	21.4	24.5	21.9	21.3	16.5

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 30 per cent when compared with normal early June planting.

(For full experimental data see paragraph 313.)

97. *Terminalia crenulata*.—Experiments with this species at Kannoth have been done for the last four 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.
1938	92	88	70	70	90
1937	12	64	82	74	58
1936	78	88	84	94	88
1935	62	48	92	64	72
Average ..	61	72	82	76	77

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1938	29.6	23.5	21.2	14.1	19.5
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 ..	25.7	23.4	22.5	17.1	16.0

The above figures show that very early May is the best time for stump planting *Terminalia crenulata* at Kannothe. Planting at this time gives less chance of poor stocking and an increased height growth of 41 per cent when compared with normal early June planting.

(For full experimental data see paragraph 313.)

98. *Artocarpus hirsuta*.—Experiments in the early stump planting of this species have been done at Kannothe for the last five 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.
1938	32	58	56	82	74
1937	22	50	66	52	50
1936	10	22	90	90	56
1935	8	42	58	20	70
1934	..	6	20	31	48
Average ..	14	36	58	55	60

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 15th.	May 1st.	May 15th.	June 1st.	June 15th.
1938	13.9	10.1	8.0	8.1	6.7
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	..	12.4	17.6	14.2	15.4
Average ..	6.6	8.5	9.5	8.4	7.4

The above figures show that the best time for stump planting *Artocarpus hirsuta* at Kannothe is the middle of May. Planting on this date gives less chance of poor stocking and an increase in mean height growth of 13 per cent when compared with normal early June planting.

(For full experimental data see paragraph 313.)

99. *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 five 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.
1938	84	79	87	96	99
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 ..	70	70	72	78	82

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1938	11.1	11.2	13.2	13.1	11.6
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 ..	28.6	22.2	18.6	17.9	14.6

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 increase height growth of 53 per cent when compared with normal early June planting.

(For full experimental data see paragraph 314.)

100. *Nilambur, Nilambur division*—Annual rainfall 112 inches, elevation about 50 feet.—In connexion with the revision of the Nilambur Working Plan a new investigation in the best date of stump planting teak has been started at this centre. The hot weather last year at Nilambur was abnormally dry and April and May were very hot dry months. In spite of this, planting fortnightly from April 1st to June 1st the poorest survival percentage obtained was 97 per cent. Although this is only the first year of the investigation it has already shown the fallacy of the belief of the Nilambur district staff that successful planting cannot be done before the middle of May. It remains to be seen how the experiments fare in the next four years.

The results of this experiment at the end of the first growing season after planting are—

Year of experiment.	Survival percentage of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1938	98	97	98	100	97

Year of experiment.	Mean height growth in inches of stumps planted on				
	April 1st.	April 15th.	May 1st.	May 15th.	June 1st.
1938	48.1	43.2	41.4	47.3	40.4

(For full experimental data see paragraph 315.)

Stump planting—Effect of age and diameter of stumps.—With the work done with *Artocarpus hirsuta* during the past year this investigation is now finished for our five main species.

Results in brief are—

101. *Teak*.—Considering both survival percentage and mean height growth, the work done 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 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.

102. *Dalbergia latifolia*.—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.

103. *Pterocarpus marsupium*.—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.

104. *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.

105. *Artocarpus hirsuta*.—Experiments were done at four centres with this species. Results so far show that stumps between 0.3" and 1.3" diameter do best and within this range it does not matter whether the stumps are one 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—

Survival percentage after one season.

Locality.	Age of stumps.	Diameter of stumps in inches.								
		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1
		0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.3	
Begur ..	One year ..	86	..	92	92	..	..	..	..	..
	Two years ..	..	62	70	80	78	..	..	..	78
Kannoth ..	One year ..	84	96	96	..	..	..	..	..	..
	Two years ..	..	82	96	..	..	..	86	..	98
Dhoni ..	One year ..	10	32	49	..	..	..	..	..	..
	Two years ..	..	..	51	53	55	..	..	..	..
Topslip ..	One year ..	..	31	..	62	..	..	..	..	..
	Two years ..	..	..	39	55	50	44	..	..	..

Mean height growth in inches after one season.

Locality.	Age of stumps.	Diameter of stumps in inches.								
		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1
		0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.3	
Begur ..	One year ..	4.4	..	6.6	7.5	..	..	..	..	..
	Two years ..	..	5.1	5.5	5.5	6.4	..	..	..	7.1
Kannoth ..	One year ..	5.5	7.5	6.6	..	..	..	13.0	15.8	..
	Two years ..	..	8.2	8.7	..	..	..	..	..	..
Dhoni ..	One year ..	6.8	11.5	12.7	..	..	..	..	..	..
	Two years ..	..	..	8.7	11.3	12.6	..	..	..	..
Topslip ..	One year ..	..	4.0	5.1	5.6	..	..	..	..	..
	Two years ..	..	..	..	4.7	5.3	5.2	..	..	..

(For full experimental data see paragraph 316.)

106. *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 1938 normally (B) planted on 1st April 1938 buried (C) planted on 1st June 1938 normally and (D) planted on 1st June 1938 buried. In treatments (B) and (D) the stumps were made normally with 1" of stem and 9" 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 treatments produced no appreciable difference in survival percentage or in mean height growth from the control.

With the early planted stumps however differences (all in favour of the buried stumps) were much greater and in three out of five cases reached significance. We have now done fourteen experiments in this subject at five centres over three years and the averaged results for the early planted stumps show an increase in survival percentage of 12 per cent and in mean height growth of 9 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				Mean height growth in inches of stumps planted on			
	1st April 1938.		1st June 1938.		1st April 1938.		1st June 1938.	
	Buried.	Normal.	Buried.	Normal.	Buried.	Normal.	Buried.	Normal.
Begur ..	98	97	99	98	38.9	36.1	11.8	14.6
Dhoni ..	98	89	99	100	23.4	19.5	16.4	16.2
Walayar ..	88	67	95	100	15.4	13.8	11.5	13.0
Topslip ..	99	90	98	96	32.4	33.9	16.1	16.3
Kannoth ..	98	100	98	94	18.0	18.6	8.8	8.0
Average ..	96	89	98	98	25.6	23.4	13.9	13.6
Average of 1936 experiments ..	68	55	91	86	32.1	31.4	18.1	17.0
Average of 1937 experiments ..	86	70	95	92	34.7	30.1	14.6	14.0
Average of 1936, 1937 and 1938 experiments ..	83	71	95	92	30.8	28.3	15.2	14.2

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 317.)

107. 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 casualties was done.

108. *Depth of planting teak stumps—District work.*—Experiments in the burying of teak stumps were done by the district staffs in six districts. Of these experiments, the results of five districts confirmed those of experimental results that the burying of stumps in premonsoon planting is decidedly beneficial. The results of the Nilgiris division were not reliable as the planting was done too late in the year to be of any use.

Height measurements were not taken by districts and those that reported in favour of burying stumps did so on the basis of the saving of casualty replacements.

South Coimbatore division reported strongly in favour of buried stumps.

The results of the remaining four districts are as follows :—

District.	Locality or range.	Date of planting.	Casualties that had to be replaced.	
			Buried stumps.	Normal stumps.
South Kanara ..	Mangalore ..	9th April 1938 ..	7	15
	Mangalore ..	1st May 1938 ..	6	12
Nilambur ..	Nilambur ..	Last week April ..	3	2
	Amarampalam ..	Do. ..	3	22
Wynaad ..	Chedleth ..	Early April ..	3	8
Palghat ..	Walayar ..	Mid April ..	6	27
	Elival ..	Do. ..	10	61
	Dhoni ..	Do. ..	3	1
Average ..			5 per cent.	19 per cent.

The above figures are very striking confirmation of experimental results and show a saving of casualty replacement of 14 per cent.

109. *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 1938 and in the other set the plants were dug up after they had sprouted and were planted on 5th May 1938.

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 abnormally dry and hot hot weathers.

110. The investigation has conclusively shown—

- that teak stumps keep much longer without deterioration if they are dug up after sprouting in the nursery,
- that there is no appreciable deterioration in mean height growth due to storage, and
- 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 318.)

111. *"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 last year two experiments were done at Begur and Kannothe comparing the results from such "shaved" stumps with those from which only the strongest of side roots had been cut.

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.

These experiments were repeated in 1938 at three centres for both early planting and monsoon planting. As will be seen in the tables below results confirmed those of last year and show that the extra care and expense of this operation while making stumps is not economically justified.

Abbreviated results after one growing season are as follows :—

		<i>Survival percentage.</i>				
Date of planting.			1st April 1938.		1st June 1938.	
Treatment.			Normal.	Shaved.	Normal.	Shaved.
Begur	..	..	97	99	97	99
Dhoni	..	..	95	99	98	98
Topslip	..	..	95	98	99	95
Average ..			96	97	98	97

Mean height growth in inches.

Date of planting.			1st April 1938.		1st June 1938.	
Treatment.			Normal.	Shaved.	Normal.	Shaved.
Begur	..	..	38.6	41.3	13.3	13.1
Dhoni	..	..	16.6	14.6	13.5	12.5
Topslip	..	..	38.5	41.7	21.6	20.1
Average	..		31.2	32.5	16.1	15.2

The above figures also again demonstrate the 100 per cent increase in height growth that is obtained in the first year by early planting.

112. *Teak plantations—Effect of planting espacement on growth, tending and costs.*—For some years it has been realized that modern teak plantation technique such as the premonsoon stump planting of stumps selected of the best size and intensive tending has upset the old ideas of plantation tending and early thinning.

It has been found that at Nilambur in first, second and third qualities (All-India second, third and fourth qualities) with an initial 6' × 6' espacement, under normal circumstances the first thinning is required to be approximately a 50 per cent thinning at ages 3, 4 and 5 years respectively for the different qualities.

This in practice tends to upset a thinning programme and in consequence the effect of initial espacement is once again being studied.

A great deal of work has been done in the past on this problem with teak in many parts of India and elsewhere and the general trend of this work has been to show that an initial espacement wider than 6' × 6' was not advisable.

It is realized however that *none of the existing work has been done using modern plantation methods* and hence we must start again to study the problem.

In consequence, two large scale experimental plots have been started at Nilambur using latin squares of blocks of plants in order to determine whether by increasing the initial espacement to 8½' × 8½' in the better quality areas we can raise teak crops of the same condition that will not require to be first thinned before those on the poorer qualities of soils. It is also hoped that plantation costs for these better qualities can be reduced.

At the end of the first growing season after planting the plots showed the following results:—

Experiment number.	Site quality.	Espacement.	Survival.	Mean height.	Relative costs.
PER CENT. INCHES.					
Experimental Plot 149 ..	I	6' × 6'	99	46.6	1.00
		8½' × 8½'	100	43.9	0.63
Experimental Plot 150 ..	II	6' × 6'	100	45.7	1.00
		8½' × 8½'	100	40.6	0.65

It remains to be seen how the plots progress.

113. During the course of preparation of the new Nilambur Working Plan it has been found that plantations do not settle down to their qualities (by height) until they are at least five years old. It is interesting to note that so far as the above experiments have gone they show that site quality has little effect on height in the first year.

All sub-plots of both treatments of both experimental plots have had exactly the same tending throughout and it has been the same as that done by the district in the surrounding plantation.

114. *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 the 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.

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' and (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" and (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. This indication needs confirmation.

115. In 1938 (i.e., at six years old) half of the 1932 plantation was sold standing. This sale fetched Rs. 173 per acre and as the expenditure on this plantation had been Rs. 68-8-0 per acre, *excluding overheads this shows a profit of Rs. 17-8-0 per acre per annum and has thus been a very profitable investment* in a scrub fuel forest even though the irrigation is expensive. It should be noted that these costs are the actuals of experimental work and therefore considerably higher than should be the case with district work.

This felled area is being regenerated naturally by irrigated teak coppice and so far, at two months after felling, the coppice is 2' 6" high and the mortality of stools has been less than 1 per cent.

The unfelled part of the 1932 plantation was given a thinning of roughly 60 per cent and the thinned poles fetched Rs. 98 per acre. The operation of first thinning thus much more than paid

for the costs of the plantation and there is still a fine main crop of 316 stems per acre on the ground.

The crop that is left has an average height of 44' and an average diameter at breast height of 5.0" at seven years old.

116. In the 1936 experiment in one treatment the irrigation was stopped after the first monsoon and the height increments in the second year were (i) unirrigated 6' 0" and (ii) irrigated 12.1'.

In the third year the corresponding height increments were (i) unirrigated 4.4' and (ii) irrigated 6.5'.

Thus the effect of the irrigation was very marked in the second year and although very appreciable in the third year, yet it was not so great as in the second year.

It is to be noted that at three years old the average height of this plantation is 22.7' in the irrigated plots and 13.7' in the unirrigated plots.

In this experiment in the first year it was found (as in the 1932 experiment) that irrigation by percolation was cheaper and more efficient than irrigation by flooding. In consequence all work after 1936 has been by percolation from shallow channels.

117. In the 1937 experiment we are trying the effect of irrigation up to the first, second and third years. At the end of the second growing season after planting the plots irrigated up to the first monsoon showed an average height of 13.7' while those irrigated up to the second monsoon showed an average height of 15.5'.

118. In the 1936 experiment we have three treatments and all these plots have been equally irrigated twice a week up to the first monsoon to get them established.

Treatments have been applied at the first monsoon and are (a) unirrigated control, (b) irrigated once a week and (c) irrigated once a fortnight.

Throughout these experiments, in one irrigation the water is allowed to flow through the area for 3 hours in the early morning.

Thus in a few years we hope to get reliable information on (i) the best method of irrigation, (ii) how many years of irrigation are essential and (iii) the minimum monthly irrigation necessary.

This type of work is of course very limited in its extent but there are many places in the Presidency where it can be done. Its financial success is due to the fact that it is done in a comparatively dry district where there is nothing to compete with the final product of teak poles. The cost of transport of such teak poles from natural teak areas is prohibitive.

It must of course be remembered that after the first planting the subsequent regeneration is by irrigated coppice and this is much cheaper than the planting.

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

Four experiments were done during the year and in addition four experiments of 1937 and four experiments of 1936 were re-measured.

In general in the 1938 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 but at the same time sowing is rather uncertain. 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 1939 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.	
1938 ..	62	71	Not done	Four experiments at four centres averaged.
1937 ..	75	74	"	Do.
1936 ..	84	53	"	Do.
1935 ..	36	73	"	Do.
1934 ..	50	50	8	Two experiments at two centres averaged.
Average ..	61	64	8	Average of eighteen experiments at four centres over five years.

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 319.)

121. *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 randomized blocks and consists of espacements of 3' x 3', 6' x 6' and 9' x 9' and three sizes of transplants 6" to 12", 12" to 18" and 3' to 4'.

At the end of the first year there was very little difference between the treatments but heavy casualties 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 98 per cent stocked with the *Trema* 22' high and the mahogany 5' to 8' 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 came in two years ago.

122. *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 espacement 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' high and was underplanted with three sizes of mahogany transplants (i) 5" high, (ii) 15½" high and (iii) 27" high. Results at the end of the first year showed little difference between the treatments, the smallest size 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' high was thinned and reduced to an even 6' × 6' spacing.

Measurement in January 1939 showed the plot to be 84 per cent stocked with mahogany of an average height of 3·2'. The *Trema* is also a full crop with an average height of 32'. 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 experiment on this pest see paragraphs 154 to 160.)

123. As a result of the work seen in Bengal three further experiments were initiated during 1937 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, Wynad division, which consists of alternate strips of mahogany and padauk (*Pterocarpus dalbergioides*) 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 154 Palghat division which is mahogany and teak in alternate strips.

At the end of the second year these plots are all fully stocked and look very promising. The Wynad plot was however visited by bison which browsed the *Trema* and by wild elephant which uprooted some of the *Pterocarpus*.

These plots are almost completely free from the shoot borer.

They were repeated in 1938 in Experimental Plots, Wynad 51, Nilambur 147, and Palghat 168. These plots are also fully stocked.

The experience we have so far had in this work shows that the best way of raising the mahogany in such areas is with a shade crop of *Trema*, the *Trema* and mahogany being in lines 6' apart and the mahogany close planted in its lines.

124. *Artificial regeneration of Bambusa arundinacea in experimental gardens*.—In 1937 experiments were done at Begur and Topslip in which direct sowing, planting of 1 year old transplants and planting of 1 and 2 year old rhizomes were compared. In addition, plants with multiple rhizomes and multiple rhizomes separated into single rhizomes were also compared. Abbreviated results are as follows :—

Experiment number.	Sowing.	One-year seedlings.	One-year rhizomes split.	One-year rhizomes not split.	Two-year rhizomes split.	Two-year rhizomes not split.
<i>Survival percentage after two seasons.</i>						
Begur—107 ..	8	88	34	38	24	17
Topslip—151.	17	78	..	86	..	76

<i>Mean height growth in feet after two seasons.</i>						
Begur—107 ..	7·5	15·3	14·0	15·8	12·7	14·7
Topslip—151.	9·4	11·4	..	11·5	..	11·4

NOTE.—The heavy casualties which occurred with rhizomes in the second year are not normal.

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.

125. These experiments were repeated in 1938 with the following results when measured at the end of the first growing season.

Experiment number.	Sowing.	One-year seedlings.	One-year rhizomes.	Two-year rhizomes.	Three-year rhizomes.
<i>Survival percentage.</i>					
Begur—128 ..	1	98	70	87	73
Topslip—182 ..	..	19	88	93	*
<i>Mean height growth in feet.</i>					
Begur—128 ..	0·6	3·7	3·2	4·9	3·1
Topslip—182 ..	..	2·5	4·4	5·0	*

* Treatment not done.

126. In addition, three experiments were done comparing multiple rhizomes with separated rhizomes. Results were as follows :—

Experiment number.	Year.	Multiple rhizomes.		Separated rhizomes.	
		Survival percentage.	Mean height in feet.	Survival percentage.	Mean height in feet.
Topslip—167 ..	1937	46	13.5	38	10.6
Begur—130 ..	1938	72	3.3	73	3.3
Topslip—179 ..	1938	60	3.4	83	4.4
Average ..		59	6.7	65	6.1

Thus so far as our data goes at present we get the tentative conclusions that for the artificial regeneration of *Bambusa arundinacea*, it is better to plant 1 or 2 year old rhizomes rather than to sow or transplant. These rhizomes should not be separated before planting.

127. *Artificial regeneration of Dendrocalamus strictus (in experimental gardens).*—Similar experiments were done with this species as with *Bambusa arundinacea*. Results at the end of the first growing season after planting are—

Experiment number.	Sowing.	One-year transplants.	One-year rhizomes.	Two-year rhizomes.
<i>Survival percentage.</i>				
Begur—129	11	96	96	*
Topslip—181	2	10	74	80
<i>Mean height in feet.</i>				
Begur—129	1.8	2.6	3.3	*
Topslip—181	4.5	4.0	4.7	4.5

* Treatment not done.

128. A further experiment was done comparing multiple rhizomes with separated rhizomes. Results at the end of the first year were—

Experiment number.	Single rhizomes.		Multiple rhizomes.	
	Survival percentage.	Mean height in feet.	Survival percentage.	Mean height in feet.
Topslip—180	67	3.7	79	4.1

Thus with *Dendrocalamus strictus* we come to the same tentative conclusions as with *Bambusa arundinacea* that it is best not to separate rhizomes before planting and that rhizome planting is superior to transplanting or direct sowing.

129. *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 1-year old rhizomes. At the end of the second growing season after planting the area is 100 per cent stocked and the plants have an average height of 9.4 feet.

In Experimental plot 71 of South Coimbatore division an area of one acre was raised by planting 1-year old rhizomes and seedlings in alternate lines. This is however in a dry district type of climate and it was attempted to raise the bamboo under the standing dry fuel thorny forest.

At the end of the second year the stocking was only 35 per cent with a mean height growth of 12.1 inches. It was obvious that the bamboo was not thriving and in consequence this year, the growth on the area is being clear felled and burned and the bamboo will be raised as an ordinary "rab" plot. This is being done because concentrated bamboo plantations in dry fuel forests (if they can be raised successfully) will be very profitable financially.

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 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 two experimental plots (No. 38, Wynad division, and No. 82, South Coimbatore division). We thus have nearly three-fourth acre of plants grown from the seed of *Terminalia crenulata* trees of proved figure. The object of the experiment is to determine whether the "figure" is transmitted through the seed.

The present state of the plots is —

Experimental Plot No. 38, Wynad division.	2 years ..	53 per cent stocked.	64.6 inches average height.
Experimental Plot No. 82, South Coimbatore division.	1 year ..	54 per cent stocked.	27.0 inches average height.

131. *Artificial regeneration of Chloroxylon swietenia.*—The experiments of 1935 and 1936 were observed during the year and remeasured. In the 1935 experiments 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 65 and a mean height growth of 22.6 inches at the end of the fourth 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 62 per cent and 18.3 inches as against 39 per cent and 16.7 inches.

132. *Araucaria cunninghamii*.—An experiment in the transplanting of this species as 1 year old transplants 8 inches high in a clear-felled area of mixed deciduous forest gave a survival percentage of 68 with a height growth of 34.2 inches at the end of the third year.

133. *Chlorophora excelsa*.—An experiment done at Begur comparing the transplanting and stump planting of this species showed that both methods were successful but stumping was rather better than transplanting. This species can also be reproduced successfully by cuttings.

134. *Morus indica and alba*.—At Nilambur at the request of the Forest Entomologist, Dehra Dun, an attempt was made in 1937 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 $\times$ 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 $\times$ 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 1939 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. 144.

Sub-Plot A.				Sub-Plot C.-1.			
			FT.				FT.
<i>Morus indica</i>	..	..	12.2	<i>Morus indica</i>	..	..	11.7
Teak	..	..	3.4	Teak	..	..	5.4
<i>Trema orientalis</i>	..	..	15.0				
Sub-Plot B.				Sub-Plot C.-2.			
<i>Morus indica</i>	..	..	9.7	<i>Morus alba</i>	..	..	6.9
Teak	..	..	2.1	Teak	..	..	7.7
<i>Tephrosia candida</i>	..	..	10.5				

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.

135. At Dhoni an experimental garden experiment was done comparing the regeneration of *Morus alba* by stumps and by cuttings. Both methods were equally successful being 97 per cent

stocked with a mean height growth of 26 inches at the end of the first growing season. No shade at all was given in this experiment.

A further plot of *Morus alba* was raised at Nilambur (Experimental Plot 152) in a swampy area in the current district teak regeneration area. At the end of the year this plot was 98 per cent stocked with an average height of 18 inches.

136. *Vitex peduncularis*.—This species has now been successfully introduced into most of our malarial districts. The seed was obtained from Assam. Decoctions of the leaves of these plants have already been used apparently successfully in three cases of black water fever (two at Nilambur and one in the Wynad). This is surprising as the plants are only two years old and about 3 to 5 feet high.

137. *Observation experimental plots of exotics in mixed deciduous forest of fair quality*.—A number of plots have been established to observe the growth and development of some exotics in areas of mixed deciduous forest of fair quality after clear-felling and burning. These areas are in general not fit for teak.

(1) *Pterocarpus dalbergioides* (Padauk).

This species is doing very well at Kannothe (Wynad division) and a number of garden experiments had shown that it was probably suitable at Nilambur in areas unfit for teak. In consequence last year at Nilambur a large scale experimental plot (No. 148) was raised to observe the growth and development of the species at this centre on a laterite type of soil. At the end of the first growing season after planting it was two third acre 98 per cent stocked with a mean height of 5.7 feet.

(2) *Dendrocalamus brandisii*.

138. There were a few clumps of this bamboo in the compound of the bungalow of the District Forest Officer, Wynad, at Manantoddy. These clumps seeded in 1935 and the experimental plot (No. 57) was planted in 1938 with 3-year old rhizomes. After the first growing season it is ½ acre 99 per cent stocked with plants of an average height of 37.6 inches.

(3) *Bambusa polymorpha*.

139. Two experimental plots (Nos. 53 and 56, Wynad division) were raised with this species by planting 2-year old rhizomes at Begur and Kannothe. At the end of the first growing season the state of the plots was as follows :—

Kannothe (Experimental Plot 53) ½ acre 96 per cent stocked, mean height 49.5 inches.

Begur (Experimental Plot 56) $\frac{1}{2}$ acre 86 per cent stocked, mean height 24.3 inches.

(4) *Chlorophora excelsa*.

140. Quarter acre of this species was raised by stump planting at Begur (Experimental Plot 54). At the end of the first year it was 78 per cent stocked with plants of an average height of 19.5 inches.

141. *Teak coppice forest—Filling in blanks with stumps.*—Observation of Experimental Plot 47, 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 1 acre. In 1939, after 13 years (i.e., nearly half of the rotation of 30 years) 55 per cent of the stumps were still surviving but were only approximately half the girth and three-fourth 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.

142. *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 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.		
				Percentage placements surviving.	Average height of replacements.	Average height of plantation.	Percentage placements surviving.	Average height of replacements.	Average height of plantation.	Percentage placements surviving.	Average height of replacements.	Average height of plantation.	Percentage placements surviving.	Average height of replacements.	Average height of plantation.	Percentage placements surviving.	Average height of replacements.	Average height of plantation.
ACS.																		
Palghat	135	2	1933	13	77	0.2	63	0.5	50	0.5	43	0.5	23	0.5	16	0.5		
Do.	140	1	1934	33	48	0.2	26	0.5	23	0.5	23	0.5	23	0.5	16	0.5		
Coimbatore South. Palghat—	61	1	1934	20	17	0.2	17	0.3	16	0.5	16	0.5	16	0.5	16	0.7		
Flat country ..	145 (1)	1	1935	19	85	0.2	74	0.5	74	0.9	74	0.9	74	0.9	74	0.9		
Hilly country ..	145 (2)	1	1935	18	85	0.1	84	0.5	84	0.6	84	0.6	81	0.9	81	0.9		
Palghat	149	3/5	1936	25	99	0.5	67	0.6	63	0.7	63	0.7	63	0.7	63	0.7		

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

144. *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 in 1937 an experiment was started to try and regenerate such areas with *Lagerstroemia flos reginae*. At the end of the second year the plot was 66 per cent stocked and looked quite promising.

145. *Teak—Flowering and fruiting on the terminal shoot.*—Observations have been carried out in the Wynad division on the flowering and fruiting on the terminal shoots of young teak trees. This occurs usually in small patches on lateritic soils.

It is observed that the terminal shoot usually dies and new branches sprout from the sides of the shoot. Thus with young trees, they do not necessarily die but suffer a considerably retarded height growth and form a low bushy crown.

146. *Regeneration of semi evergreens after clearing and burning what is now deciduous forest.*—In Experimental plots 41, Wynad division, and 153, Palghat division, an attempt was made in 1937, 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 Kannothe 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*.

147. The tentative conclusions from these experiments at the end of the second year are :—

- Artocarpus hirsuta* grows best without such a cover or shade crop.
- Both *Hopea* and *Mesua* can probably be raised in such localities under a cover crop of *Tephrosia candida*.
- 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.

The experiments were repeated in 1938 with *Hopea* and *Mesua* at Kannothe (Wynad Experimental plot 52) and with *Hopea* and *Cedrela* at Dhoni (Palghat Experimental plot 167). This repetition confirmed the tentative conclusions drawn from the work of 1937 and also showed that *Cedrela* can be raised with a certainty on such areas by these methods.

Mixed deciduous forest of good quality—Entomological Work.

I. Teak Defoliators.

148. The Forest Entomologist, Dehra Dun, maintained an insectary at Nilambur during the year from April 23rd to August 9th, 1938 for the purpose of trying to breed and release parasites of the teak defoliators. It was however necessary to close down the insectary earlier than was planned owing to shortage of funds.

Parasitism censuses—Parasitism censuses of the teak defoliators, *Hapalia machaeralis* and *Hyblaea puera* and of the undergrowth defoliators *Lygropia quaternalis* and *Sylepta* sp. indicated that the parasitism percentage fluctuates more widely in the teak defoliators than in a well controlled species such as *Lygropia*. In the teak defoliators the rise in the parasitism percentage is due to their specific parasites and not to the polyphagous parasites. In *Lygropia*, the specific parasites are subordinate to other elements in the parasite complex and a greater stability results from this condition.

The conclusion is that the larger the number of compensating or polyphagous parasitic species available, the narrower would be the oscillations in the total parasitism percentage.

149. *Wilt disease*.—A most important factor in defoliator control in Nilambur is wilt disease. It is hoped that a specialist can be found who will identify and study the causative organism which is at present unknown.

During the past season defoliation was economically negligible in extent.

A new scheme for measuring the loss of increment due to defoliators has been discussed with the Forest Entomologist, Forest Research Institute, and the Central Silviculturist, Dehra Dun and is being started in the coming year.

150. *Exchange of parasites with Burma*.—The exchange of teak defoliator parasites with Burma was successfully continued and during the year two additional species were successfully imported and released at Nilambur.

151. *Recoveries of previously released parasites*.—*Cedria paradoxa* (as reported last year) was released in 1937. Cocoons of this species were recovered in April 1938 thus showing that the parasite had successfully passed through 10 to 12 generations since its release.

152. *Undergrowth and alternative hosts*.—A list of desirable plant species in the undergrowth of teak plantations was given in last year's report and later published in the Indian Forester, 1938, page 489. Further work has enlarged this list of useful plants, additional alternative hosts of parasites have been discovered and

new records of parasites have been made in Nilambur. An up-to-date summary will be included in the Central Silviculturist's Bulletin on the "Pure Teak Plantation."

153. *Publications*.—Three publications on the parasites of teak defoliators are being published by the Forest Research Institute, Dehra Dun, in the near future.

II. Mahogany borers.

154. (a) *Collar borer—Pagiophloeus longiclavis—Uprooting as a control measure*.—Plants are liable to be attacked for at least six months of the year. Regular analyses at Dehra Dun throughout the year of mahogany plants pulled up as attacked as soon as they showed any external sign of ill health showed that the incidence of living borers in such plants is very low (often nil), and it is therefore concluded that this method is not economically worth while except for a limited period at the beginning of the season.

155. *Traps*.—Experiments with billets as traps for the beetle show that *Cedrela toona* freshly cut, can be used as attractive traps and that more beetles could be destroyed by this method than by uprooting (for equivalent labour). Further experiments in this method are in progress.

156. *Experimental plots*.—The data for incidence of attack in these plots show that the liability to attacks is greater in plantations in open sites than in those with overhead shade given by tree canopy or by undergrowth or by cover crops. Deep undergrowth sheltering mahogany in clear felled plots prevents increase in incidence of attack more effectively than does overhead shade of tree canopy. It is probable that dense stocking of mahogany in lines, with intermediate shelter growth will give good protection.

The average incidence of attack varies with locality more widely than with conditions inside the plantations and in some localities the collar borer does not occur; it is evident that external sources of breeding are the chief danger factors. These breeding sources are at present unknown and are the subject of intensive experiment.

A preliminary note on the collar borer was drawn up under the direction of the Forest Entomologist, Dehra Dun, in September 1938.

157. (b) *Shoot borer—Hypsipyla robusta—Experimental plots*.—From the experimental plots the data of which have been examined by the Forest Entomologist, it is concluded that—

- (i) the 1937 and 1938 incidence of attack by *H. robusta* was higher in the pruned plots than in the unpruned plots and hence pruning is of no advantage as a control measure,
- (ii) incidence varies with locality and this variation is greater than that produced by pruning,

- (iii) attacks are more abundant in young mahogany grown in the open than under canopy shade but this is complicated by the effect of weed or undergrowth and shade crops,
- (iv) the basis of silvicultural control appears to lie in measures that reduce the period of production of lateral shoots or which prevent easy access to them (i.e., dense mixture with undergrowth).

158. *Sack banding experiments*.—In four centres, 50 mature trees of *Aglaia roxburghiana*, *Chikrassia tabularis*, *Cedrela toona*, *Dysoxylum malabaricum*, and *Srietenia macrophylla* were banded with sacking and the bands were examined weekly for caterpillars or cocoons of *H. robusta* throughout 1937 and 1938.

No evidence was obtained of movements of caterpillars down the trunks of any of these trees.

The crowns of these trees were examined by climbing in March to May 1938. A few twigs were observed to be bored by *H. robusta*; no evidence was obtained of attack on the flowers or fruits.

It is concluded that the crowns of mature meliaceous trees do not serve as breeding grounds of the shoot borer to an extent that contributes appreciably to the incidence of attack in young mahogany plantations.

159. *Biology*.—By observations of caged larvæ and by deduction from field evidence it has been ascertained that *robusta* larvae of almost all ages are able to bore into mahogany shoots and that normally a larva leaves a slow growing shoot after having tunnelled it and attacks another. In shoots two-fifths to one-fourth of an inch diameter a larva probably does not remain for more than three or four days. The incidence censuses indicate that the larval population is on an average about half of the number of attacked shoots (range 33 to 82 per cent).

Larvæ of all sizes are found in shoots from April to August and moths emerge in each month up to December at least, indicating several overlapping generations.

Hypsipyla robusta is remarkably free from parasitism, only a species of *Agrypus* was recorded.

A species of *Sycanus* is predaceous on *robusta* caterpillars.

An *Erotylid* which enters the tunnels of *robusta* has been observed to destroy about 24 larvæ in a life of three months.

160. *Mahogany shoot borer—District work*.—Two years ago in Nilambur division a small experiment was done by the district to see whether a spray of lead arsenite was efficacious in reducing the incidence of the mahogany shoot borer. The experiment indicated that there might be possibilities in the method.

This work was continued by a carefully laid out experiment in the Wynad division done by the district staff. This experiment gave us a definite result that the spraying had no effect at all on the incidence of the pest.

III. *Phassus malabaricus*.

161. The work with *Phassus malabaricus* on *Trema orientalis* described last year was continued and all data obtained sent to the Forest Entomologist, Dehra Dun.

NOTE.—The above paragraphs on entomological work are partly extracts from the reports the Forest Entomologist has given us of the work his staff have been doing, and partly extracts from the summaries and deductions that he has made from the data sent to him of the work we are doing ourselves. We have been in constant touch with the Forest Entomologist, Dehra Dun, and are very grateful for the help and advice he has given us.

The paragraphs on the mahogany shoot and collar borers should be read with paragraphs 121, 122 and 123 which give accounts of the large scale practical attempts that we are making to raise mahogany as free as possible from these two pests, the control measures being purely silvicultural. These attempts have so far been remarkably successful but our great need at the moment is to discover the natural breeding grounds of these two pests.

(b) *Evergreen rain forests*.

162. All the artificial regeneration experiments done in evergreen rain forests with the exception of one set (Experimental Plot 27, Wynad 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 (vide paragraphs 224 to 225).

(c) *Dry fuel forests*.

163. *Direct sowing in a burned over area best season*.—Remeasurement of experiments 140 to 151 and 186 Emmanur Experimental Garden at the beginning of the second hot weather showed that the best season for direct sowing in 1937 was June to July, but several species showed a secondary best date in early September and October though these results were not nearly as good as those from the early sowings in point of view of height growth.

(For full experimental data see paragraph 320.)

164. A repetition of the above experiment was made in 1938 with 14 species *Acacia arabica*, *Acacia ferruginea*, *Acacia planifrons*, *Albizia amara*, *Albizia lebbek*, *Cassia auriculata*, *Pterocarpus santalinus*, *Terminalia chebula*, *Acacia auriculiformis*, *Acacia sundra*, *Prosopis juliflora*, *Azadirachta indica*, *Cassia siamea* and *Wrightia tinctoria*. Measurements in January 1939 showed the best date of sowing to be July to August. Owing to the failure of the north-east monsoon sowings in September and October were very poor indeed.

(For full experimental data see paragraph 321.)

165. 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, 1936 and 1937 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.

Year of experiment.	Survival percentage of sowings on								Remarks.
	1st April	1st May	1st June	1st July	1st August	1st September.	1st October.	1st November.	
1934	..	..	13	16	18	19	30	22	Average of 4 species.*
1935	..	..	24	48	60	37	37	50	Average of 5 species.*
1936	..	..	12	43	46	39	55	25	Average of 6 species.*
1937	..	24	22	37	36	32	34	46	Average of 13 species.*
Average	..	..	20	27	37	36	35	34	Average of 4 years work.*
1938	..	24	47	56	66	77	66	24	Average of 14 species.†

Year of experiment.	Mean height growth in inches of sowings on								Remarks.
	1st April	1st May	1st June	1st July	1st August	1st September.	1st October.	1st November.	
1934	..	..	6.8	8.7	11.7	12.4	12.9	12.3	Average of 4 species.
1935	..	..	42.3	34.6	35.6	32.2	33.5	18.5	Average of 5 species.
1936	..	..	66.8	53.7	52.0	48.7	45.2	37.8	Average of 6 species.
1937	..	43.6	38.6	33.0	34.9	33.5	34.0	30.6	Average of 13 species.
Average	..	..	36.2	32.6	33.4	31.0	30.7	20.9	Average of 4 years work.
1938	..	10.5	11.0	11.7	11.8	13.2	6.6	3.0	Average of 14 species.†

* After two seasons growth. † After one seasons growth.

166. The above figures show that the best date of sowing at Emmanur has been very variable during the past five 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.

1938—July to August.

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—

1934—0 per cent (best date was October 1st).

1935—7 per cent.

1936—48 per cent.

1937—14 per cent.

Average—17 per cent 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

1934—0 per cent (best date was October 1st).

1935—110 per cent.

1936—450 per cent.

1937—70 per cent.

1938—308 per cent.

Average—188 per cent 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 re-sowing 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).

167. 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 places 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 Satyamangalam corresponds very closely with that of many of the other 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.	1938.
January	0.62	2.74	0.14	..	..	..
February	0.59	..	0.25	3.91	2.68	0.16
March	0.80	0.71	..	2.51	0.33	0.45
April	2.18	1.43	4.06	0.98	4.02	1.58
May	3.42	3.43	1.19	2.61	2.56	0.29
June	1.42	1.37	1.61	2.04	1.26	0.18
July	1.32	0.64	0.10	1.05	1.53	3.40
August	2.62	1.46	2.93	1.48	1.74	4.40
September	3.60	..	1.54	5.67	3.14	3.94
October	7.83	8.80	8.52	6.76	6.42	0.33
November	4.70	5.49	1.17	2.63	2.91	0.69
December	0.72	..	1.53	1.90	0.23	2.43
Total	29.22	26.07	22.04	31.44	26.82	17.94
Number of rainy days.	..	53	54	70	70	56

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 1934; a critical month in this work. 1938 was a year of small rainfall. This was due to a severe failure of the north-east monsoon in October and November.

168. *Best date of sowing—District work.*—An interesting experiment was done in this subject with *Acacia planifrons* at Ayyalur in Madura district. Abbreviated results of this experiment (measured on 1st February 1939) at the end of the first growing season after planting are—

Date of sowing.	1st April.	1st May.	1st June.	1st July.	1st August.	1st September.	1st October.	1st November.
Survival percentage	82	100	60	61	67	73	83	74
Mean height in inches	17.4	20.3	15.7	13.0	14.1	6.2	5.3	4.0

The above figures show that the best date of sowing at Ayyalur in 1938 was May 1st and that sowing on this date gave an increase in survival per cent of 22 per cent and an increase in mean height growth of 255 per cent at the end of the first growing season after sowing as compared with (the district) normal sowing in September/October.

This result is particularly interesting as Ayyalur was the range in which the first rab-cum-kumri work was done in 1933 and the district staff up to now have been convinced that sowing before the middle of September at Ayyalur was a waste of time.

The above result is of course that of only one year's work and its indication must be regarded with extreme caution. When the experiment has been repeated for 3 or 4 years reliable conclusions can be drawn.

169. In order that the climate of Ayyalur may be compared with that of other dry district work centres, below is given the normal and the 1938 rainfall of Ayyalur together with that of the Emmanur Experimental Garden.

	Rainfall in inches.		Emmanur Experimental Garden.
	Ayyalur.		
	1938.	Normal.	Mean of 5 years.
January ..	..	1.47	0.07
February ..	0.40	0.08	2.08
March ..	2.40	0.10	1.26
April ..	1.80	1.97	2.57
May ..	..	1.20	1.19
June ..	..	0.68	1.61
July ..	0.60	0.24	0.37
August ..	7.20	2.52	2.20
September ..	4.00	2.12	0.77
October ..	3.80	9.80	8.66
November ..	..	6.38	3.33
December ..	1.60	1.85	0.77
Total ..	21.80	28.41	24.88

It should be noted that at the time of measurement the full effect of the hot weather had not been felt and consequently it is doubtful if a number of the germinations of the late sowings will survive. The experiment will be finally measured in January 1940 when all plants can be considered to be established.

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

170. In Experiments 171 to 176 Emmanur Experimental Garden of 1937 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.

Remeasurements in January 1939 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 *Cassia auriculata*, *Acacia planifrons*, *Albizia amara*, *Cassia siamea*, *Dolichandrone crispata* and *Zizyphus jujuba*.

Results averaged for all six species together with results of previous years' 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.	
		Worked pits.	No soil working.	Worked pits.	No soil working.
1934 ..	4	8	14	29	45
1935 ..	6	20	7	47	25
1936 ..	6	18	11	42	41
1937 ..	6	9	11	49	53
Average ..	..	14	11	42	41

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.
1934 ..	4	13.7	10.1	14.8	10.4
1935 ..	6	14.7	9.3	19.2	17.1
1936 ..	6	15.3	14.7	25.3	25.8
1937 ..	6	8.5	6.2	22.5	18.1
Average ..	..	13.1	10.1	20.5	17.9

(For full experimental data see paragraph 322.)

171. The experiment was repeated in 1938 (Emmanur Experimental Garden Experiments 230 to 236) with seven species. Measurements in January 1939 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 arabica*, *Acacia planifrons*, *Albizia amara*, *Cassia auriculata*, *Cassia siamea*, *Dolichandrone crista* and *Zizyphus jujuba*.

Results averaged for all seven species are :—

	Area not burned.		Area burned.	
	Worked pits.	No soil working.	Worked pits.	No soil working.
Percentage survivals	51	48	78	72
Mean height growth in inches	3.3	3.3	12.5	10.9

(For full experimental data see paragraph 323.)

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

172. *Direct sowing—Comparison of dry and watered beds.*—Experiments 152 to 163 and 187 Emmanur Experimental Garden with 13 species had as their object to see whether the best date of direct sowing was different when the beds were watered. Re-measurement 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.

173. This experiment was repeated in 1938 in experiments 197 to 204, 209 to 212, 218 and 247 Emmanur Experimental Garden with 14 species and with a similar result. The species experimented with are *Acacia arabica*, *Acacia ferruginea*, *Acacia planifrons*, *Albizia amara*, *Albizia lebbek*, *Cassia auriculata*, *Pterocarpus santalinus*, *Terminalia chebula*, *Acacia auriculiformis*, *Acacia sundra*, *Cassia siamea*, *Prosopis juliflora*, *Azadirachta indica* and *Wrightia tinctoria*.

174. *Comparison of sowing, entire transplanting and stump-planting.*—In experiments 180 to 185, six species were experimented with by these three methods of regeneration. These are all species with which either difficulty is found with direct sowing or which give very variable results.

Measurement in January 1939 (at the end of the second growing season) showed that *Azadirachta indica*, *Dolichandrone crista*, *Hardwickia binata* and *Soymida febrifuga* had done best by stump-planting. *Pterocarpus santalinus* did best by transplanting but quite well by sowing and *Wrightia tinctoria* was best by transplanting but also did well by stump-planting.

(For full experimental data see paragraph 324.)

175. The experiment was repeated in 1938 in Emmanur Experimental Garden Experiments 224 to 229 with six species all of which either stump or transplant well or which often do not do well by sowing.

Results showed that all species had done reasonably well by all three methods but it remains to be seen how they fare in the coming hot weather.

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 325.)

176. *Comparison of stump-planting and transplanting.*—Experiments 177 to 179 Emmanur Experimental Garden had as their objects (a) to find the best season for stump-planting, (b) to compare stump-planting and transplanting, (c) to compare transplanting at the commencement of the south-west and north-east monsoons.

Three species were experimented with *Pterocarpus santalinus*, *Soymida febrifuga* and *Wrightia tinctoria*. These species either transplant or stump well or else give very variable results by sowing.

Re-measurement 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. Two-year old stumps were better than one-year old stumps and that July 1st and October 1st were the best dates for stump-planting.

(For full experimental data see paragraph 326.)

177. The experiment was repeated in 1938 (Emmanur Experimental Garden Experiments 221 to 223) with *Azadirachta indica*, *Pterocarpus santalinus* and *Wrightia tinctoria*. Measurements in January 1939 again showed that transplanting is better done 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.

The best time for stump-planting was August. This was however due to the failure of the north-east monsoon.

(For full experimental data see paragraph 327.)

178. *Dry fuel forest—District regeneration work.*—Throughout the dry districts there was a general failure of the north-east monsoon and consequently most districts report poor results from late sowings in September and October. A number of districts however report very good results from early sowings varying in date from May to August. The benefits of early sowings are thus again brought into prominence. It should always be remembered that if early sowings fail they can always be re-sown but if late sowings are relied on and fail nothing can be done about it.

A number of districts report extensive co-operation with local tree-planting days in the supplying of seeds and plants.

There has in general been great activity and a large amount of success in the artificial regeneration of bamboos (both *Dendrocalamus strictus* and *Bambusa arundinacea*) in many of the dry districts.

179. *District notes on rab and rab-cum-kumri regeneration.*—Chittoor division reports success with *Acacia ferruginea* (which is now being used in place of *Acacia sundra* which was disappointing) *Bauhinia purpurea*, *Anacardium occidentale*, and *Tephrosia purpurea* (as a cover crop for *Pterocarpus santalinus*).

Chittoor also reports damage to quite large *Cassia siamea* plants by porcupines and rodents.

Guntur division reports the successful raising of *Acacia arabica* (after passing the seed through goats) in conjunction with a field crop of cotton (*Gossypium* sp.)

Anantapur division and several other districts report the successful raising of rab regeneration in poor localities without a burn by the use of intensive soil working.

Chittoor division reports success in the raising of *Shorea talura* regeneration both artificial and natural.

180. *Cassia auriculata* has been very successfully raised in a number of divisions both with and without field crops. Several divisions report that this species can be raised in very poor localities even without a burn provided that intensive soil working is done. Some of the most interesting works with this species were done in an experiment in Vellore East division in which the effect of weeding and soil working was studied. The results were that there were twenty times as many survivals in the weeded and soil worked plots as in the controls and the height growth of these plants was four times that of the control plants.

181. Chittoor division reports that the reclamation of *Strobilanthes* invaded areas by rab work continues successfully. In this division also good work has been done in the introduction of *Agave* species as a living fence to demarcate reserve forest where it adjoins cultivation.

182. *Santalum album.*—The Research Ranger, Denkanikota, reports the following regeneration works with sandal of various types :—

(a) *Drooping variety of sandal.*—Seeds from sandal trees of a drooping variety in Manchi (Salem North division) were collected and sown in pots on 6th October 1938, in the Denkanikota pot-culture plot to study the nature and behaviour of regeneration obtained.

Weight of seeds	..	..	..	..	187 per ounce.
Purity per cent	..	..	..	..	88
Germination per cent	..	..	..	..	57
Plant per cent	..	..	..	..	54

No difference is noticed in the seedling stage and they look like the seedlings obtained from the ordinary variety.

(b) *Sandal seeds from Horseleykonda (a healthy area), Anantapur district.*—Seeds were collected in March 1939 from this reserved forest as there is no spike in this locality. A careful classification of a sample of 500 seeds revealed the existence of—

Three-venation seeds	..	..	..	..	350
Four-venation seeds	..	..	..	..	75
Five-venation seeds	..	..	..	..	8
Multiple venations	..	..	..	..	67

On 30th March 1939, sowings have been carried out using 200 seeds in each of three-venation and four venation, 50 seeds of five venation and 200 of multiple venation for carrying out germination tests.

Weight of sandal seeds without pulp—153 per ounce.

Purity per cent—87.

183. *Improvement of the sandal host ratio.*—Anantapur division reports great benefit by the thinning out of too profuse natural sandal regeneration combined with the introduction of suitable host plants such as *Cassia siamea*.

Similar results are reported from Chittoor division where the sandal was of bigger size and many of the plants removed were saleable. *Cassia siamea* was largely introduced to provide further host plants and these introduced plants were lopped for manure leaves at two years old. This sale of manure leaves more than paid for the host introduction.

The above operation therefore has not only greatly improved the sandal that was left but has also been remunerative.

184. *Plantations for manure leaves—Regeneration of Poinciana elata by cuttings.*—In the past three 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 74 per cent stocking at the end of the second growing season and looks very promising.

In consequence, last 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.

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 1939 at the end of the second growing season are as follows :—

Locality.	Survival percentage of cuttings planted on				
	1st June 1937.	1st July 1937.	1st August 1937.	1st Sep- tember 1937.	1st Octo- ber 1937.
Emmanur Experimental Garden.	44	14	34	8	44
South Salem division ..	42	28	22	50	62
Average ..	43	21	28	29	53

185. 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 1939 are as follows :—

Locality.	Survival percentage of cuttings planted to depths of		
	9 inches.	18 inches.	3 feet.
Emmanur Experimental Garden.	8	34	50
South Salem division ..	12	28	44
Average ..	10	31	47

186. In the experiments on the best size of cutting, cuttings of three sizes (a) 6 feet long and 11½ inches mid-girth, (b) 3 feet long and 8 inches mid-girth, (c) 1½ feet long and 6 inches mid-girth were planted to a depth of 1 foot on 5th July 1937. Results in January 1939 were as follows :—

Locality.	Survival percentage of cuttings of the following sizes.		
	Big.	Medium.	Small.
Emmanur Experimental Garden.	72	2	2
South Salem division ..	54	18	0
Average ..	63	10	1

We have thus got a definite indication that the cuttings should be planted either in the south-west monsoon in early June or else in the north-east monsoon in October.

We also have the definite indication that within the ranges experimented with the larger the cutting and the deeper it is planted, the better the result.

187. The experiments were repeated in 1938 and results in January 1939 were as follows :—

I. Best date of planting.

Locality.	Survival percentage of cuttings planted on				
	1st June 1938.	1st July 1938.	1st August 1938.	1st Sep- tember 1938.	1st Octo- ber 1938.
Emmanur Experimental Garden.	68	52	86	92	98
South Salem division ..	*	*	62	96	96
Average ..	34	26	74	94	97

* Not done through lack of stock.

II. Best depth of planting.

Locality.	Survival percentage of cuttings planted to depths of		
	9 inches.	18 inches.	3 feet.
Emmanur Experimental Garden.	58	86	84
South Salem division ..	87	71	62
Average ..	73	79	73

III. Best size of cutting.

Locality.	Survival percentage of cuttings of the following sizes.		
	Big.	Medium.	Small.
Emmanur Experimental Garden.	90	56	8
South Salem division. ..	66	64	28
Average ..	78	60	18

The above results of the first year must be regarded with caution as the full effect of the hot weather had not been felt at the time of measurement. They, however, confirm the preliminary indications obtained by the 1937 experiments.

188. *Manure leaf plantation—District work.*—Vellore East, Vellore West and Salem South divisions all report successful work in the raising of plantations for manure leaf. The species generally used are *Cassia siamea*, *Poinciana elata*, *Azadirachta indica*, *Tamarindus indica*, *Albizia lebbek*, *Pongamia glabra*, *Dodonea viscosa* and *Anona squamosa*.

Salem South division reports that after repeated trials they have come to the conclusion that results from sowings of *Poinciana elata* are generally poor and that the best method of regeneration for the species is by large cuttings. These large cuttings are however at present not available in sufficiently large quantities for large scale work by many divisions.

189. *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.

190. *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 monsoon (20th August 1938) a consignment of stumps was sent from Denkanikota to Emmanur. The 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.
- (D) Two and a half to three years old packed in gunny.

In addition, a parallel control experiment was similarly done at Emmanur with local stumps. The results of the experiments are given in the following table :—

Date of making stumps at Denkanikota.	Age of stumps.	Denkanikota stumps.			Emmanur stumps.	
		Date of planting.	Percentage of sprouting of stumps stored in		Date of planting.	Percentage of sprouting of stumps.
			Tins.	Gunny.		
20th August 1938.	One and a half to two years.	23rd August 1938.	32	24	23rd August 1938.	40
Do.	Two and a half to three years.	Do.	40	32	Do.	40

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, (7) the North East monsoon is a better time to send the stumps than the South West monsoon.

191. *Santalum album*—*Comparison of sowing, transplanting and stump planting*.—An experiment at Emmanur with this species showed the following results in survival percentage :—

Sowing 17 per cent, transplanting 33 per cent, stump planting 19 per cent.

192. *Introduction of grasses*.—The introduction of grasses is being done in a number of the dry districts. Last year results were in general poor owing to the failure of the North East monsoon. The best results were reported with Kolukkattai grass (*Pennisetum cenchroides*) in Chittoor and Guntur divisions and with Nendra (*Ischaemum laxum*) in Guntur division.

Chittoor division also tried to introduce three Australian grasses *Panicum prolutum*, *Panicum antidotale* and *astrable* but results were poor owing to the unfavourable climatic conditions and late receipt of the seed.

193. *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 four 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 were very striking.

194. 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. The species were raised by sowing in May 1936 in two large compact blocks each 40 lines of 15 plants. In July 1936 when stocking was fairly complete soil working was started. The soil working was done in blocks of five lines of 15 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.

195. It should be noted that the operation of soil working is done in lines between the plants, care being taken that the soil within three inches of each plant is not disturbed. The first operation is a scratching of the soil to a depth of about one inch to two inches and each further soil working proceeds deeper and slightly farther away from the plant line until a depth of about nine inches has been reached. (This is district practice in some of the districts producing the best "rabs.")

These large scale experiments have been repeated each year since 1936.

196. The abbreviated results of these experiments are given in the tables below. The results of the experiments of 1935, 1936 and 1937 are given at the end of the second growing season after

sowing as at this time the plants are considered to be established. The results of the 1938 experiment are of course only given up to the end of the first growing season after sowing.

Measurements at the end of the second growing season after sowing.

Year of experiment.	Control.		Soil worked.		Remarks.
	Survival.	Mean height in inches.	Survival.	Mean height in inches.	
	PER CENT.		PER CENT.		
1935	29	15.7	48	31.5	Seven experiments and seven species.
1936	70	48.3	88	66.0	Two experiments and two species.
1937	59	31.8	71	34.6	Three experiments and three species.
Average of 1935, 1936 and 1937 experiments.	53	31.9	69	44.0	Twelve experiments with seven species over three years.

Measurements at the end of the first growing season after sowing (1938 experiments).

Species.	Control.		Soil worked.		Remarks.
	Survival.	Mean height in inches.	Survival.	Mean height in inches.	
	PER CENT.		PER CENT.		
<i>Acacia arabica</i>	96	22.9	100	34.9	All differences are significant.
<i>Acacia ferruginea</i>	99	25.2	98	27.7	
<i>Caesia rames</i>	100	19.2	100	28.3	
<i>Azadirachta indica</i>	100	22.4	100	27.5	
Average of all species	99	22.4	100	29.6	Emmanur Experimental Garden experiments 213 to 215 and 237.

The above figures show that soil working averaged over the three years of the experiments has produced by the end of the second growing season after sowing an increase in survival percentage of 16 per cent and in mean height growth of 39 per cent.

197. 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 reb 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 first 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.

198. *Grassland catchment areas—General.*—The experiments started in 1934 to examine the possibility of reforesting some of the important catchment areas of the Nilgiris were continued. The indigenous sholas in these areas appear to be rapidly dwindling,

giving place to a degenerated grass-land mainly due to fire and grazing. On these open grasslands, the soil is very poor and exposed, and the severe frosts of winter, followed by desiccating winds, and a severe drought of the hot weather, make regeneration an exceptionally difficult problem.

199. Two experimental gardens were therefore opened, one at Jacko's Nulla, and the other at Brooklands. The climatic conditions of these two gardens are rather different, as shown in the following table :

Particulars.	Experimental garden at	
	Jacko's Nulla.	Brooklands.
Rainfall in inches from 1st April 1938 to 31st March 1939.	28.72	35.42
Number of rainy days	94.	100.
First frosty night	10th Nov. 1938.	10th Nov. 1938.
Lowest temperature on above date	28 degrees.	30 degrees.
Last frosty night	6th Mar. 1939.	1st Apr. 1939.
Lowest temperature on above date	30 degrees.	28 degrees.
Total number of frosty nights during the period	55.	72.
Lowest temperature recorded	20 degrees.	16 degrees.
Date of above reading	19th Dec. 1938 and 10th Feb. 1939.	19th Dec. 1938.

200. *Jacko's Nulla Experimental Garden No. 1.*—The work done in previous years was summarized in paragraph 164 of the Annual Report for 1936-37 and in paragraph 192 of the Annual Report for 1937-38. In addition to continuing observations in the experiments already started, some changes were introduced in detail, in consequence of experience gained. Pits were definitely given up in favour of beds. The size of the beds was reduced to 10' × 10' as frost protection of larger beds was found very difficult to keep efficient.

After careful examination of the various shrubby species which we hoped might serve as useful nurses, we have come to the conclusion that *Cytisus scoparius* is the only satisfactory one so far tried. It is easily raised by direct sowing in worked beds, its height growth is accelerated by a pandal covering (though it is frost hardy) and in about three years it grows sufficiently dense to be an effective frost protection for more tender species, and finally, being a leguminous plant, it seems definitely to help foster plants in their growth possibly due to nitrogen fixation.

We have continued our experiments with exotics, but have concentrated more attention on indigenous shola species than in previous years, and have succeeded in raising *Viburnum erubescens*, *Ligustrum perrotetii*, *Eugenia arnottiana*, *Cinnamomum wightii*, *Rapanea wightiana*, *Elaeocarpus oblongus*, and *Mahonia leschenaultii*, by nursery raised transplants, forest transplants, and by stump planting. Among exotics may be mentioned *Acacia dealbata*, *Acacia decurrens*, *Acacia mollissima*, *Acacia melanoxylon*, *Cupressus macrocarpa*, *Cupressus torulosa*, *Pinus longifolia*, *Pinus insignis*,

Casuarina montana, *Zizyphus incurva*, *Morus alba*, *Morus indica*, *Hakea saligna* and *Pithecolobium dulce* (Samoran variety) all of which hold out promise of success.

Very considerable damage by field rats has of late been evident, and the poison "rough on rats" is being used with promising results.

201. For the determination of the best date for stump planting in these areas, small scale experiments were started with *Acacia melanoxylon*, *Acacia dealbata*, *Mahonia leschenaultii*, *Eurya japonica*, *Viburnum erubescens*, *Rhododendron arboreum*, *Rapanea wightiana*, *Symplocos foliosa*, *Litsea wightiana*, *Cinnamomum wightii*, *Eugenia arnottiana* and *Daphniphyllum glaucescens*. The dates tried were from 25th May 1938 to 25th August 1938 at fortnightly intervals. *Viburnum erubescens* and *Rhododendron arboreum* gave 25th May 1938 as the best date, *Eurya japonica*, *Litsea wightiana* and *Eugenia arnottiana* gave 10th June 1938 as the best date, *Acacia dealbata*, *Mahonia leschenaultii*, *Rapanea wightiana*, *Cinnamomum wightii* and *Daphniphyllum glaucescens* gave 25th June 1938 as the best date, while *Acacia melanoxylon* and *Symplocos foliosa* gave 25th July 1938 as the best date. It is realized that these experiments must be done on a larger scale for a larger number of species, commencing probably from the middle of April (compare premonsoon stump planting of teak experiments) and results obtained may turn out to be a very valuable contribution to the problem of afforesting these grassland catchment areas with shola species indigenous to the locality.

An enumeration of survivals of the various species introduced from 1935 onwards has been done in March 1939. No purpose is served by recording the enumeration details here. It is sufficient to say that last year's conclusions are practically all confirmed by this year's results.

We have succeeded in practically filling up the garden with various species to an extent that will necessitate an addition to its area for continuing the work next year.

202. *Jacko's Nulla Experimental Garden No. 2.*—The fifteen patches opened in the District Experimental Plot (vide paragraph 194 of the Annual Report for 1937-38) have been maintained during the year. The only attention given was replacement of a few casualties, and frost protection, in addition to routine weeding. Enumeration in March 1939 gave the following results:—

Transplants.					Survival.	Casualties
					PER CENT.	PER CENT.
<i>Hakea saligna</i>	..	..	..	..	97	4
<i>Cupressus macrocarpa</i>	..	..	..	..	78	16
<i>Eugenia arnottiana</i>	..	..	..	..	36	0
<i>Acacia melanoxylon</i>	..	..	..	..	48	50
<i>Acacia dealbata</i>	..	..	..	..	63	27
<i>Oytisus scoparius</i>	..	..	..	..	47	0

Stumps—	Stumps and cuttings.				Survival.	Casualties
					PER CENT.	PER CENT.
<i>Mahonia leschenaultii</i>	..	..	..	..	80	0
<i>Acacia dealbata</i>	..	..	..	..	54	0
<i>Acacia melanoxylon</i>	..	..	..	..	66	0
<i>Rubus lasiocarpus</i>	..	..	..	..	30	0
<i>Hypericum mysorens</i>	..	..	..	..	9	0
Cuttings—						
<i>Buddleia</i> (1937 and 1938)	..	..	..	..	25	0
<i>Tithonia lagitiflora</i> (1937)	..	..	..	..	18	0
<i>Morus indica</i> (1938)	..	..	..	..	78	0
Average for 15 beds	..				52	7

The replacement of casualties has therefore been negligible, and the success leaves an average of 178 plants per bed of 330 square feet or one plant per 1.85 square feet. Ocular inspection shows the beds fully stocked, and the success that has attended less than two years work here, proves that our experiments have taught us a successful line of approach to the problem.

203. *Brooklands Experimental Garden.*—The work of previous years has been summarized in paragraph 163 of the Annual Report for 1936-37 and in paragraph 195 of the Annual Report for 1937-38. The work was continued with slight changes suggested by further experience during the year under review. As a result of the broom sowings done from 1934, a very good growth of broom has resulted in plot III of this experimental garden. In addition, in consequence of protection, a good growth of *Acacia dealbata* from root suckers has also resulted. Preliminary tests on the suitability of these species as nurses have been carried out by sowings, planting transplants, cuttings and stumps.

In plot III we have got the following survivals in March 1939 under the broom covering:—

	PER CENT.
<i>Pinus longifolia</i> transplants—Nursery stock	56
<i>Evodia roxburghiana</i> transplants—Forest stock	25
<i>Rhododendron arboreum</i> transplants	10
<i>Meliosma arnottiana</i> transplants	55
<i>Rapanea wightiana</i> transplants	29
<i>Symplocos wightiana</i> transplants	32
<i>Litsea wightiana</i> transplants	33
<i>Neolitsea</i> transplants	44
<i>Cinnamomum wightii</i> transplants	49
<i>Litsea wightiana</i> stumps	45
<i>Mahonia</i> stumps	69
<i>Eugenia arnottiana</i> stumps	16
<i>Eugenia arnottiana</i> sowings 1 lb.	74
<i>Cupressus torulosa</i> sowings 6 oz.	140

In plot IV (b) under the *Acacia dealbata* the survivals are fewer. This is probably due to the denser shade and possibly insect pests from the *Acacia dealbata*. The experiment will be continued with judicious opening of the *Acacia* cover.

The success that has attended our attempts under the very severe conditions in plots III and IV of the Brooklands Experimental Garden is encouraging. Here also we find that the best method is sowing broom in worked soil about three years before trying the more valuable crop.

Though sowings are cheapest initially, there is a constant risk of uneven stocking. Sowings of a few conifers like *Pinus longifolia*, mossed nursery raised transplants for most of the conifers, and stump plants for most of the indigenous shola species is indicated. The best date for these operations is still to be experimented on. Now that some success has been obtained, further experiments on the comparative merits of sowing, transplanting, and stump planting for the more successful species, and experiments on the best dates for each of these operations on a very small scale are being initiated.

204. *Regeneration of tree species in patches of natural gaultheria broom and gorse.*—In paragraph 198 of the Annual Report for 1937–38 the unsatisfactory nature of *Gaultheria* as a nurse, and the difficulty of getting natural patches of broom of sufficient size have been mentioned. A patch of gorse (*Ulex europaeus*) 44' × 36' was therefore selected in Ulnad Reserved Forests, near Andy corner, 99 pits at 4 feet intervals were dug, without interfering with the gorse cover, and transplants of *Neolitsea zeylanica*, *Symplocos foliosa*, *Cupressus macrocarpa*, *Cinnamomum wightii* and *Hakea saligna* were planted on 23rd September 1938. As gorse is very inflammable, the patch was fire protected by a scraped line all round.

In March 1939 the survivals are—

Species.	Survival PER CENT.
<i>Neolitsea zeylanica</i>	55
<i>Symplocos foliosa</i>	52
<i>Cupressus macrocarpa</i>	48
<i>Cinnamomum wightii</i>	39
<i>Hakea saligna</i>	36

The indications are thus encouraging, though penetration into the interior of a gorse bush for planting and subsequently for inspection is so difficult, that some technique will have to be evolved to facilitate this. The matter is under consideration. One suggestion is cutting narrow lines at 8 feet intervals in two directions at right angles, dividing the gorse into 8 feet square patches chess-board pattern, and putting four pits in each patch, 2 feet away from the cut lines. Present observation tends to suggest that this will give success.

It is a general observation that unlike *Eupatorium* the gorse thrives in full overhead light and not under shade. Hence if our planted species which derive initial protection from the gorse, grow taller than the gorse, the shade will kill out the gorse, and we shall have replaced the gorse by a tree growth composed mainly of shola species, such as *Litsea*, *Neolitsea*, *Cinnamomum*, *Symplocos foliosa*, etc. The successful introduction of three species of *Lauraceae* is of interest in view of the possibility of the manufacture of Lauric acid, which is assuming some importance now.

205. *Willows*—*Salix alba* var.—*Cærulea*.—In spite of the very adverse conditions that these sets have gone through since they left England in 1935, we still have some sets alive, which appear to be

established. The prospect of thus raising acclimatized stock is now encouraging.

Salix babylonica.—In paragraph 200 of last year's annual report we have mentioned that even after initial sprouting the species is liable to a set back during the first frost and probably the second frost. It has since been observed that even 3 feet tall sprouts get killed back thus. On an analogy with the tall willow sets which are planted in the Thames valley, an experiment was tried with *Salix babylonica* sets 5 to 7 feet high, planted about one foot deep. The sets sprouted satisfactorily. Such tall sets could of course not be covered for frost, and were therefore left uncovered during the 1938–39 winter. Some of them shed their leaves, but are sprouting again. In March 1939 the sets appear very healthy. It is however realized that it is too early with this species to say that we have been successful. It is only after another winter that we can decide on its efficiency. In Double Crossing, a number of sets on both sides of the stream were getting on exceptionally well. These were therefore further protected with an efficient fencing against ponies and buffaloes. The sets are established and doing particularly well.

Salix tetrasperma.—As mentioned in paragraph 201 of last year's annual report the local willow sets were used to replace casualties in the willow experiments. The plants are doing well. A further experiment was done with sets about 8 feet long, and about 4 inches diameter. Ten sets were planted in Aramby shola willow plot. All sprouted initially. Except the top 1½ feet sprouts from lower down the stem were nipped off, to encourage the formation of a crown only at the top for basket making. All sets died down to ground level. Two of the sets however produced shoots from near ground level subsequently and their development is being watched. Unlike *Salix babylonica*, small sets are better than tall sets for this species. A further experiment will be tried with tall succulent comparatively thin sets to see if they do any better than those types already tried.

206. *General*.—On an analogy with our teak stump planting experiments, a small initial experiment was done on the depth of planting willow sets planting flush with the ground, and planting with a portion of the set above ground. Both treatments at present appear equal in effect.

207. *Mulberry*.—Experiments with this species have been continued. It suffers from frost, but is not killed, as it sprouts freely after the frost is over. A very high percentage continues alive, but growth has so far been slow. Accelerated growth may be expected when the plant has produced for itself a sufficient root system.

208. *Frost protection*.—The remarks in paragraph 204 of last year's annual report have all received confirmation. One further advance in efficient frost protection is that it is a saving of labour and maintenance if palm mats are used instead of twigs or bracken for the covering of pandals, that the plants under such mat coverings

appear better than under the twig or bracken covering, and the mats can be used at least once again during the next cold weather.

The *Eucalyptus* and *Hakea* plants under the artificially raised patch of broom in Jacko are doing very well indeed.

Buddleia variegata which has been raised with the hope of utilizing it as a nurse casts at present such an uneven and comparatively light shade, that it has not been of use as a nurse so far.

209. Tan Barks.—Wattle.

Acacia decurrens and *Acacia mollissima* from authentic South African seed have been experimented with. The plants are better raised by transplanting nursery raised plants, than by direct sowing in the experimental gardens, as they are liable to be frosted back. However a great measure of success has attended direct sowing in worked patches in the Jacko's Experimental Garden, where the patches are flanked by broom and thus receive lateral protection, if those patches are provided with a pandal overhead in addition.

It is observed that young *Acacia mollissima* and young *Acacia decurrens* raised from genuine South African seed have raised, reddish rather membranous decurrent lines running from the petioles downwards. This has obviously given the specific term *decurrrens*. The *Acacia decurrens* from Naduvattam does not give such distinctly reddish and membranous decurrent lines, but has got brownish decurrent ridges on the young twigs. Some of the South African origin plants also resemble the Naduvattam origin plants. The Assistant Silviculturist has collected and pressed a series of specimens showing the transition from *Acacia mollissima* at one end, through *Acacia decurrens* (South African origin), *Acacia decurrens* (Naduvattam origin), *Acacia decurrens* (Ootacamund Adashola origin), *Acacia dealbata* (Coonoor origin), *Acacia dealbata* (Ootacamund origin) and *Acacia dealbata* (Ootacamund origin showing a type of Albinism). The variations observed may be of considerable importance, in the matter of raising of true tan bark bearing wattle plantations. Our suspicions of cross breeding between *Acacia decurrens* and *Acacia dealbata* appear to receive further support by this observation. Floral studies have not yet been made, for we have no flowers yet of South African origin *Acacia mollissima* and *Acacia decurrens*. The subject will receive attention as soon as flowers are available.

Acacia decurrens—District work.—Both Madura and the Nilgiris divisions report very good results with *Acacia decurrens* seed of South African origin.

210. *Camphor*.—An attempt to raise camphor plants in the nursery from seed of Dehra Dun origin received from the Forest Research Institute, Dehra Dun, has been unsuccessful. It is felt that Ootacamund is too cold for raising this species in unprotected nurseries. Further experiments are being continued.

211. *Seradix*.—Experiments have been started to determine the efficacy in forest work of the proprietary plant hormone "Sera-

dix" which in suitable dilutions is said to promote root formation on cuttings. There are no results yet to report.

212. *Rhododendron Plot*.—The experimental plot to determine if protection from fire and grazing helps to establish and develop *Rhododendron arboreum* already struggling in the area is continued under observation. An analysis of measurements up to date of the plot shows that both in height, growth and in number of plants the *Rhododendron* is steadily increasing with protection.

When the plot was opened in 1935, there were large blanks. Attempts with various species to stock these blanks have been continued. Enumeration in March 1939 showed 609 broom plants in 208 pits (to serve finally as frost protection), 47 *Acacia dealbata* stump plants, 3 *Acacia dealbata* transplants, 17 *Acacia melanoxylon* stump plants, 11 *Acacia melanoxylon* transplants, 64 *Mahonia* stump plants, 9 *Caprius macrocarpa* transplants, 3 *Eurya* stump plants, 12 *Hakea* transplants, 7 *Hakea* stump plants.

As a routine measure till the plot is reasonably stocked, casualties will be replaced, during the ordinary maintenance work, as this operation does not in any way affect the main observation on the *Rhododendron*.

213. *Arboretum*.—An arboretum and tree increment plot was opened in Stair Case shola for (1) the botanical identification of Nilgiri shola species, (2) the study of the diameter increment of these species, (3) phenological observations and (4) observations on the diameter when the various species become unsound; 761 trees were numbered, and most of these have been kindly identified for us by Forest Botanist, Forest Research Institute, Dehra Dun. As the identification of some of them requires confirmation, 48 sheets of specimens have been collected during the year and are being sent to the Forest Botanist. Only five more trees now require confirmation.

(vii) TENDING, THINNING, CLEANING, ETC.

214. *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 forking 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 1,500 acres per annum it is seen that the annual saving due to this piece of research alone is a considerable sum of money.

215. The research has consisted of a number of small-scale experiments followed by a series of large-scale experiments. The fourth and last of these large-scale experiments was concluded this year at Walayar.

These experiments were all arranged in large randomized blocks in the form of a latin square and each covered an area of approximately two acres.

The abbreviated results of the whole of this large-scale investigation is as follows :—

[NOTE.—The treatment of hand pulling of weeds was only done in two out of the four localities and hence the averages of this treatment cannot be directly compared with the averages of the other four treatments which include other localities. The hand pulling averages have therefore been corrected accordingly and these corrected averages are marked thus*.]

Survival percentage.—At the end of the first growing season after planting—

Treatment.	Locality.				Average.
	Nilambur.	Dhoni.	Mount Stuart.	Walayar.	
4' forking ..	99	79	93	90	90
4' scraping ..	99	75	89	91	89
Clean scraping.	97	77	92	87	88
Hand pulling.	..	75	90	..	87*
Weed cutting.	95	85	83	91	89

At the end of the first hot weather after planting—

Treatment.	Locality.				Average.
	Nilambur.	Dhoni.	Mount Stuart.	Walayar.	
4' forking ..	98	75	89	88	88
4' scraping ..	98	75	92	91	89
Clean scraping.	96	77	90	86	87
Hand pulling.	..	75	88	..	86*
Weed cutting.	94	85	84	91	89

At the end of the second growing season after planting—

Treatment.	Locality.				Average.
	Nilambur.	Dhoni.	Mount Stuart.	Walayar.	
4' forking ..	97	70	80	87	84
4' scraping ..	95	73	81	91	85
Clean scraping.	96	76	78	86	84
Hand pulling.	..	73	82	..	87*
Weed cutting.	93	80	67	91	83

Mean height growth in feet, at the end of the first growing season after planting—

Treatment.	Locality.				Average.
	Nilambur.	Dhoni.	Mount Stuart.	Walayar.	
4' forking ..	1.9	1.3	1.2	2.0	1.6
4' scraping ..	2.2	1.2	1.0	1.8	1.6
Clean scraping.	2.0	1.4	0.9	1.8	1.5
Hand pulling.	..	1.2	0.8	..	1.3*
Weed cutting.	1.6	0.9	0.7	0.9	1.0

At the end of the first hot weather after planting—

Treatment.	Locality.				Average.
	Nilambur.	Dhoni.	Mount Stuart.	Walayar.	
4' forking ..	5.0	3.7	3.9	3.3	4.0
4' scraping ..	5.3	3.9	3.4	3.0	3.9
Clean scraping.	4.6	4.1	3.6	3.1	3.9
Hand pulling.	..	3.4	2.7	..	3.2*
Weed cutting.	3.2	2.7	2.0	1.8	2.4

Mean height growth in feet at the end of the second growing season after planting—

Treatment.	Locality.				Average.
	Nilambur.	Dhoni.	Mount Stuart.	Walayar.	
4' forking ..	12.6	7.0	7.4	6.8	8.5
4' scraping ..	13.2	6.4	6.9	6.5	8.3
Clean scraping.	12.3	6.4	7.1	6.2	8.0
Hand pulling.	..	6.9	6.0	..	7.7*
Weed cutting.	10.0	4.8	4.8	3.9	5.9

216. As the main teak weeding controversy has been between the merits of 4' forking and 4' scraping, a comparison of these two treatments only averaged for the four experiments is given below :—

Time of measurement.	Treatment.	Survival, per cent.	Mean height in feet.	Remarks.
End of first growing season after planting.	4' forking ..	90	1.6	No significant difference in any of the four experiments.
	4' scraping ..	89	1.6	
End of first hot weather after planting.	4' forking ..	88	4.0	Difference significant in one of the four experiments.
	4' scraping ..	89	3.9	
End of second growing season after planting.	4' forking ..	84	8.5	No significant difference in any of the four experiments.
	4' scraping ..	85	8.3	

217. *Costs.*—The actual costs of the treatments are not given as they vary from district to district but below are given the relative costs in terms of the weed cut control. The costs are those of weeding only in each case.

Treatment.	Locality.				Average.
	Nilambur.	Dhoni.	Mount Stuart.	Walayar.	
4' forking ..	3.1	3.1	2.6	2.8	2.9
4' scraping ..	1.5	1.8	1.7	1.3	1.6
Clean scraping.	3.8	2.8	2.5	2.6	2.9
Hand pulling.	..	2.6	2.0	..	2.3*
Weed cutting.	1.0	1.0	1.0	1.0	1.0

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!

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 193 to 197.

So far, they show that weeding (soil working) by forking in such dry areas is very beneficial indeed.

It is not proposed to do any more of these large scale teak weeding experiments in these types of conditions as more than sufficient evidence has been obtained.

218. *Pruning in young plantations—Teak.*—At Nilambur there is a local practice of pruning in young plantations each year up to the first thinning. This pruning is done at the time of weeding or climber cutting, usually at the end of the hot weather each year and consists in the removal with a sharp bill hook of all side branches up to the height that a man can reach.

The advantages claimed for it are—

- (a) it is alleged to produce increased height growth,
- (b) it enables an inspecting officer to see through the young plantations and hence quickly spot centres of *Calycopteria floribunda* (a climbing pest at Nilambur) in their initial stages,
- (c) as it is always done at the time of some other operation it is claimed that its cost is negligible.

To determine the truth of these claims a large-scale experiment of randomized blocks (Experimental plot 151) was laid out in the 1937 plantation at Walluvasseri and it was pruned in May 1938 at one year old.

In February 1939, i.e., at the end of one growing season after treatment, it was found that the control trees had put on a height increment during the year of 6.3' per tree as compared with the 5.4' per tree of the treated plots. An enumeration of branches showed that the control had 3.1 branches per stem as compared with the 0.3 branches per stem of the treated plots.

It remains to be seen how these plots progress.

219. *Thinning research—Teak.*—The plots at Nilambur and in the Wynad, 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.

The set of plots on the best date of first thinning at Nilambur have already completely demonstrated that in good quality areas 4, 6 and 8 years are all too late for the first thinning. They have therefore been thinned as far as possible to normal standards (the All-India cum Burma yield tables) and will be maintained as second rotation sample plots.

Their place in the thinning research scheme is taken by the set of plots established to test whether Dr. Craib's theory of thinning is applicable to teak plantations. This theory is that thinning should anticipate suppression and serious competition should not be allowed to start. In this set we have 6 sample plots, 3 of which are the controls and are being thinned according to current district practice (so far they have been 50 per cent thinned at 4 years old). In the other set, thinnings were done at 2 years old and again 4 years old and each of these thinnings was 50 per cent.

220. *Effect of pruning young Swietenia macrophylla.*—An experiment (Experimental plot 135, Nilambur division) was started in 1935 to determine whether the pruning of 8-year old mahogany is beneficial and to see whether applying coal tar to the wounds prevents rot. During the first 2½ 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. All wounds have now closed and there is no sign of rot at any wound.

This plot at 10 years old was heavily thinned and has been converted into a sample plot. It is 0.15 acre in extent and contains 47 stems with an average height of 45 feet and an average diameter at breast height of 5.6".

(viii) MIXTURES—Nil.

(ix) UNDERPLANTING.

(a) *Teak plantations.*

221. *Underplanting in teak plantations.*—During the year all old plots were maintained.

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 very 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 under-planting.	Age of teak at under-planting.	Survival per cent of under-planted crop.	Mean height growth in January 1939.	Increment during the year.
				PER CENT.	FEET.	FEET.
NILAMBUR DIVISION.						
98	<i>Swietenia macrophylla</i>	1930	37	9	7.3	+1.2
102	Do.	1930	37	7	4.3	+0.6
99	<i>Cedrela toona</i>	1930	37	23	7.4	+0.9
103	Do.	1930	37	14	7.6	+0.5
101	<i>Bambusa arundinacea</i>	1930	37	85	15.8	+3.8
100	<i>Cephalostachyum pergracile</i>	1930	37	76	44.5	+10.0
104	Do.	1930	37	55	40.0	+7.5
105	Do.	1931	38	100	41.6	+7.8
106	Do.	1931	38	77	40.7	+6.1
WYNAD DIVISION.						
8	<i>Cephalostachyum pergracile</i>	1932	33	80	15.0	+6.1
NILAMBUR DIVISION.						
138	<i>Hopea parviflora</i>	1929	..	69	9.4	+2.0
145	<i>Bambusa polymorpha</i>	1937	6	96	5.6	+5.0
PALGHAT DIVISION.						
159	<i>Bambusa polymorpha</i>	1937	7	94	1.4	+0.5

223. In addition to the above, a further plot was laid out last year at Nilambur (Experimental Plot 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 52 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 15 years old and measure in mean height *Mesua* 5.78 feet and *Calophyllum* 6.34 feet showing a height increment during the year of 0.60 feet and 1.11 feet respectively.

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

Experimental plot number.	Species.	Canopy.	Age.	Average height in inches.	Height increment during the year.
WYNAD DIVISION.					
42	<i>Mesua ferrea</i>	Full evergreen cover.	7	30.0	3.9
43	<i>Artocarpus hirsuta</i>	Do.	7	33.1	8.1
44	<i>Gluta travancorica</i>	Do.	6	44.3	11.6
45	<i>Hopea parviflora</i>	Top canopy only	5	86.3	22.0
46	<i>Artocarpus hirsuta</i>	Do.	5	69.0	22.7
47	<i>Cedrela toona</i>	Do.	5	61.2	8.5
48	<i>Gluta travancorica</i>	Do.	5	66.9	21.1
49	<i>Swietenia macrophylla</i>	Do.	4	61.7	15.5
50	<i>Dipterocarpus indicus</i>	Do.	5	45.0	14.8

It should be noted that Experimental plot 49 suffered 50 per cent casualties during the year due to the Mahogany collar borer.

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, Wynad 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 1939 at the end of the third growing season after planting show rather poor results with most species and in all treatments. 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 :—

Species.	Stock used.	C		A		D		B		E		
		No burn—no cover crop.		Burn—no cover crop.		No burn cover crop.		Burn cover crop.		Natural undergrowth.		
		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.	
		INCHES.		INCHES.		INCHES.		INCHES.		INCHES.		
1 <i>Artocarpus hirsuta</i> .	Stumps, 0.3"/0.4"	..	56	9.8	53	27.7	34	12.7	27	15.4	51	6.8
2 <i>Swietenia macrophylla</i> .	Transplants, 22"	..	11	31.3	6	28.4	8	30.5	15	29.6	28	33.7
3 <i>Hopea parviflora</i> .	Sowing	..	63	28.5	46	18.2	19	13.6	18	12.4	66	11.9
4 <i>Hopea parviflora</i> .	Transplants, 22"	..	63	40.5	68	38.5	42	38.2	50	37.0	59	46.4
5 <i>Cedrela toona</i> ..	Cuttings 18" ..	..	13	26.7	27	22.9	10	31.5	19	19.5	23	50.5
6 <i>Do.</i> ..	Stumps, 0.2"/0.3"	..	11	36.9	19	30.5	2	25.3	9	21.7	20	52.6
7 <i>Chikrasia tabularis</i> .	Stumps	..	13	27.5	10	20.5	2	11.0	11	20.8	12	23.8
8 <i>Dipterocarpus indicus</i> .	Transplants, 3½"	..	13	44.2	13	37.5	3	44.3	6	31.0	11	29.6
9 <i>Dysoxylum malabaricum</i> .	Transplants, 13"	..	2	22.0	4	26.2	..	..	2	10.3	7	23.3
10 <i>Mesua ferrea</i> ..	Transplants, 14"	..	21	25.1	21	22.4	11	17.7	9	26.7	31	14.8
Average of all species together.		..	27	29.3	27	27.3	13	22.5	17	2.24	31	29.8

It is to be noted from the above figures that the burn has had practically no effect at all either beneficial or deleterious. This confirms the results of experiments 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 given in the following table at the end of the second growing season after planting.

It is to be noted that the *Tephrosia* cover crop is doing very well and that results at this centre are very much better than those at Chandanathode.

Species.	Stock used.	No burn— no cover crop.		Burn— no cover crop.		No burn cover crop.		Burn cover crop.		Natural under- growth.	
		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.
		INCHES.		INCHES.		INCHES.		INCHES.		INCHES.	
<i>Hopea parviflora</i> ..	Transplants, 3½"	77	9.2	66	8.2	80	6.5	90	6.7	76	7.4
<i>Swietenia macrophylla</i> ..	Transplants, 30"	92	45.2	92	46.0	93	33.1	98	33.7	99	50.2
<i>Mesua ferrea</i> ..	Transplants, 6½"	43	8.2	34	7.7	93	8.7	93	7.7	45	7.3
<i>Palaequium ellipticum</i> ..	Transplants, 5½"	8	0.5	20	7.5	79	0.2	68	8.2	15	7.8
<i>Artocarpus hirsuta</i> ..	Stumps, 0.4"/0.8"	97	15.0	89	15.7	93	6.3	95	9.0	87	10.8
<i>Hopea parviflora</i> ..	Sowing ..	77	4.0	46	4.4	95	3.5	89	3.6	70	8.6
<i>Cedrela toona</i> ..	Cuttings, 10"	92	29.8	90	28.0	45	35.2	46	38.2	53	42.8
Average of all species	..	69	16.8	62	16.8	83	14.6	83	15.3	64	18.6

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. At both Karian shola and Chandanathode evergreens do much better under top canopy shade than after clear felling with or without burning and cover crops.
- (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 *Chikrassia tabularis*.
- (6) Weeding is worth while as it gives a small gain in initial height 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.

It should be noted that the two evergreen research centres, Chandanathode (in the Wynad) 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 for rainfall statement).

229. *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 fourth year :—

Dipterocarpus indicus I (less than top canopy).

Swietenia macrophylla I and II (Top canopy only).

Cedrela toona, *Hopea parviflora* II (Slightly more than top canopy).

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

The experiment was repeated in 1936 using three shade conditions : I. Clear felling, II. Top canopy and III. Full evergreen shade and is showing similar results.

230. *Effect of burning in evergreen forest before artificial regeneration of evergreen species under top canopy shade*.—The investigation in this subject has been concluded and all the experiments done show 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 five 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.

231. *Direct sowing—Best date (under top canopy only).*—Experiments were done at each of two centres. In Chandanathode Experimental Garden Experiments 146 to 149, *Acrocarpus fraxinifolius*, *Cedrela toona*, *Swietenia macrophylla* and *Gluta travancorica* were experimented with.

Acrocarpus and *Cedrela* showed early August, *Gluta* showed early June and *Swietenia* early April as the best dates for sowing. At this centre however results were in general very poor owing to the very heavy monsoon.

In Karian Shola Experimental Garden Experiments 127, 126 and 130 *Bischofia javanica*, *Swietenia macrophylla* and *Acrocarpus fraxinifolius* were experimented with. *Bischofia* showed late May, *Swietenia* early April and *Acrocarpus* early August as the best dates of sowing.

It is to be noted that these results confirm previous years' indications that regeneration by sowing in evergreens should be done either before or after the heavy rains of the monsoon which usually occur in early July. Sowings done during the period of heavy rain usually fail as the germinating seedlings cannot stand the drip.

(For full experimental data see paragraph 328.)

232. *Entire transplanting—Best date (under top canopy only).*—Nine 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 transplanting as—

Chandanathode	..	<i>Hopea parviflora</i> late June and early August to mid September.
	..	<i>Swietenia macrophylla</i> late June and early August to mid September.
	..	<i>Cedrela toona</i> August and early September.
	..	<i>Hardwickia pinnata</i> August and early September.
Karian shola	..	<i>Swietenia macrophylla</i> mid June to mid August.
	..	<i>Mesua ferrea</i> mid June and late July to mid August.
	..	<i>Cedrela toona</i> mid June to mid August.
	..	<i>Hopea parviflora</i> early July and early August.
	..	<i>Palaquium ellipticum</i> mid August.

It is thus seen that in general (in confirmation of last year's results) the heavy rain of the south-west monsoon is a bad time for transplanting. This period is usually in July, but varies slightly from year to year. In some years 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 best period for transplanting is usually August and early September.

Chandanathode Experimental Garden Experiments 150 to 153, Karian shola Experimental Garden Experiments 115, 116 and 118 to 120.

(For full experimental data see paragraph 329.)

233. *Stump planting—Best date—(Top canopy only).*—Two experiments were done at Chandanathode and three at Karian shola to find the best date for stump planting of *Cedrela toona*, *Artocarpus hirsuta* and *Acrocarpus fraxinifolius*. These experiments all indicated that the monsoon period just before the really heavy rains of the south-west monsoon is the most suitable. This period was mid May to late June.

Cedrela at Chandanathode and *Artocarpus* at Karian shola however both did reasonably well in mid July which was after the period of heavy rain.

Chandanathode Experimental Garden Experiments 154 and 155, Karian shola Experimental Garden Experiments 121 to 123.

(For full experimental data see paragraph 330.)

234. *Comparison of sowing, transplanting small, medium and large transplants, and stumping with small and large stumps—(Under top canopy cover).*—Thirty-five experiments were done with 11 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*, *Gluta travancorica* and *Artocarpus integrifolia*, stumping was best for *Artocarpus hirsuta* while for *Bischofia javanica*, *Cedrela odorata*, *Cedrela toona*, *Swietenia macrophylla*, *Hopea parviflora*, *Mesua ferrea* and *Michelia champaka* transplants do best.

235. 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.
<i>Araucaria cunninghamii</i>	4
<i>Artocarpus integrifolia</i>	10 (but sowing best)
<i>Artocarpus hirsuta</i>	10 (but stumps best)
<i>Acrocarpus fraxinifolius</i>	14 (but sowing best)
<i>Bischofia javanica</i>	12
<i>Calophyllum elatum</i>	8
<i>Cedrela odorata</i>	6
<i>Cedrela toona</i>	12
<i>Dysoxylum malabaricum</i>	12
<i>Gluta travancorica</i>	8 (does well—if basketed)
<i>Hopea parviflora</i>	6 to 12
<i>Mesua ferrea</i>	12
<i>Michelia champaka</i>	12
<i>Swietenia macrophylla</i>	12 to 18.

(In most 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 331.)

236. *Transplanting (under top canopy cover)*—*Comparison of natural forest seedlings and nursery transplants*.—In experiment No. 98 of Karian shola Experimental Garden nursery seedlings of *Hopea parviflora* were compared with two sizes of forest transplants in 1937. The nursery transplants had succeeded very much better than either size of forest transplants used by the end of the second year.

Four more experiments comparing nursery seedlings with forest transplants of *Mesua ferrea*, *Hopea parviflora*, *Calophyllum elatum* and *Palaquium ellipticum* were started at Karian shola in 1938.

Measurements at the end of the first growing season after planting (in January 1939) showed that no advantage had been gained by using forest transplants.

These experiments combined with previous years' results indicate that there is in general with most species no advantage gained by using natural forest plants instead of nursery plants.

(For full experimental data see paragraph 332.)

237. *Comparison of direct sowing, entire transplanting with naked transplants and basketed plants (under top canopy only)*.—At Chandanathode and Karian shola, three experiments of 1937 were remeasured and three new experiments were started in 1938 in this subject.

In all these six experiments, with the species *Dysoxylum malabaricum*, *Gluta travancorica*, *Vateria indica* and *Dipterocarpus indicus*, the basketed plants are doing much the best, showing a very much higher survival percentage and an increase of height growth over both direct sowing and naked root transplanting.

This confirms previous years' results.

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.

Chandanathode Experimental Garden Experiments 114, 138 and 141 and Karian shola Experimental Garden Experiments, 85, 102 and 124.

(For full experimental data see paragraph 333.)

238. *Comparison of stumps and cuttings from nursery transplants and natural forest trees (under top canopy only)*.—In Chandanathode Experiment 156 and Karian shola Experiments 99, 113 and 114

stumps and cuttings from nursery transplants and natural forest seedlings and trees were compared for the species *Cedrela toona* and *Chikrassia tabularis*.

With *Cedrela toona* the material from nursery seedlings did better than that from natural forest seedlings and cuttings did better than the stumps.

With *Chikrassia tabularis* stumps made from natural forest seedlings (which often come up profusely) proved the best method of regenerating the species.

This success with material that is normally wasted is a valuable asset.

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

(For full experimental data see paragraph 334.)

239. *The attempted raising of exotics in evergreen forest*—*Araucaria cunninghamii*.—In 1936 seedlings of *Araucaria cunninghamii* eighteen months old which had been in bamboo tubes for ten months and which were 2" to 6" high were planted out at Karian-shola under top canopy cover.

In January 1939 these plants showed a survival percentage of 90 per cent and a mean height of 39.8". The species is however very tender to damage by deer.

Chlorophora excelsa.—At Chandanathode in 1938 two experiments were done in raising this species by stump planting. Stumps of (a) 0.2" to 0.3" diameter and (b) 0.4" to 0.5" diameter (made from one year old nursery seedlings) were planted (i) under top canopy cover and (ii) after clear felling ever-greens. In both cases the larger stumps did better than the smaller stumps. Those in the clear felling did much better than those under top canopy cover.

It is to be noted however that this species is doing very much better in mixed deciduous forest than in evergreens.

(x) SILVICULTURAL SYSTEMS—Nil.

(xi) MISCELLANEOUS.

(a) *Sandal spike disease research*.

240. *Introduction*.—The works under the Sandal Spike Investigation were carried out in accordance with the programme prepared by the Provincial Silviculturist and the District Forest Officer in consultation with the Conservators of Forests, Salem and Working Plans Circles. The Entomological works were carried out on the lines suggested by the Imperial Entomologist, Dr. Beeson, who was able to inspect our experiments once again in November 1938 and offer his valuable criticisms, remarks, and suggestions which are elsewhere detailed in this report.

241. *I. Nature and spread of the disease.*—During the year, although the spread of the disease in already affected localities was considerable, yet the new outbreaks were few in number, the most noteworthy being two in Salem North division in Dharmapuri range and one in Valliyur R.F., Nanguneri range of Tinnevely district. This latter outbreak is roughly 200 miles as the crow flies from the nearest known spike.

The particulars regarding the nearness to cultivation, rights of way, interference with hosts and the composition of hosts, etc., which have been found associated with the new outbreaks of infection have not yet been received for these areas for correlation. In all these new outbreaks control operations have been carried out.

An important step taken during the year was the transfer of a number of spike control areas both big and small, to the district staff to be carried out as routine operations. The success obtained during the past seven years has clearly proved efficacy of these operations and established their practicability in the field. Hence there was no longer any necessity to keep all these areas under special experimental operations except to retain a few of them under the control of the research staff to have a certain amount of comparison regarding the amount of infection prevalent within the large blocks of the controlled areas.

242. *II. Transmission of the disease*—(i) *Experiments to determine the size of the vector.*—During the year, 10 plants were caged with six meshes to an inch wiregauze, after testing the healthiness of the plants by pruning. The number of control plants was increased to 1,040 as 240 more plants in the area had grown big enough to act as controls. The details of caging are tabulated below :—

Serial number.	Size of cages.	Number of plants caged.	Date of caging.	Number of plants spiked.	Date of spike manifestation.	Percentage of plants spiked.
1	Twenty meshes to an inch.	10	Nine in March 1933. One in December 1933.	Nil	These cages were removed in 1936 as per the instructions of Dr. Beeson.	0
2	Ten meshes to an inch.	10	Two in March 1933. Seven in December 1933. One in September 1933.	..		..
3	Six meshes to an inch.	10	Six in June 1938.	..		..
4	Four meshes to an inch.	15	Four in July 1938. Three in March 1933. Six in September 1935.	Nil		0
5	Three-eighth inch mesh.	10	Four in August 1937. Six in September 1937.	..		..
6	Two meshes to an inch.	10	Six in September 1934. Four in November 1934.	10	One in September 1938. One on 18th July 1936; one on 18th March 1937; one on 25th June 1937; six on 18th December 1937 and one on 11th March 1938.	100

Serial number.	Size of cages.	Number of plants caged.	Date of caging.	Number of plants spiked.	Date of spike manifestation.	Percentage of plants spiked.
7	One mesh to an inch.	10	Ten in September 1934.	9	One in October 1935; one in November 1936; one in December 1936; one in May 1937; one in October 1937; two in December 1937 and two in March 1938.	90
8	Uncaged controls.	1,040		729		70

This experiment has definitely indicated that—

- the insects of the types found inside twenty meshes to an inch cage are not likely to be the vectors,
- that the vector easily gets into cages of one mesh to an inch, two meshes to an inch, $\frac{3}{8}$ inch mesh and four meshes to an inch, and infects the plants, and
- the probable size of the vector is thus between $1/20''$ and $1/4''$.

243. *Border line insects.*—The insects about which there was any doubt whether they could pass through a $\frac{1}{4}$ mesh or not were tested as follows.

A wooden box was made and divided into two compartments by a partition wall of wiregauze of four meshes to an inch. The mouths of both the compartments had light proof shutters. The insects were enclosed in one compartment and the shutter closed. Light was admitted by opening the shutter of the other compartment. The following insects were found coming through the wiregauze :—

Type number.	Family.	Name of insects (if known).
3	Pentatomidae ..	<i>Halyomorpha picus</i> Fabr.
4	Do. ..	<i>Plautia fimbriata</i> Fabr.
11	Curculionidae ..	<i>Episomus Lacerta</i> F.
12	Do. ..	<i>Mylocerus discolor</i> Boh.
13	Do. ..	<i>Sympiezomias cretaceus</i> Fst.
*14	Pentatomidae ..	<i>Menida labecula</i> Dist.
18	Jassidae ..	<i>Petaloccephala nigrilinea</i> Wlk.
18 C	Do. ..	<i>Petaloccephala granulosa</i> Dist.
23	Fulgoridae ..	<i>Sarima nigroclypeata</i> Mel.
24 A	Membracidae ..	<i>Otinotus oneratus</i> Wlk.
22	Do. ..	<i>Gocosterphus tuberculatus</i> Motsch.
28	Jassidae ..	<i>Moonia albimaculata</i> Dist.
*29 A	Do. ..	<i>Neodartus scutellatus</i> Dist.
*21	Do. ..	<i>Jassus indicus</i> Wlk.
20	Do. ..	<i>Bythoscopus indicus</i> Leth.
19	Do. ..	<i>Acropona walkeri</i> Kirk.
97	Lygaeidae ..	<i>Oxycaenus laetus</i> Kirby.
108	Curculionidae ..	<i>Centorrhynchus ? asperulus</i> Fst.
*109	Jassidae ..	(3 species?)
146	?	?

* Denotes those types which are still included in the suspected vector list.

In this experiment difficulty was found in that in some cases, insects below $\frac{1}{4}''$ in size did not pass through the wire mesh. Dr. Beeson examined this experiment and suggested that foliage

should be tried as an attraction and that it should be tried in the dark as well as in the light, as light might be a repellant to night insects. This is being carried out.

It should be noted that the above list is merely a preliminary tentative list and is not final.

244. (i) *Sticky papers experiments*.—In this plot in Noganur R.F., sticky papers 3' × 3' were exposed at cage height every month in accordance with the Forest Entomologist's suggestions. At the end of twenty days exposure each month, they were taken out and sent to the Forest Entomologist for his kind identification and remarks. Similarly, sticky papers were hung up in the Javalagiri R.F. platform area and after exposing for twenty days were similarly sent to Dehra Dun.

As a result of the examination of sticky paper catches the following insects were suggested as probable vectors and individual transmission experiments are being carried out with them :—

Family.	Name of insect.
<i>Jassidae</i>	* <i>Nirvana pallida</i> .
<i>Do.</i>	* <i>Drubescus angulatus</i> .
<i>Do.</i>	<i>Deltocephalus</i> sp.
<i>Do.</i>	<i>Eutettix</i> sp.
<i>Do.</i>	* <i>Kartura</i> sp.
<i>Do.</i>	* <i>Paralimnus albinaculatus</i> .
<i>Do.</i>	* <i>Pettigoniella</i> sp.
<i>Do.</i>	* <i>Rhombopsis</i> sp.
<i>Do.</i>	<i>Scaphoides festivus</i> .
<i>Do.</i>	<i>Chikkaballapura</i> sp.
<i>Do.</i>	* <i>Pediopsis orientalis</i> .
<i>Do.</i>	* <i>Selanocephalus</i> sp.
<i>Aphidae</i>	* <i>Macrosiphum</i> sp.

* Types that are included in the revised list of suspected insects to be tried in the coming year.

245. (ii) *Platform experiments*.—These were designed to fix the periods of infection as stated in the last year's report. They were continued in two localities, at Aiyur and Javalagiri, and plants were exposed on platforms, the period of exposure being limited to one month as was done last year. In the case of Aiyur, the locality of the experiment was changed in February 1938. The results obtained so far are summarised as follows :—

246. *Platform experiments at Aiyur*—(a) *Site selected near Samayeri tank in Aiyur Extension III R.F. where sandal was sparsely distributed*.—

Started in April 1931.

Year.	Period of exposure.	Number of plants exposed.	Number of plants spiked.
1931	Three months ..	14	1
1932	Two months ..	28	4
1933	Two months ..	28	4
1934	Two months ..	14	1
1934	One month ..	28	3
1935	One month ..	14	2
1937	One month ..	28	2

(b) *Site changed to near Aiyur Rest House in Aiyur Extension IV R.F. where sandal growth is dense*.—(Started in February 1938).

No spike manifestation has occurred in the set of plants exposed on the platforms in this locality so far.

247. *Platform experiments—Javalagiri*.—Among the Javalagiri platform plants there was no incidence of spike from the time of its start to 1937 which is suspected to be due to the presence of plentiful and attractive healthy sandal plants in the locality. However, two plants, one exposed in August 1937 and one in December 1937 exhibited the disease in the month of October 1938.

248. *Experiments to find out at what period of the day the infection is effected*.—The experiment detailed last year was continued but the locality of the experiment was changed in February 1938 from the Samayeri site where the sandal was sparsely distributed to a site nearer Aiyur bungalow where there are plenty of both healthy and spiked sandal trees, as it was thought that the virulence of the disease had moved towards the bungalow judging from the large number of trees that manifested the disease.

Results.—I. Site selected near Samayeri tank in Aiyur Extension III R.F., where sandal was sparsely distributed :—(a) Two sets of 16 plants were started one set for exposure at night and the other for the day.

Year.	Period of exposure.	Exposed during			
		Night.		Day.	
		Number of plants exposed.	Number spiked.	Number of plants exposed.	Number spiked.
1935	Two months ..	16	1	82	2
1938	Two months ..	16	1	82	2

As noted last year this set of results is regarded with suspicion as infection at dusk or dawn may have been included as either day or night. The experiment was therefore changed as follows :—

Platform cage experiments.—Three sets of 16 plants, one for the day, one for exposure during dusk and dawn, and one for the night :—

Started on 7th September 1936.

Year.	Period of exposure.	Exposed during					
		Day number.		Night number.		Dusk and dawn number.	
		Exposed.	Spiked.	Exposed.	Spiked.	Exposed.	Spiked.
1937	Two months ..	32	..	32	2	32	..

Site changed near Aiyur Rest House in Aiyur Extension IV R.F., where sandal growth is dense.—Started in February 1938.

No spike manifestation so far.

249. The results obtained from the platform experiments are consolidated as shown in the tabular statement below giving the number of cases against each month of each year in which infection occurred. For periods of two months exposure, the middle of the period is taken as the date of infection.

Months.	Years.						Total.
	1932.	1933.	1934.	1935.	1936.	1937.	
January	..	..	..	..	..	..	0
February	..	..	1	..	..	..	1
March	..	..	..	..	1	1	2
April	2	..	..	..	..	1	3
May	..	..	..	..	..	..	0
June	..	1	..	1	..	..	2
July	..	..	..	..	..	..	0
August	..	..	1	2	..	1	4
September	..	2	1	..	1	..	4
October	..	2	1	1	1	..	4
November	2	..	..	..	..	2	4
December	..	..	..	..	..	1	1

The above figures although small in number show a main infective season from August to November and a secondary infective season in March and April.

250. *Day and night insect collections.*—In order to get an idea of the difference between day and night insect collections in a spike area during the infective season a test collection was made by the same staff in Noganur spike area from 9 p.m. to 1 a.m., on the night of November 17th and from 2 p.m. to 6 p.m., during the day of the 18th November.

These were classified by the Forest Research Institute, Dehra Dun, as follows:—

“The total number of insects caught during the day is 371 in 56 species, and that during the night is 542 in 86 species, in all 913 excluding 45 spiders and millipedes.

“In the *Jassidae*, 14 species have been obtained, of which 7 were caught during the day and 10 during the night; 3 *Acropona Idiocerus* and *Jassus* have been caught both during the day and the night. *Empoasca* sp. *Pediopsis* sp. and *Deltocephalus* sp. have been found only in the day collections while *Bythoscopus* sp. *Dious* sp. *Eutettix* sp. *Ledra* sp. *Nephotettix* sp. and *Petaloccephala granulosa* have been caught only during the night. *Aphids* have also been obtained both during the day and the night collections.”

These test collections have thus shown a marked difference between the suspected insects caught by day and those caught by night.

251. (iii) *Insect group transmission cages at Kenilworth Castle area.*—The experiments detailed last year were continued.

During the year, fresh sets of plants were put in the cages at the end of each quarter, after removing the old set. The following table gives the total number of insects released in each cage during each period:—

Cage number.	Natural orders released in each cage.	Period of exposure.		Total number of insects released.	Number of plants exposed.	Remarks.
		From	To			
1	<i>Jassidae</i>	19 10 36	8 9 37	748	3	
		9 9 37	25 4 38	525	3	
		26 4 38	6 9 38	318	3	
		7 9 38	6 12 38	634	3	
2	<i>Pentatomidae</i>	19 10 36	8 9 37	3,014	3	
		9 9 37	25 4 38	2,068	3	
		26 4 38	6 9 38	418	3	
		7 9 38	6 12 38	1,179	3	

Cage number.	Natural orders released in each cage.	Period of exposure.		Total number of insects released.	Number of plants exposed.	Remarks.
		From	To			
3	<i>Jassids and Pentatomids.</i>	19 10 36	8 9 37	2,748	3	
		9 9 37	25 4 38	2,388	3	
		26 4 38	6 9 38	250	3	
		7 9 38	6 12 38	963	3	
4	<i>Fulgorids</i>	19 10 36	8 9 37	385	3	
		9 9 37	8 6 38	268	3	One plant was suspicious but returned to normal subsequently.
		9 6 38	6 8 38	175	3	
		7 9 38	6 12 38	301	3	
5	<i>Jassids and Fulgorids.</i>	19 10 36	8 9 37	198	3	
		9 9 37	8 6 38	318	3	One plant was suspicious but returned to normal subsequently.
		9 6 38	6 9 38	175	3	
		7 9 38	6 12 38	405	3	
6	<i>Pentatomids and Fulgorids.</i>	19 10 36	8 9 37	2,125	3	
		9 9 37	8 6 38	2,018	3	
		9 6 38	6 9 38	315	3	
		7 9 38	6 12 38	936	3	
7	<i>Coreids, Pyrrhocoreids, and Chrysomelids.</i>	19 10 36	8 9 37	384	3	
		9 9 37	8 6 38	318	3	
		9 6 38	6 9 38	142	3	
		7 9 38	6 12 38	515	3	
8	All except those released in cages 1 to 7, 9 and 10.	19 10 36	8 9 37	1,815	3	
		9 9 37	8 6 38	2,518	3	
		9 6 38	6 9 38	851	3	
		7 9 38	6 12 38	1,378	3	
9	<i>Membracid and Curculionids.</i>	19 10 36	8 9 37	3,019	3	
		9 9 37	8 6 38	2,818	3	
		9 6 38	6 9 38	648	3	
		7 9 38	6 12 38	1,743	3	
10	<i>Locustids and Acridiids.</i>	19 10 36	8 9 37	985	3	
		9 9 37	8 6 38	899	3	
		9 6 38	6 9 38	414	3	
		7 9 38	6 12 38	330	3	

The sandal plants which were reported as suspicious in the cages in which Fulgorid and Jassid, and Fulgorid alone were released in the last year's report, returned to normal subsequently.

No other cases of suspicion or spike manifestation occurred during the year in these group cages.

Dr. Beeson inspected these experiments and it was decided to continue them in this locality with some slight modifications.

252. (iv) *Transmission Experiments with Individual Species of Insects.*—The experiments described last year were continued in both the localities—Denkanikota potculture plot and Javalagiri reserve forest with many individual species or types.

The work carried out so far is summarized thus:—

In *Jassidae*, 19 species, viz., *Petaloccephala nigrilinea*, *Petaloccephala granulosa*, *Acropona walkeri*, *Jassus indicus*, *Jassus*

pauperculus, *Neodartus accoscephaloides*, *Neodartus scutellatus*, *Neodartus* sp. *Idiocerus clypealis*, *Moonia albimaculata*, *Ledra mutica*, *Ledropsis* sp. *Bythoscopus indicus*, *Pentimnia submiger*, *Nirvana* sp. and six unidentified *Jassids* have been tested in 126 experiments till 11th January 1939, 70 at Denkanikota utilizing 5,901 insects from 89 (in *Ledra mutica*) to 1,544 (in *Petaloccephala nigrilinea*) including eight experiments with unidentified species varying from 4 to 68 insects, and 56 experiments at Javalagiri utilising from 19 (in *Ledra mutica*) to 2,257 (in *Acropona walkeri*) including three experiments with unidentified species varying from 2 to 35 insects. The number of experiments per species has varied from 1 to 15 comprising in all 15,243 individuals of *Jassidae* 5,901 at Denkanikota and 9,342 at Javalagiri.

In *Pentatomidae*, 21 species viz., *Catacanthus incarnatus*, *Chrysocoris* sp. *Chrysocoris stockerus*, *Nezara viridula*, *Nezara viridula* var *torcuata*, *Coptosoma siamicum*, *Coptosoma cribrarium*, *Plautia fimbriata*, *Nymphs of Hotea* sp., *Menida labecula*, *Hotea nigrorufa*, *Hotea curculionides*, *Dalpada clavata*, *Plautia* sp., *Dolichoris indicus*, *Rhynchocoris plagiata*, *Sastragula heterospila*, *Hotea* sp. *Halyomorpha picus*, *Antestia cruciata* and *Canthecona fercellata* (a predator bug) have been tested in 121 experiments till 11th January 1939, 65 at Denkanikota utilising insects from 63 (in *Halyomorpha picus*) to 1,779 (in *Coptosoma siamicum*) and 56 experiments at Javalagiri from 29 (*Hotea* sp.) to 2,459 (in *Coptosoma siamicum*). The number of experiments per species has varied from 1 to 9 comprising in all 21,627 individuals of *Pentatomids*, 10,363 at Denkanikota and 11,264 at Javalagiri.

In *Fulgoridae*, 15 species viz., *Fulgorid* sp., *Eurybrachys tomentosa*, *Forculus viridis*, *Sarima nigroclypeata*, *Coinquinda nigroclava*, *Flatta ferrugata*, *Satapa granulosa*, *Seliza* near *partite*, *Saturnis marginellus*, *Centromaria* sp., *Dictyophara*, *Tambinia verticalis*, *Ricania fenestrata* and *Brahmaloka fletcheri*, have been tested till 15th January 1939 in 82 experiments, 34 at Denkanikota utilising 2,811 insects from eight (in *Fulgorid* sp.) to 1,144 (in *Sarima nigroclypeata*) and 48 experiments at Javalagiri from 98 (in *Tambinia verticalis*) to 1,632 (in *Sarima nigroclypeata*). The number of experiments per species has varied from 1 to 9 comprising in all 8,203 individuals of *Fulgoridae*, 2,811 at Denkanikota and 5,392 at Javalagiri.

In *Lygaeidae*, 3 species viz., *Graptostethus argentatus*, *Graptostethus servus* and *Oxycarenus latus* have been tested till 2nd December 1938 in 17 experiments, eight at Denkanikota utilising 853 insects from 33 (in *Oxycarenus latus*) to 741 (in *Graptostethus servus*) and nine at Javalagiri utilising from 24 (in *Oxycarenus latus*) to 2,361 (in *Graptostethus argentatus*).

The number of experiments per species has varied from 1 to 8 comprising in all 3,388 individuals of *Lygaeidae*, 853 at Denkanikota and 2,535 at Javalagiri.

In *Tettigonidae*, four species, viz., *Letana inflata* (nymphs and adults separately), *Xiphidiopsis straminula*, *Sathrophyllis rugosa*, and *Orihacris* sp. have been tested in 36 experiments till 7th January 1939, 12 at Denkanikota with the nymphs and adults of *Letana inflata* and 24 at Javalagiri utilising from 67 insects (in *Sathrophyllis rugosa*) to 12 (in *Letana inflata*). The number of experiments per species has varied from 2 to 14 comprising in all 4,906 individuals of *Tettigonidae*, 850 at Denkanikota and 4,056 at Javalagiri.

In *Membracidae*, 3 species viz., *Leptocentrus taurus*, *Otinotus oneratus* and *Coccosterphus tuberculatus* have been tested in 28 experiments till 5th January 1939, 14 at Denkanikota utilising from 89 insects (in *Leptocentrus taurus*) to 1,205 (in *Coccosterphus tuberculatus*) and 14 experiments at Javalagiri from 495 insects (in *Leptocentrus taurus*) to 690 (in *Coccosterphus tuberculatus*). The number of experiments has varied from 5 to 13 comprising in all 3,694 individuals of *Membracidae*, 1909 at Denkanikota and 1,785 at Javalagiri.

In *Coreidae* one species only, namely, *Homeocerus* sp. has been tested in two experiments at Denkanikota alone utilising 61 insects in all.

In *Capsidae* one species only namely *Lucinatus punctatus* has been tested in 13 experiments five at Denkanikota comprising 320 insects and eight at Javalagiri comprising 634 insects utilising 945 insects in all.

In *Melalonthidae*, one species *Schizomycha xanthoedera* has been tested in a single experiment utilising 90 insects only.

In *Lycidae*, *Lycostomus similis* has been tested in two experiments at Denkanikota utilising 74 in one and 101 in the other or 175 in all.

253. *Suspicious symptoms*.—During the year, suspicious spike like symptoms appeared on two plants in the case of feeding in individual transmission cages with *Jassus indicus* (*Jassidae*) and one plant in a cage fed with *Coccosterphus tuberculatus* (*Membracidae*) as detailed below :—

(a) *Type No. 21*.—*Jassus indicus*—*Case No. 1*.—Three healthy plants and one grafted plant were introduced into a 3 feet cube cage in pots and individual insects of *Jassus indicus* were introduced daily into the cage. On 22nd February 1938, the plants were removed from the cage and kept under observation in the potculture garden. The above cage experiment was done at Denkanikota potculture plot. In September 1938 all plants shed their leaves probably due to insufficient watering. This acted as defoliation and on 3rd November 1938, the new foliage that appeared

on this plant No. B 24 looked suspicious. The leaves from this plant were grafted on six healthy sandal plants to decide if it is a case of spike and at the same time six healthy plants were grafted with genuine spike leaf to act as controls.

None of the *Jassus* material grafted sandal plants or the controls have yet manifested the disease but sufficient time has not yet elapsed.

(b) *Jassus indicus*—Case No. 2.—Three healthy sandal plants were introduced with a grafted plant on 9th November 1937 in a 3-foot cube cage at Denkanikota. 26 insects of this individual were released by 16th January 1938. The three healthy plants were removed on 17th January 1938 from the cage and kept under observation. They were defoliated on 16th August 1938. In February 1939, one plant, No. 5051, gave rise to suspicious symptoms. Grafting has been carried out on six plants and at the same time, grafting with genuine spike leaves on six other healthy plants to serve as controls was done on 15th February 1939. The results of grafting are awaited.

(c) Type No. 22—*Coccosterphus tuberculatus*.—On 1st March 1938, three plants with a grafted plant were introduced in a cage at Denkanikota potculture plot. By 11th May 1938, 52 insects were released. The healthy plants were removed and kept isolated on 12th May 1938. Plant No. 6684 gave rise to suspicious shoots on 7th January 1939. Grafting of the leaves from this plant was carried out on 15th February 1939 on six healthy sandal plants with necessary controls. Results are awaited.

(d) *Nezara viridula* suspicious plants described in last year's report.—None of the plants grafted with the material from the above plants have manifested the disease whereas 3/10 of the controls have exhibited the disease.

These suspicious plants (two in number) have returned to normal.

The suspicious plants detailed in (a) to (c) have not in any way been connected with death of or unhealthiness of the host plants as was the case described last year with *Moonia albimaculata*. They are well tended and kept under close observation but so far they show no signs at all of returning to normal.

254. *Experiments with Aphids, Thrips and Red spider*.—These were done in single pot cages. None of the plants experimented with have manifested the disease. The insects were allowed to feed on spike twigs and leaves before being released in these cages and in addition a small spiked twig was also put in.

The experiments were inspected by Dr. Beeson who suggested the use of both healthy and diseased plants in the same cage. A new type of cage is now being devised.

255. *The individual transmission experiments*.—The work done so far detailed above was gone through by the Forest Entomologist during his camp in November 1938 and a revised list of suspected insects after carrying out various eliminations was prepared for use in the experiments during the coming year. A list was also prepared showing the types of insects that were considered to have been given a fair trial and these types of insects which are considered to have been sufficiently tested are also detailed below.

It was decided that the following conditions should be satisfied before it can be considered that an insect has been well and sufficiently tested:—

- It must have been tested in both the infective seasons (i.e., March and April and August to November) and if possible in more than one year.
- The average mortality of insects was worked out by sleeving insects on the food plants of each species and also from observation of the cage experiments, and it was found that the average period an insect lives in our cage experiments is about two weeks. Therefore the maximum period between releases during the experiment should be one week or less.
- The number of insects released should be reasonable. (This depends on the occurrence of the species, etc., and cannot be defined.)
- Throughout the experiment at least one insect must be present in the cage the whole time.

256. *List of insects that have been given a fair trial in the individual transmission experiments*:—

Type No.	Family.	Name of insect
18-C	Jassidae	<i>Petaloccephala grahnsa</i> Dist.
21-A	Do.	<i>Jassus pauperulus</i> Spang.
29	Do.	<i>Neodartus accochaloides</i> Mel.
51	Pentatomidae	Nymphs of <i>Chrysocoris</i> Sp.
71	Do.	<i>Chrysocoris stockius</i> Linn.
23	Fulgoridae	<i>Sarima nigrocypta</i> Mel.
23-A	Do.	<i>Coinquinda nigrocypta</i> Dist.
89-A	Lygaeidae	<i>Graptostethus argenteus</i> Fabr.
24	Membracidae	<i>Otinotus oneratus</i> W.

257. *III. Revised list of suspected insects to be tried in the coming year*.—A revised list of suspects was prepared during the year after eliminating the following insects:—

Those—

- That cannot pass through $\frac{1}{4}$ inch mesh,
- that are found in the potculture plot at Denkanikota,
- that are not common to Javalagiri and Denkanikota mass infection cages, and
- that are eliminated on biological grounds.

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The revised list of suspects is given below :—

Type No.	Family.	Name of insect.	Remarks.
14	Pentatomid	<i>Menida labecula</i> Dist.	Test in October.
20-A	Jassid	<i>Parabalocratus porrectus</i> Wlk.	
20-B	Do.	?	
21	Do.	<i>Jassus indicus</i> Wlk.	
21-B	Do.	?	
23-C	Fulgorid	<i>Brahmaloka fletcheri</i> Dist.	Test in October.
24-B	Membracidae	<i>Oxyrhachis mangiferana</i> Dist.	
24-C	Do.	<i>Tricentrus transversus</i> Dist.	
25-A	Pentatomidae	<i>Coptosoma fuscomaculatum</i> Dist.	
26	Cercopidae	<i>Poophilus costalis</i> Wlk.	
26-A	Do.	<i>Aphrophora</i> sp.	
27-B	Membracidae	<i>Membracid</i> sp.	
27-C	?	?	
27-D	?	?	
29-A	Jassidae	<i>Neodartus scutellatus</i> Dist.	
29-B	Do.	<i>Neodartus</i> sp.	
38	Cercopidae	<i>Machaeota</i> sp.	
53	Pentatomidae	<i>Menida varipennis</i> Westw.	
73	?	?	
77-A	Jassidae	<i>Ledropsis</i> sp.	
82	Pentatomidae	<i>Brachycercoris camelus</i> Costa	(Test in October.)
92	Fulgoridae	<i>Dictyophora</i> sp.	(Test in March-April.)
92-A	Do.	<i>Centromeria</i> sp.	(Test both seasons.)
92-B	Do.	<i>Tambinia verticalis</i> Dist.	(Test both seasons.)
92-C	Fulgoridae	?	(Test both seasons.)
109	Jassidae	(3 species) ?	Test both seasons.
112-A	Fulgoridae	<i>Saliza near partite</i> Mel.	Test both seasons.
112-B	Do.	<i>Saliza</i> sp.	Test both seasons.
124-A	Lygaeidae	<i>Aphanus sodidus</i> Fabr.	
130	Pentatomidae	<i>Dolycoris indicus</i> Stal.	
152	Do.	<i>Nezara viridula</i> Var.	
152-A	Do.	<i>Nezara viridula</i> L. Var. <i>torquata</i> F.	
168	Capsidae	<i>Lucinatus punctatus</i> Kirby	Well tested but do again.
175	Fulgoridae	Nymphs of <i>Fulgorid</i> sp.	
178-A	Jassidae	<i>Penthimia submiger</i> Dist.	
183	?	?	
185	Pentatomidae	<i>Hotea nigrorufa</i> Wlk.	
188	Do.	Nymphs of <i>Hotea</i> sp.	
203	Fulgoridae	<i>Salurnis marginellus</i> Guer.	
204	Pentatomidae	<i>Coptosoma ostensum</i> .	
212	Do.	?	
214	Do.	Nymphs of <i>Coptosoma</i> sp ?	
228	Do.	?	
238	Do.	Nymphs of <i>Chrysocoris</i> sp.	
240	Pentatomidae	Nymphs.	
263	Do.	<i>Sastragala heterospila</i> Wlk.	

Suspects derived from the sticky papers experiments at Noganur and Javalagiri—

Family.	Name of insect.
<i>Aphidae</i>	<i>Macrosiphum</i> sp.
<i>Jassidae</i>	<i>Nirvana pallida</i> (Test in October).
Do.	<i>Drubescus angulatus</i> .
Do.	<i>Eutettix disciguttatus</i> .
Do.	<i>Kartura</i> sp.
<i>Jassidae</i>	<i>Parabinnus albimaculatus</i> .
Do.	<i>Tettigoniella</i> sp.
Do.	<i>Rhombopsis</i> sp.
Do.	<i>Pediopsis orientalis</i> .
Do.	<i>Selanocephalus</i> sp.

List of suspects derived from distribution, etc., and other collections such as Kenilworth Castle—

Family.	Name of insect.
<i>Jassidae</i>	<i>Kolla unimaculata</i> .
Do.	<i>Nirvana suturalis</i> .
Do.	<i>Rhysomorphus indicus</i> .

258. Potculture collections.—In connexion with the above elimination it was thought essential to carry out an insect survey in the potculture plot at Denkanikota where all experiments under controlled conditions are carried out.

In this plot spiked, disease masking, and healthy sandal plants have remained together for over ten years. As no natural transmission of the disease in this plot has occurred it is a legitimate assumption that the vector is absent.

The insects collected in this plot were sent to Dehra Dun and identified. The list of insects so identified is given in Part II, paragraphs 335 and 336.

259. IV. Control operations.—This is dealt with under headings, viz., (1) Prevention and (2) Cure.

(1) Prevention.

The work mainly consists of isolating a resistant strain of sandalwood.

(a) Acquired resistance.—(i) Grafting under controlled conditions.—The following further combinations have been raised for grafting to test the efficacy of individual species either to build up resistance in sandal or otherwise against the disease :—

Serial number.	Species.	Number of combinations.
1	<i>Ocimum sanctum</i>	15
2	<i>Toddalia aculeata</i>	22
3	<i>Chloroxylon swietenia</i>	78
4	<i>Cariassa carandas</i>	32
5	<i>Atalantia monophylla</i>	23
6	<i>Miliusa eriocarpa</i>	15
7	<i>Olea glandulifera</i>	15
8	<i>Bambusa arundinacea</i>	12
9	<i>Acacia auriculiformis</i>	23

Serial number.	Species.	Number of combinations.
10	<i>Terminalia arjuna</i>	11
11	<i>Breynia rhamnoides</i>	20
12	<i>Strychnos potatorum</i>	25
13	<i>Semecarpus anacardium</i>	12
14	<i>Pithecolobium dulce</i>	13
15	<i>Gyrocarpus jacquini</i>	27
16	<i>Strychnos nux vomica</i>	9
17	<i>Melia indica</i>	93

(ii) *Mound experiments*.—These are continued and the following combinations have manifested the disease :—

Name of combinations.	Number spiked.
<i>Terminalia arjuna</i>	1
<i>Murraya koenigii</i>	6
<i>Canthium didymum</i>	3
<i>Chloroxylon swietenia</i>	1

Sandal in combination with the other species are so far healthy.

(iii) *Scientific tending of sandal and introduction of resistant*

II-C	II-D	I-C	I-D
II-B	II-A	I-B	I-A

hosts.—The results obtained as a result of grafting under controlled conditions were applied to the field conditions. Eight blocks of 5 acres each, were selected in Noganur reserve forest as

shown in the sketch on the margin; in four plots, all resistant hosts were retained and susceptible hosts removed and sandal tended; in four plots all susceptible hosts were retained and sandal tended. Necessary controls were also maintained.

The plot is in the direction of the spread of spike in the reserve. The experiment was started in the year 1931. In the month of September 1938, spike appeared in the control plot as well as in the plots in which susceptible hosts are favoured whereas the plots in which resistant hosts are favoured were free from the disease. By the end of December 1938, spike appeared in the resistant host plots along the margin adjacent to the natural forests where there is plenty of healthy and also spiked sandal. The ratio of spike manifestation incidence in the plots is :—

Resistant : Susceptible : 1 : 90.

This once again clearly indicates the striking effect of introducing resistance imparting hosts, in spike areas, where spike is spreading in an epidemic form.

(b) *Autogenic resistance*.—(i) The 22 resistant sandal plants of 1932 set planted in the Javalagiri reserve forest are continuing healthy and three plants have yielded fruits.

(ii) Seventy-five plants possessing autogenic resistance isolated by grafting them four times, each time with a normal dose, were planted in Javalagiri reserve forest in October 1937. There was a large number of casualties at the end of 1938 among these due to failure of rains. Six of these got spiked as a result of natural infection and only 26 plants are now continuing healthy. Some of these have flowered and fruited. The indication is thus that although these plants resist artificial infection by grafting, they do not necessarily resist natural infection.

The work of isolating more resistant plants is in progress.

10 similar plants planted in Sanamavu reserve forest in 1932 to act as controls are perfectly healthy flowering and fruiting.

(iii) *Sandal plants from 4 venated seeds*.—None of the plants are yet ready for grafting.

(iv) *Noganur reserve forest peculiar sandal tree*.—The peculiar sandal tree referred to in last year's report was kept under observation during the year. This tree was found apparently affected with spike on 19th December 1937 and leaves and twigs were sent to the Forest Botanist, Forest Research Institute, Dehra Dun, on 24th February 1938 and the results of his analysis are detailed below :—

“Some of the leaves and twigs of the tree sent by you are found to be infested with fungus *hyphae* which are both hyaline and smoke coloured the former being slender in structure and the latter comparatively stouter.

None of the specimens, except one leaf is found to bear the fruit bodies of the fungus *Gloeosporium* sp. referred to in my previous report. Fruit bodies of no other fungi can be made out on the specimens. There is very little sign of starch accumulation in the leaves but there is marked deposition of starch in the twigs.”

Pollination experiments were carried out on 21st November 1937 as detailed in the last year's report. No fruits were obtained on any of the plants kept in pots or on the twigs of peculiar sandal.

On 30th June 1938 and 1st July 1938, 50 potted plants were grafted with bark material from the diseased twigs of the peculiar sandal at varying dosage of 4 to 8 patches to each plant.

(This was done as leaf grafts have repeatedly failed to produce any transmission of either spike or suspicious symptoms.)

On 27th July 1938, fusion of grafts was observed only on 36 plants. All the grafted plants were later defoliated. None of the plants have yet manifested the disease but one is very suspicious. The peculiar sandal plant itself is now dead.

Root sucker.—The root sucker obtained by trenching and cutting of the roots in May 1932 is continuing in the same "peculiar" state.

Seedling regeneration.—As reported last year a few "peculiar" seedlings have been raised from seed from the "peculiar" tree. These are however not yet big enough to test by grafting.

(v) *Introduction of sublethal doses of infective material to induce immunity.*—Till February 1939, seven doses have been given to 14 sandal plants and two doses for the 26 plants added to this experiment during the last year.

All plants are continuing healthy.

(vi) *Prevention of infection by spraying with insect repellent sprays.*—As detailed last year the insect repellants detailed below were sprayed on healthy sandal plants in diseased areas once a month and the results are tabulated :—

Locality.	Repellants used.	Date of start.	Number of plants sprayed.	Number of plants spiked till February 1939.	Percentage of spike.
Javalagiri ..	Lead arsenite ..	March 1935 ..	108	11	10.1
	Copper arsenite ..	Do. ..	108	24	22.2
	Nicotine ..	Do. ..	108	17	15.7
	Derrisol ..	Do. ..	108	11	10.1
	Cinchona ..	Do. ..	108	13	12.0
	Controls water ..	Do. ..	108	28	25.9
Aiyur ..	Lead arsenite ..	August 1933 ..	50	5	10.0
	Copper arsenite ..	Do. ..	50	6	12.0
	Nicotine ..	Do. ..	50	9	18.0
	Asafoetida ..	Do. ..	50	5	10.0
	Cinchona ..	Do. ..	50	5	10.0
	Controls water ..	Do. ..	50	14	28.0

The results obtained for a period of three years in the case of Javalagiri and five years in the case of Aiyur are striking.

(vii) *Lopping and spraying.*—The experiments started in Noganur reserve forest in 1935-36 to test whether re-infection of lopped trees in newly affected localities could be prevented by spraying them with a composite spray of lead and copper arsenites were continued during the year. So far (February 1939) 13 out of 500 sprayed plants (i.e., 3 per cent) and 81 out of 2,670 controls (not sprayed, i.e., 3 per cent) manifested the disease. The disease has spread in this reserve forest during this year in a virulent form unchecked.

The fact that no infection occurred till March 1938 in the sprayed plants indicates that the spray is probably effective but later could not stop an epidemic form of spread of the disease.

(viii) *Injection experiments.*—During the year, a new set of injection experiments, using the same chemicals, was started, as it was thought that the dosage given in respect of each chemical in the old experiment was insufficient. In order to find out the maximum possible dosage, a start has been made since

December 1938 with more concentrated solutions. The dosage will be increased until the plant shows signs of wilting, etc. The following chemicals are used and 50 plants have been allotted for each treatment :—

Name of chemical.	Dosage given in December 1938.	Remarks.
1 Aluminium sulphate ..	Concentrated solution (Saturated solution).	No wilting sign observed in any of the cases so far.
2 Zinc sulphate ..	Do.	
3 Manganese chloride ..	Do.	
4 Pyridine ..	1 : 400.	
5 Strychnine hydrochloride ..	Saturated solution.	
6 Formalin ..	1 : 5.	
7 Nicotine ..	1 : 40.	
8 Water controls ..		
9 Ordinary controls ..		

(2) Cure and control of spike.

260. As has already been noted during the year a number of areas in which control operations were being done by the research staff were handed over to the district, retaining only such areas as are needed for experimental purposes. Among the areas transferred were those of Manchi, Devasthanam, Kothanur and Kodagarai.

Areas under the research staff.

Examples of outbreaks, the control measures adopted and their effect in areas under the research staff are as follows :—

(i) *Hosur Cattle Farm area.*—A spike outbreak was reported last year in the locality which is about $4\frac{1}{2}$ miles as the crow flies from the Kenilworth Castle area and 13 miles from Thalli Spike area. Ninety trees were found affected and all these were treated with Atlas and removed. Lopping of all apparently healthy trees numbering 506 within the Cattle Farm limits and 256 in the patta lands nearby were carried out in February 1938. The results so far are—

	Spiked.
June 1938 ..	2
September 1938 ..	1
October 1938 ..	2
Total ..	5

or 5 out of 756 lopped trees have so far manifested the disease. There is no further spread outside the limits. This shows the efficacy of control operations in newly infected localities if they are properly and promptly carried out.

(ii) *Denkanikota Reserve Forest 1937 area*.—One tree was found spiked in Denkanikota Reserve Forest in a locality about three-fourths of a mile from the main spike area in November 1937. The tree was girdled and treated with Atlas. The area was demarcated by a belt of 100 feet width and all apparently healthy trees numbering 390 were lopped. So far 5/390 lopped trees have manifested the disease and there is no further spread.

(iii) *Denkanikota Reserve Forest 1936 subsidiary area*.—This is situated at a distance of 2 miles as the crow flies from the nearest spike area. Spike was noticed in 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.

Four out of 73 lopped trees have manifested the disease so far and they were killed at once with Atlas solution. No further recrudescence has occurred in the area.

(iv) *Denkanikota Reserve Forest main spike area*.—The disease started in this area in the year 1926. Control operations were carried out in December 1932 and January 1933. The extent of the area is 300 acres. Some of the trees in the unreserve adjoining this area were found spiked in 1932-33 and there were some spiked trees in the patta lands adjoining this area. Permission to carry out the control operations in the unreserve and permission to carry out the control operations in the patta lands were obtained from the Revenue department and from the pattadars respectively and control operations were completed by March 1934 in the unreserves and by November 1934 in the patta lands.

During the year 1938, the disease spread slightly outside the demarcated limits in one corner of the plot. This portion was at once demarcated and all apparently healthy trees in the same portion were lopped.

It is interesting to note that the incidence of spike is gradually but progressively lessening in this block though its extent is 300 acres.

New areas dealt with in 1938-39.

(1) *Salem North division*.—Two cases—one near the path going from Kodagarai to Belrampatti in Kesurgulli Reserved Forest and one near the path going from Erimalai to Belrampatti in Kesurgulli Reserved Forest of Dharmapuri Range—were reported in the month of September 1938. The two spiked trees—one in the former and one in the latter—were at once killed with Atlas. Regular control operations were carried out by the district staff.

(2) *Tinnevely division*.—On 3rd June 1938 one sandal tree was found affected in Valliyur Reserved Forest, Nanguneri Range, Tinnevely division, which is approximately about 200 miles from the nearest known spike and the tree was found to be dying on 9th July 1938. A belt of 100 feet width round this area was demarcated and at the same time all sandal trees within the belt were lopped, numbered and listed. Further observations revealed on 19th July 1938, 6 out of 14 trees so marked were unhealthy and the original tree was completely spiked. This tree was uprooted and burnt. In addition, two other trees to the south of 100 feet belt were observed to be similarly affected and therefore the original belt was extended 6 chains south and then the two belts were demarcated. All the trees in the second belt were also lopped.

On 26th October 1938, four more spiked trees were uprooted and burnt and on 31st October 1938, two more trees were found affected with spike which were uprooted and burnt.

The remaining trees are kept under observation.

The above is a striking instance of the effect of the issue of the "Standing orders for the detection and control of spike" by the Chief Conservator of Forests two years ago. It has stimulated the interest and observation of subordinates and in this case owing to the keenness of the Ranger, the outbreak was reported in its very initial stages even though it occurred a very long distance from the nearest known spike and in a district in which the disease has not been known before.

Experiments in electroculture.

261. As electroculture is reputed not only to improve the condition of healthy plants but also to cure several plant diseases including insect borne diseases, a few simple experiments were started in order to get a preliminary indication of its efficacy (or otherwise) in the treatment of spike.

Four sets of plants were treated on 11th February 1939 as follows :—

- (a) In order to determine whether it can cure spike, a set of very newly spiked plants were treated.
- (b) In order to determine whether it can cure spike in the disease masking stage, a set of plants were treated in which the virus had been introduced artificially by grafting, the grafts had fused, but no manifestation had taken place.
- (c) In order to determine the efficacy of electroculture as a preventive measure, a set of healthy plants were treated and then grafted with spiked tissue.
- (d) A further set of healthy plants were treated to see whether the treatment caused any marked beneficial effects in height, girth, foliage, etc.
- (e) a fifth set of healthy plants were kept untreated as control.

All plants were completely measured and described before treatment.

Treatment consisted of connecting the plants by means of a copper wire to the magneto of a 5 H.P. B.S.A. Motor cycle and the "dosage" given was 25 kicks (approximately 50 sparks) of the kick starter.

Great care was taken to see that the copper wire was in no way earthed except through the plants under treatment that it touched.

Results are awaited.

Technique to find out if an area is susceptible to infection or not and how far the environmental factors influence the resistance or susceptibility.

262. The experiments started in 1935-36 are continued and plants from different localities are being raised for infection purposes.

General.

263. (i) *Periodical insect collections*—(a) *Thalli Reserved Forest*.—Spike started in this Reserved Forest in 2 bits in 1915 and in the southernmost end in 1929. Still the disease has not spread uniformly throughout the area. Healthy patches are found interspersed due not only to the different floristic compositions in the healthy and diseased patches but also probably to a differing insect fauna. In order to find out the actual difference in the insect fauna and thereby possibly to get at the vector, periodical collections for 10 days each month are being made and the insects so collected are sent to Dehra Dun for identification.

(b) *Field crops*.—As spike usually starts in association with or in close proximity to field crops it is possible that the vector may be an insect connected with the field crops. In order to test this theory, insect fauna is collected in field crops in newly infected localities close to Denkanikota and sent to Dehra Dun for analysis and advice.

(ii) Twenty-five types of insects out of the remaining 57 types not yet identified have been sent to the Forest Entomologist, Dehra Dun, for his kind identification.

(iii) In order correctly to record the annual incidence of the disease each year, Dr. Beeson suggested the selection of 100 plants in different localities in February every year, their defoliation, rejection of those that manifest spike immediately and to keep the rest exposed to infection from April. Early in April in the following year all the plants are again defoliated to bring out masked symptoms. The number of plants spiked in these sets will give the annual infection.

So far till February 1939, 53 at Javalagiri, 10 at Noganur and 4 at Aiyur during the year 1938 set are spiked showing the higher infection at Javalagiri than at Aiyur and Noganur, but full figures for 1938 will be available only in May 1939.

The annual incidence of the 1937 set was 35 at Javalagiri and 4 at Aiyur, showing that infection is higher at Javalagiri than at Aiyur.

Summary.

264. The main results obtained during the year are—

- (1) The visit of Dr. Beeson in November 1938 during which a complete stock taking of all work done since his previous visit in 1936 was done and future work was outlined.
- (2) Elimination of many insects on the experimental evidence obtained and the preparation of an up-to-date list of suspected insects for future trial.
- (3) Suspicious spike like symptoms have been obtained by feeding individual species of *Jassus indicus*, *Nezara viridula* and *Coccosterphus tuberculatus* on healthy plants in cages. These were in no way connected with the unhealthiness or death of the host plants as was the case with *Moonia albimaculata* reported last year. The *Nezara* suspicious plants in due course returned to normal, but the suspicious plants for *Jassus indicus* and *Coccosterphus tuberculatus* so far show no signs of returning to normal. Grafting has so far failed to transmit the suspicious symptoms to healthy plants.
- (4) Control operations as practised by the district staffs have been carefully inspected, summarized and defects in applying the control operations detailed and remedies described.
- (5) Control works and recent advances in our knowledge of the disease have been written up for publication as Indian Forest Records.

Summarising and recording of information.

265. Apart from the above work, during the year a large number of experiments of the past eight years were summarised. These experiments refer in general to two aspects, (a) sandal parasitism, and (b) spike disease.

As these experimental results have in general not yet been recorded in these annual reports, and as they have had and are having a great influence on the work now being done and the experimental methods that are being used, they are described very briefly as follows:—

I. Experiments on sandal parasitism.

266. (a) Sandal is an obligatory parasite.

(b) Experiments have shown that different host plants promote the different physiological functions of sandal such as growth, seeding, resistance to disease and probably also heartwood formation to very different degrees. Therefore suitable hosts should

be introduced where they are lacking in order to produce sandal of the highest economic value.

(c) The capacity to be haustorised by sandal varies according to species of host—Leguminous hosts are generally well parasitised and non-leguminous hosts only moderately.

(d) There are hosts such as aloes, Divi Divi (*Caesalpinia coriaria*), *Grevillia robusta*, *Flueggia leucopyrus*, which are very difficult to parasitise.

(e) Sandal is sometimes self-parasitised.

(f) Parasitisation generally and largely takes place on tender roots. Dr. Barber has well illustrated this fact and states that the roots of sandal touch the host roots and secrete a liquid which softens the epidermis and through this the parasitic root enters the host root and suction takes place.

(g) In self-parasitisation, parasitisation is mutual, but the number of haustorial connexions depend on the number of tender roots of one plant which touch the roots of the other.

(h) The amount of haustoria on each sandal plant when 2 or 3 sandal plants are together and mutually parasitised, varies from time to time, as tested by pot plants, and depending on this, the morphological appearance of each sandal varies from time to time.

(i) A sandal plant parasitising on a host thrives whereas one parasitising on another sandal plant soon dies, but in the latter case death does not occur as soon as is the case with a single sandal plant with no host and no other sandal plant.

(j) When 2 sandal plants are parasitising on each other and also on a common host, removal of one sandal retards the growth of the other immediately on removal, but the sandal left quickly recovers and flourishes very well afterwards.

(k) A sandal parasitising on an evergreen host or a host which is full of foliage continues to remain evergreen, whereas a sandal parasitising on a deciduous host generally behaves similarly to its hosts and is deciduous.

II. Experiments on spike disease.

267. *Periods of infection to manifestation and manifestation to death*—(1) *Infection to manifestation*—(a) *Natural infection in the field*—

	DAYS.
Minimum period	64
Maximum period	402
Average period	209

(Approximately 7 months).

All plants were below 2½" girth.

(b) Artificial infection by grafting—

	DAYS.
Minimum period	31
Maximum period	576
Average period	138

(Approximately 4½ months.)

(All plants were below 2½" girth.)

(2) Manifestation to death—

(a) Natural infection of forest trees in the forest—

	DAYS.
Minimum period	64
Maximum period	1,100
Average period	456

(Approximately 15 months.)

Girth class in inches.	Average period in DAYS.
0—3	308
3—6	425
6—9	452
9—12	538
12—21	954

(b) Natural infection of plants in pots—

	DAYS.
Minimum period	69
Maximum period	676
Average period	264

(Approximately 9 months.)

(All plants were below 2½" girth.) Note that the average period closely corresponds to the 0"—3" girth class figures given in (a) above.

(c) Artificial infection of grafting of plants in pots.— Period of death from manifestation.

	DAYS.
Minimum period	45
Maximum period	882
Average period	445

(Approximately 15 months.)

(All plants were below 2½" girth.)

III. Experiments on the transmission of the disease.

268. (1) Grafting with scion, bud, bark and leaf from the diseased plant has given the following results:—

	Splked. PER CENT.
Scion grafts	23
Bud grafts	29
Bark grafts	45
Leaf grafts	70

The leaf graft was therefore selected as the standard test.

(2) Grafting material from disease masking plants has given the following results :—

	Spiked. PER CENT.
Disease masking leaves from grafted plants on which fusion had taken place	45
Bark pieces from grafted plants on which fusion had taken place	29
Disease masking leaves from apparently healthy branches of a partially spiked tree newly infected	39
Disease masking leaves from healthy looking branches of an artificially spiked sandal plant	33

(3) Yellow spiked sandal leaves when grafted do not transmit the disease. (Period of the experiment 2nd July 1930 to 15th October 1933.)

(4) Grafting tissues from spike like plants of *Zizyphus oenoplia*, *Dodonea viscosa*, *Datura stramonium*, and *Vinca rosea* have not induced spike in sandal nor has the grafting of mosaic sandal and *Malvastrum coromandalianum* leaves been successful. (Period of the experiment 23rd June 1930 to 10th May 1935.)

(5) Slices of haustoria from spiked sandal plants when grafted have not induced the disease. (Period of the experiment 1st July 1930 to 10th May 1935.)

(6) Sets of single stemmed healthy plants were grafted on the main stem and this main stem was completely girdled by cutting with a knife, one month, 21 days, 16 days, 10 days, 1 day and one hour after grafting respectively for the different sets. The disease developed in the cases of plants girdled one month and 21 days after grafting but not in the remainder thus showing that 21 days after grafting is a sufficient time in which the virus can circulate. (1930 to 1936).

(7) Needle inoculation of spiked sap failed to produce transmission of the disease. (1932 to 1935.)

(8) Rubbing healthy sandal tender branches with a serrated instrument like a saw after previously rubbing it on the tender branches of spiked plants produced transmission of the disease to the extent of 1 per cent thus indicating the possibility of tissue transplantation by insects. (1932 to 1935.)

(9) Healthy bark patches soaked in spiked sandal sap for 2 hours and grafted did not transmit the disease. (Period of the experiment 4th May 1932 to 10th May 1935.)

(10) Grafting healthy bark patches soaked for one hour in spike sap did not transmit the disease. (Period of the experiment 12th August 1932 to 10th May 1935.)

(11) Healthy leaves trimmed and dipped in spike sap for varying periods from 15 minutes to 6 hours and then grafted did not produce the disease. (Period of experiment covers 3 years 1932 to 1935.)

(12) Dried spike leaves were grafted with no positive results. (Period of experiment 19th November 1929 to 30th May 1933.)

(13) Grafting of parts of phyllody from newly spiked plants did not transmit the disease. (Period of the experiment 24th July 1930 to 30th May 1933.)

(14) Grafting green tissue below brown coloured layer of bark taken from spiked plant did not produce the disease. (24th July 1930 to 30th May 1933 is the period of the experiment.)

(15) Healthy sandal plants were grafted with spiked leaf tissue and immediately kept in darkness for six weeks and then exposed to sunlight. In due course 33 per cent of the plants developed the disease thus showing that the virus had lived and circulated during the six weeks in which it was deprived of sunlight.

(16) Flaps were made with a knife in the tender bark of a number of species. Spiked leaves were put into these flaps which were then bandaged up for 11 days. After this period the spiked material was taken out of the flaps and used for grafting healthy plants.

Results were as follows :—

Species.	Spiked. PER CENT.
<i>Lantana camara</i>	50
<i>Acacia farnesiana</i>	33
<i>Pongamia glabra</i>	17
<i>Nerium odorum</i>	17
<i>Wrightia tinctoria</i> , <i>Zizyphus oenoplia</i> , <i>Melia azadirachta</i> ..	..

This experiment shows that the virus is capable of living while in association with the sap of host plants which are known to make the sandal parasitic on them susceptible to the disease.

(17) Spiked leaves kept immersed in distilled water for 15 and 60 hours respectively and the material then taken and used for grafting—100 per cent of the plants grafted in each case manifested the disease, thus showing that soaking in water does not destroy the virus.

(18) Soaking spiked leaves in arsenic solutions even though very dilute and for a short time apparently destroyed the virus, for grafting with such material in no case gave positive results.

(19) Introduction of flowers of sulphur into the sandal plant by grafting and then infecting it by grafting diseased tissues has not prevented the disease—30 per cent of the plants showed spike.

(20) Boiled extract from spiked sandal leaves injected into healthy plants and then grafted with spike leaves has not given any immunizing effect, as 17 per cent of the plants got the disease.

(21) Secretion from Cicads was injected and no transmission occurred. (Period of the experiment 11th May 1931 to 11th May 1935).

(22) Healthy leaf inserted in Cicad secretion for 15 minutes and then grafted to healthy sandal—No transmission took place. Period of experiment 11th May 1931 to 11th May 1935.

(23) Grafting of *Acacia* gall on sandal, did not transmit any disease. (Period of experiment 15th August 1931 to 10th May 1935).

(24) Well matured spiked sandal stems and healthy sandal plants kept together in distilled water for one day and the healthy sandal then transplanted with *Acacia farnesiana* did not get the disease. (Period of experiment 3rd August 1931 to 10th May 1935.)

(25) Healthy leaf trimmed and dipped in spike sap extracted by a centrifuge for half an hour and grafted to healthy sandal. No transmission occurred. (Period of experiment 13th November 1931 to 10th May 1935.)

(26) No "spike" was transmitted by grafting spiked sandal leaves and bark treated with liquid air. (Period of the experiment 3rd September 1930 to 15th October 1933.)

(b) Periodicity of height growth.

269. *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:—

A. Evergreen forest.

270. (i) *Chandanathode*.—All species grew throughout the year very slowly and steadily, but with an appreciably increased rate from the beginning of April to the middle of June, and from the middle of September to the middle of November. The last week of April and the first week of May were periods of very active growth. The middle of June to the middle of September was a period of comparative quiescence, and December to February was a period of rather slow growth. (Chandanathode Experimental Garden Experiment No. 66.)

Species.—*Swietenia macrophylla*, *Dysoxylum malabaricum*, *Hopea parviflora*, *Dipterocarpus indicus*, *Cedrela toona*.

(ii) *Karianshola*.—In the Karianshola Experimental Garden No. 1, *Swietenia macrophylla*, *Hopea parviflora*, and *Mesua ferrea* grew from early April 1938 to about the middle of May 1938, and exhibited supplementary short periods of growth towards the end of June 1938, the end of July 1938 to the beginning of September 1938, the beginning of October 1938, and early November to the end of December 1938. The rate of growth of *Swietenia macrophylla* was comparatively greater than that of *Hopea parviflora*, and *Mesua ferrea* grew slower than *Hopea*.

In the Karianshola Experimental Garden No. 2 all species grew slowly during the year with a slight retardation in growth about the middle of May, early September and the end of December. *Artocarpus hirsuta* exhibited rapid growth throughout the year and spurts of very rapid growth in April and the end of August.

Species.—*Swietenia macrophylla*, *Hopea parviflora*, *Cedrela toona*, *Dipterocarpus indicus*, *Artocarpus hirsuta*.

In Karianshola Experimental Garden Experiments 131 to 136 study of the periodicity of height growth of *Bischofia javanica*, *Acrocarpus fraxinifolius*, *Mesua ferrea*, *Artocarpus hirsuta*, *Vateria indica*, and *Gluta travancorica* have been started. Measurements are available only from November 1938, and it is too early to draw conclusions. In general November and January were periods of very rapid growth, while December was a period of comparative quiescence.

Species.—*Bischofia javanica*, *Acrocarpus fraxinifolius*, *Mesua ferrea*, *Artocarpus hirsuta*, *Vateria indica*, *Gluta travancorica*.

B. Mixed deciduous forests.

(i) Nliambur.

271. Teak grew actively from April 1938 to January 1939. February and March 1939 were periods of comparative rest. The most active growth was from the end of May to early December.

Mahagony grew vigorously in April 1938, rather slowly in May 1938 and then fairly steadily from June 1938 to the end of January 1939. February and March 1939 was a period of rest. In April 1938, June 1938, end of August 1938, and December 1938 plants in the 3 feet espacement exhibited greater height increment than plants in the 6 feet and 9 feet espacements. Andaman padauk exhibited active growth from the 3rd week of March 1938 to the 3rd week of December 1938, followed by a period of rest. In consequence of monkey damage during November 1938, the trend of growth has to some extent been obscured.

Bambusa polymorpha exhibited vigorous growth from mid-April 1938 to the third week of February 1939. This was followed by a month of rest to the third week of March 1939, when active growth recommenced.

Species.—*Tectona grandis*, *Swietenia macrophylla*, *Pterocarpus dalbergioides*, *Bambusa polymorpha*.

(ii) Kannoth.

272. All species grew throughout the period from the middle of March 1938 to the end of December 1938 but with short periods of retarded growth in early July, early August, and early November.

Species.—*Terminalia paniculata*, *Tectona grandis*, *Swietenia macrophylla*, *Pterocarpus dalbergioides*, *Pterocarpus marsupium*, *Dalbergia latifolia*, *Terminalia crenulata*, *Artocarpus hirsuta*, *Bambusa polymorpha* (started 14th October 1938).

(iii) Begur.

273. With the exception of *Castanospermum australe* all the other species started growing about the end of March 1938, and this growing season lasted till about the end of November 1938, with a supplemental very short period of growth in the middle of December. With *Castanospermum australe* the growth was almost negligible throughout the year except for a short spurt in the latter half of December. Both bamboos grew exceedingly fast during August and September.

Species.—*Tectona grandis*, *Dalbergia latifolia*, *Terminalia crenulata*, *Pterocarpus marsupium*, *Artocarpus hirsuta*, *Swietenia macrophylla*, *Schleichera trijuga*, *Castanospermum australe*, *Chloroxylon swietenia* (Ceylon origin), *Dendrocalamus strictus*, *Bambusa arundinacea*.

A new series of periodic height measurements were started in October 1938. It is too early to generalize from these measurements. But the measurements indicate that height increment continued up to early January 1939.

Species.—*Tectona grandis*, *Swietenia macrophylla*, *Artocarpus hirsuta*, *Terminalia paniculata*, *Lagerstræmia lanceolata*, *Lagerstræmia flos reginæ*, *Trema orientalis*, *Schleichera trijuga*, *Chlorophora excelsa*, *Bambusa arundinacea*, *Bambusa polymorpha*, *Dendrocalamus strictus*, *Dendrocalamus brandisii*.

(iv) Dhoni.

274. All species exhibited growth from early April to the Middle of December. The most noticeable growth was during June, July and August for Teak and *Terminalia crenulata*. Results for *Swietenia macrophylla* have been obscured by casualties and borer attack.

Species.—*Tectona grandis*, *Terminalia crenulata*, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Swietenia macrophylla*.

A new series of experiments (periodic height measurements) was started in October 1938. It is too early to draw conclusions from these experiments. In general however it appears that there

has been a period of active growth from the middle of October to the end of December, and a supplementary period in early January.

Species.—*Tectona grandis*, *Artocarpus hirsuta*, *Lagerstræmia lanceolata*, *Lagerstræmia flos reginæ*, *Trema orientalis*, *Swietenia macrophylla*, *Terminalia paniculata*.

(v) Topslip.

275. Teak of South Burma, Mount Stuart, Mysore and Nilambur origins exhibited active growth from early April to early December 1938, broken by three weeks of considerably retarded growth in June 1938.

Terminalia crenulata also exhibited similar growth, but from about the third week of April. *Xylia xylocarpa* and *Pterocarpus marsupium* exhibited similar growth to *Terminalia crenulata* but appreciably slower.

The growth of *Dalbergia latifolia* was very slow, from the end of March 1938 to the end of May 1938, rather more rapid from early July to early September 1938, and very slow again from early October to the middle of November 1938. June 1938, the greater portion of September 1938, the second half of November 1938, and December 1938 were periods of rest.

Species.—*Tectona grandis* of four origins, *Terminalia crenulata*, *Pterocarpus marsupium*, *Xylia xylocarpa*, *Dalbergia latifolia*.

(vi) Anaipadi.

276. A new series of periodic height measurements were started at Anaipadi in October 1938. The available measurements are yet too few for generalization. All the species however exhibited active growth from October to December. The growth tended to fall to almost nothing in early December in most cases, with a supplementary period of growth in the latter half of December, and early January. By the middle of January, a period of rest commenced.

Species.—*Tectona grandis*, *Terminalia paniculata*, *Terminalia crenulata*, *Pterocarpus marsupium*, *Dalbergia latifolia*, *Lagerstræmia flos reginæ*, *Lagerstræmia lanceolata*, *Swietenia macrophylla*.

(C) Dry fuel forest.

277. *Emmanur*.—In general the species experimented on exhibited three periods of active growth—

- (1) During March, April and May 1938.
- (2) During August, September and the first half of October 1938.
- (3) During the latter half of December and the first half of January 1939.

The second period mentioned was, in the case of several species, appreciably the period of fastest growth.

Species.—*Acacia auriculiformis*, *Acacia ferruginea*, *Acacia sundra*, *Albizia amara*, *Anacardium occidentale*, *Azadirachta indica*, *Cassia siamea*, *Prosopis juliflora*.

A new series of experiments on periodic height measurements were started in July 1938. It is yet too early to generalize conclusions from these measurements. All the species have grown fast during August 1938, and then slower and slower, until up to about early November. From early November, the growth has been slow and steady to the end of January 1939.

Species.—*Acacia auriculiformis*, *Acacia ferruginea*, *Acacia sundra*, *Albizia amara*, *Albizia lebbek*, *Azadirachta indica*, *Cassia siamea*, *Prosopis juliflora*.

(c) Weeds.

Lantana eradication.

278. (a) *Biological methods*.—Observation of the *lantana* seed fly was continued. During the past year the incidence of this fly was much smaller than in the previous year. This was possibly due to the drought caused by the failure of the north-east monsoon.

Leaf defoliation of *lantana* was observed to be generally severe.

279. (b) *Chemical methods*.—Work in the eradication of *lantana* by sodium chlorate spraying was continued and more large scale work carried out.

It is now quite definite that under climatic conditions such as those in North Salem division *lantana* of a density of 10,000 stems per acre can be controlled at a total cost of Rs. 8 to Rs. 12 per acre.

Details of the making up of the solution and of the spraying have been given in past reports and are not therefore repeated.

280. (c) *Silvicultural methods*.—The work of underplanting *lantana* with bamboos which was started in 1933 in North Salem was continued. The planting is done by coolies crawling under the *lantana* and putting in 1 or 2 year old bamboo rhizomes without disturbing the *lantana*. No cutting or clearing is done.

This work is definitely successful at a cost of roughly Rs. 3 to Rs. 4 per acre and the best species tried so far is *Bambusa arundinacea*. In 3 to 6 years roughly 75 per cent of the bamboo plants have come right through the *lantana* and the issue is no longer in any doubt.

281. (d) *Combination of lantana eradication improving the host/sandal ratio and introducing economically profitable species*.—In Salem North division the work of attempting to eradicate *lantana* is not an isolated problem but is intimately connected with other forest problems. In many of the sandal forests *lantana* has come in and in many places is almost the exclusive host of sandal. *Lantana* is a host plant that makes the sandal parasitic on it susceptible to the spike disease. *Lantana* has also very considerably reduced the grazing areas.

Therefore in general we wish to eradicate the *lantana* and replace it by more suitable host plants for the sandal which will render the sandal resistant to spike disease and at the same time be profitable in themselves.

Work on this problem has been going on for some 5 years and is now definitely successful. The *lantana* is cleared by spraying and is replaced by *Cassia siamea* or *Bambusa arundinacea*. This is done in long strips about 25 to 50 feet wide and spaced out roughly 2 to 5 chains apart according to the growth on the ground.

It is to be noted that in the early stages of this regeneration work regrowth of *lantana* can be cleared by spraying as the sodium chlorate spraying has no effect on young *Cassia siamea* or bamboo after they are over about 6" high.

It should also particularly be noted that the maximum benefits are obtained from this work when it is done in accessible areas near markets and lines of export for in such cases the concentrated plantations of bamboos and *Cassia siamea* can be profitably worked by themselves and more than pay for their introduction. The *Cassia siamea* can be lopped for manure leaf as well as worked for fuel.

Interesting experiments were done in this work to determine (1) whether uprooting and burning the *lantana* or spraying it was cheapest and (2) whether line sowings or patch sowings gave the better results.

The general indications of these experiments so far are that spraying is about 30 per cent to 50 per cent cheaper than uprooting and burning, that there is very little difference in results between line sowings and patch sowings and thirdly that soil working has a very great beneficial effect.

282. *General*.—The general results of this *lantana* eradication work are that spraying is the cheapest and most efficient method of controlling the pest and costs roughly Rs. 10 per acre. Cutting and burning is not nearly so efficient and costs about Rs. 10 to Rs. 12 per acre; arsenical poisoning, though efficient costs roughly Rs. 13 to Rs. 18 per acre. The density of *lantana* dealt with is approximately 10,000 stems per acre.

283. In February 1939 very fierce fires (largely due to the almost complete failure of the north-east monsoon of October, November 1938) have swept through many of the experimental areas of North Salem division. The full extent of the damage is not yet known and it remains to be seen how the various species and experiments have withstood this calamity. This will be made a special report in next year's publication.

284. In order to test the capability of *Bambusa arundinacea* to suppress *lantana* in mixed deciduous forest of good quality four experiments are in progress. (Experimental Plot 32, Wynad division, Experimental Plot 67, South Coimbatore division and Experimental

Plot 150, A and B in Palghat division). In each experiment, plots of about 1 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 1 year old transplants and rhizomes at 15' × 15' espacement in alternate lines. No cutting of *lantana* at all was done and it was as little disturbed as possible.

By the end of the second year it was obvious that the bamboo could not establish itself under the *lantana* without some clearing of the latter (unlike our dry districts). In consequence a very little clearing of the *lantana* was done just over each bamboo plant.

At the end of the third year the establishment is as follows :—

Division.	Experimental plot number.	Survival percentage.	Mean height in inches.
Wynad	32	84	23·8
Coimbatore South	67	52	15·9
Palghat	150 A	90	42·0
	150 B	85	31·6
Average ..	78		28·3

285. *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., 3 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. In August 1938 the *Strobilanthes* flowered in all three plots. Leaf, flower and fruit specimens have been collected and sent to the Forest Botanist, Forest Research Institute, Dehra Dun, and his identifications are awaited.

286. *Attempted suppression of Eupatorium in the Nilgiris*.—The weed *Eupatorium* is seriously invading grazing grounds 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.

So far, the experiments appear promising but a little further attention is necessary after the initial introduction as the grass is kept down by the buffaloes which graze in the vicinity while the *Eupatorium* has no such set back.

It is also to be noted that the *Eupatorium* is very easily got rid of by a sodium chlorate spray but as it is a shallow rooted species it can more cheaply be pulled out by hand after rain. The *Eupatorium* thus uprooted is a good base for making "compost" for nursery manure.

II. WORKING PLANS AND STATISTICS.

287. (i) *Working Plans*.—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.

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 plan 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.	..	..	Field work nearly completed. Drafting of the plan is in progress.
II	Anantapur and Chittoor divisions.	..	..	Do.
III	Wynad division ..	..	..	Do.
IV	Kurnool East division.	..	Kurnool South division.	Do.
V	Guntur division ..	..	..	Do.

Working Plans for Vellore East and Cuddapah South divisions were sanctioned during the year. The cost of preparation of these plans was 5·6 pies and 1·5 annas per acre respectively.

288. (ii) *Yield, volume and form factor tables*.—Yield tables.—In paragraph 317 of last year's report mention was made of the New All-India cum Burma Teak yield tables that were being prepared by the Central Silviculturist, Forest Research Institute, Dehra Dun. It is expected that these tables will be published about June 1939.

Mention was also made of a practical thinning guide that we had been able to produce from these tables for the purpose of easy check of thinnings by an inspecting officer.

This thinning table has caused great interest and a number of districts have been checking how their thinnings in the past have compared with the standards we have had (Bourne's Nilambur yield tables since 1921 and the All-India tables for the past year).

This check has shown that in the past there has been a general tendency of under-thinning in the early thinnings. At Nilambur this early under-thinning has been followed by a final thinning in which the crop was reduced to roughly the yield table standard by number of stems per acre.

The practical effect of this has been shown by the fact that over the 10-year period of the last Nilambur Working Plan the theoretical working plan estimated yields were in practice considerably over-estimated for final yields but equally underestimated for thinning yields.

The above is a rather striking example of the use of up-to-date yield tables in showing the tendencies of divisional practice. It is only by such periodical "stock-taking" that such tendencies become apparent.

289. *Sample plots*.—During the year the following new sample plots were opened:—

Division.	Species.	Number of sample plots.
Nilambur	Teak, North Burma origin	4
Do.	Teak ("Craib" plots)	6
Do.	Teak (beyond present rotation age).	5
Do.	<i>Swietenia macrophylla</i>	2
Mount Stuart	Teak (All-India origins)	16
Palghat	<i>Swietenia macrophylla</i>	2
Wynad	Teak (effect of <i>lantana</i>)	4
Total		39

Including the above 39 sample plots, a total number of 184 sample plots representing 17 species in seven forest divisions was maintained.

All sample plots due for remeasurement were remeasured.

The sectional ladder constructed last year was successfully used for measurement of standing sample trees. It was found particularly useful, where trees were of such small diameter that the swing seat apparatus could not be used, but of such height that ordinary bamboos were insufficient.

290. It is of interest to note that three of our teak sample plots (Nos. 17, 18 and 19, Nilambur) are now in the second rotation. They were laid out by Bourne in 1918 and have been measured regularly since then. At rotation age, they were clear felled and regenerated by the district in May 1937.

In January 1939 after two growing seasons measurements showed them to be—

Sample plot.	Survival percentage.	Mean height in feet.
17	98	7.52
18	99	6.42
19	99	7.05

These plots are part of a series which in the course of time will give us definite information as to whether there is any soil deterioration due to a crop of pure teak.

291. *Permanent preservation plots*.—Thirteen permanent preservation plots in 10 divisions representing 17 particular species and some evergreen types have been maintained. Four other plots in three divisions for *Dalbergia latifolia*, *Swietenia mahogany*, *Swietenia macrophylla* and *Pinus insignis* are being opened.

Four linear tree increment plots for evergreen species in four divisions Nilgiris, Palghat, South Coimbatore and Wynad have also been maintained. In addition to the above there are five protected trees, of specially large dimensions in four divisions, that are permanently maintained.

292. *Tree increment plots*.—Including a *Dolichandrone crispata* permanent preservation plot in North Cuddapah, which also serves as a tree increment plot, 37 tree increment plots have been maintained. Five of these plots have a total base line length of 5 miles and the remaining 32 plots aggregate an area of 377 acres.

III. MISCELLANEOUS.

293. *Tours, records and staff*.—The Provincial Silviculturist and the Assistant Silviculturist toured for 187 and 153 days respectively during the year under report.

The sandal spike disease research works in Salem North division were inspected by the Provincial Silviculturist and also by the Forest Entomologist, Dehra Dun.

The Assistant Silviculturist was deputed to the "Research demonstration course" held at Dehra Dun in October 1938 and at its conclusion did some special study in statistical work and soil analysis.

In connexion with the problems of the regeneration of evergreens in Tinnevely the Provincial Silviculturist toured in the forests of that division with the District Forest Officer, Tinnevely, and the Conservator of Forests, Coimbatore Circle, in May 1938.

At the request of the Public Works Department the Provincial Silviculturist toured in the Cauvery Coleroon delta with the Executive Engineers concerned to advise on the forest problems and possibilities of the delta (January 1939).

294. During the year several tours of instruction for forest officers were organized and carried out, and were attended by Conservators and selected District Forest Officers. These tours included the mixed deciduous forest experimental work being carried out at Dhoni (Palghat division) the dry fuel forest experimental work at Emmanur (North Coimbatore division) and the district dry fuel forest regeneration work of Madura and Chittoor divisions. These tours of instruction are of the greatest use in keeping forest officers in touch with the progress of works in different parts of the presidency and in guarding against districts being in ignorance of developments made by their neighbours. They also provide valuable opportunities for discussion and criticism of current policy.

The Forest Entomologist, Dehra Dun visited us in November 1938. This visit was regrettably short but nevertheless very valuable to us. He visited the spike research works of North Salem division and the entomological works on mahogany pests, teak defoliators and other similar works being conducted in Nilambur and Wynad divisions.

It is particularly to be noted that the numerous visits of officers of the Forest Research Institute, Dehra Dun to us and of our officers to Dehra Dun that have taken place during the past two years have resulted in a much closer co-operation and have been of great benefit to works in this Presidency.

295. *Books and publications*.—The "Note on a tour in South Bengal" referred to in paragraph 322 of the last year's report was published during the year, and the "Notes on the cultivation of the Green Wattle (*Acacia decurrens*)" "*Cassia auriculata*", and the "Financial aspect of wattle planting (*Acacia decurrens*)" have been sanctioned by the Government to be published. Their publications are awaited.

A "Note on the possibilities of camphor cultivation in South India" was prepared by the Assistant Silviculturist.

The following investigations were written up as pamphlets during the year, and are being published as Indian Forest Records by the Forest Research Institute, Dehra Dun:—

- (1) "An investigation into the best age and diameter of stumps to use when stump planting teak (*Tectona Grandis*) in localities having a general west coast type of climate.
- (2) "A note on the artificial regeneration of the dry fuel forests of the Madras Presidency.
- (3) "An investigation into the relative merits and costs of five different weeding methods in the formation of teak (*Tectona grandis*), plantations in areas having a west coast type of climate.
- (4) "A note on the control and eradication of new outbreaks of the spike disease of sandal (*Santalum album*).
- (5) "Further studies in the spike disease of sandal (*Santalum album*)."

In addition to the above a popular illustrated note on sandal, its mode of growth, uses, value, pests, spike disease and its control, etc., was prepared for the information of the general public.

An article on "Host plants and the spike disease of sandal" was also contributed to the Indian Forester.

296. *Records*.—The specific and general ledger files now number 470 and 192 respectively, 34 new specific and 36 new general ledger files having been opened during the year.

Twenty-five new experimental plots and 222 new experimental garden experiments were opened and 7 experimental plots and

179 experimental garden experiments were closed during the year. In consequence 124 experimental plots and 371 experimental garden experiments were open at the close of the year.

One hundred and fifteen photographs were added to the collection during the year and the total number of photographs now ledgered is 688 under specific and 383 under general ledger files.

Photographs have been supplied to illustrate popular forest publications and sets of forest photographs have also been lent to exhibitions during the year.

297. *Office inspections*.—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 have now been made annual and both the office inspection and the inspection of the ledger files were made by the Conservator of Forests, Working Plans Circle.

298. *Administrative change*.—The Provincial Silviculturist's division which hitherto was part of the Working Plans Circle was transferred to the Ootacamund Circle during the year.

299. *Staff*.—The Assistant Conservator of Forests, remained in the division as Assistant throughout the year.

The subordinate staff consisted of 3 Research Rangers, 10 Foresters and 1 Forest Guard.

The office establishment consisted of 1 Head Clerk, 2 clerks and 1 typist.

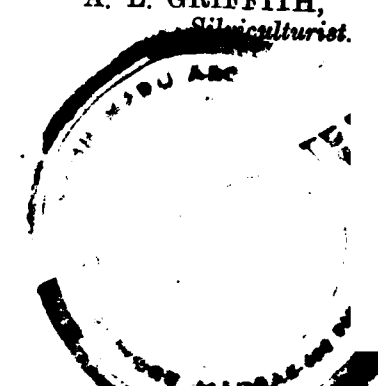
300. *Discipline*.—The general discipline of the staff was satisfactory.

301. *General*.—It must be noted that the works of the division increase steadily year by year and in addition to the ordinary experimental work we are the information bureau and maintain the central forest library for the Presidency. In addition we have to arrange and control all the seed supplies (vide paragraphs 36 to 38 for the extent of this work).

All this has greatly increased office work and if we are to maintain our position satisfactorily, write up investigations now concluded and efficiently to disseminate the information collected an increase of office staff will be essential.

OOTACAMUND,
24th May 1939.

A. L. GRIFFITH,
Silviculturist.



Locality	Total for year from 1st April 1938 to 1st April 1939.															INCH. (17)	YMAA. (18)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)			(16)	Average of years.
Mananur ..	..	6.30	2.13	..	3.44	5.52	5.51	0.56	0.71	1.25	1.21	..	1.40	3.08	2.46	23.03	29.27	4	
		14	4	..	6	12	12	5	2	6	8	3	..	3	10	9	87	75	44
		1.58	0.29	0.18	3.49	4.40	3.94	0.33	0.69	2.43	1.11	..	..	0.35	4.39	2.97	18.79	29.74	44
Satyamangalam ..	..	7	1	2	7	9	10	3	3	4	3	..	2	8	8	8	51	55	15
		0.34	6.08	1.08	4.17	9.89	3.24	0.80	0.33	0.11	0.29	..	..	2.72	6.21	6.33	29.05	34.44	15
		2	8	8	5	15	14	2	1	2	2	2	..	2	7	7	61	70	4
<i>High elevation forests.</i>																			
Jacko's nullah ..	..	2.79	3.31	3.78	5.59	5.45	3.00	0.70	0.35	1.45	0.60	0.10	1.60	2.65	3.15	23.72	34.88	3	
		8	6	18	18	15	9	4	4	5	3	1	3	4	8	8	94	104	3
		4.68	4.63	4.35	5.18	6.80	4.30	0.75	0.35	1.73	1.05	0.05	1.55	3.78	5.15	35.42	48.76	3	
Windy corner (Yemma- kul).	..	10	8	19	19	15	9	5	4	5	3	1	2	6	9	100	113	3	
		2.63	2.75	3.58	6.51	4.51	3.74	1.67	0.38	0.80	0.76	0.12	0.77	2.68	3.96	28.22	34.54	3	
		12	12	22	23	24	19	18	14	9	5	5	2	5	10	14	171	181	3

303. *Seed weightments* (vide paragraph 35).—For germinative capacity and plant per cent the maxima are given.

Species.	Month in which to collect seeds.	Number of seeds per		Number of weightments.	Plant per cent.	Germinative capacity.	Number of tests.	Number of seeds tested.	Plants per lb. of seed.
		Ounce.	Lb.						
<i>Acacia arabica</i> *	XII-III	151	2,416	10	75	75	6	6,000	1,812
<i>Acacia auriculi formis</i> .	III-IV	1,210	19,380	15	65	80	30	14,000	12,584
<i>Acacia baileyana</i> ..	VIII	918	14,638	4	14	53	4	1,000	2,056
<i>Acacia cyanophylla</i> ..	IV	2,010	32,160	5	93	94	12	4,300	29,909
<i>Acacia dealbata</i> ..	I-IV	2,313	37,008	4	33	45	12	1,200	12,213
<i>Acacia decurrens</i> ..	XII-I	1,550	24,800	4	11	37	4	2,000	2,728
<i>Acacia ferruginea</i> ..	XII-IV	167	2,672	24	80	90	25	10,500	2,138
<i>Acacia leucophloea</i> ..	I-IV	1,079	17,264	30	30	35	29	13,100	5,179
<i>Acacia melanoxylon</i> ..	IV	2,023	32,368	4	78	83	12	1,200	25,247
<i>Acacia mollissima</i> ..	I-II	1,600	25,600	4	10	52	4	2,000	2,560
<i>Acacia planifrons</i> ..	VI-VIII	722	11,552	7	35	42	7	7,000	4,043
<i>Acacia sundra</i> ..	XI-V	745	11,920	15	90	90	35	13,000	10,728
<i>Acrocarpus fraxinifolius</i> .	III-VI	900	14,400	50	21	25	60	58,000	3,024
<i>Alangium lamareckii</i> .	V & XII	48	768	2	0	1	2	1,000	..
<i>Albizia amara</i> ..	I & V	393	6,288	26	74	83	36	56,000	4,653
<i>Albizia lebbek</i> ..	I & VI	315	5,040	30	49	65	12	8,000	2,470
<i>Albizia stipulata</i> ..	..	1,997	31,952	2	1	8	10	1,000	320
<i>Anacardium occidentale</i> .	III-V	5.3	84	12	98	98	40	12,000	82
<i>Artocarpus hirsuta</i> ..	IV-VI	61	976	100	81	97	80	65,000	791
<i>Azadirachta indica</i> ..	V-X	132	2,112	14	89	90	18	20,000	1,880
<i>Balanocarpus utilis</i> ..	X	6	100	2	36	39	2	2,000	36
<i>Bambusa arundinacea</i> .	II-IV	2,325	37,200	16	37	38	9	4,000	13,764
<i>Bambusa polymorpha</i> .	III	1,326	21,216	3	32	40	22	7,000	6,789
<i>Bauhinia purpurea</i> ..	II	25	400	2	95	98	2	2,000	380
<i>Bauhinia racemosa</i> ..	II-IV	219	3,504	5	12	17	8	7,000	420
<i>Bauhinia variegata</i> ..	IV	44	704	2	45	50	2	3,000	317
<i>Berberis tinctoria</i> ..	V	2,880	11,520	2	23	54	2	2,000	2,650
<i>Bischofia javanica</i> ..	II	2,591	41,456	5	75	79	2	2,000	31,092
<i>Callitris rhomboidea</i> .	IV-VI	4,856	77,696	4	18	22	5	500	13,985
<i>Calophyllum elatum</i> .	V-IX	5	83	22	67	89	23	7,800	55
<i>Canthium didymum</i> .	III-VII	345	5,520	12	12	42	5	5,000	662
<i>Cassia auriculata</i> ..	I-III	856	13,696	4	51	59	8	8,000	6,985
<i>Cassia fistula</i> ..	II-VI	176	2,816	25	47	55	50	25,000	1,324
<i>Cassia marginata</i> ..	II-V	130	2,080	22	47	65	30	18,800	978
<i>Cassia siamea</i> ..	II-VI	1,040	16,640	25	87	98	30	9,000	14,477
<i>Cassia tomentosa</i> ..	II-IV	1,033	16,523	4	8	13	15	1,500	1,322
<i>Casuarina montana</i> .	IV	1	15	3	53	56	4	350	8
<i>Casuarina montana</i> .	..	39,900	638,400	2	5	15	2	1,000	31,920
<i>Ocotelea odorata</i> ..	III	2,104	33,664	2	15	27	2	10,000	5,050
<i>Ocotelea toona</i> ..	IV-VIII	4,400	70,400	35	62	82	30	28,000	43,648
<i>Chlorophora excelsa</i> ..	..	8,900	142,400	2	29	31	4	50,000	41,289
<i>Chloroxylon vietnamica</i> .	III-VIII	2,550	40,800	44	64	69	58	42,000	28,112
<i>Chloroxylon vietnamica</i> (Ceylon).	III-X	1,406	22,496	50	58	73	38	38,000	13,048
<i>Chorisia speciosa</i> ..	..	..	..	..	0	46	1	2,000	0
<i>Citrus scoparius</i> ..	III-IV	3,188	51,008	2	24	30	5	5,000	12,242

* Best results are with seed passed through goats.

Species.	Month in which to collect seed.	Number of seeds per		Number of weigh-ments.	Plant per cent.	Germinative capa-city.	Number of tests.	Number of seeds tested.	Plants per lb. of seed.
		Ounce.	Lb.						
<i>Cryptomeria japonica</i> ..	IV	4,160	66,560	2	0	0	2	2,000	0
<i>Cupressus macrocarpa</i> ..	IV-VI	4,363	69,708	4	8	8	6	1,000	5,577
<i>Cupressus torulosa</i> ..	V-VI	3,960	63,360	2	5	9	7	500	3,168
<i>Dalbergia latifolia</i> ..	I-VI	513	8,208	25	55	65	66	50,000	4,514
<i>Dalbergia sissooides</i> ..	XII-III	454	7,264	90	51	70	70	40,000	3,705
<i>Daphniphyllum glaucescens</i> ..	V-VI	143	2,288	4	5	8	10	1,000	114
<i>Dendrocalamus brandisii</i> ..	II	3,475	55,600	1	1	2	2	1,000	556
<i>Dendrocalamus longispadhus</i> ..	III-IV	2,367	37,872	6	1	2	2	2,000	379
<i>Dendrocalamus strictus</i> ..	III-IV	1,269	20,304	15	47	48	5	1,500	9,543
<i>Dipterocarpus indicus</i> ..	III-VII	5	78	10	20	41	10	1,000	16
<i>Dodonaea viscosa</i> ..	I-IV	3,220	54,520	2	12	12	5	500	6,542
<i>Dolichandrone crispata</i> ..	II-IV	858	13,728	12	48	54	12	8,800	6,589
<i>Dolichandrone falcata</i> ..	III	743	11,888	2	2	3	2	2,000	238
<i>Dysoxylum malabaricum</i> ..	VII-VIII	5	80	10	85	85	35	4,000	68
<i>Elaeocarpus oblongus</i> ..	V	7.5	120	2	3	3	2	1,000	4
<i>Erythroxylon monogynum</i> ..	IX-III	900	14,400	14	2	4	8	5,000	288
<i>Eucalyptus maculata</i> ..	..	6,112	97,792	2	12	13	2	200	11,735
<i>Eugenia arnotiana</i> ..	VI-VII	* 110	1,760	8	71	73	24	4,000	1,250
<i>Eurya japonica</i> ..	IV	25,600	..	2	0	0	2	10,000	0
<i>Foodia roxburghiana</i> ..	V & XII	2,678	42,848	6	15	17	2	2,000	6,427
<i>Feronia elephantum</i> ..	X-IV	1,408	22,528	6	5	9	8	8,000	1,126
<i>Givodia rotleriformis</i> ..	X-IV	† 11	176	10	..	..	10	10,000	0
<i>Glochidion neilgherrense</i> ..	III-IV	1,428	22,848	3	4	5	3	1,100	914
<i>Gluta travancorica</i> ..	IV-VIII	2	32	7	90	96	34	8,000	29
<i>Gmelina arborea</i> ..	III-VI	42	672	3	56	64	25	8,500	376
<i>Hakea saligna</i> ..	IX-XII	2,328	37,248	8	68	78	16	2,200	25,329
<i>Hardwickia binata</i> ..	III-VII	† 148	2,368	7	..	..	5	5,000	0
<i>Hardwickia pinnata</i> ..	V-VI	4.6	74	1	80	85	5	500	59
<i>Harrisonia bennettii</i> ..	I	269	4,304	5	8	12	3	300	344
<i>Holoptelia integrifolia</i> ..	III-IV	1,080	17,280	5	15	17	4	800	2,592
<i>Hopea parviflora</i> ..	V-VII	82	1,312	25	54	68	54	50,000	708
<i>Jacaranda mimosaefolia</i> ..	..	4,320	69,120	2	6	18	2	1,000	4,147
<i>Juniperus procera</i> ..	I	1,384	22,144	8	5	12	16	1,800	1,107
<i>Lagerstroemia flos-reginae</i> ..	XII-II	3,920	62,720	12	55	60	14	40,000	34,496
<i>Lagerstroemia lanceolata</i> ..	XII-III	5,727	91,632	6	13	20	24	65,000	11,912
<i>Lantana camara</i> ..	VIII	† 1,302	20,832	5	2	3	2	2,000	417
<i>Leucaena glauca</i> ..	I	866	13,856	6	33	38	3	7,000	4,572
<i>Ligustrum neilgherrense</i> ..	I-III	851	13,616	4	66	74	10	1,000	8,987
<i>Litsea wightiana</i> ..	IV	177	2,832	2	17	17	2	2,000	481
<i>Mahonia leschenaultii</i> ..	III-IV	1,913	30,608	6	48	53	5	2,000	14,692
<i>Markhamia platycalyx</i> ..	..	1,180	18,880	2	1	1	2	2,000	189
<i>Meliosoma wightii</i> ..	III-V	140	2,240	2	10	14	3	100	224
<i>Mesua ferrea</i> ..	XII-III	30	480	15	68	70	24	8,000	326
<i>Michelia nilagirica</i> ..	IV-VI	336	5,376	4	23	24	12	3,000	1,236
<i>Morus alba</i> ..	..	26,015	416,240	4	5	13	4	5,000	20,812
<i>Mundulea suberosa</i> ..	IV	958	15,328	2	35	54	2	2,000	5,865

* With pulp; without pulp 148 to the ounce.

† With corky layer; without corky layer 48 per ounce.

‡ Kernel only. Pods 68 per ounce.

§ With pulp; 2,092 per oz. without pulp.

|| Without pulp; with pulp 5/2 to the ounce.

Species.	Month in which to collect seed.	Number of seeds per		Number of weigh-ments.	Plant per cent.	Germinative capa-city.	Number of tests.	Number of seeds tested.	Plants per lb. of seed.
		Ounce.	Lb.						
<i>Myrsine wightiana</i> ..	IV	1,632	26,112	2	20	20	2	2,000	5,222
<i>Neolitsea zeylanica</i> ..	V-VII	218	3,488	4	18	18	4	1,200	628
<i>Palaquium ellipticum</i> ..	V-VIII	7	112	16	63	63	30	8,000	71
<i>Photinia notoniana</i> ..	VII	10,560	..	2	0	0	2	5,000	0
<i>Pinus insignis</i> ..	..	1,326	21,216	2	4	8	2	1,000	849
<i>Pinus longifolia</i> ..	IV	223	3,568	4	46	80	4	2,000	1,640
<i>Pithecolobium dulce</i> ..	II-V	186	2,976	7	33	46	12	1,200	982
<i>Poinciana regia</i> ..	IV	80	1,280	2	5	5	2	2,000	64
<i>Polyalthia longifolia</i> ..	IV-IX	21	336	2	2	3	2	2,000	7
<i>Pongamia glabra</i> ..	III-V	28	448	2	3	5	2	2,000	13
<i>Prosopis juliflora</i> ..	V	926	14,816	24	78	89	30	95,000	11,556
<i>Prosopis spicigera</i> ..	II-VII	666	10,976	14	88	88	10	7,000	9,659
<i>Pterocarpus dalbergioides</i> ..	III-IV	* 53	848	36	29	49	50	15,000	246
<i>Pterocarpus marsupium</i> ..	I-VI	60	960	75	90	97	100	45,000	864
<i>Pterocarpus santalinus</i> ..	II-VII	30	475	22	65	88	54	24,000	309
<i>Quercus incana</i> ..	II	14	224	2	51	80	2	2,000	114
<i>Sapindus emarginatus</i> ..	II-IV	61	976	2	9	11	2	2,000	88
<i>Santalum album</i> ..	X-XI & III-IV	† 148	2,368	60	58	85	60	52,000	1,372
<i>Schleichera trijuga</i> ..	II-VIII	59	944	16	72	76	24	14,000	680
<i>Semecarpus anacardium</i> ..	II-IV	13	208	2	53	57	2	2,000	110
<i>Shorea talura</i> ..	V	† 29	464	25	55	64	10	6,500	255
<i>Soyimida febrifuga</i> ..	II-VII	378	6,048	10	25	28	10	9,000	1,512
<i>Stipa tenassima</i> ..	..	13,200	211,200	2	2	3	2	5,000	4,224
<i>Strychnos nux-vomica</i> ..	V-XII	21	336	2	11	13	2	2,000	37
<i>Strychnos potatorum</i> ..	III-VI	36	576	2	4	4	2	2,000	23
<i>Swietenia macrophylla</i> ..	XII-III	60	960	50	71	78	70	55,000	682
<i>Symplocos foliosa</i> ..	III-VII	§ 80	1,280	2	0	0	2	2,000	0
<i>Tamarindus indica</i> ..	II-V	41	656	10	11	15	5	10,000	72
<i>Tectona grandis</i> ..	XI-V	52	832	50	58	62	60	78,000	483
<i>Terminalia arjuna</i> ..	XI-XII & IV-VI	22	352	2	17	19	2	2,000	60
<i>Terminalia chebula</i> ..	XI-IV	16	263	20	50	60	52	24,000	132
<i>Terminalia crenulata</i> ..	I-VI	22	352	60	58	72	85	75,000	204
<i>Terminalia paniculata</i> ..	XI-IV	1,010	16,160	106	2	2	105	180,000	323
<i>Ternstroemia japonica</i> ..	II-VII	180	2,880	2	0	0	2	2,000	0
<i>Trema orientalis</i> ..	I-VI	4,720	75,520	25	5	7	15	35,000	3,776
<i>Vateria indica</i> ..	VII-VIII	1.4	22	10	76	80	6	1,500	17
<i>Viburnum coriaceum</i> ..	VII	566	9,056	2	4	4	2	2,000	362
<i>Viburnum erubescens</i> ..	VII	1,015	16,240	4	7	7	4	2,000	1,137
<i>Vitex altissima</i> ..	XII-IV	335	5,360	4	1	1	4	5,000	54
<i>Vitex littoralis</i> ..	V-VII	88	1,408	2	0	30	3	230	0
<i>Vitex poduncularis</i> ..	VII-VIII	269	4,304	10	15	20	10	10,000	646
<i>Wrightia tinctoria</i> ..	II-V	809	12,944	10	8	11	4	4,000	1,036
<i>Xylia zyllocarpa</i> ..	I-V	87	1,392	24	79	99	65	53,000	1,100
<i>Zizyphus glabrata</i> ..	II	234	3,744	2	1	1	2	2,000	37
<i>Zizyphus incursa</i> ..	I	† 116	1,856	6	38	69	5	2,000	705
<i>Zizyphus jujuba</i> ..	I-VII	45	720	10	11	21	8	10,000	79

* Seed from the Andamans.

† With pulp; without pulp 203 per ounce.

‡ Without wings; with wings 15 per ounce.

§ With pulp; without pulp 132 per ounce.

|| Kernel. Best results are obtained with fermented seed

¶ Without pulp; with pulp 80 to the ounce.

NOTE.—Seeds of *Acrocarpus fraxinifolius*, *Calophyllum elatum*, *Mesua ferrea* and *Dysoxylum malabaricum* very often only germinate to a small extent in the first year, the main germination often being in the second year.

304. Seed pre-treatment (vide paragraph 24)—

Species.	Number of tests made.	Average germinative capacity with			
		Un-treated.	Cold water.	Hot water.	Boiling water.
<i>Acacia auriculiformis</i>	8	14	14	16	17
<i>Acacia baileyana</i>	4	2	3	19	42
<i>Acacia cyanophylla</i>	9	11	14	17	35
<i>Acacia dealbata</i>	6	45	68	60	87
<i>Acacia decurrens</i>	4	1	1	8	24
<i>Acacia ferruginea</i>	8	49	41	48	39
<i>Acacia leucophloea</i>	12	23	12	17	24
<i>Acacia melanoxylon</i>	1	83	81	91	90
<i>Acacia mollissima</i>	5	5	2	11	29
<i>Acacia planifrons</i>	3	21	16	19	10
<i>Acacia sundra</i>	10	34	28	30	25
<i>Acrocarpus fraxinifolius</i>	25	8	8	9	6
<i>Albizzia amara</i>	20	43	37	31	37
<i>Albizzia lebbek</i>	1	20	13	10	11
<i>Anacardium occidentale</i>	6	70	58	54	24
<i>Azadirachta indica</i>	8	43	38	31	7
<i>Balanocarpus utilis</i>	2	42	35	39	20
<i>Bauhinia purpurea</i>	10	17	20	22	14
<i>Bauhinia racemosa</i>	2	3	1	2	1
<i>Berberis tinctoria</i>	2	56	0	0	0
<i>Calophyllum elatum</i>	5	17	16	13	0
<i>Cassia auriculata</i>	12	7	6	6	2
<i>Cassia fistula</i>	14	11	11	8	6
<i>Cassia marginata</i>	12	17	22	13	5
<i>Cassia siamea</i>	15	50	36	46	3
<i>Chlorophora excelsa</i>	15	18	15	12	0
<i>Chloroxylon swietenia</i>	11	14	12	11	1
<i>Chorisia speciosa</i>	2	46	0	0	0
<i>Cupressus torulosa</i>	2	7	0	0	0
<i>Dalbergia latifolia</i>	22	31	26	29	5
<i>Dalbergia sissooides</i>	30	26	26	32	5
<i>Dendrocalamus strictus</i>	5	33	22	22	0
<i>Dolichandrone crispata</i>	3	24	19	22	2
<i>Dolichandrone falcata</i>	2	3	2	2	0
<i>Eleocarpus oblongus</i>	1	3	0	0	0
<i>Eugenia arnottiana</i>	3	53	51	40	42
<i>Evodia roxburghiana</i>	2	17	15	3	0
<i>Feronia elephantum</i>	2	9	3	8	0
<i>Glochidion neilgherrense</i>	2	3	0	0	0
<i>Gluta travancorica</i>	10	44	48	42	21
<i>Gmelina arborea</i>	25	20	19	18	6
<i>Hakea saligna</i>	2	45	0	0	0
<i>Harrisonia bennetti</i>	4	10	14	7	2
<i>Juniperus procera</i>	4	2	4	5	1

Species.	Number of tests made.	Average germinative capacity with			
		Un-treated.	Cold water.	Hot water.	Boiling water.
<i>Lagerstroemia lanceolata</i>	30	5	4	4	0
<i>Leucaena glauca</i>	10	24	27	33	35
<i>Ligustrum neilgherrense</i>	2	66	21	13	2
<i>Litsea zeylanica</i>	2	15	9	7	0
<i>Mahonia leschenaultii</i>	4	51	6	2	0
<i>Markhamia platycalyx</i>	1	1	1	0	0
<i>Meliosma wightii</i>	1	14	8	0	0
<i>Michelia neilgherrense</i>	1	5	0	0	0
<i>Myrsine wightiana</i>	2	10	14	11	20
<i>Neolitsea zeylanica</i>	2	16	18	0	0
<i>Palaequium ellipticum</i>	12	40	50	40	0
<i>Pinus longifolia</i>	4	34	54	27	49
<i>Pinus insignis</i>	2	4	8	4	0
<i>Pithecolobium dulce</i>	8	43	13	38	5
<i>Pongamia glabra</i>	2	5	3	2	3
<i>Prosopis juliflora</i>	5	71	72	61	54
<i>Pterocarpus dalbergioides</i>	4	17	18	14	5
<i>Pterocarpus santalinus</i>	12	25	71	33	19
<i>Pterocarpus santalinus*</i>	3	14	18	17	4
<i>Pterocarpus marsupium</i>	90	40	31	32	12
<i>Quercus incana</i>	2	81	0	0	0
<i>Sapindus emarginatus</i>	2	11	9	11	10
<i>Schleichera trijuga</i>	16	32	30	28	0
<i>Soyimida febrifuga</i>	10	1	3	1	0
<i>Strychnos nux vomica</i>	2	3	13	18	10
<i>Tectona grandis</i>	40	28	27	24	8
<i>Terminalia chebula</i> —					
(1) (Whole fruit)	12	19	15	24	6
(2) (Fleshy covering removed)	3	4	6	5	7
(3) (Kernel)	4	6	1	2	0
<i>Terminalia crenulata</i> —					
(1) Fresh seed	80	28	31	25	6
(2) Stored 14 months	10	9	8	7	8
<i>Terminalia paniculata</i>	24	10	8	9	0
<i>Trema orientalis</i>	1	1	1	1	0
<i>Vateria indica</i>	2	61	53	54	0
<i>Vitex littoralis</i>	2	30	38	11	0
<i>Vitex peduncularis</i>	2	9	8	2	0
<i>Wrightia tinctoria</i>	1	11	9	5	3
<i>Xylia xylocarpa</i>	42	20	26	25	13
<i>Zizyphus incurva</i>	5	31	24	24	22
<i>Zizyphus jujuba</i>	11	15	20	8	13

* Seed coat removed.

305. *Seed storage* (vide paragraph 34)—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.	Method of storage.	Number of individual tests.	Number of series of the same sample of seed.	Remarks.
<i>Acacia auriculiformis</i> .	(1) Stoppered bottle.	32	12	No falling off up to one year.
	(2) Earthen pot ..	36	12	
	(3) Gunny bag ..	36	12	
	(4) Air-tight tins ..	48	12	
<i>Acacia cyanophylla</i> ..	(1) Stoppered bottle.	21	6	No falling off up to eight months. Seed ten months old only slightly less fertile than fresh seed.
	(2) Earthen pot ..	21	6	
	(3) Gunny bag ..	21	6	
	(4) Air-tight tins ..	28	8	
<i>Acacia ferruginea</i> ..	(1) Stoppered bottle.	34	24	Seed good up to sixteen months and then rapidly deteriorates. Keeps best in (2).
	(2) Earthen pot ..	38	24	
	(3) Gunny bag ..	38	24	
	(4) Air-tight tins ..	36	24	
<i>Acacia leucophloea</i> ..	(1) Air-tight tins ..	8	4	Seed good after six months.
<i>Acacia sundra</i> ..	(1) Stoppered bottle.	31	24	Seed good after fifteen months. Does not keep in (1). Seed good after eight months falling off slightly by twelve months.
	(2) Earthen pot ..	45	24	
	(3) Gunny bag ..	45	24	
	(4) Mud pot with wood ash.	53	24	
<i>Acrocarpus fraxinifolius</i> .	(1) Gunny bag ..	120	25	Seed after nineteen months as good as fresh seed.
	(2) Air-tight tins ..	30	18	
<i>Albizia amara</i> ..	(1) Air-tight tins ..	25	12	Seed good up to two and a half years, keeps best in (2).
	(2) Mud pot with wood ash.	57	20	
	(3) Gunny bag ..	25	12	
<i>Anacardium occidentale</i> .	(1) Air-tight tins ..	36	24	Seed good up to eighteen months. Keeps best in (1) or (3).
	(2) Gunny bag ..	56	24	
	(3) Earthen pot ..	36	24	
<i>Artocarpus hirsuta</i> ..	(1) Gunny bag ..	50	12	Seed good up to three months and then rapidly deteriorates, keeps best if in pit covered with 2 inches of dry earth or in puddled mud.
	(2) Dry earth ..	20	12	
	(3) Puddled mud ..	20	12	
<i>Bischofia javanica</i> ..	(1) Gunny bag ..	2	6	Keeps for four months and then rapidly deteriorates.
<i>Calophyllum elatum</i> .	(1) Gunny bag ..	3	7	Keeps for at least one year. In the seed bed it often only germinates in the second year.
<i>Cassia fistula</i> ..	(1) Air-tight tins ..	58	24	Seed good up to two years except in (1).
	(2) Earthen pots ..	38	24	
	(3) Gunny bag ..	38	24	
<i>Cassia marginata</i> ..	(1) Air-tight tins ..	28	12	Seed good after ten months.
	(2) Gunny bag ..	12	..	
<i>Cassia siamea</i> ..	(1) Air-tight tins ..	30	12	Seed good after three years; keeps best in (1).
	(2) Mud pots with wood ash.	50	12	
	(3) Gunny bag ..	30	12	
<i>Cedrela toona</i> ..	(1) Gunny bag ..	30	6	Seed good up to three months falling to 50 per cent at five months.
	(2) ..	..	..	
<i>Chloroxylon swietenia</i> .	(1) Air-tight tins ..	84	12	Good up to three months and then rapidly deteriorates. No difference between Ceylon and Madras seed.
	(2) Earthen pots ..	40	12	
	(3) Gunny bag ..	78	12	
<i>Dalbergia latifolia</i> ..	(1) Gunny bag ..	144	20	Good up to six months. No seed has given any result after one year.
	(2) Air-tight tins ..	62	15	
	(3) Earthen pot ..	14	12	
<i>Dalbergia sissooides</i> ..	(1) Gunny bag ..	12	12	Good up to six months and then rapidly deteriorates.
	(2) Air-tight tins ..	12	12	
	(3) Wood ash ..	12	12	
<i>Dendrocalamus longispatus</i> .	(1) Air-tight tins ..	2	6	Good up to three months and then rapidly deteriorates.
<i>Dipterocarpus indicus</i> .	(1) Gunny bag ..	2	6	Good up to four weeks and then rapidly deteriorates.

Species.	Method of storage.	Number of individual tests.	Number of series of the same sample of seed.	Remarks.
<i>Dysoxylum malabaricum</i> .	(1) Dry gunny bag.	10	6	Seed good up to six weeks—Keeps in wet gunny bag but not in dry gunny bag.
	(2) Wet gunny bag.	10	6	
<i>Gluta travancorica</i> ..	(1) Gunny bag ..	42	6	Seed good up to four months dropping to 50 per cent at six months.
<i>Gmelina arborea</i> ..	(1) Gunny bag ..	75	15	Variable—Seed usually good up to six or eight weeks.
<i>Hopea parviflora</i> ..	(1) Gunny bag ..	50	6	Seed good after twenty days falling to 0 after forty days.
<i>Lagerstroemia flos reginae</i> .	(1) Gunny bag ..	57	10	Seed good up to eight months by all three methods and then rapidly deteriorates.
	(2) Gunny bag with wood ash.	57	10	
	(3) Air-tight tins ..	57	10	
<i>Lagerstroemia lanceolata</i> .	(1) Gunny bag ..	38	6	Seed good up to four months. Seed good up to six months. Seed good up to three months. Seed good up to four months dropping to 30 per cent at six months.
	(2) Air-tight tins ..	38	6	
	(3) Wood ash ..	14	6	
<i>Mesua ferrea</i> ..	(1) Gunny bag ..	17	6	Seed good up to four months dropping to 30 per cent at six months.
<i>Palaquium ellipticum</i> .	(1) Gunny bag ..	24	6	Variable—Usually good up to about two months.
<i>Prosopis juliflora</i> ..	(1) Stoppered bottle.	44	12	Seed good after one year. Keeps best in (3).
	(2) Earthen pot ..	48	12	
	(3) Gunny bag ..	48	12	
	(4) Air-tight tins ..	48	12	
<i>Pterocarpus dalbergioides</i> .	(1) Gunny bag ..	16	12	Seed good up to twenty-six months.
<i>Pterocarpus marri-pium</i> .	(1) Gunny bag ..	140	18	Variable, usually good up to six months sometimes good up to one year.
	(2) Air-tight tins ..	50	12	
<i>Pterocarpus santalinus</i> .	(1) Gunny bag ..	44	12	Good up to six months; indications are that it is good up to ten months.
	(2) Earthen pot ..	35	12	
	(3) Stoppered bottle.	35	12	
<i>Santalum album</i> ..	(1) Air-tight tins ..	50	24	Seed good up to two years; keeps best in gunny.
	(2) Gunny bag ..	40	24	
<i>Schleichera trijuga</i> ..	(1) Gunny bag ..	7	12	Seed kept by all methods for six months without any deterioration.
	(2) Gunny bag with wood ash.	7	12	
	(3) Air-tight tins ..	7	12	
<i>Swietenia macrophylla</i> .	(1) Gunny bag ..	64	12	Seed good up to five months falling to 0 at seven months.
<i>Tectona grandis</i> ..	(1) Gunny bag ..	205	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 ..	90	16	
<i>Terminalia chebula</i> ..	(1) Gunny bag ..	52	12	Seed good up to eight months falling to about 50 per cent after twelve months.
	(2) Stoppered bottle.	28	12	
	(3) Earthen pot ..	28	12	
<i>Terminalia crenulata (tomantosa)</i> .	(1) Gunny bag ..	166	22	Seed good up to one year.
	(2) Stoppered bottle.	42	12	
	(3) Air-tight tins ..	37	12	
<i>Terminalia paniculata</i> .	(1) Gunny bag ..	48	12	Seed good up to five months.
	(2) Stoppered bottle.	38	12	
	(3) Air-tight tins ..	48	12	
<i>Trema orientalis</i> ..	(1) Gunny bag ..	70	12	Seed kept by all methods for six months and then rapidly deteriorated.
	(2) Gunny bag with wood ash.	65	12	
	(3) Air-tight tins ..	65	12	
<i>Vateria indica</i> ..	(1) Gunny bag ..	8	6	Seed kept for one month and then rapidly deteriorated.
<i>Vitex peduncularis</i> ..	(1) Gunny bag ..	6	6	We have not been able to keep this seed longer than one month. Its germination is very poor and it must be sown at once.
	(2) Air-tight tins ..	6	6	
<i>Xylia xylocarpa</i> ..	(1) Gunny bag ..	164	20	Very variable—usually good up to three months.
	(2) Stoppered bottle.	50	12	
	(3) Air-tight tins ..	50	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 X months." Often this is the maximum period tested and not necessarily the maximum period the seed remains fertile.

306. *Size, age and condition of seed bearers—Teak* (vide paragraph 42)—

Wynad Division Experimental Plot 35—Arrangement—Six Blocks of 10 × 10 stakes each 6' × 6' arranged.

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 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 10 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 No. 92 of 1935. *Date of stump planting*—4th April 1936.

South Coimbatore Experimental Plot 81.—Arrangement, etc., as above. Stock used.—(A) (B) (C) stumps 0.3" to 0.6" diameter as above from Topslip Experimental Garden Experiment No. 166 of 1937. *Date of stump planting*—5th May 1938.

Measurements in January 1939.

Locality.	Treatment.	Survival per-centage.	Mean height in feet.	Difference of means.	Signifi-cance.
Wynad Experimental Plot 35.	Over-mature	99	6.65 ± 0.28	+ 0.50 ± 0.11	S.
	Mature	99	6.15 ± 0.22	Control.	S.
	Under-mature	95	5.77 ± 0.24	- 0.38 ± 0.10	S.
Palghat Experimental Plot 155.	Over-mature	90	13.57 ± 0.52	+ 0.99 ± 1.06	N.S.
	Mature	94	12.68 ± 0.61	Control.	S.
	Under-mature	87	15.50 ± 0.57	+ 2.82 ± 1.08	S.
South Coimbatore Ex-perimental Plot 81.	Over-mature	90	1.57 ± 0.07	+ 0.04 ± 0.09	N.S.
	Mature	97	1.53 ± 0.05	Control.	S.
	Under-mature	93	1.23 ± 0.06	- 0.30 ± 0.08	S.

307. *Dalbergia latifolia* (vide paragraph 42)—

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 No. 93 of 1935. *Date of stump planting*—17th May 1936.

Wynad Experimental Plot 36.—Arrangement, etc., as above Stock used—(A) (B) (C) stumps 0.1" to 0.2" diameter as above from Begur Experimental Garden Experiment No. 69 of 1936. *Date of stump planting*—8th May 1937.

South Coimbatore Experimental Plot 78.—Arrangement, etc., as above. Stock used—(A) (B) (C) stumps 0.2" to 0.3" diameter as above from Topslip Experimental Garden Experiment of 1937. *Date of stump planting*—20th May 1938.

Measurements in January 1939.

Locality.	Treatment.	Survival per-centage.	Mean height in feet.	Difference of means.	Signifi-cance.
Palghat Experimental Plot 157.	Over-mature	82	6.43 ± 0.38	+ 0.71 ± 0.63	N.S.
	Mature	85	5.72 ± 0.51	Control.	S.
	Under-mature	85	4.02 ± 0.28	- 1.70 ± 0.58	S.
South Coimbatore Ex-perimental Plot 78.	Over-mature	71	1.25 ± 0.05	+ 0.04 ± 0.07	N.S.
	Mature	97	1.21 ± 0.05	Control.	S.
	Under-mature	96	1.20 ± 0.05	- 0.01 ± 0.07	N.S.
Wynad Experimental Plot 36.	Over-mature	100	1.81 ± 0.07	- 0.30 ± 0.09	S.
	Mature	99	2.11 ± 0.06	Control.	S.
	Under-mature	97	1.04 ± 0.06	- 0.17 ± 0.09	N.S.

308. *Pterocarpus marsupium* (vide paragraph 42)—

Wynad Experimental Plot 31.—Arrangement, etc., as above. Stock used—(A) (B) (C) stumps 0.40" average diameter as above from Begur Experimental Garden Experiment No. 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 No. 90 of 1935. *Date of stump planting*—4th April 1936.

South Coimbatore Experimental Plot 77.—Arrangement, etc., as above. Stock used—(A) (B) (C) stumps 0.3" to 0.6" diameter as above from Topslip Experimental Garden Experiment No. 164 of 1937. *Date of stump planting*—16th May 1938.

Measurements in January 1939.

Locality.	Treatment.	Survival per-centage.	Mean height in feet.	Difference of means.	Signifi-cance.
Wynad Experimental Plot 31.	Over-mature	97	7.27 ± 0.24	+ 0.50 ± 0.32	N.S.
	Mature	99	6.77 ± 0.21	Control.	S.
	Under-mature	98	6.72 ± 0.20	- 0.05 ± 0.29	N.S.
Palghat Experimental Plot 156.	Over-mature	80	11.70 ± 0.84	- 0.55 ± 0.94	N.S.
	Mature	88	12.25 ± 0.41	Control.	S.
	Under-mature	88	11.38 ± 0.54	- 0.87 ± 0.68	N.S.
Topslip Experimental Garden Experiment 181.	Over-mature	87	0.45 ± 0.02	- 0.24 ± 0.03	S.
	Mature	91	0.69 ± 0.03	Control.	S.
	Under mature	89	0.62 ± 0.02	- 0.07 ± 0.04	N.S.

309. *Terminalia crenulata* (vide paragraph 42)—

Wynad Experimental Plot 37.—Arrangement, etc., as above. Stock used—(A) (B) (C) stumps 0.56" average diameter as above from Begur Experimental Garden Experiment No. 70 of 1936. *Date of stump planting*—9th May 1937.

Pulghat Experimental Plot 158.—Arrangement, etc., as above. *Stock used*—(A) (B) (C) stumps 0.2" to 0.9" diameter as above from Dhoni Experimental Garden Experiment No. 91 of 1935. *Date of stump planting*—17th May 1936.

South Coimbatore Experimental Plot 79.—Arrangement, etc., as above. *Stock used*—(A) (B) (C) stumps 0.3" to 0.7" diameter as above from Topslip Experimental Garden Experiment No. 165 of 1937. *Date of stump planting*—17th May 1938.

Measurements in January 1939.

Locality.	Treatment.	Survivals per centage.	Mean height in feet.	Difference of means.	Significance.
Wynad Experimental Plot 37.	Over-mature	93	5.97 ± 0.10	+ 0.26 ± 0.16	N.S.
	Mature	95	5.71 ± 0.12	Control.	
	Under-mature	92	5.47 ± 0.14	- 0.24 ± 0.19	N.S.
Palghat Experimental Plot 158.	Over-mature	97	16.42 ± 0.28	+ 1.05 ± 0.47	S.
	Mature	98	15.37 ± 0.39	Control.	
	Under-mature	88	15.35 ± 0.51	- 0.02 ± 0.64	N.S.
Topslip Experimental Garden 159.	Over-mature	90	2.57 ± 0.08	+ 0.24 ± 0.11	S.
	Mature	89	2.33 ± 0.08	Control.	
	Under-mature	77	2.39 ± 0.08	+ 0.06 ± 0.11	N.S.

310. *Pre-monsoon stump planting*—Begur Experimental Garden (vide paragraph 83)—

Experiment No. 114 of 1938.—Species—*Artocarpus hirsuta*. Arrangement—ABCDE EDCBA repeated ten times in single lines of 10 plants (i.e., 100 plants per treatment). *Espace-ment*—6' × 3'. *Soil preparation*—Crowbar holes. *Stock used*—Stumps from one year old nursery plants. *Dates of stump planting*—Fortnightly from 1st May 1938 to 1st July 1938. *Size of stumps*—0.4" to 0.5" diameter. *Tending*—Normal district weeding.

Measurement in January 1939.

Date of planting.	Survival percent.	Mean height in inches.	Difference of means.	Significance.
A 1st May 1938	56	6.96 ± 0.63	+ 0.58 ± 0.74	N.S.
B 15th May 1938	48	5.56 ± 0.67	- 0.82 ± 0.77	N.S.
C 1st June 1938	74	6.38 ± 0.38	Control.	
D 15th June 1938	93	6.61 ± 0.33	+ 0.23 ± 0.50	N.S.
E 1st July 1938	79	4.05 ± 0.28	- 2.83 ± 0.46	S.

311. *Pre-monsoon stump planting*—Dhoni Experimental Garden (vide paragraph 88)—

Experiment No. 162 of 1938.—Species—*Artocarpus hirsuta*. Arrangement, etc., as above. *Stock used*—Stumps 0.4" to 0.5" diameter made from one year old plants. *Dates of stump planting*—Fortnightly from 1st May 1938 to 1st July 1938.

Measurements in January 1939.

Date of planting.	Survival per centage.	Mean height in inches.	Difference of means.	Significance.
A 1st May 1938	59	12.63 ± 0.89	+ 0.70 ± 1.10	N.S.
B 15th May 1938	65	10.72 ± 0.73	- 1.21 ± 0.98	N.S.
C 1st June 1938	75	11.93 ± 0.65	Control.	
D 15th June 1938	63	13.24 ± 0.84	+ 1.31 ± 1.06	N.S.
E 1st July 1938	54	9.44 ± 0.66	- 2.49 ± 0.86	S.

312. *Pre-monsoon stump planting*—Topslip Experimental Garden (vide paragraph 93)—

Experiment No. 178 of 1938.—Species—*Artocarpus hirsuta*. Arrangement, etc., as above. *Stock used*—Stumps 0.4" to 0.5" diameter made from one year old plants. *Dates of stump planting*—Fortnightly from 1st May 1938 to 1st July 1938.

Measurements in January 1939.

Date of planting.	Survival per centage.	Mean height in inches.	Difference of means.	Significance.
A 1st May 1938	37	4.86 ± 0.56	- 2.34 ± 0.65	S.
B 15th May 1938	25	4.56 ± 0.66	- 2.64 ± 0.73	S.
C 1st June 1938	91	7.20 ± 0.33	Control.	
D 15th June 1938	92	6.02 ± 0.20	- 1.18 ± 0.80	S.
E 1st July 1938	15	5.13 ± 0.55	- 2.07 ± 0.64	S.

313. *Pre-monsoon stump planting*—Kannoth Experimental Garden (vide paragraph 94)—

Experiment No. 57 of 1938.—Species—*Tectona grandis*. Arrangement—ABCDE EDCBA repeated ten times in single lines of 10 plants (i.e., 100 plants per treatment). *Espace-ment*—6' × 6'. *Soil preparation*—Crowbar holes. *Stock used*—Stumps from one year nursery plants. *Dates of stump planting*—Fortnightly from 1st April 1938 to 1st June 1938. *Size of stumps*—0.5" to 0.6" diameter. *Tending*—Normal district weeding.

Experiment No. 58 of 1938.—Species—*Dalbergia sissooides*. Arrangement, etc., as above. *Espace-ment*—6' × 3'. *Size of stumps*—0.2" to 0.3" diameter.

Experiment No. 59 of 1938.—Species—*Pterocarpus marsupium*. Arrangement, etc., as above. *Size of stumps*—0.4" to 0.5" diameter.

Experiment No. 61 of 1938.—Species—*Terminalia crenulata*. Arrangement, etc., as above. *Size of stumps*—0.5" to 0.6" diameter.

Experiment No. 60 of 1937.—Species—*Artocarpus hirsuta*. Arrangement, etc., as above. *Size of stumps*—0.5" to 0.6" diameter. *Dates of stump planting*. Fortnightly from 15th April to 15th June 1938.

NOTE.—All the above experiments were done in a taungya crop of hill paddy sown on 24th May 1938.

Kannoth 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. 57, <i>Tectona grandis</i> .	A 1st April 1938.	12th January 1939.	99	15.31±0.92	+6.71±1.02	S.
	B 15th April 1938.	Do.	97	12.47±0.71	+3.87±0.83	S.
	C 1st May 1938.	Do.	98	11.24±0.60	+2.64±0.74	S.
	D 15th May 1938.	Do.	100	10.28±0.50	+1.68±0.56	S.
	E 1st June 1938.	Do.	99	8.60±0.44	Control.	..
Experiment No. 58, <i>Dalbergia sissooides</i> .	A 1st April 1938.	9th January 1939.	96	16.48±0.95	+2.91±1.18	S.
	B 15th April 1938.	Do.	94	13.10±0.76	-0.47±1.04	N.S.
	C 1st May 1938.	Do.	100	14.06±0.67	+0.49±0.97	N.S.
	D 15th May 1938.	Do.	100	11.28±0.63	-2.29±0.95	S.
	E 1st June 1938.	Do.	98	13.57±0.71	Control.	..
Experiment No. 59, <i>Pterocarpus marsupium</i> .	A 1st April 1938.	9th January 1939.	100	80.58±1.91	+20.74±2.05	S.
	B 15th April 1938.	Do.	100	24.22±1.54	+14.38±1.71	S.
	C 1st May 1938.	Do.	94	16.04±1.43	+6.20±1.61	S.
	D 15th May 1938.	Do.	96	13.71±0.80	+3.97±1.09	S.
	E 1st June 1938.	Do.	88	9.84±0.75	Control.	..
Experiment No. 61, <i>Terminalia crenulata</i> .	A 1st April 1938.	9th January 1939.	92	29.59±1.76	+10.08±2.15	S.
	B 15th April 1938.	Do.	88	23.52±1.40	+4.01±1.87	S.
	C 1st May 1938.	Do.	70	21.20±1.91	+1.69±2.28	N.S.
	D 15th May 1938.	Do.	70	14.14±1.52	-5.37±1.96	S.
	E 1st June 1938.	Do.	90	19.51±1.24	Control.	..
Experiment No. 60, <i>Artocarpus hirsuta</i> .	A 15th April 1938.	9th January 1939.	32	13.94±1.83	+5.84±1.94	S.
	B 1st May 1938.	Do.	58	10.07±0.80	+1.97±0.94	S.
	C 15th May 1938.	Do.	56	8.00±0.76	-0.10±0.91	N.S.
	D 1st June 1938.	Do.	82	8.10±0.50	Control.	..
	E 15th June 1938.	Do.	74	6.78±0.41	1.87±0.65	S.

314. Pre-monsoon stump planting—Walayar Experimental Garden (vide paragraph 99)—

Experiment No. 9 of 1938.—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 1st April 1938 to 15th June 1938. Size of stumps.—0.5" to 0.6" diameter. Tending—Normal district weeding.

Growth data after one season.

Date of measurement—13th January 1939.

Date of treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A. 1st April 1938	84	11.12 ± 0.49	-0.47 ± 0.71	N.S.
B. 15th April 1938	79	11.18 ± 0.42	-0.41 ± 0.60	N.S.
C. 1st May 1938	87	13.23 ± 0.54	+1.64 ± 0.74	S.
D. 15th May 1938	96	13.10 ± 0.10	+1.51 ± 0.71	S.
E. 1st June 1938	99	11.59 ± 0.51	Control.	..
F. 15th June 1938	94	8.21 ± 0.30	-3.33 ± 0.59	S.

315. Pre-monsoon stump planting—Nilambur Experimental Garden (vide paragraph 100)—

Experiment No. 10 of 1938.—Species—*Tectona grandis*. Arrangement, etc., as above. Dates of stump planting—Fortnightly from 1st April 1938 to 1st June 1938. Stock used—Stumps 0.5" to 0.6" diameter, from one year old nursery plants. Tending—Normal district plantation practice.

Measurements in January 1939.

Date of planting.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A. 1st April 1938	98	48.05 ± 2.23	+7.69 ± 3.12	S.
B. 15th April 1938	97	43.23 ± 1.87	+2.87 ± 2.80	N.S.
C. 1st May 1938	98	41.44 ± 2.03	+1.08 ± 2.98	N.S.
D. 15th May 1938	100	47.30 ± 1.85	+6.94 ± 2.86	S.
E. 1st June 1938	97	40.36 ± 2.18	Control.	..

316. Effect of age and diameter of stumps—*Artocarpus hirsuta* (vide paragraph 105)—

Kannoth Experimental Garden Experiment No. 71.—Arrangement—ABC CBA, etc., in single lines of ten plants repeated ten times, i.e., 100 plants per treatment. Espacement—6'×3'. Stock used—Stumps one year old 0.2"/0.3", 0.3"/0.4" and 0.4"/0.5" diameter, two years old 0.3"/0.4", 0.4"/0.5", 0.7"/0.9" and 1.1"/1.3" diameter. Date of stump planting—6th June 1938.

NOTE.—This experiment was done in a taungya crop of hill paddy sown on 30th May 1938.

Begur Experimental Garden—Experiment No. 123.—Arrangement, etc., as above but for eight treatments. Stock used—Stumps one year old 0.2"/0.3", 0.4"/0.5" and 0.5"/0.6" diameter, two years old 0.3"/0.4", 0.4"/0.5", 0.5"/0.6", 0.6"/0.7" and 1.1"/1.3" diameter. Date of stump planting—5th June 1938.

Dhoni Experimental Garden—Experiment No. 157.—Arrangement, etc., as above but for six treatments. Stock used—Stumps one year old 0.2"/0.3", 0.3"/0.4" and 0.4"/0.5" diameter and two years old 0.4"/0.5", 0.5"/0.6" and 0.6"/0.7" diameter. Date of stump planting—1st June 1938.

Topslip Experimental Garden—Experiment No. 177.—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 stumps two years old 0.5"/0.6", 0.6"/0.7" and 0.7"/0.8" diameters. Date of stump planting—1st June 1938.

Experiment number.	Age of stumps.	Diameter of stumps in inches.	Date of measurement.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Kannoth Experimental Garden—Experiment No. 71.	One year.	0.2 to 0.3	11th Janua 1939.	84	5.52 ± 0.36	— 1.08 ± 0.65	N.S.
		0.3 to 0.4	Do.	93	7.46 ± 0.52	+ 0.86 ± 0.67	N.S.
	Two years.	0.4 to 0.5	Do.	96	6.60 ± 0.42	Control.	S.
		0.3 to 0.4	Do.	82	8.20 ± 0.54	+ 1.60 ± 0.68	S.
		0.4 to 0.5	Do.	96	8.69 ± 0.54	+ 2.09 ± 0.68	S.
Begur Experimental Garden—Experiment No. 123.	One year.	0.2 to 0.3	4th February 1939.	86	4.35 ± 0.27	— 3.19 ± 0.96	S.
		0.4 to 0.5	Do.	92	6.63 ± 0.33	— 0.91 ± 0.58	N.S.
	Two years.	0.5 to 0.6	Do.	92	7.54 ± 0.45	Control.	S.
		0.3 to 0.4	Do.	62	5.16 ± 0.44	— 2.38 ± 0.62	S.
		0.4 to 0.5	Do.	70	5.54 ± 0.51	— 2.00 ± 0.68	S.
Dhoni Experimental Garden—Experiment No. 157.	One year.	0.2 to 0.3	9th January 1939.	10	6.80 ± 0.34	— 5.91 ± 1.09	S.
		0.3 to 0.4	Do.	32	11.47 ± 0.11	— 1.24 ± 1.04	N.S.
	Two years.	0.4 to 0.5	Do.	49	12.71 ± 1.04	Control.	S.
		0.4 to 0.5	Do.	51	8.73 ± 0.77	— 3.98 ± 1.29	S.
		0.5 to 0.6	Do.	53	11.34 ± 0.69	— 1.37 ± 1.26	N.S.
Topslip Experimental Garden—Experiment No. 177.	One year.	0.3 to 0.4	21st January 1939.	31	4.00 ± 0.31	— 1.53 ± 0.49	S.
		0.4 to 0.5	Do.	39	5.05 ± 0.39	— 0.53 ± 0.54	N.S.
	Two years.	0.5 to 0.6	Do.	62	5.58 ± 0.38	Control.	N.S.
		0.5 to 0.6	Do.	55	4.67 ± 0.33	— 0.91 ± 0.50	N.S.
		0.6 to 0.7	Do.	50	5.28 ± 0.39	— 0.30 ± 0.54	N.S.
		0.7 to 0.8	Do.	44	5.20 ± 0.41	— 0.38 ± 0.56	N.S.

317. *Effect of depth of stump planting—Teak* (vide paragraph 106)—

*Begur Experimental Garden Experiment No. 126.—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 1938 buried, (B) planted on 1st April 1938 normal, (C) planted on 1st June 1938 buried and (D) planted on 1st June 1938 normal. *Stock used—*One year old stumps 0.5" to 0.6" diameter. *Weeding—*Normal district practice.

*Dhoni Experimental Garden Experiment No. 154.—Arrangement, etc., as above. Stock used—*Stumps one year old 0.5" to 0.8" diameter.

*Walayar Experimental Garden Experiment No. 8.—Arrangement, etc., as above. Stock used—*One year old stumps 0.6" to 0.7" diameter.

*Topslip Experimental Garden Experiment No. 169.—Arrangement, etc., as above. Stock used—*One year old stumps 0.4" to 0.6" diameter.

*Kannoth Experimental Garden Experiment No. 62.—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 25th May 1938.

Locality.	Date of planting.	Treatment.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
Begur Experimental Garden—Experiment No. 126.	1st April 1938.	Buried.	99	38.88 ± 1.97	+ 4.56 ± 2.14	S.
	1st June 1938.	Normal.	97	36.07 ± 2.03	Control.	S.
	1st April 1938.	Buried.	99	11.77 ± 0.63	— 2.81 ± 0.85	S.
	1st June 1938.	Normal.	98	14.56 ± 0.66	Control.	S.
Dhoni Experimental Garden—Experiment No. 154.	1st April 1938.	Buried.	98	23.37 ± 1.29	+ 3.85 ± 1.63	S.
	1st June 1938.	Normal.	89	19.62 ± 1.00	Control.	S.
	1st April 1938.	Buried.	99	16.38 ± 0.95	+ 0.16 ± 1.27	N.S.
	1st June 1938.	Normal.	100	16.22 ± 0.86	Control.	S.
Walayar Experimental Garden—Experiment No. 8.	1st April 1938.	Buried.	88	15.44 ± 0.87	+ 1.62 ± 1.04	N.S.
	1st June 1938.	Normal.	67	13.82 ± 0.58	Control.	S.
	1st April 1938.	Buried.	95	11.51 ± 0.47	— 1.60 ± 0.71	S.
	1st June 1938.	Normal.	100	13.01 ± 0.63	Control.	S.
Topslip Experimental Garden—Experiment No. 169.	1st April 1938.	Buried.	99	32.44 ± 1.80	— 1.42 ± 2.76	N.S.
	1st June 1938.	Normal.	90	33.86 ± 2.08	Control.	S.
	1st April 1938.	Buried.	98	16.14 ± 0.68	— 0.19 ± 0.92	N.S.
	1st June 1938.	Normal.	96	16.33 ± 0.62	Control.	S.
Kannoth Experimental Garden—Experiment No. 62.	1st April 1938.	Buried.	98	18.04 ± 1.19	+ 4.40 ± 1.44	S.
	1st June 1938.	Normal.	100	13.55 ± 0.81	Control.	S.
	1st April 1938.	Buried.	98	8.82 ± 0.43	+ 0.82 ± 0.62	N.S.
	1st June 1938.	Normal.	94	8.00 ± 0.39	Control.	S.

318. *Stump planting—Storage of stumps—Teak* (vide paragraphs 109 and 110)—

*Begur Experimental Garden Experiment No. 124.—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 1938, 15th March 1938, 25th March 1938, 10th April 1938 and planted on 10th April 1938. *Stock used—*One year old stumps 0.5" to 0.6" diameter. *Tending—*Normal district weeding.

*Begur Experimental Garden Experiment No. 125.—Arrangement, etc., as above. Treatment—*Stumps were prepared on 5th April 1938, 10th April 1938, 15th April 1938 and 1st May 1938 and planted on 1st May 1938. *Stock used—*One year old stumps 0.5" to 0.6" diameter.

*Anaipadi Experimental Garden Experiment No. 168.—Arrangement, etc., as above. Treatment—Set I—*Stumps were prepared on 5th March 1938, 15th March 1938, 25th March 1938 and 10th April 1938 and planted on 10th April 1938. *Set II—*Stumps were prepared on 5th April 1938, 10th April 1938, 15th April 1938, 1st May 1938 and 5th May 1938 and planted on 5th May 1938. *Stock used—*One year old stumps 0.4" to 0.6" diameter.

*Dhoni Experimental Garden Experiment No. 152.—Arrangement, etc., as above. Treatment—*As above. *Stock used—*One year old stumps 0.4"/0.6" diameter.

Experiment number.	Date of stump planting.	Date of measurement.	Day of storage.	Survival percent- age.	Mean height in inches.
Begur Experimental Garden— Experiment No. 124.	10th April 1938.	4th February 1939.	15 25 35	93 57 12 4	108. 13.9 17.8 18.2 14.3
Do. No. 125	1st May 1938.	4th February 1939.	0 15 20 25	98 91 84 70	13.5 13.3 13.9 11.5
Anaipadi Experimental Gar- den—Experiment No. 168.	10th April 1938.	21st January 1939.	15 25 35	91 82 40 5	83.4 31.4 32.1 16.4
	5th May 1938.	21st January 1939.	15 20 25	77 86 80 61	20.3 21.9 23.7 24.4
Dhoni Experimental Garden— Experiment No. 152.	10th April 1938.	9th January 1939.	15 25 35	99 26 10 2	15.0 12.8 11.1 6.5
	5th May 1938.	9th January 1939.	15 20 25	99 81 48 27	16.4 15.2 13.6 13.2

319. Comparison of direct sowing with transplanting different sizes of transplants—*Swietenia macrophylla* (vide paragraphs 119 and 120)—

Kannoth Experimental Garden Experiment No. 72 of 1938.—(First year measurements.) Arrangement—ABCD DCBA, etc., in single lines of ten plants repeated ten times (i.e., 100 plants per treatment). Espacement—6' × 3'. Soil preparation—Pits 6" × 6" × 9" for all treatments. Tending—Normal district practice. Stock used—Sowing—10 seeds per patch. Transplants—(i) 6 months old 9" to 12" high (ii) 6 months old 18" to 24" high and (iii) 6 months old 24" to 36" high. Date of sowing—11th May 1938. Transplanting—15th June 1938. This experiment was done in a ponam crop of hill paddy sown on 24th May 1938.

Dhoni Experimental Garden Experiment No. 161 of 1938.—(First year measurements.) Arrangement, etc., as above. Stock used—Sowing—10 seeds per patch. Transplants—(i) 2 months old 6" to 9" high, (ii) 1 year old 12" to 18" high and (iii) 1 year old 24" to 30" high. Date of sowing—15th May 1938. Transplanting—11th June 1938.

Begur Experimental Garden Experiment No. 122 of 1938.—(First year measurements.) Arrangement, etc., as above. Stock used—Sowing—Ten seeds per patch. Transplants—(i) 1½ years old 30" to 42" high, (ii) 1½ years old 18" to 24" high and (iii) 6 months old 8" to 12" high. Date of sowing—6th June 1938. Transplanting—3rd July 1938.

Topslip Experimental Garden Experiment No. 176 of 1938.—(First year measurements.) Arrangement, etc., as above. Stock used—Sowing 10 seeds per patch. Transplants—(i) 4 months old 6" to 9" high, (ii) 1 year old 18" to 24" high and (iii) 1 year old 30" to 40" high. Date of sowing—1st May 1938. Transplanting—10th June 1938.

Begur Experimental Garden Experiment No. 92 of 1937.—(Second year measurements.) Arrangement, etc., as above. Stock used—Sowing 10 seeds per patch. Transplanting—4 months old 10" high, 1 year old 21" and 36" high. Date of sowing—7th June 1937. Transplanting—16th June 1937.

Dhoni Experimental Garden Experiment No. 141 of 1937.—(Second year measurements.) Arrangement, etc., as above. Stock used—Sowing 10 seeds per patch. Transplanting—1 year old and 7½", 15" and 22½" high. Date of sowing—23rd April 1937. Transplanting—30th June 1937.

Topslip Experimental Garden Experiment No. 150 of 1937.—(Second year measurements.) Arrangement, etc., as above. Stock used—Sowing 10 seeds per patch. Transplanting—1 year old and 7½", 21" and 35" high. Date of sowing—1st May 1937. Transplanting—2nd July 1937.

Kannoth Experimental Garden Experiment No. 51 of 1937.—(Second year measurements.) Arrangement, etc., as above. Stock used—Sowing 10 seeds per patch. Transplanting—3 months old and 7½" high, 1 year old and 15" and 35" high. Date of sowing—15th May 1937. Transplanting—19th June 1937.

Dhoni Experimental Garden Experiment 117 of 1936.—(Third year measurements.) Arrangement, etc., as above. Stock used—Sowing ten seeds per patch. Transplanting—Two months old 15" high and one year old and 21" and 30" high. Date of sowing—19th May 1936. Transplanting—12th June 1936.

Topslip Experimental Garden Experiment No. 137 of 1936.—(Third 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 No. 66 of 1936.—(Third year measurements.) Arrangement, etc., as above. Stock used—Sowing ten seeds per patch. Transplants—(i) and (ii) one year old 15" and 33" high and (iii) three months old and 7½" high. Date of sowing—28th May 1936. Transplanting—16th June 1936.

Kannoth Experimental Garden Experiment No. 33 of 1936.—(Third 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 and (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.

First year measurements.

Experiment number.	Treatment.	Survival percentage.	Initial height.	Height after one year.	Increment first year.
Begur Experimental Garden Experiment No. 122.	Sowing	96	..	12.0	+ 12.0
	Transplants (i) ..	61	10.0	11.5	+ 1.5
	Do. (ii) ..	88	21.0	18.5	- 2.5
	Do. (iii) ..	84	36.0	29.9	- 6.1
Dhoni Experimental Garden Experiment No. 161.	Sowing	98	..	18.0	+ 18.0
	Transplanting (i) ..	74	7.5	15.3	+ 7.8
	Do. (ii) ..	79	15.0	21.0	+ 6.0
	Do. (iii) ..	96	27.0	32.0	+ 5.0
Topalip Experimental Garden Experiment No. 176.	Sowing	1	..	17.0	+ 17.0
	Transplanting (i) ..	72	7.5	14.1	+ 6.6
	Do. (ii) ..	66	21.0	23.0	+ 2.0
	Do. (iii) ..	29	35.0	26.6	- 8.4
Kannoth Experimental Garden Experiment No. 72.	Sowing	53	..	12.2	+ 12.2
	Transplanting (i) ..	77	10.5	12.5	+ 2.5
	Do. (ii) ..	36	21.0	17.1	- 3.9
	Do. (iii) ..	84	30.0	30.7	+ 0.7

Second year measurements.

Experiment number.	Treatment.	Survival percentage.	Initial height in inches.	Height after		Increment	
				One year.	Two years.	First year.	Second year.
Begur Experimental Garden Experiment No. 92.	Sowing	50	..	7.9	25.8	+ 7.9	+ 17.9
	Transplanting (i) ..	61	10.0	11.8	30.2	+ 1.8	+ 18.4
	Do. (ii) ..	64	21.0	22.2	29.2	+ 1.2	+ 7.0
	Do. (iii) ..	73	36.0	31.5	35.1	- 4.5	+ 3.6
Dhoni Experimental Garden Experiment No. 141.	Sowing	89	..	19.3	44.4	+ 19.3	+ 25.1
	Transplanting (i) ..	50	7.5	17.5	42.0	+ 40.0	+ 24.5
	Do. (ii) ..	66	15.0	21.6	42.0	+ 6.6	+ 20.4
	Do. (iii) ..	68	22.5	28.2	46.8	+ 5.7	+ 18.6
Topalip Experimental Garden Experiment No. 150.	Sowing	66	..	12.8	32.7	+ 12.8	+ 19.9
	Transplanting (i) ..	42	7.5	10.8	26.8	+ 3.3	+ 16.0
	Do. (ii) ..	67	21.0	20.2	29.8	- 0.8	+ 9.6
	Do. (iii) ..	39	35.0	21.4	34.1	- 13.6	+ 12.7
Kannoth Experimental Garden Experiment No. 51.	Sowing	60	..	12.4	42.6	+ 12.4	+ 30.2
	Transplanting (i) ..	67	7.5	15.0	49.5	+ 7.5	+ 34.5
	Do. (ii) ..	68	15.0	19.6	56.2	+ 4.6	+ 36.6
	Do. (iii) ..	77	35.0	31.5	61.3	- 3.5	+ 29.8

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.
Dhoni Experimental Garden Experiment No. 117.	Sowing	98	..	20.8	50.3	79.2	+ 20.8	+ 29.5	+ 28.9
	Transplanting (i) ..	39	35	19.3	49.5	80.4	+ 4.3	+ 30.2	+ 30.9
	Do. (ii) ..	69	21	25.7	52.5	80.4	+ 4.7	+ 26.8	+ 27.9
	Do. (iii) ..	68	30	34.4	57.0	95.2	+ 4.4	+ 12.6	+ 38.2
Topalip Experimental Garden Experiment No. 137.	Sowing	73	..	12.4	45.6	64.2	+ 12.4	+ 33.2	+ 18.6
	Transplanting (i) ..	31	6	11.3	41.7	64.4	+ 5.3	+ 30.4	+ 22.7
	Do. (ii) ..	29	12.5	14.6	39.2	59.4	+ 2.1	+ 24.6	+ 20.2
	Do. (iii) ..	66	26	24.0	50.6	68.6	- 2.0	+ 26.6	+ 18.0
Kannoth Experimental Garden Experiment No. 33.	Sowing	79	..	9.6	31.8	49.6	+ 9.5	+ 22.2	+ 17.8
	Transplanting (i) ..	52	10.5	12.3	32.5	50.8	+ 1.8	+ 20.2	+ 18.3
	Do. (ii) ..	58	25	19.4	36.2	52.2	- 5.6	+ 16.8	+ 16.0
	Do. (iii) ..	72	42	32.3	44.9	65.7	- 9.7	+ 12.6	+ 20.8
Begur Experimental Garden Experiment No. 66.	Sowing	87	..	12.2	47.8	89.8	+ 12.2	+ 35.6	+ 42.0
	Transplanting (i) ..	35	7.5	11.0	49.6	83.5	+ 4.1	+ 38.0	+ 33.9
	Do. (ii) ..	19	15.0	15.0	46.6	79.3	+ 0.0	+ 31.6	+ 32.7
	Do. (iii) ..	79	33	22.6	57.8	99.3	- 10.4	+ 35.2	+ 41.5

NOTE.—Negative increment is due to shoot borer attack or dying back.

320. *Direct sowing in a burned over area—Best season* (vide paragraph 163)—

Experiments Nos. 140 to 151 and 186—Emmanur Experimental Garden.—*Species*—As shown in the table below. *Arrangements*—ABCDEF FEDCBA repeated ten times in single lines of twenty patches i.e., 200 of each treatment. *Espace-ment*—2' × 2'. *Soil preparation*—Nine inches cube pits ash from the burn being worked into each pit. *Stock used*—Ten seeds per patch. *Dates of sowing*—On the 1st of each month from May to November 1937. *Treatment*—Clean weeded in 1' diameter circles round the plants.

Experiment number.	Species.	Measurements on 16th 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	<i>Acacia arabica.</i>	Survival percentage.	86	61	78	87	81	72	78	87
		Mean height in inches.	53.1	34.9	35.9	37.6	39.0	40.2	40.2	33.9
141	<i>Acacia ginea.</i>	Survival percentage.	3	1	4	2	2	2	30	28
		Mean height in inches.	79.8	89.5	43.7	78.0	62.8	61.3	40.5	30.0
142	<i>Acacia frons.</i>	Survival percentage.	58	50	65	26	44	79	63	46
		Mean height in inches.	52.8	22.0	22.5	29.6	23.6	32.1	30.1	26.5
143	<i>Albizia amara.</i>	Survival percentage.	37	7	9	23	14	21	28	23
		Mean height in inches.	46.0	42.6	19.2	21.8	16.7	17.6	16.6	18.3
144	<i>Albizia lebbek.</i>	Survival percentage.	21	22	57	75	54	61	73	78
		Mean height in inches.	68.6	38.6	28.7	23.5	28.4	27.4	25.0	18.6
145	<i>Cassia culata.</i>	Survival percentage.	38	27	61	47	29	26	36	22
		Mean height in inches.	48.5	32.5	34.8	24.9	22.9	22.4	21.5	20.3

Experi- ment num- ber.	Species.	Measurements on 16th 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 Sep- tember 1937.	1st Octo- ber 1937.	1st Nov- ember 1937.	
146	<i>Pterocarpus santalinus.</i>	Survival percentage.	0	3	9	11	11	26	4	19	
		Mean height in inches.	0	8.8	13.7	13.2	14.8	14.4	12.6	11.4	
147	<i>Terminalia chebula.</i>	Survival percentage.	0	1	4	1	2	1	0	0	
		Mean height in inches.	0	4.0	6.1	8.5	6.8	7.0	0	0	
148	<i>Acacia auriculi-formis.</i>	Survival percentage.	*	8	18	12	14	7	30	5	
		Mean height in inches.	*	51.3	49.3	46.6	51.2	52.1	45.8	54.5	
149	<i>Acacia sundra.</i>	Survival percentage.	*	23	27	37	33	33	58	17	
		Mean height in inches.	*	47.1	54.2	44.1	43.5	44.3	44.3	38.7	
150	<i>Cassia siamea.</i>	Survival percentage.	*	34	47	50	55	49	73	31	
		Mean height in inches.	*	53.0	31.6	31.1	29.0	33.1	34.7	27.6	
151	<i>Prosopis juliflora.</i>	Survival percentage.	*	*	65	61	72	66	83	74	
		Mean height in inches.	*	*	53.8	55.2	54.7	56.1	56.5	48.7	
186	<i>Azadirachta indica.</i>	Survival percentage.	*	*	*	*	2	1	44	2	
		Mean height in inches.	*	*	*	*	68.0	94.0	50.4	58.7	
Average survival percentage ..			24	22	37	36	32	34	46	34	
Average mean height ..			43.6	38.6	33.0	34.0	33.5	34.0	30.6	18.5	

* Not done owing to late ripening of seed.

NOTE.—In the averages of mean height the figures of *Azadirachta indica* are omitted as they would give undue weight to the later sowings.

321. Experiments Nos. 189 to 196, 205 to 208, 217 and 246.

Emmanur Experimental Garden.

(vide paragraph 164)

Species as shown in table below. Arrangement, etc., as above.

Dates of sowing—On the 1st of each month from April to November 1938.

Experi- ment No.	Species.	Measurements on 9th January 1939.	Date of sowing (10 seeds per patch).								
			1st April 1938.	1st May 1938.	1st June 1938.	1st July 1938.	1st Aug. 1938.	1st Sep- tember. 1938.	1st Octo- ber 1938.	1st Nov- ember 1938.	
189	<i>Acacia arabica</i> ..	Percentage survivals.	40	61	71	63	88	65	17	19	
		Mean height in inches.	21.5	19.2	20.2	18.0	19.0	12.2	2.1	1.2	
190	<i>Acacia ferruginea.</i>	Percentage survivals.	5	26	28	94	100	89	48	26	
		Mean height in inches.	20.6	16.4	12.3	14.3	14.3	9.1	5.0	2.7	
191	<i>Acacia sundra</i> ..	Percentage survivals.	19	50	66	85	88	70	24	42	
		Mean height in inches.	10.6	11.0	9.7	10.2	9.8	5.0	1.3	1.6	
192	<i>Albizia amara</i> ..	Percentage survivals.	15	47	76	92	98	66	40	54	
		Mean height in inches.	8.8	9.0	9.1	8.5	8.7	4.0	1.7	1.6	
193	<i>Albizia lebbek</i> ..	Percentage survivals.	27	55	74	94	80	61	10	6	
		Mean height in inches.	4.3	7.2	5.5	6.5	5.4	3.7	1.3	1.3	

Experi- ment No.	Species.	Measurements on 9th January 1938.	Date of sowing (10 seeds per patch).								
			1st April 1938.	1st May 1938.	1st June 1938.	1st July 1938.	1st Aug. 1938.	1st Sep- tember 1938.	1st Octo- ber 1938.	1st Nov- ember 1938.	
194	<i>Cassia auriculata.</i>	Percentage survivals.	81	94	96	99	99	83	63	93	
		Mean height in inches.	15.0	13.0	12.9	13.8	13.7	6.0	2.4	1.9	
195	<i>Pterocarpus santalinus.</i>	Percentage survivals.	8	8	22	10	37	21	1	3	
		Mean height in inches.	2.8	4.1	4.0	4.6	4.2	2.4	1.0	1.0	
196	<i>Terminalia chebula.</i>	Percentage survivals.	0	0	2	2	3	1	0	0	
		Mean height in inches.	0	0	1.7	1.7	1.8	3.0	0	0	
205	<i>Acacia auriculi-formis.</i>	Percentage survivals.	*	25	32	25	44	43	3	1	
		Mean height in inches.	*	11.1	12.3	9.7	12.1	6.1	7.3	1.0	
206	<i>Acacia planifrons.</i>	Percentage survivals.	*	68	87	93	98	87	25	15	
		Mean height in inches.	*	18.4	16.7	16.9	10.6	10.3	4.0	2.3	
207	<i>Cassia siamea</i> ..	Percentage survivals.	*	79	95	64	99	90	44	28	
		Mean height in inches.	*	16.6	16.8	15.7	18.0	6.5	3.1	1.8	
208	<i>Wrightia tinctoria.</i>	Percentage survivals.	*	53	77	81	89	93	2	9	
		Mean height in inches.	*	6.5	6.4	6.5	4.8	2.8	4.3	1.1	
217	<i>Prosopis juliflora.</i>	Percentage survivals.	*	*	33	53	86	92	39	31	
		Mean height in inches.	*	*	24.4	26.1	27.0	14.7	5.6	2.1	
246	<i>Azadirachta indica.</i>	Percentage survivals.	*	*	*	*	95	76	1	0	
		Mean height in inches.	*	*	*	*	11.0	5.3	4.0	0	
Average survival percentage.			24	47	58	66	77	66	24	25	
Average Mean height.			10.5	11.0	11.7	11.8	12.2	6.6	3.0	1.5	

* Not done owing to late ripening of seed.

NOTE.—In the averages of mean height growth the figures of *Azadirachta indica* are omitted as they would give undue weight to the later sowings.

322. Direct sowing—Comparison of burning and no burning, soil working and no soil working before sowing (vide paragraph 170)—

Experiments Nos. 171 to 176—Emmanur Experimental Garden.—

Species:—As shown in the table below. Arrangement—A plot 120' × 120' divided into twenty sub-plots of which ten were burned and ten were not burned arranged 1, 2, 2, 1, etc., with 4' buffer lines between treatments. Treatments A and B randomised in the unburned strips and C and D in the burned strips. A and B not burned. C and D burned. A and C worked pits 9" cube. B and D soil loosened just enough to sow seed. Espacement—2' × 2'. Soil preparation—In the soil worked area 9" × 9" × 6". Ash mixed with the soil. In the non-soil worked area just enough soil working to be able to sow. Stock used.—Ten seeds per patch. Date of sowing—3rd July 1937. Treatment—Kept clean weeded throughout.

NOTE.—In the burned area brushwood was piled 6 feet high and beaten down to 4 feet high before burning.

Experiment number.	Species.	Measurement on 21st January 1939.	Area not burned.		Area burned.	
			Worked pits.	No soil working.	Worked pits.	No soil working.
171	<i>Acacia planifrons</i> .	Percentage of survivals. Mean height growth in inches.	29 14.5	23 13.6	55 31.1	45 23.6
172	<i>Albizia amara</i> .	Percentage of survivals. Mean height growth in inches.	3 21.7	7 8.0	30 16.2	43 12.0
173	<i>Cassia auriculata</i> .	Percentage of survivals. Mean height growth in inches.	20 9.9	19 8.1	60 29.7	64 22.6
174	<i>Cassia siamea</i> ..	Percentage of survivals. Mean height growth in inches.	1 3.0	0 0	52 33.7	43 29.5
175	<i>Dolichandrone crista</i> .	Percentage of survivals. Mean height growth in inches.	0 0	7 4.0	12 8.0	28 6.9
176	<i>Zizyphus jujuba</i> .	Percentage of survivals. Mean height growth in inches.	2 2.0	6 3.2	84 11.3	80 9.0
Average of all species— Percentage survivals.			9	11	49	33
Mean height in inches.			8.5	6.2	22.5	18.1

323. Experiments Nos. 230 to 236—Emmanur Experimental Garden (vide paragraph 171).—

Species as shown in the table below. Arrangement, etc., as above. Date of sowing—16th July 1938.

Experiment number.	Species.	Measurements on 13th January 1938.	Area not burned.		Area burned.	
			Worked pits.	No soil working.	Worked pits.	No soil working.
230	<i>Acacia arabica</i> ..	Percentage survivals. Mean height growth in inches.	28 6.0	14 7.6	44 10.2	21 16.3
231	<i>Albizia amara</i> ..	Percentage survivals. Mean height growth in inches.	81 3.4	85 3.3	86 8.8	75 7.3
232	<i>Acacia planifrons</i> ..	Percentage survivals. Mean height growth in inches.	87 4.0	87 3.7	95 15.5	94 12.3
233	<i>Cassia auriculata</i> ..	Percentage survivals. Mean height growth in inches.	70 2.5	53 2.8	87 15.8	75 14.0
234	<i>Cassia siamea</i> ..	Percentage survivals. Mean height growth in inches.	26 3.1	13 3.2	98 16.0	87 14.5
235	<i>Dolichandrone crista</i> .	Percentage survivals. Mean height growth in inches.	62 1.5	64 1.5	74 4.7	96 4.5
236	<i>Zizyphus jujuba</i> ..	Percentage survivals. Mean height growth in inches.	6 1.8	5 1.4	64 7.7	64 7.3
Average of all species— Percentage survivals Mean height growth in inches.			51 3.3	46 3.3	78 12.5	73 10.9

324. Comparison of sowing, entire transplanting and stump planting (vide paragraph 174).—

Experiments Nos. 180 to 185—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 sowing, 9" crowbar holes for stump-planting and soil worked 9" × 9" × 9" for transplanting. Stock used—Sowing ten seeds per patch, trans planting and stump-planting one year old

plants from Emmanur nursery. Date of sowing—23rd July 1937. Date of transplanting—8th October 1937. Date of stump planting—21st September 1937. Treatment—Clean weeding in one-foot diameter circles round the plants.

Measurements in January 1939.

Experiment number.	Species.	Percentage survivals.			Mean height in inches.		
		Sowing.	Trans-planting.	Stump-ing.	Sowing.	Trans-planting.	Stump-ing.
180	<i>Azadirachta indica</i> ..	0	15	43	..	35.7	43.6
181	<i>Dolichandrone crista</i> .	25	19	67	19.7	14.5	23.9
182	<i>Hardwickia binata</i> ..	7	14	58	19.9	18.8	21.0
183	<i>Pterocarpus santalinus</i> .	34	52	4	12.3	13.7	21.3
184	<i>Wrightia tinctoria</i> ..	8	52	31	32.1	33.2	36.5
185	<i>Soymida febrifuga</i> ..	0	10	33	..	8.9	10.7

325. Comparison of sowing, entire transplanting and stump-planting (vide paragraph 175).—

Experiments Nos. 224 to 229—Emmanur Experimental Garden.—Species—As in the table below. Arrangement, etc., as above. Date of sowing—15th July 1938. Date of transplanting—14th November 1938. Date of stump planting—27th September 1938.

Measurement in January 1939.

Experiment number.	Species.	Percentage survivals.			Mean height in inches.		
		Sowing.	Trans-planting.	Stump-ing.	Sowing.	Trans-planting.	Stump-ing.
224	<i>Dolichandrone crista</i> .	49	53	54	5.1	4.0	1.7
225	<i>Hardwickia binata</i> ..	34	6	50	6.5	4.0	2.8
226	<i>Pterocarpus santalinus</i> .	24	50	85	4.0	6.6	2.2
227	<i>Soymida febrifuga</i> ..	47	18	63	4.0	5.8	1.8
228	<i>Wrightia tinctoria</i> ..	78	46	63	3.1	3.2	2.7
229	<i>Azadirachta indica</i> ..	61	42	75	10.8	3.8	3.8

326. (i) Stump-planting—Best date—(ii) Stump-planting and transplanting comparison—(iii) Comparison of transplanting at the commencement of the South-west monsoon and north-east monsoon (vide paragraph 176).—

Experiments Nos. 177 to 179—Emmanur Experimental Garden.—Species—As in the table below. Arrangement—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 10 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, E-1, one year old stumps 0.1" to 0.2" diameter. A-2, C-2, D-2, E-2, two-year old stumps 0.15" to 0.3" diameter. B and F one-year old transplants 12" to 33" in height. Treatment—Kept clean weeded. 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 23rd January 1939.	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.	C-1.	D-1.	E-1.	B.	F.	
177	<i>Pterocarpus santalinus</i> .	Percentage survivals ..	2	8	31	38	87	50	
		Mean height in inches ..	11.5	19.4	13.2	11.8	15.3	13.6	
178	<i>Sesuvia portulacastrum</i> .	Percentage survivals ..	3	6	18	43	11	14	
		Mean height in inches ..	10.3	7.2	6.4	8.9	8.1	3.4	
179	<i>Wrightia tinctoria</i> .	Percentage survivals ..	18	18	67	54	30	67	
		Mean height in inches ..	41.8	33.2	24.7	14.5	22.1	11.9	

327.—Experiments Nos. 221 to 223—Emmanur Experimental Garden (vide paragraph 177)—

Species—As in the table below. Arrangement, etc., as above.
Stock used—As above. Dates of stump-planting—1st July 1938, 1st August 1938, 1st September 1938 and 1st October 1938. Dates of transplanting—18th July 1938 and 5th November 1938.

Experiment number.	Species.	Measurement on 12th January 1939.	Stump-planting on					Transplanting on	
			1st July 1938.	1st August 1938.	1st September 1938.	1st October 1938.	18th July 1938.	5th November 1938.	
			A-1.	C-1.	D-1.	E-1.	B.	F.	
221	<i>Pterocarpus santalinus</i> .	Percentage survivals ..	3	5	27	19	22	46	
		Mean height in inches ..	5.3	2.3	2.9	1.7	5.0	5.3	
222	<i>Asclepias indica</i> .	Percentage survivals ..	19	80	14	1	4	27	
		Mean height in inches ..	15.4	14.3	5.9	2.0	12.5	4.7	
223	<i>Wrightia tinctoria</i> .	Percentage survivals ..	5	21	50	0	23	78	
		Mean height in inches ..	8.6	4.7	5.4	0	8.9	4.4	

328. Direct sowing—Best date (under top canopy only) (vide paragraph 231)—

Chandanathode Experimental Garden Experiment No. 148.—
Species—*Acrocarpus fraxinifolius*. Arrangement—ABCD DCBA repeated ten times in single lines of ten plants (i.e., one hundred 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 1938; (B) 1st June 1938; (C) 1st July 1938; (D) 1st August 1938. Weeding—Normal district practice.

Chandanathode Experimental Garden Experiment No. 147.—
Species—*Cedrela toona*. Arrangement, etc. as above. Dates of sowing—As above.

Chandanathode Experimental Garden Experiment No. 146.—
Species—*Swietenia macrophylla*. Arrangement, etc., as above. Dates of sowing—(A) 1st April 1938; (B) 1st May 1938; (C) 1st June 1938.

Chandanathode Experimental Garden Experiment No. 149.—
Species—*Gluta travancorica*. Arrangement, etc., as above. Dates of sowing—(A) 15th May 1938; (B) 15th June 1938; (C) 15th July 1938; (D) 15th August 1938.

Karianshola Experimental Garden Experiment No. 127.—
Species—*Bischofia javanica*. Arrangement, etc., as above. Dates of sowing—(A) 15th May 1938; (B) 1st June 1938; (C) 15th June 1938; (D) 1st July 1938; (E) 15th July 1938.

Karianshola Experimental Garden Experiment No. 126.—
Species—*Swietenia macrophylla*. Arrangement, etc., as above. Dates of sowing—(A) 1st April 1938; (B) 15th April 1938; (C) 1st May 1938; (D) 15th May 1938; (E) 1st June 1938.

Karianshola Experimental Garden Experiment No. 93.—
Species—*Acrocarpus fraxinifolius*. Arrangement, etc., as above. Dates of sowing—(A) 1st June 1938; (B) 15th June 1938; (C) 1st July 1938; (D) 15th July 1938; (E) 1st August 1938.

Experiment number	Species	Measurement on 23rd January 1939.	Stump-planting on				Transplanting on	
			1st July 1937.	1st August 1937.	1st September 1937.	1st October 1937.	28th July 1937.	7th October 1937.
			A-1.	C-1.	D-1.	E-1.	B.	F.
177	<i>Pterocarpus santalinus</i> .	Percentage survivals ..	52	8	31	38	87	50
		Mean height in inches ..	11.5	10.4	11.2	11.8	15.3	13.6
178	<i>Sesuvia portulacastrum</i> .	Percentage survivals ..	3	20.9	18	43.8	18	14
		Mean height in inches ..	10.3	7.2	6.4	3.9	8.1	3.4
179	<i>Wrightia tinctoria</i> .	Percentage survivals ..	18	23	57	54	30	57
		Mean height in inches ..	41.8	33.2	24.7	14.5	22.1	11.9

327.—Experiments Nos. 221 to 223—Emmanur Experimental Garden (vide paragraph 177)—

Species—As in the table below. Arrangement, etc., as above.

Stock used—As above. Dates of stump-planting—1st July 1938, 1st August 1938, 1st September 1938 and 1st October 1938. Dates of transplanting—18th July 1938 and 5th November 1938.

Experiment number	Species	Measurement on 12th January 1939.	Stump-planting on				Transplanting on	
			1st July 1938.	1st August 1938.	1st September 1938.	1st October 1938.	18th July 1938.	5th November 1938.
			A-1.	C-1.	D-1.	E-1.	B.	F.
221	<i>Pterocarpus santalinus</i> .	Percentage survivals ..	14	5	27	19	22	46
		Mean height in inches ..	6.7	2.3	3.5	1.7	5.0	5.3
222	<i>Acacia robusta</i> .	Percentage survivals ..	1	20	14	3	4	27
		Mean height in inches ..	2.0	14.3	5.9	2.0	12.5	4.7
223	<i>Wrightia tinctoria</i> .	Percentage survivals ..	10	21	50	0	26	78
		Mean height in inches ..	5.8	4.7	5.4	0	8.9	4.4

328. Direct sowing—Best date (under top canopy only) (vide paragraph 231)—

Chandanathode Experimental Garden Experiment No. 148.—
Species—*Acrocarpus fraxinifolius*. Arrangement—ABCD DCBA repeated ten times in single lines of ten plants (i.e., one hundred 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 1938; (B) 1st June 1938; (C) 1st July 1938; (D) 1st August 1938. Weeding—Normal district practice.

Chandanathode Experimental Garden Experiment No. 147.—
Species—*Cedrela toona*. Arrangement, etc. as above. Dates of sowing—As above.

Chandanathode Experimental Garden Experiment No. 146.—
Species—*Swietenia macrophylla*. Arrangement, etc., as above. Dates of sowing—(A) 1st April 1938; (B) 1st May 1938; (C) 1st June 1938.

Chandanathode Experimental Garden Experiment No. 149.—
Species—*Gluta travancorica*. Arrangement, etc., as above. Dates of sowing—(A) 15th May 1938; (B) 15th June 1938; (C) 15th July 1938; (D) 15th August 1938.

Karianshola Experimental Garden Experiment No. 127.—
Species—*Bischofia javanica*. Arrangement, etc., as above. Dates of sowing—(A) 15th May 1938; (B) 1st June 1938; (C) 15th June 1938; (D) 1st July 1938; (E) 15th July 1938.

Karianshola Experimental Garden Experiment No. 126.—
Species—*Swietenia macrophylla*. Arrangement, etc., as above. Dates of sowing—(A) 1st April 1938; (B) 15th April 1938; (C) 1st May 1938; (D) 15th May 1938; (E) 1st June 1938.

Karianshola Experimental Garden Experiment No. 93.—
Species—*Acrocarpus fraxinifolius*. Arrangement, etc., as above. Dates of sowing—(A) 1st June 1938; (B) 15th June 1938; (C) 1st July 1938; (D) 15th July 1938; (E) 1st August 1938.

Locality.	Species.	Experi- ment number.	Survival percentage in January 1939.					
			1st April 1938.	15th April 1938.	1st May 1938.	15th May 1938.	1st June 1938.	15th June 1938.
Chandanathode	<i>Acrocarpus fraxinifolius</i>	148	..	..	5	..	..	..
	<i>Cedrela toona</i>	147	13	..	8	..	2	..
	<i>Swietenia macrophylla</i>	146	..	..	10	..	5	..
	<i>Gluta travancorica</i>	149	..	..	..	61	..	72
	<i>Bischofia javanica</i>	127	100	80	..	66	67	36
Karianshola	<i>Swietenia macrophylla</i>	126	..	..	68	32	18	24
	<i>Acrocarpus fraxinifolius</i>	130	..	..	..	..	33	..

Mean height growth in January 1939 in inches.

Locality.	Species.	Experi- ment number.	1st April 1938.	15th April 1938.	1st May 1938.	15th May 1938.	1st June 1938.	15th June 1938.	1st July 1938.	15th July 1938.	1st August 1938.	15th August 1938.
			..	..	..	..	..	..	..	..	..	..
Chandanathode	<i>Acrocarpus fraxinifolius</i>	148	..	..	5.4	..	2.0	..	2.9	..	2.7	..
	<i>Cedrela toona</i>	147	7.2	..	5.4	..	6.0	..	6.0	..	3.2	..
	<i>Swietenia macrophylla</i>	146	..	..	7.0	..	8.0	8.0	..	7.7	..	..
	<i>Gluta travancorica</i>	149	..	..	..	11.0	7.4	6.1	..	5.0	..	..
	<i>Bischofia javanica</i>	127	13.4	10.8	9.4	8.2	8.4	5.5	5.9	5.9	5.1	..
Karianshola	<i>Swietenia macrophylla</i>	126	..	..	..	..	..	..	..	..	..	..
	<i>Acrocarpus fraxinifolius</i>	130	..	..	..	..	..	..	..	..	..	..

329. Entire transplanting—Best date (under top canopy only) (vide paragraph 232).—

Chandanathode Experimental Garden Experiment No. 150.—
Species—*Hopea parviflora*. Arrangement—ABCDEFGF
GFEDCBA repeated ten times in single lines of ten plants
(i.e., one hundred plants per treatment). Espacement—
3' × 1½'. Soil preparation—1' cube pits. Stock used—One
year old plants 12" to 18" high. Dates of transplanting—
(A) 15th June 1938; (B) 1st July 1938; (C) 15th July 1938;
(D) 1st August 1938; (E) 15th August 1938; (F) 1st Septem-
ber 1938; (G) 15th September 1938. Weeding—Normal
district practice.

Chandanathode Experimental Garden Experiment No. 151.—
Species—*Swietenia macrophylla*. Arrangement, etc., as
above. Stock used—One year old plants 18" to 24" high.

Chandanathode Experimental Garden Experiment No. 152.—
Species—*Cedrela toona*. Arrangement, etc., as above.
Stock used—One year old plants 9" to 12" high.

Chandanathode Experimental Garden Experiment No. 153.—
Species—*Hardwickia pinnata*. Arrangement, etc., as above.
Stock used—One year old plants 9" to 12" high.

Karianshola Experimental Garden Experiment No. 116.—
Species—*Swietenia macrophylla*. Arrangement, etc., as
above. Stock used—One year old plants 20" to 28" high.
Dates of transplanting—(A) 15th June 1938; (B) 1st July
1938; (C) 15th July 1938; (D) 1st August 1938; (E) 15th
August 1938; (F) 1st October 1938; (G) 15th October 1938.

Karianshola Experimental Garden Experiment No. 115.—
Species—*Mesua ferrea*. Arrangement, etc., as above. Stock
used.—One year old plants 8" to 14" high.

Karianshola Experimental Garden Experiment No. 118.—
Species—*Cedrela toona*. Arrangement, etc., as above. Stock
used—One year old plants 25" to 35" high.

Karianshola Experimental Garden Experiment No. 119.—
Species—*Hopea parviflora*. Arrangement, etc., as above.
Stock used—One year old plants 4" to 11" high.

Karianshola Experimental Garden Experiment No. 120.—
Species—*Palaquium ellipticum*. Arrangement, etc., as
above. Stock used—One year old plants 10" to 16" high.

Measurements in January 1939.

Locality.	Experi- ment number.	Species.	Survival percentage of plants transplanted on						Mean height growth in inches of plants transplanted on												
			15th June	1st July	15th July	1st August	15th August	1st Septem- ber	15th Septem- ber	1st October	15th October	15th June	1st July	15th July	1st August	15th August	1st Septem- ber	15th Septem- ber	1st October	15th October	
Chandanathode	150	<i>Hopea parviflora</i>	1938.	96	98	98	93	65	95	..	..	1938.	11.6	11.9	11.6	11.9	15.7	19.8	..	..	
	151	<i>Swietenia macrophylla</i>	..	81	83	98	93	94	92	..	..	..	18.6	18.6	18.6	18.8	19.8	..	..	..	
	152	<i>Cedrela toona</i>	..	74	58	98	100	90	77	77	..	..	10.3	6.5	6.5	6.4	4.3	..	..	..	
	153	<i>Hardwickia pinnata</i>	..	72	59	93	61	77	..	..	..	..	4.1	4.1	4.1	4.1	4.3	..	..	..	
	..	<i>Swietenia macrophylla</i>	..	89	64	93	84	83	..	..	..	..	23.1	22.5	..	..	..	23.0	15.4	..	
	116	<i>Mesua ferrea</i>	..	70	44	62	56	36	..	..	..	..	7.4	7.6	7.4	..	..	8.3	6.7	..	
Karianshola	118	<i>Cedrela toona</i>	..	92	92	91	94	..	..	..	..	27.6	28.8	27.6	..	..	..	26.0	17.4	..	
	119	<i>Hopea parviflora</i>	..	80	85	90	58	..	..	..	..	7.7	7.7	7.7	..	..	6.9	8.0	..		
	120	<i>Palaquium ellipticum</i>	..	4	9	4	17	..	..	..	..	11.2	9.5	11.2	..	..	11.9	9.5	..		
	..	..	..	8	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
Chandanathode	150	<i>Hopea parviflora</i>	1938.	11.6	15.8	12.9	11.9	11.6	11.9	15.7	..	..	1938.	11.6	11.9	11.6	11.9	15.7	19.8	..	..
	151	<i>Swietenia macrophylla</i>	..	18.3	17.5	15.6	18.6	18.6	18.8	19.8	..	..	..	18.6	18.6	18.6	18.8	19.8	..	..	
	152	<i>Cedrela toona</i>	..	10.0	7.9	10.0	10.3	6.5	5.5	6.4	..	..	..	10.3	6.5	6.5	6.4	4.3	..	..	
	153	<i>Hardwickia pinnata</i>	..	6.3	5.6	4.8	5.3	4.1	4.1	4.3	..	..	..	4.1	4.1	4.1	4.1	4.3	..	..	
	..	<i>Swietenia macrophylla</i>	..	25.1	23.7	25.0	23.1	22.5	..	..	..	..	23.1	22.5	..	..	..	23.0	15.4	..	
	116	<i>Mesua ferrea</i>	..	8.3	7.9	7.0	7.6	7.4	..	..	..	..	7.4	7.6	7.4	..	..	8.3	6.7	..	
Karianshola	118	<i>Cedrela toona</i>	..	27.5	29.9	26.3	28.8	27.6	..	..	..	27.6	28.8	27.6	..	..	..	26.0	17.4	..	
	119	<i>Hopea parviflora</i>	..	6.4	8.1	7.5	7.7	7.0	..	..	..	7.7	7.7	7.7	..	..	6.9	8.0	..		
	120	<i>Palaquium ellipticum</i>	..	11.3	12.5	10.6	9.5	11.2	..	..	..	11.2	9.5	11.2	..	..	11.9	9.5	..		
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		

330. Stump planting—Best date (under top canopy only) (vide paragraph 233)—

Chandanathode Experimental Garden Experiment No. 154—Species—*Artocarpus hirsuta*. Arrangement—ABCDE EDCBA repeated ten times in single lines of ten plants (i.e., one hundred plants per treatment). Espacement—3' × 1½'. Soil preparation—Crowbar holes. Stock used—One year old plants, stumps 0.3" to 0.4" diameter. Dates of stump planting—(A) 15th May 1938; (B) 1st June 1938; (C) 15th June 1938; (D) 1st July 1938 and (E) 15th July 1938. Weeding—Normal district practice.

Chandanathode Experimental Garden Experiment No. 155—Species—*Cedrela toona*. Arrangement, etc., as above. Stock used—One-year old plants, stumps 0.2" to 0.3" diameter.

Karianshola Experimental Garden Experiment No. 123—Species—*Cedrela toona*. Arrangement, etc., as above. Stock used—One-year old plants, stumps 0.3" to 0.5" diameter.

Karianshola Experimental Garden Experiment No. 121—Species—*Artocarpus hirsuta*. Arrangement, etc., as above. Stock used—One-year old plants, stumps 0.3" to 0.5" diameter.

Karianshola Experimental Garden Experiment No. 122—Species—*Acrocarpus fraxinifolius*. Arrangement, etc., as above. Stock used—One-year old plants, stumps 0.3" to 1.0" diameter.

Measurements in January 1939.

Locality.	Experi- ment num- ber.	Species.	Survival percentage of stumps planted on					Mean height growth in inches of stumps planted on				
			15th May 1938.	1st June 1938.	15th June 1938.	1st July 1938.	15th July 1938.	15th May 1938.	1st June 1938.	15th June 1938.	1st July 1938.	15th July 1938.
Chandanathode.	154	<i>Artocarpus hirsuta</i> .	54	41	31	4	22	2.1	2.0	2.1	1.0	1.9
	155	<i>Cedrela toona</i> ..	24	12	56	18	65	5.3	2.7	4.9	3.2	4.6
Karianshola ..	123	<i>Cedrela toona</i> ..	27	18	5	0	14	11.6	10.3	6.4	0	7.1
	121	<i>Artocarpus hirsuta</i> .	68	75	63	36	67	2.5	2.5	2.4	2.3	2.5
	122	<i>Acrocarpus fraxinifolius</i> .	0	48	83	0	12	9.2	9.0	6.8	0	5.4
	..	..	..	..	..	..	..	..	..	..	..	..

331. Comparison of sowing, transplanting, small, medium and large transplants and stumping with small and large stumps (under top canopy cover) (vide paragraphs 234 and 235)—

Arrangement—For all experiments ABC, etc., etc., CBA repeated ten times in single lines of ten plants (i.e., one hundred per

treatment). *Espacement*—For all experiments $3' \times 1\frac{1}{2}'$. *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.

I. *Acrocarpus fraxinifolius*.

Chandanathode Experimental Garden Experiment No. 85.—Stock used—

- (A) Sowing ten seeds per patch (3rd June 1936).
- (B) Transplants $7\frac{1}{2}"$ 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 $7\frac{1}{2}"$ 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) Sowings ten seeds per patch (18th June 1937).
- (B) Transplants $5\frac{1}{2}"$ 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).

Chandanathode Experimental Garden Experiment No. 139.—Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants $7\frac{1}{2}"$ high, one year old (5th August 1938).
- (C) Transplants 15" high, one year old (5th August 1938).
- (D) Stumps 0.1" to 0.2" diameter, one year old (5th August 1938).
- (E) Stumps 0.3" to 0.5" diameter, two years old (5th August 1938).

Karianshola Experimental Garden Experiment No. 105.—Stock used—

- (A) Sowing ten seeds per patch (30th May 1938).
- (B) Transplants 2" high, two months old (27th June 1938).
- (C) Transplants 50" high, one year old (23rd June 1938).
- (D) Stumps 0.3" to 0.5" diameter, two months old (23rd June 1938).
- (E) Stumps 0.8" to 1.0" diameter, one year old (23rd June 1938).

II. *Artocarpus hirsuta*.

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).

Chandanathode Experimental Garden Experiment No. 135.—Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants $10\frac{1}{2}"$ high, one year old (8th August 1938).
- (C) Transplants 21" high, one year old (8th August 1938).
- (D) Transplants 42" high, one year old (8th August 1938).
- (E) Stumps 0.2" to 0.3" diameter, one year old (8th August 1938).
- (F) Stumps 0.5" to 0.7" diameter, one year old (8th August 1938).

Karianshola Experimental Garden Experiment No. 103.—Stock used—

- (A) Sowing ten seeds per patch (25th May 1938).
- (B) Transplants 2½" high, three months old (27th June 1938).
- (C) Transplants 21" high, one year old (23rd June 1938).
- (D) Transplants 37½" high, one year old (23rd June 1938).
- (E) Stumps 0.2" to 0.3" diameter, one year old (23rd June 1938).
- (F) Stumps 0.5" to 0.6" diameter, one year old (23rd June 1938).

*III. 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).

Chandanathode Experimental Garden Experiment No. 136.—Stock used—

- (A) Sowing five seeds per patch (15th June 1938).
- (B) Transplants 21" high, one year old (4th August 1938).
- (C) Transplants 40" high, seventeen months old (4th August 1938).
- (D) Stumps 0.3" to 0.4" diameter, one year old (4th August 1938).
- (E) Stumps 0.5" to 0.8" diameter, seventeen months old (4th August 1938).

Karianshola Experimental Garden Experiment No. 125.—Stock used—

- (A) Sowing ten seeds per patch (19th May 1938).
- (B) Transplants 7" high, two months old (22nd June 1938).
- (C) Stumps 0.3" to 0.4" diameter, one year old (22nd June 1938).

*IV. Bischofia javanica.**Karianshola Experimental Garden Experiment No. 128.—Stock used—*

- (A) Sowing ten seeds per patch (14th July 1938).
- (B) Transplants 4½" high, two months old (14th July 1938).
- (C) Transplants 15" high, six months old (14th July 1938).
- (D) Transplants 30" high, six months old (14th July 1938).

*V. Cedrela odorata.**Chandanathode Experimental Garden Experiment No. 144.—Stock used—*

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants 12" high, sixteen months old (5th August 1938).
- (C) Transplants 40" high, sixteen months old (5th August 1938).
- (D) Stumps 0.3" to 0.4" diameter, sixteen months old (5th August 1938).
- (E) Stumps 0.5" to 0.7" diameter, sixteen months old (5th August 1938).

*VI. Cedrela toona.**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).

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).

Chandanathode Experimental Garden Experiment No. 143.—Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants 12½" high, one year old (2nd August 1938).
- (C) Transplants 30" high, one year old (2nd August 1938).
- (D) Stumps 0.1" to 0.2" diameter, one year old (2nd August 1938).
- (E) Stumps 0.3" to 0.5" diameter, one year old (2nd August 1938).

Karianshola Experimental Garden Experiment No. 109.—Stock used—

- (A) Transplants 35" high, one year old (23rd June 1938).
- (B) Stumps 0.3" to 0.4" diameter, one year old (23rd June 1938).
- (C) Stumps 0.7" to 0.8" diameter, one year old (23rd June 1938).

VII. Gluta travancorica.

Karianshola Experimental Garden Experiment No. 107.—Stock used—

- (A) Sowing ten seeds per patch (14th May 1938).
- (B) Transplants 5½" high, two months old (1st August 1938).
- (C) Transplants 21" high, two years old (27th June 1938).
- (D) Transplants 35" high, two years old (27th June 1938).

VIII. Hopea parviflora.

Chandanathode Experimental Garden Experiment No. 113.—Stock used—

- (A) Sowing ten seeds per patch (4th June 1937).
- (B) Transplants 6" high, one year old (5th July 1937).
- (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).

Chandanathode Experimental Garden Experiment No. 137.—Stock used—

- (A) Sowing ten seeds per patch (19th June 1938).
- (B) Transplants 3" high, one year old (1st August 1938).
- (C) Transplants 13½" high, two years old (1st August 1938).
- (D) Transplants 27" high, two years old (1st August 1938).

Karianshola Experimental Garden Experiment No. 104.—Stock used—

- (A) Sowing ten seeds per patch (5th June 1938).
- (B) Transplants 2" high, two months old (14th July 1938).
- (C) Transplants 12½" high, one year old (14th July 1938).

IX. Mesua ferrea.

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).

Chandanathode Experimental Garden Experiment No. 142.—Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants 6" high, eighteen months old (4th August 1938).
- (C) Transplants 15" high, eighteen months old (4th August 1938).

X. Michelia champaka.

Stock used—

- (A) Sowing ten seeds per patch (12th May 1938).
- (B) Transplants 13" high, one year old (5th August 1938).
- (C) Stumps 0.3" to 0.5", one year old (5th August 1938).

XI. Swietenia macrophylla.

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).

Chandanathode Experimental Garden Experiment No. 140.—Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
 (B) Transplants 6" high, one year old (1st August 1938).
 (C) Transplants 18" high, eighteen months old (1st August 1938).
 (D) Transplants 35" high, eighteen months old (1st August 1938).

Karianshola Experimental Garden Experiment No. 106.—Stock used—

- (A) Sowing ten seeds per patch (3rd June 1938).
 (B) Transplants 7" high, six months old (3rd June 1938).
 (C) Transplants 21" high, sixteen months old (3rd June 1938).
 (D) Transplants 35" high, eighteen months old (3rd June 1938).

Species.	Locality.	Experi- ment number.	Year of forma- tion.	Percentage survivals in January 1939.						Remarks.
				Sow- ing.	Small trans- plants.	Medium trans- plants.	Large trans- plants.	Small stumps.	Large stumps.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
<i>Artocarpus fraxinifolius</i>	Chandanathode	85	1936	28	2	10	..	2	4	Sowing generally best.
	Chandanathode	115	1937	12	10	12	..	0	10	
	Karianshola	83	1937	61	1	..	52	17	25	
	Chandanathode	139	1938	11	27	67	..	1	12	
	Karianshola	105	1938	39	57	..	21	20	39	
	Karianshola	60	1936	61	4	..	14	0	37	Large stumps best but sowing is often successful.
	Chandanathode	111	1937	6	11	2	32	39	62	
<i>Artocarpus integrifolia</i>	Karianshola	81	1937	46	0	20	22	55	92	
	Chandanathode	135	1938	58	68	68	61	44	49	
	Karianshola	103	1938	75	72	21	11	60	42	
	Chandanathode	112	1937	28	..	10	17	8	7	
	Do.	136	1938	94	..	92	95	45	42	Sowing best.
	Karianshola	125	1938	83	66	92	85	87	..	
	Karianshola	128	1938	1	89	92	..	0	..	Medium transplants best.
	Chandanathode	144	1938	0	64	76	59	32	16	Transplanting best although stumping is good.
	Chandanathode	89	1936	10	..	75	39	65	56	
	Do.	118	1937	9	..	..	86	..	..	
<i>Bischofia javanica</i>	Karianshola	88	1937	80	84	..	95	34	64	
<i>Cedrela odorata</i>	Chandanathode	143	1938	2	..	99	97	81	85	
<i>Cedrela toona</i>	Karianshola	109	1938	..	..	..	98	49	28	
	Do.	107	1937	93	84	7	..	..	..	
	Chandanathode	113	1937	1	81	94	98	..	..	Transplanting best.
	Chandanathode	82	1937	16	2	2	27	..	..	
	Chandanathode	137	1938	30	99	97	..	..	..	
	Karianshola	104	1938	98	90	81	..	..	..	
	Chandanathode	117	1937	0	..	58	32	..	..	Transplanting best.
	Karianshola	87	1937	85	10	29	..	..	..	
	Chandanathode	142	1938	7	63	100	..	..	82	
	Chandanathode	145	1938	0	..	..	..	..	..	
	Do.	86	1938	0	10	27	3	..	..	
<i>Mezua ferrea</i>	Karianshola	59	1936	3	25	49	56	..	..	
<i>Mitchelia champeyana</i>	Chandanathode	116	1937	0	0	46	59	..	..	
<i>Sclerodermis macrophylla</i>	Karianshola	84	1937	60	89	91	81	..	..	
	Chandanathode	140	1938	1	96	97	88	..	..	
	Karianshola	106	1938	10	87	87	90	..	..	

332. *Transplanting under top canopy shade—Comparison of natural forest seedlings and nursery transplants* (vide paragraph 236).—

Karianshola Experimental Garden Experiment No. 98.—Species—Hopea parviflora. Arrangement—ABC CBA repeated 10 times in single lines of ten plants (i.e., 100 plants per treatment). Espacement—3' × 1½'. Soil preparations—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 1939.

		A 3" nursery transplants.	B 4½" forest transplants.	C 10½" forest transplants.
Survival percentage	:: :: :: ::	11	5	1
Mean height in inches	:: :: :: ::	5.3	5.0	12.0

1938 experiments.

Karianshola Experimental Garden Experiment No. 108.—Species—Mesua ferrea. Arrangement, etc., as above. Stock used—(A) nursery transplants, 18" to 20" high, one year old. (B) forest transplants 18" to 26" high. Date of planting—7th July 1938.

Karianshola Experimental Garden Experiment No. 110.—Species—Hopea parviflora. Arrangement, etc., as above. Stock used—(A) nursery transplants 8" to 12" high one year old; (B) forest transplants 8" to 12" high. Date of planting—7th July 1938.

Karianshola Experimental Garden Experiment No. 111.—Species—Calophyllum elatum. Arrangement, etc., as above. Stock used—(A) nursery transplants 9" to 14" high, 18 months old; (B) forest transplants 9" to 14" high. Date of planting—7th July 1938.

Karianshola Experimental Garden Experiment No. 112.—Species—Palaquium ellipticum. Arrangement, etc., as above. Stock used—(A) nursery transplants 8" to 12" high, one year old; (B) forest transplants 8" to 12" high.

Measurements in January 1939.

Experi- ment number.	Species.	Survival percentage.		Mean height in inches.	
		Nursery plants.	Forest plants.	Nursery plants.	Forest plants.
108	<i>Mesua ferrea</i>	63	25	11.1	17.9
110	<i>Hopea parviflora</i>	75	90	9.6	9.5
111	<i>Calophyllum elatum</i>	8	11	5.7	8.9
112	<i>Palaquium ellipticum</i>	10	19	8.9	8.4

333. *Comparison of direct sowing naked root transplanting and basket planting* (vide paragraph 237).—

Chandanathode Experimental Garden Experiment No. 114.—Species—Dysoxylum malabaricum. Arrangement—ABC

CBA repeated 10 times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement—3' × 1½'. Soil preparation—1' cube pits. Stock used—(A) Sowing three seeds per patch (8th August 1937); (B) transplants 7½" high 1-year old (22nd July 1937); (C) transplants 7½" high 1-year old basketed on 21st July 1937 (1st September 1937). Treatment—Kept clean weeded.*

Karianshola Experimental Garden Experiment No. 85.—Species—Gluta travancorica. Arrangement, etc., as above. Stock used—(A) Transplants 7½" high 18 months old (6th August 1937); (B) transplants 8" high 18 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); (C) transplants 6" high two months old basketed one month (14th October 1937).

Chandanathode Experimental Garden Experiment No. 138.—Species—Dysoxylum malabaricum. Arrangement, etc., as above. Stock used—(A) Sowing three seeds per patch (23rd July 1938); (B) transplants 12½" high 1-year old (4th August 1938); (C) transplants 12½" high 1-year old basketed on 29th June 1938 (17th August 1938).

Chandanathode Experimental Garden Experiment No. 141.—Species—Dipterocarpus indicus. Arrangement, etc., as above. Stock used—(A) Sowing 10 seeds per patch (10th June 1938); (B) 14" transplants 1-year old (4th August 1938); (C) 14" transplants 1-year old basketed on 9th July 1938 (17th August 1938).

Karianshola Experimental Garden Experiment No. 124.—Species—Vateria indica. Arrangement, etc., as above. Stock used—(A) Sowing 10 seeds per patch (14th July 1938); (B) 12" transplants 1-year old (22nd June 1938); (C) 8" transplants 1-year old basketed on 12th May 1938 (22nd June 1938).

Measurements in January 1939.

Locality.	Experi- ment number.	Species.	Treatment.	Survival per- centage.	Mean height in inches.
Chandanathode.	114/1937.	<i>Dysoxylum malabaricum.</i>	(A) sowing ..	2	5.0
			(B) 7½" transplants ..	26	7.0
			(C) 7½" basketed transplants.	93	6.1
Karianshola ..	85/1937. ..	<i>Gluta travancorica</i> ..	(A) 7½" transplants ..	1	8.0
			(B) 8" basketed transplants.	44	13.6
	102/1937.	<i>Vateria indica</i> ..	(A) sowing ..	4	4.0
			(B) 6" transplants ..	88	12.9
			(C) 6" basketed transplants.	87	16.1

Measurements in January 1939—cont.

Locality.	Experi- ment number.	Species.	Treatment.	Survival per- centage.	Mean height in inches.
Chandanathode.	138/1938.	<i>Dysoxylum malabaricum</i> .	(A) sowing	17	3.0
			(B) 12½" transplants.	8	8.3
			(C) 12½" basketed transplants.	10	6.7
	141/1938.	<i>Dipterocarpus indicus</i> .	(A) sowing	1	7.0
			(B) 14" transplants ..	58	11.8
			(C) 14" basketed transplants.	87	6.7
Karianshola ..	124/1938.	<i>Vateria indica</i> ..	(A) sowing	92	7.4
			(B) 12" transplants ..	80	11.6
			(C) 8" basketed transplants.	88	6.4

334. Comparison of stumps and cuttings from nursery transplants and natural forest trees (under top canopy only) (vide paragraph 238).—

Karianshola Experimental Garden Experiment No 99 of 1937.—
Species—*Cedrela toona*. **Arrangement**—ABC CBA repeated 10 times in single lines of 10 plants (i.e., 100 plants per treatment). **Espacement**—3' × 1½'. **Soil preparation**—Crowbar holes. **Stock used**—(A) Stumps from nursery seedlings 1-year old 0.4" to 0.8" diameter; (B) cuttings from nursery seedlings 1-year old 10" long and 0.2" to 0.5" diameter; (C) cuttings from forest trees 10" long and 0.3" to 0.8" diameter. **Date of planting**—11th August 1937. **Treatment**—Kept clean weeded.

1938 Experiments.

Chandanathode Experimental Garden Experiment No. 156.—
Species—*Cedrela toona*. **Arrangement**, etc., as above. **Stock used**—(A) Stumps from nursery seedlings 1-year old and 0.2" to 0.3" diameter; (B) cuttings from nursery seedlings 1-year old 18" and 0.2" to 0.4" diameter; (C) cuttings from forest trees 18" long and 0.5" to 0.9" diameter. **Date of planting**—2nd August 1938.

Karianshola Experimental Garden Experiment No. 113.—**Species**—*Cedrela toona*. **Arrangement**, etc., as above. **Stock used**—(A) Stumps from nursery seedlings 1-year old and 0.4" to 0.5" diameter; (B) Cuttings from nursery seedlings 1-year old 9" long and 0.4" to 0.5" diameter; (C) cuttings from forest seedlings 9" long and 0.4" to 0.5" diameter. **Date of planting**—21st June 1938.

Karianshola Experimental Garden Experiment No. 114.—**Species**—*Chickrassia tabularis*. **Arrangement**, etc., as above. **Stock used**—(A) Direct sowing 10 seeds per patch; (B) stumps from forest seedlings 0.4" to 0.7"; (C) cuttings from forest seedlings 9" long and 0.4" to 0.7" diameter. **Date of planting**—7th July 1938. **Date of sowing**—8th July 1938.

Measurements in January 1939.

Locality.	Experi- ment. number.	Species.	Treatment.	Survival percent- age.	Mean height growth in inches.
Karianshola ..	99/1937 ..	<i>Cedrela toona</i> ..	(A) Stumps	31	2.9
			(B) Nursery cuttings.	71	4.1
			(C) Forest cuttings ..	..	..
Chandanathode.	156/1938.	<i>Cedrela toona</i> ..	(A) Stumps	77	5.0
			(B) Nursery cuttings.	84	12.3
			(C) Forest cuttings ..	..	..
Karianshola ..	113/1938.	<i>Cedrela toona</i> ..	(A) Stumps	23	11.4
			(B) Nursery cuttings.	28	14.2
			(C) Forest cuttings ..	..	..
Chandanathode.	114/1938.	<i>Chickrassia tabularis</i> .	(A) Sowing	42	5.4
			(B) Forest stumps ..	80	6.5
			(C) Forest cuttings ..	29	9.2

335. Insects collected in the Denkanikota pteculture plot a healthy area—

Family.	Species.	May.	June.	July.	August.	Sep- tember.
Jassidae ..	<i>Nirvana longitudinalis</i> ..	1	..	..	..	..
	<i>Ledra mutica</i> ..	1	..	..	..	..
	<i>Petaloc-phala granulosa</i> ..	1	..	..	..	..
	Do. <i>nigritinea</i> nymphs	4	1	..	2	..
	<i>Chikkaballapura</i> sp. ..	..	..	..	..	2
	<i>Idiocerus</i> sp. ..	1	..	..	..	..
	<i>Idiocerus clypealis</i> ..	..	..	..	..	1
	<i>Bythoscopus indicus</i> ..	..	..	..	..	..
	<i>Moonia albimaculata</i> ..	1	..	..	..	1
	<i>Moonia</i> sp. ..	..	2	..	..	..
	<i>Moonia variabilis</i> ..	1	..	..	..	..
	<i>Moonia</i> nymph ..	1	..	..	..	..
	<i>Tettigoniella</i> sp. ..	1	..	..	..	..
	<i>Pentimnia capularis</i> ..	1	..	..	..	4
	<i>Neodartus acocephaloides</i> ..	1	..	..	..	..
	<i>Mahunia</i> sp. (near) ..	1	..	..	..	..
	<i>Scaphoideus morous</i> ..	..	..	..	..	1
	Jassid nymphs ..	1	..	..	..	1
	<i>Deltocephalus</i> sp. ..	1	..	..	..	..
	<i>Jassus pauperculus</i> ..	..	..	..	..	2
	<i>Dicus bipunctatus</i> ..	2	..	..	..	1
	<i>Tuphlocybini</i> ..	1	..	..	..	..
	<i>Eulettia</i> sp. ..	1	..	..	..	..
Fulgoroidea ..	<i>Scaphoideus</i> sp. ..	1	..	..	..	..
	<i>Acrona walkeri</i> ..	1	..	..	..	..
	<i>Ledra quadricarinata</i> ..	3	1	1	1	3
	<i>Ledra</i> sp. nymphs ..	2	..	..	1	..
	Jassid (not determinable) ..	1	..	1	..	..
	<i>Phrynomorphus indicus</i> ..	..	..	..	..	4
	<i>Sarima nigrocypta</i> ..	1	..	..	..	..
	Do. <i>subfasciata</i> ..	1	..	..	..	2
	Do. nymphs ..	1	..	..	..	..
	<i>Eurybrachys tomentosa</i> ..	10	..	1	..	..
Membracidae ..	<i>Flata ferrugata</i> ..	..	..	..	1	..
	<i>Satapa</i> sp. ..	..	..	1	..	..
	<i>Orthopagus</i> sp. ..	..	..	1	..	..
	<i>Colequindia nigroclavata</i> ..	1	..	..	..	..
	Fulgoroidea not determinable ..	2	..	..	..	..
	<i>Oxyrhachis mangiferana</i> ..	5	..	..	..	..
	<i>Celyphus oblectus</i> ..	1	..	..	..	..
	<i>Leptocentrus taurus</i> ..	2	..	..	..	..
	<i>Otiolus omerus</i> ..	1	..	..	1	1
	<i>Coosterphus tuberculatus</i> ..	..	..	..	1	3
Coccidae ..	<i>Gargara</i> sp. ..	2	2	..	1	1
	<i>Anchon</i> sp. ..	..	..	..	..	1
	<i>Drosicha</i> sp. ..	1	8	..	..	..
Tingitidae ..	..	8	2	2	3	1
Peyllidae ..	..	2	..	..	..	..
Pentatomidae ..	<i>Coptosoma cribrarium</i> ..	48	9	1	..	2
	Do. <i>indicum</i> ..	12	..	1	..	..
	Do. <i>variegatum</i> ..	..	..	..	1	..
	<i>Canthecoma furcellata</i> ..	1	..	..	..	..
	<i>Halya dentatus</i> ..	1	2	..	..	..
	<i>Halyomorpha picus</i> ..	1	..	..	..	..
	<i>Chrysocoris purpureus</i> ..	1	..	..	..	..
	Do. <i>stockerus</i> ..	1	..	..	1	3
	Do. <i>pulchellus</i> ..	..	..	..	..	2
	<i>Hotea curculionoides</i> ..	1	..	..	1	..
	<i>Agonoscelis nubila</i> ..	..	..	1	..	..

Family.	Species.	May.	June.	July.	August.	September.
<i>Pentatomidae</i>	<i>Plautia fimbriata</i>	..	..	..	2	..
	<i>Chrysocoris</i> nymphs	..	..	..	..	4
	<i>Pentatomidae</i> (not identifiable).	3	..	..	..	1
	Do. nymphs	2	..	..	..	..
<i>Coreidae</i>	<i>Homocoeus</i> sp.	1	..	..	..	..
	<i>Riptortus linearis</i>	..	..	..	1	1
	<i>Cletus pugnator</i>	4	..	1	..	1
	<i>Coreid</i> (not determinable)	1	..	..	2	..
<i>Lygaeidae</i>	<i>Lygaeus hospes</i>	2	..	..	..	..
	<i>Ozycaenus letus</i>	3	..	..	..	..
	<i>Arocatus continctus</i>	..	..	..	1	..
	<i>Sadoletus validus</i>	2	..	..	..	..
	<i>Graptostethus servus</i>	..	1	1	3	..
	Do. <i>argentatus</i>	5	3	..	..	4
	<i>Geocoris</i> sp.	1	..	..	..	..
<i>Pyrrhocoridae</i>	<i>Dysdercus cingulatus</i>	4	..	..	..	..
<i>Phymatidae</i>	<i>Amblythyreus rhombiventris</i>	1	..	..	..	..
<i>Reduviidae</i>	<i>Sphedanolestes signatus</i>	..	..	1	..	..
	<i>Alcinena</i> sp.	..	..	2	..	..
	<i>Reduviid</i> (not determinable)	..	..	..	1	..
	<i>Reduviid</i> nymphs	2	..	..	..	..
<i>Blattidae</i>	<i>Blattella humbertiana</i>	1	..	1	..	..
	<i>Moreka</i> sp.	1	..	..	..	..
	<i>Phlebotomus pallens</i>	..	..	..	1	1
	<i>Blattid</i> nymphs	4	..	..	..	..
<i>Tettigoniidae</i>	<i>Letana inflata</i>	..	..	3	..	..
	<i>Xiphilopsis straminea</i>	..	..	..	1	..
	Nymphs	1	1	1	2	3
<i>Acrididae</i>	<i>Orthacris</i> sp.	5	7	2	7	6
	<i>Ditripternis venusta</i>	1	..	..	..	..
	Nymphs	2	..	..	..	..
<i>Gryllidae</i>	Nymphs	1	..	..	..	..
<i>Mantidae</i>	Nymphs	1	1	..	..	..
<i>Forficulidae</i>	<i>Elaenon bipartitus</i>	..	1	..	..	..
	Nymphs	1	..	..	..	..
<i>Lepidoptera</i>	Moths	5	1	1	4	..
<i>Diptera</i>	..	3	2	..	..	..
<i>Stratiomyidae</i>	..	..	..	..	1	..
<i>Apidae</i>	..	..	..	..	1	..
<i>Scolidae</i>	..	..	..	..	1	..
<i>Chalcidae</i>	<i>Brachymeria</i> sp.	1	..	..	..	..
<i>Lamidae</i>	<i>Sthenias grisor</i>	1	..	..	..	..
	<i>Ropica signata</i>	1	..	..	..	..
	<i>Hyagnis persimilis</i>	2	..	..	..	..
<i>Chrysomelidae</i>	<i>Chirida ventralis</i>	..	1	..	1	..
	<i>Colaspoda</i> sp.	..	1	..	..	..
	<i>Cryptoccephalus</i> sp.	2	..	..	..	..
	<i>Eumolpini</i> sp.	2	1	..	..	..
	<i>Galerucini</i> sp.	..	..	..	2	2
	<i>Gynantrophthalma</i> sp.	1	..	..	..	3
	<i>Halticini</i> sp.	1	..	2	..	..
	<i>Cassida</i> sp.	..	..	1	..	..
	<i>Pagria signata</i>	3	1	1	..	..
	<i>Nagya fannulata</i>	..	..	..	3	..
	<i>Pentocometis subfasciata</i>	..	..	1	..	1
	<i>Monolepta bifasciata</i>	..	..	1	..	..
	<i>Paria lefevrei</i>	..	1	..	1	..
	<i>Mischra</i>	..	..	..	..	1
	<i>Chrysomelid</i> (not identifiable).	..	1	..	..	..
<i>Curculionidae</i>	<i>Alcidus pictus</i>	1	..	1	..	..
	<i>Myllocerus discolor</i>	9	..	2	..	..
	Do. <i>pactus</i>	18	..	15	15	6
	Do. <i>delicatulus</i>	1	1	1	9	3
	Do. <i>viridanus</i>	14	..	2	13	2
<i>Curculionidae</i>	<i>Myllocerus</i> 11 - <i>pustulatus</i> var <i>maculatus</i> .	4	..	..	1	..
	Do. var <i>marmoratus</i>	..	..	..	5	..
	Do. <i>dorsatus</i>	..	..	..	11	15
	Do. sp.	4	..	4	8	3
	<i>Episomus lacerta</i>	3	1	..	1	2
	<i>Sympiezomias cretaci</i>	3	..	..	3	2
	<i>Peltotrachelus cognatus</i>	2	..	..	..	..
	Do. <i>pubes</i>	..	..	1	7	2
	<i>Amblyrhinus pericollis</i>	..	..	3	..	1
	<i>Barts</i> sp.	..	..	..	..	1
	<i>Ophilia</i> sp.	1	..	..	..	..
	<i>Paremcops farinosus</i>	..	..	1	..	..
	<i>Rhynchites</i> sp.	..	..	..	1	..
	<i>Balaninus</i> sp.	1	..	..	..	..
	<i>Dereodus sparsus</i>	4	..	..	..	..
	<i>Cleonina</i>	1	..	..	..	..
<i>Anthribidae</i>	<i>Curculionidae</i> (unnamed)	2	3	1	..	..
	<i>Zygadenodes horni</i>	7	..	..	..	..

FOR THE YEAR 1938-39

Family.	Species.	May.	June.	July.	August.	September.
<i>Buprestidae</i>	<i>Sternocera chrysis</i>	..	..	..	1	..
	<i>Agrius</i> sp.	2	..	..	..	..
	<i>Sphenoptera</i> sp.	9	1	..	..	..
	<i>Trachys bicolor</i>	1	..	..	..	..
	<i>Trachys</i> sp.	1	..	..	..	..
<i>Nitidulidae</i>	Unamed	2	..	1	1	..
<i>Elatridae</i>	Unamed	1	..	..	..	2
Do.	<i>Dichronychus tristis</i>	1	..	..	..	..
<i>Meloidae</i>	<i>Mylabris</i> ? <i>phalerata</i>	..	..	..	..	6
<i>Anobiidae</i>	<i>Gastrallus</i> sp.	1	..	..	..	..
<i>Coccinellidae</i>	<i>Chilocoris nigrinus</i>	..	1	..	1	..
	<i>Seymna nubilus</i>	..	..	3	..	..
	<i>Jauravia allidula</i>	..	..	..	..	3
	Do. <i>soror</i>	2	1	..	..	..
	<i>Verania discolor</i>	1	..	..	..	..
	<i>Chilomanus sezmaculata</i> var	1	..	4	3	1
	<i>undulata</i> .	..	..	..	..	..
	<i>Jauravia</i> sp.	1	..	..	..	..
	<i>Rodolia fumida</i>	1	..	3	1	..
	<i>Rodolia</i> sp.	..	2	..	..	..
	<i>Seymna</i> sp.	..	..	..	..	1
	<i>Thea cincta</i>	..	..	..	..	1
	<i>Coccinellid</i> (unnamed)	4	3	..	..	..
	Do. larvae	2	..	..	..	..
<i>Monomidae</i>	<i>Monomma</i> sp.	1	..	..	..	..
<i>Carabidae</i>	<i>Risophilus</i> sp.	3	..	..	..	1
	<i>Onophagus</i> sp.	1	..	..	..	..
<i>Melyridae</i>	Unamed	..	..	..	..	1
Do.	<i>Idgia</i> sp.	..	..	..	..	1
<i>Lagriidae</i>	<i>Lagria</i> sp.	..	..	..	..	1
<i>Anthicidae</i>	<i>Anthicus</i> sp.	1	..	1	..	..
<i>Mordellidae</i>	Unamed	1	..	1	..	..
<i>Lycaidae</i>	<i>Lycaotomus praestus</i>	..	..	..	..	14
<i>Clavicornia</i>	Unamed	..	..	2	2	..
<i>Hydrophilidae</i>	Unamed	1	..	..	..	..
<i>Tenebrionidae</i>	Unamed	1	..	..	..	..
Do.	<i>Platyonotus perforatus</i>	..	..	..	1	..
<i>Anthribidae</i>	<i>Arceus</i> sp.	1	1	..	..	1
<i>Bruchidae</i>	<i>Pachymerus gonagra</i>	4	2	..	2	..
	<i>Bruchus</i> sp.	12	2	1	1	..
<i>Aphodinae</i>	<i>Aphodius</i> sp.	2	..	..	..	..
<i>Cteninae</i>	<i>Oxyctonia versicolor</i>	3	..	..	2	..
<i>Rutelinae</i>	<i>Anomala dussumiciri</i>	1	..	..	1	..
	<i>Adoretus</i> sp.	2	..	..	..	..
<i>Melolonthinae</i>	<i>Apogonia</i> sp.	1	..	..	..	..
	<i>Holotricha</i> sp.	2	..	..	..	..
	<i>Schizonycha</i> sp.	1	..	..	..	..
	<i>Serica</i> sp.	1	..	..	..	..
Spider	..	7	..	..	..	..

336. Comparison of day and night insect collections (April 1939)—

Insects collected in Denkanikota potculture plot during four days in October and December 1938 sent by the Research Ranger, Denkanikota.

Name of species or family.	16th October 1938 5 p.m.— 8 p.m.	23rd October 1938 7 p.m.— 8-30 p.m.	11th December 1938 7 p.m.— 8-30 p.m.	26th December 1938 4-30 p.m.— 6-45 p.m.
PENTATOMIDAE.				
<i>Sastragala heterocarpa</i> Walk	1	..	..	..
<i>Tolomia latipes</i> Dall	2	..	..	..
<i>Plautia Ambriata</i> Fabr	1	..	3	..
<i>Chrysocoris stockerus</i> Linn	..	1	..	1
<i>Nezara viridula</i> Linn	..	..	..	2
<i>Memidabecula</i> Dist	..	1	1	1
<i>Hotea nigrorufa</i> Walk	..	..	..	1
<i>Canthecona parva</i> Dist	..	..	1	1
<i>Antistia cruciata</i> Fabr	..	3	..	..
<i>Coptosoma</i> sp.	..	2	4	..
<i>Dalpada</i> sp.	..	..	1	..
<i>Pentatom</i> ds (broken)	..	..	1	..
<i>Pentatomidae</i> nymphs	8	5	1	..

Name of species or family.	16th October 1938 5 p.m.— 8 p.m.	23rd October 1938 7 p.m.— 8-30 p.m.	11th December 1938 7 p.m.— 8-30 p.m.	26th December 1938 4-30 p.m.— 6-45 p.m.
COREIDÆ.				
<i>Homocerus</i> sp.	1	..	7	..
<i>Cletus</i> sp.	1	..	..	..
<i>Cletomorpha hastata</i> Fabr.	..	1	..	..
<i>Phinacitius basalis</i> Westw.	..	..	..	1
LYGIDÆ.				
<i>Geocoris lituratus</i> Fleb.	..	..	..	1
<i>Oxyarenus latus</i> Kirby	..	..	..	1
<i>Lygaeidae</i>	..	..	..	3
<i>Graphostethus argentatus</i> Fabr.	2	12	1	..
<i>Lygaeidae</i> nymphs	..	..	2	..
PYRRHOCORIDÆ.				
<i>Dysdercus cingulatus</i> Fabr.	1	..	..	..
TINGITIDÆ.				
<i>Tingitidae</i> (unidentifiable)	1	..	1	2
CAPSIDÆ.				
<i>Capsidae</i> (unidentifiable)	2	3	1	1
REDUVIDÆ.				
<i>Alcmena stramineipes</i> Dist.	..	..	..	1
<i>Harpactor marginatus</i> Fabr. Var.	1	..	..	..
PSYLLIDÆ.				
<i>Psyllidae</i> (not identifiable)	..	..	..	1
JASSIDÆ.				
<i>Penthimia subniger</i> Dist.	..	1	..	..
<i>Penthimia compacta</i> Walk.	..	1	..	1
<i>Idiocerus clypealis</i> Leth.	..	1	..	1
<i>Bythoscopus indicus</i> Leth.	1	5	2	1
<i>Nehela</i> sp.	1	..	1	3
<i>Moonia albimaculata</i> Dist.	..	3	1	1
<i>Neodartus acocephaloides</i> Melich.	..	2	..	..
<i>Nirvana paelida</i> Melich.	..	1	..	2
<i>Acropona walkeri</i> Kirk.	..	1	3	1
<i>Jassus elegans</i> Dist.	..	4	1	3
<i>Eutettix disciguttus</i> Walk.	..	..	..	4
<i>Deltoccephalus</i> sp.	..	1	..	..
<i>Paralimnus confusus</i>	..	1	..	..
<i>Petaloccephala nigricinea</i> Walk.	..	2	..	..
<i>Petaloccephala granulosa</i> Dist.	..	1	..	..
<i>Typhlocybinae</i>	..	..	..	2
<i>Eutettix</i> sp.	1	1	..	..
<i>Jassid</i> (unidentifiable)	..	1	1	2
<i>Jassid</i> nymphs	..	2	..	..
<i>Acropona</i> nymphs	1	1	3	2
CEROPIIDÆ.				
<i>Peuceptyelus sigillifer</i> Walk.	..	..	..	2
FULGORIDÆ.				
<i>Sarima subfasciata</i> Mel.	..	2	..	1
<i>Sarima nigroclypeata</i> Mel.	3	1	..	5
<i>Sarima</i> sp.	..	1	..	..
<i>Ricania fenestrata</i> Fabr.	..	..	..	1
<i>Salurnia marginellus</i> Guer.	..	..	4	..
<i>Fulgoridae</i>	..	..	..	1
<i>Fulgoridae</i> nymphs.	..	1	1	1
MEMBRACIDÆ.				
<i>Tricentrus transversus</i> Dist.	1	3	..	..
<i>Coccosterphus tuberculatus</i> Motsch.	5	8	2	2
<i>Otinotus oneratus</i> Walk.	..	..	2	1 + 4
<i>Parayasa affixa</i> Dist.	4	6	..	2
<i>Leptocentrus taurus</i> Fabr.	..	..	5	..
COCOIDÆ.				
<i>Drosicha</i> sp.	..	1	..	..

Name of species or family.	16th October 1938 5 p.m.— 8 p.m.	23rd October 1938 7 p.m.— 8-30 p.m.	11th December 1938 7 p.m.— 8-30 p.m.	26th December 1938 4-30 p.m.— 6-45 p.m.
BLATTIDÆ.				
<i>Mareta</i> sp.	..	1	..	..
<i>Blattidae</i> sp.	..	1	..	..
MANTIDÆ.				
<i>Euantissa pulchra</i> F.	..	1	..	..
TETTIGONIDÆ.				
<i>Sathrophyllia</i> sp.	..	..	1	..
<i>Tettigonidae</i>	1	..	2	3
<i>Tettigonidae</i> nymphs	3	2	5	3
ACRIDÆ.				
<i>Acrididae</i> nymphs	2	2	1	1
COCCINELLIDÆ.				
<i>Jauravia albidula</i> Motsch.	2	2	4	7
<i>Verania cardoni</i> Wa.	..	2	3	4
<i>Cailomenes sexmaculata</i>	..	..	..	..
<i>Undulata</i> Schaller	..	..	1	1
<i>Chilocrus</i> sp.	1	..	..	..
CHRYSONELLIDÆ.				
<i>Lema</i> sp.	..	..	1	..
<i>Cryptoccephalus</i> sp.	..	..	..	6
<i>Glerucini</i> sp.	..	..	1	..
<i>Monolepta bifasciata</i> Hornst.	..	..	1	..
<i>Platypria hystrix</i> F.	..	..	..	1
<i>Chirida ventralis</i> Boh.	..	2	1	1
ELATERIDÆ.				
<i>Cardiophorus</i> sp.	1	..	..	..
<i>Cardiophorus ophidius</i> Cand.	..	1	..	..
Var <i>nigricollis</i> Fleut.	..	1	..	..
<i>Mylocerus viridannus</i> F.	5	7	2	..
<i>Mylocerus discolor</i> Boh.	..	2	1	..
<i>Mylocerus curvicornis</i> Fst.	..	1	..	1
<i>Mylocerus</i> sp.	1	4	4	..
<i>Episomus lacerta</i> Fabr.	..	1	4	1
<i>Apion</i> sp.	..	1	..	..
<i>Curculionidae</i>	..	..	3	1
BRUCHIDÆ.				
<i>Bruchus theobromae</i> L.	..	..	..	9
<i>Bruchus uberatus</i> Fabr.	..	..	..	1
<i>Spermophagus atroapicalis</i> Pic.	..	2	..	1
<i>Pachymarus</i> sp.	2	2	..	..
<i>Bruchus</i> sp.	2	..	..	1
ANTHRIDÆ.				
<i>Zygamodes horni</i> Jord.	..	1	..	1
<i>Anacerus</i> sp.	..	..	..	1
CISTIDÆ.				
<i>Nitidulidae</i>	2	..	..	..
<i>Agrius</i> sp.	..	3	..	..
<i>Gastrallus</i> sp.	..	1	..	..
<i>Olavicorn</i>	..	1	..	..
<i>Coloptera</i> (minute)	..	..	1	..
LEPIDOPTERA.				
<i>Herperidea</i>	..	1	..	1
<i>Moth</i> (unidentified)	..	..	..	1
<i>Chrysopa</i> sp. (chrysopini)	2	..	..	1
Grand total ..	66	128	84	113

337. *Entomological investigations on the spike disease of sandal—*

A summary of the fauna obtained on sticky papers by N. C. CHATTERJEE, D.Sc., F.R.E.S., Forest Research Institute, Dehra Dun.

In order to get an idea as to what insects were moving about or were carried away by surface wind currents from the surrounding vegetation throughout the day and the night, sticky papers were put up at heights of 2' to 8' from ground level in the sandal forests of North Salem, Madras. Five paper sheets of 4' × 3' in size uniformly brushed with a composition of rosin and castor oil were exposed for 20 days every month at two field stations. The seasonal incidence of insects caught on such papers exposed at Javalagiri and Noganur reserve forests during October 1937 and September 1938 is given in the tabular statement below. The collections comprise over 11,000 individuals and consist of both strong winged and weak winged insects; and specimens of a phasmid of over 65 mm. in length down to a thrips of 1.25 mm. in length have been caught. The records in the tabular statement are however not complete as no catches were made during the important months April, May and June at Javalagiri.

It may be noted that with the exception of thrips the number of individuals of any species obtained in the sticky paper catches is not large during any month and any conclusions drawn from these samples should be taken as tentative, with reference to the selection of species for purposes of experiments. In the present note comments are mostly devoted to the *Jassid* fauna.

On biological and morphological grounds the *Coleoptera*, *Diptera*, *Embioptera*, *Hymenoptera*, *Isoptera*, *Lepidoptera*, *Neuroptera*, *Orthoptera* and *Dermaptera* are unimportant, as far as the choice of a vector in the transmission of the spike disease of sandal is concerned. Therefore all species in the various families of these orders are lumped together in the total given in the statement. In *Coleoptera* several species of *Anthicidae*, *Anthribidae*, *Bostrychidae*, *Brenthidae*, *Bruchidae*, *Buprestidae*, *Cantharidae*, *Carabidae*, *Chrysomelidae*, *Cicindelidae*, *Cisterlidæ*, *Cleridae*, *Coccinellidae*, *Colydidae*, *Coprinæ*, *Cryptophogidae*, *Cucujidae*, *Curculionidae*, *Elaterridae*, *Endomychidae*, *Erotylidae*, *Histeridae*, *Hydrophilidae*, *Lagriidae*, *Lamiidae*, *Lycidae*, *Melasiidae*, *Melolonthidae*, *Nitidulidae*, *Ptinidae*, *Rhysodidae*, *Sandalidae*, *Scolytidae*, *Silphidae*, *Stephylinidae* and *Tenebrionidae* are included. In *Diptera* species of *Agromyzidae*, *Asilidae*, *Bibionidae*, *Chironomidae*, *Conopidae*, *Culicidae*, *Muscidae*, *Mycetophilidae*, *Psychodidae*, *Sarcophagidae*, *Stratiomyidae*, *Syrphidae*, *Tachinidae*, *Tipulidae*, *Trypetidae*, with several others not identifiable have been obtained; In *Hymenoptera* the following families are represented; *Apidae*, *Braconidae*, *Chalcidoidae*, *Chrysididae*, *Formicidae*, *Ichneumonidae*, *Mutillidae*, *Pompilidae*, *Proctotrypoidae*, *Scoliidae*, *Sphegidae* and *Vespidæ*. The *Isoptera* included specimens of *Termes horni* Ws. The *Lepidoptera* contains a few individuals of *Microlepidoptera*, *Noctuidæ*, and *Pyralidæ* all in a badly mutilated condition. The

Neuroptera are represented by *Chrysopidae*, and *Mantispidæ*, the *Psocoptera* by *Psocidae*, while the *Orthoptera* and *Dermaptera* are represented by *Acridiidae*, *Blattidae*, *Forficulidae*, *Gryllidae*, *Mantidae*, *Phasmidae*, and *Tettigoniidae*. Several species of spiders, mites and ticks have also been obtained.

For various reasons the species of *Hemiphera-Heteroptera* are lumped together under the family names, so also the species of the families *Cercopidae*, *Coccidae*, *Membracidae*, *Psyllidae* and *Tingitidae* in *Hemiptera-Homoptera*. As the family *Jassidae* contains the most vectors of virus diseases, particular effort has been made in their identification and all the species caught have been identified as far as possible with the help of available reference, collection and literature at the Forest Research Institute. These are several new species which have been placed under their generic names for the present. In all 43 species of *Jassidae*, have been collected on the sticky papers in 883 individuals. Of these, 40 species have been recorded previously on sandal during the course of the survey of the insect fauna of that tree by the Forest Research Institute during 1930-31; and 13 species have been found amongst rank vegetation in abandoned agricultural fields at Denkanikota, Kenilworth castle, Pane and Thalli areas during October, November and December. Three additional species, *Chikkaballapura* sp., *Cicadula indica*, and *Kartwa* (*Chiasmis*) sp., are now recorded from the sticky papers.

In the analysis of the fauna obtained a permissible hypothesis is that a species found in a heavily spiked area, if present in a healthy area may be regarded as a probable vector. The incidence records of the *Jassidae* indicate that the probable vector should be one of the following species:—*Acropona walkeri*, *Bythoscopus indicus*, *Chikkaballapura* sp., *Cicadula indica*, *Dentocephalus* sp., *Eutettix disciguttus*, *Eutettix* sp., *Idiocerus atkinsoni*, *I. clypealis*, *Jassus elegans*, *J. indicus*, *Kolla unimaculata*, *Moonia albimaculata*, *Nirvana pallida*, *N. suturalis*, *Orosius* sp., *Paralimnus albomaculatus*, *Pediopsis* sp., *Penthimia* sp., *Petaloccephala nigrilinea*, *Rhombopsis* sp., and *Scaphoideus* spp. From the records of transmission experiments conducted by A. L. Griffith and S. Rangaswami, it can be said that *A. Walkeri*, *B. indicus*, *I. Atkinsoni*, *I. Clypealis*, *J. elegans*, *J. indicus*, *M. albimaculata*, *Penthemia* sp., and *P. nigrilinea*, all common and easily caught species, have been sufficiently tested during 1937-38 season with negative results. We are thus left with the following species for future intensive transmission tests, viz., *Chikkaballapura* sp., *Cicadula indica*, *Dentocephalus* sp., *Eutettix disciguttus*, *Eutettix* sp., *Kolla unimaculata*, *Nirvana pallida*, *N. suturalis*, *Orosium* sp., *Paralimnus albomaculatus*, *Pediopsis* sp., *Rhombopsis* sp., and *Scaphodeus* sp. They are uncommon and not easily caught species and all of them can pass through a mesh of four to an inch. Further more in Denkanikota pot culture area spike disease has never been recorded to have been naturally transmitted amongst the healthy sandal plants in spite of the vicinity

of a large number of spiked pot plants for a number of years. Collections made in this area during May, June, July, August and September included in the *Jassidæ*, *Chikkaballa pura* sp., *Deltocephalus* sp., *Eutettix* sp., and *Scaphoideus*, sp. As more than one species is involved in *Deltocephalus*, *Eutettix* and *Scaphoideus*, they are retained amongst the suspects for the present.

It may be observed here that several *Jassids* live amongst dry leaves, grasses, and bushes during the day, sometimes at a considerable distance from the actual food plant and come out of their hiding places only during the night; while several species are diurnal in habits. Transmission tests made for several years by the Forest Research Institute and Madras Forest Department with the commoner *Jassids* found on sandal have yielded negative results so far. With the exception of *Chikkaballapura* sp., and *Cicadula indica* Pr. the distribution and the number of individuals obtained of the eleven uncommon and not easily caught species mentioned above, during the sandal insect survey of 1930 and 1931 are recorded in Ind. For. Rec. XIX, 4 pages 12-28 (1934). During the eighteen months' survey work in four localities of South India, in certain cases only one or very few specimens have been obtained of these species on Sandal. The available data from both the sandal insect survey and the present sticky paper catches are very indicative and suggest that the probable *Jassid* vector of the spike disease of sandal should be a species, which ordinarily does not live on sandal. It is therefore important to organize special searches for securing the 13 species mentioned above which do not live on sandal during the seasons of infection in heavily spiked areas. Further more the food plants of these *Jassids* are not known and careful investigations in this direction may lead to the discovery of several of them breeding in some common weed in rank vegetation harbouring the same or the composite virus of spike.

In the *Fulgoridæ* only four species, viz., *Eurybrachys tomentosa*, *Ricania* sp., *Sarima nigroclypeata* and *Tambinia verticalis* have been caught and all of them have been sufficiently tested in transmission experiments with negative results.

In the *Aphididæ* the most common species is *Macrosiphus* sp., which is present in Noganur but very rare in Javalagiri.

The most abundant fauna found in the sticky paper catches are several *Thysanoptera* or thrips and most of them can pass through a mesh of twenty to an inch. They are *Elaphrothrips beesoni*, *Elaphrothrips chandena*, *Haplothrips gangibeueri*, *Taeniothrips balsaminæ* and *Thrips florum*.

A total of 523 thrips has been obtained at Javalagiri and 3,460 at Noganur. During the seasons 1935-36, 1936-37 and 1937-38 the sandal plants in the experimental cages at Denkanikota, Javalagiri and Noganur have been exposed to the attacks of thrips from outside throughout the year but transmission of the disease by these

small creatures has never been recorded. Transmission tests made by the Forest Research Institute with thrips gave negative results. Very probably they are not connected with the transmission of the spike disease.

In conclusion it may be stated that transmission tests with several of the species of *Cercopidæ*, *Coreidæ*, *Fulgoridæ*, *Lygaeidæ*, *Membracidæ*, and *Pentatomidæ* done by Griffith and Rangaswami have been previously made by the Forest Research Institute with negative results. The present records by these authors fully confirm the negative conclusions already drawn by us.

Seasonal incidence of insects caught on sticky papers in North Salem Forest division.

Order, family or species.		J = Javalagiri. Months.								
		X	XI	XII	IV	V	VI	VII	VIII	IX
<i>Coleoptera</i>	N	256	94	94	105	105	132	55	78	72
	J	23	21	21	..	..	..	35	69	106
	J	80	107	106	51	50	151	67	60	250
<i>Diptera</i>	N	11	10	10	..	..	..	30	39	82
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
HEMIPTERA-HOMOPTERA.										
<i>Aphididæ</i>	N	5	27	..	..	..	..	..	1	4
	J	..	..	..	..	..	..	..	..	1
	J	..	..	..	..	..	..	..	..	..
<i>Cercopidæ</i>	N	1	1	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Coccidæ</i>	N	..	..	..	..	..	3	..	..	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
FULGORIDÆ.										
<i>Eurybrachys tomentosa</i> ..	N	..	..	..	1	..	..	..	1	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Ricania</i> sp.	N	3	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Sarima nigroclypeata</i> ..	N	3	..	..	..	..	5	..	2	1
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Tambinia verticalis</i> ..	N	1	..	..	..	..	1	..	..	1
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
JASSIDÆ.										
<i>Acropona walkeri</i>	N	..	..	..	1	2	1	2	..	1
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Acropona</i> sp.	N	1	23	..	..	..	..	..	1	1
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Bythoscopus indicus</i> ..	N	7	..	1	..	..	..	2	..	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Bythoscopus</i> sp.	N	..	2	..	..	..	..	..	..	1
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Chikkaballapura</i> sp. ..	N	..	..	..	80	80	7	8	1	5
	J	..	..	..	..	..	..	11	8	7
	J	..	..	..	..	..	..	..	..	..
<i>Cicadula indica</i>	N	..	..	..	..	..	..	..	..	7
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Deltocephalus</i> sp.	N	..	..	..	..	1	2	3	2	7
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Dios bipunctatus</i>	N	..	1	..	..	..	..	5	..	3
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Drabescus angulatus</i> ..	N	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Drabescus</i> sp.	N	1	1	2	..	..	..	..	..	1
	J	..	2	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Eutettix spicus</i>	N	..	..	..	..	..	..	2	..	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Eutettix disciguatus</i> ..	N	..	..	..	..	..	..	..	1	..
	J	..	..	..	..	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>Eutettix</i> sp.	N	..	..	1	..	2	..	13	2	..
	J	..	..	..	2	..	..	..	..	..
	J	..	..	..	..	..	..	..	..	..
<i>diocerus atkinsoni</i>	N	15	1	1	..	..	..	..	..	..
	J	..	..	..	..	..	..	1	2	..
	J	..	..	1	..	..	..	..	5	..

Order, family or species.	Months.								
	X	XI	XII	IV	V	VI	VII	VIII	IX
<i>Idiocerus clypealis</i>	J	..	..	..	..	2	1	..	1
<i>Idiocerus nivesparsus</i>	J	..	..	..	..	..	..	..	1
<i>Jassus elegans</i>	J	..	..	..	..	..	..	21	3
<i>Jassus indicus</i>	J	11	4	..	1	1	16	2	7
<i>Jassus</i> sp.	J	..	..	..	..	..	57	..	..
<i>Kartwa</i> sp.	J	..	1	1	..	..	1	4	..
<i>Kolla unimaculata</i>	J	..	1	..	..	..	..	..	..
<i>Ledra quadricarina</i>	J	..	..	..	1	..	..	1	..
<i>Ledra</i> sp.	J	1	..	..	..	..	..	..	..
<i>Ledropsis</i> sp.	J	..	..	..	..	..	2	..	..
<i>Moonia albimaculata</i>	J	1	..	..	..	5	10	..	..
<i>Neodartus acocephaloides</i>	J	..	1	1	..	..	6	2	1
<i>Neodartus</i> sp.	J	2	..	..	..	..	1	..	..
<i>Nirvana pallida</i>	J	..	10	..	6	7	..	..	..
<i>Nirvana suturalis</i>	J	2	2	3	..	..	..	1	..
<i>Orosius</i> sp.	J	..	..	1	..	1	1	..	1
<i>Parabolocratus</i> sp.	J	..	..	..	..	..	..	1	..
<i>Paralimnus albomaculatus</i>	J	..	1	1	..	..	1	..	..
<i>Pediopsis</i> sp.	J	..	..	..	3	3	4	5	1
<i>Petelocephala nigrilinea</i>	J	7	15	..	..	1	5	..	5
<i>Phrynomorphus indicus</i>	J	..	..	1	..	..	1	..	..
<i>Platymetopsis</i> sp.	J	..	..	..	..	..	1	1	..
<i>Rhombopsis</i> sp.	J	..	..	1	1	..	1	..	..
<i>Scaphoideus festivus</i>	J	2	2	7	..	..	..	2	..
<i>Scaphoideus</i> sp.	J	..	1	..	..	3	8	..	1
<i>Selenocephalus</i> sp.	J	..	..	..	1	1	1	..	1
<i>Tettigoniella</i> sp.	J	..	..	1	..	..	..	..	..
<i>Typhlocyba</i> sp.	J	..	..	..	1	1	1	1	5
<i>Jassids</i> (broken)	J	39	18	18	7	7	14	11	6
<i>Membracidae</i>	J	7	7	7	..	..	9	8	9
<i>Psyllidae</i>	J	1	1	1	..	1	..	..	2
<i>Peyllidae</i>	J	1	2	2	3	2	5	5	2
<i>Tingitidae</i>	J	..	1	1	..	1	1	..	1

HEMIPTERA-HETEROPTERA.

<i>Aradidae</i>	..	..	..	1	..	..	..	..	..
<i>Capridae</i>	1	..	..	..	..	..	..	..	..
<i>Coreidae</i>	21	..	..	..	..	1	2	..	1
<i>Lygaeidae</i>	5	6	5	2	2	3	3	4	1
<i>Pentatomidae</i>	2	2	2	..	..	1	1	4	..
<i>Reduviidae</i>	11	4	3	..	..	1	1	1	1
<i>Pentatomidae</i>	..	..	..	1	..	..	..	..	1
<i>Reduviidae</i>	..	..	..	..	..	..	..	1	..

Order, family or species.		Months.										
		X	XI	XII	IV	V	VI	VII	VIII	IX		
<i>Hemiptera</i> (broken)	..	..	N	18	10	10	2	2	7	52	..	..
			J	4	4	2				2	6	9
<i>Hymenoptera</i> *	..	..	N	300	370	389	312	312	353	307	239	379
			J	35	33	33				246	197	295
<i>Isoptera</i> *	..	..	..	..	..	..	21	20	1	1	..	..
			J	..	..	..				5	..	7
<i>Lepidoptera</i> *	..	..	..	6	6	5	3	2	15	5	10	20
			J	4	4	2				1	5	7
<i>Neuroptera</i>	..	..	..	2	..	..	..	..	..	..	..	..
			J	..	..	..	..	..	..	..	..	..
<i>Orthoptera</i> * and <i>Dermaptera</i>	..	..	N	56	12	11	15	14	..	27	21	3
			J	2	2	1	..	..	..	..	6	18
<i>Psocoptera</i> *	..	..	..	3	..	..	..	..	..	..	..	..
			J	..	..	..	..	..	..	..	..	..
<i>Thysanoptera</i> (thrips)	..	..	N	983	1,806	..	67	67	30	15	16	476
			J	12	12	13	..	..	..	115	58	313

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