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ANNUAL REPORT ON SILVICULTURAL RESEARCH IN THE MADRAS PRESIDENCY FOR THE YEAR 1939-40

PART I.

Results—Working Plans—Statistics—Staff.

I. RESULTS AND INDICATIONS.

(i) GENERAL.

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

The fifth silvicultural conference was held at Dehra Dun in November 1939 and was attended by the Provincial Silviculturist and the District Forest Officer, Nilambur.

The Research Ranger, Denkanikota, was deputed to the Forest Research Institute, Dehra Dun, and Ranchi in order to study the entomology of the spike disease of sandal and lac work.

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

A. Mixed deciduous forest of good quality.

2. (i) The production of practical measures by the Forest Entomologist, Dehra Dun, to control the ravages of the Mahogany shoot and collar borers. This is a result of the intensive work that has been done both by the Forest Entomologist and the research staff of this province in the past four years. It is an example of the benefits that are derived by the close co-operation of practical foresters with the Forest Research Institute.

(ii) Confirmation of earlier indications in methods of improvement of stump production in teak nurseries. We now make much more economical use of our seed and have greatly improved the quantity and quality of the stumps produced.

(iii) Demonstration of the fact that the principle of pre-monsoon stump planting can be applied in an East Coast type of climate with similar and even greater benefits than those derived in a West Coast type of climate. These investigations have been done by the districts of Upper Godavari and Kurnool West and are valuable contributions to the forest research of the province.

(iv) Soil and root studies in teak have been started in Nilambur division. These are the beginnings of important investigations and have so far consisted of the collection of information and a preliminary survey of the problems.

(v) The establishment of a number of species of exotic bamboos which are non-thorny and more desirable than our local bamboo (*Bambusa arundinacea*).

B. High elevation forests.

3. A good start has been made in the raising of wattle (*Acacia decurrens*) plantations for tan bark in the Palni hills and in the Nilgiris.

C. Dry fuel forests.

4. (i) Large scale confirmation from several sources of the alarmingly high rate of stool mortality (about 10 per cent) in the coppice working of these forests and hence the vital necessity for their artificial improvement and regeneration by methods such as those of rab and taungya.

(ii) The conclusion of a number of earlier investigations into details of the regeneration methods of rab and taungya and the start of more advanced investigations into such subjects as the effects of ash and the burn, of the interval between burning and sowing, and of the taungya crops on the forest crops.

(iii) The wide scale introduction of bamboos into dry districts in places where they are either absent or scanty (and hence valuable) and into areas invaded by pests such as *Lantana* and *Strobilanthes* for the purpose of reclaiming them.

D. The spike disease of sandal.

5. (i) Great progress in insect collections under different conditions and their identification. This was largely due to the deputation of the Research Ranger, Denkanikota, to Dehra Dun and the help and co-operation of the Forest Entomologist.

(ii) Demonstration of the effects produced by spike control operations when carried out intensively in experimental areas. In the Denkanikota spike control area in six years without control the diseased area increased from 5 acres to 350 acres and in the next eight years under strict control measures the diseased area only increased from 350 acres to 395 acres and in addition five isolated attacks at distances of from half mile to $2\frac{1}{2}$ miles from the main area were controlled and eradicated.

E. Seed indents.

6. During the year the Provincial Silviculturist arranged for the collection and supply of 266 seed indents comprising 93 species and $11\frac{1}{2}$ tons of seed and 36 indents of 16 species totalling 325,000 seedlings and stumps. A large proportion of this stock was collected by the research staff in addition to their ordinary duties.

Climates.

7. 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 268. In this statement the rainfall figures are given in inches month-wise 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, 1939 to June 1st, 1940) covers all the 1939 experiments. The rainfall is totalled for the year April 1st, 1939 to April 1st, 1940 as this period covers most measurements and is to be compared with the average annual rainfall given in the last column.

(ii) NATURAL REGENERATION.

By seed—Attempts to induce natural regeneration under mother trees.

8. *Hopsea parviflora*.—In Experimental Plot 54, South Coimbatore division, *Hopsea* 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 first full seed year was 1939 and in this year the treated and control plots showed 2,495 and 2,964 seedlings respectively.

9. *Calophyllum clatum*.—Experimental Plot 56, South Coimbatore division, which is a similar experiment gave practically no results until this year as there was little or no seed fall since the experiment was started seven years ago.

Seed fall in 1939 was fair and the treated and the control plots showed 73 and 37 seedlings respectively. This is an indication that the treatment is successful but we must see the effects of a full seed year for confirmation.

10. *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 seven years but the treatment has shown no beneficial or deleterious effects. Seeding has been fair at the end of 1939 in the Wynad plot and should soon give us some data.

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

12. *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 1936 in which burning before and after the seed fall has been added to the above treatments.

Enumerations at the end of February 1938, 1939 and 1940 show that burning either before or after seed fall is deleterious.

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. One year later 105 seedlings per tree of this crop were surviving. In the third year the new seedlings averaged 466 per tree.

We have thus not yet found the reason that this regeneration eventually disappears.

*Canopy manipulation over natural regeneration—
Hopea parviflora.*

13. 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 feet to 10 feet high. Three treatments were applied in which (a) all but the top canopy was cut, (b) the undergrowth was cut, and (c) control in which nothing was done.

Casualties have been negligible and during the nine years the plots have been open the treatments have shown the following average annual height increment: (a) 14.5 inches, (b) 8.8 inches and (c) 7.8 inches.

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.

14. 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.

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:—

A—Top canopy 223 per cent.

B—Full evergreen shade—control 12 per cent.

In the whole of the plots, and they total 2.7 acres, the established regeneration has shown the following average annual percentage increase: (a) top canopy only (unfenced) 316 per cent, (b) full evergreen shade (control) 62 per cent.

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

15. In order to continue this investigation two more sets of plots were opened in 1937. In the first set (Experimental Plots 75 and 76 South Coimbatore division) the progress of established regeneration of *Hopea parviflora* 3 feet to 8 feet high is observed under the conditions of (a) clear felling and (b) top canopy cover.

Since applying the treatments these plots have shown an average height increment per tree of (a) 1.6 feet and (b) 1.0 foot. Thus the beneficial effect of opening the canopy has shown itself even in the 2 years after the operation.

16. In the second set (Experimental Plots 72, 73 and 74 of South Coimbatore division) opened in 1938 the progress of established regeneration of *Hopea parviflora* 3 feet to 10 feet 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.

In the first two years, the established regeneration has shown an average annual height increment per plant of (a) +0.7' (b) +0.6' and (c) +0.2' while the average annual recruitment to the class of regeneration 3' high has been (a) 74 per cent, (b) 73 per cent, (c) 19 per cent. The small regeneration on the ground has so far increased in all treatments.

Mesua ferrea.

17. 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'—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 shown an average annual height increment of (A) 10.7 inches and (B) 5.1 inches; but the small regeneration on the ground is not as good as it was in either plot.

Experimental Plots 3 and 4 Wynaad division were opened in 1932 and two treatments applied (a) cutting undergrowth, (b) control. They show an average annual height increment of (a) 5.9 inches and (b) 1.9 inches. The state of small regeneration on the ground has not moved.

Experimental Plots 5 and 6 Wynaad division were similarly opened in 1932. In these two experiments the treated and control plots have shown movements very similar indeed to those of Experimental Plots 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.

Palaequium ellipticum.

18. In 1938 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 feet to 6 feet high and unestablished regeneration on the ground of this species. The shade conditions are (a) clear felling, (b) top canopy shade only and (c) full evergreen cover—control.

Measurements since the plots were opened show that the treatments have produced an average annual height increment per tree of (a) 1.69', (b) 0.52' and (c) 0.41'. 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.

Pterocarpus santalinus (Red sanders).

19. A valuable species in some of the dry districts which 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 four years ago and preliminary counts showed that this "mat" of regeneration contains approximately 550 seedlings per 100 square feet.

Although two of the past four years have been poor ones climatically with only two-thirds of the normal rainfall, enumerations show that the established regeneration class (over 3 feet high) has increased by 380 per cent while the total number of seedlings has decreased due to early dying back of younger seedlings by only 11 per cent. The treatment of opening the canopy by 30 per cent

to 50 per cent has thus been markedly successful in the first four years. We must however continue to observe the experiment until it has passed through at least one more climatically normal year.

20. A similar experiment in the bringing on of natural regeneration of *Pterocarpus santalinus* is reported from Kodur in Cuddapah South division. It is however too early to report results yet.

By coppice.

21. In Experimental Plot No. 11, Chittoor division 3 species (*Acacia sundra*, *Albizzia amara* and *Azadirachta indica*) were dealt with and 3 treatments applied (1) high cutting with trimming, (2) low cutting with trimming, (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 5½ years after applying treatments showed 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>	7	14	13
<i>Albizzia amara</i>	7	14	9
<i>Azadirachta indica</i>	7	9	*
Average for all 3 species ..	7	12	11

* Treatment omitted owing to insufficient number of stools.

It is thus seen that for all three treatments and all three species (1,224 stools) the ordinary operation of coppicing has caused 10 per cent mortality.

It should be noted that further appreciable mortality has occurred in the past year.

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

22. A further experiment in this subject (Experimental Plot No. 18, North Coimbatore division) was started last 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.

After one year it has been observed that 8½ per cent of the stools are definitely dead while a further ¼ per cent are still green but have produced no shoots yet. It is probable that further mortality will occur.

After a further two years when mortality will be complete details will be given by species and by girth classes.

Teak coppice—Mortality of stools.

23. In 1937, a large scale experiment covering 30 acres in area was started in order to determine the effect of different methods of coppicing on the mortality of stools and the resulting coppice shoots. Nine hundred and sixty teak trees in the area having only one shoot per stool were allotted to four treatments and these treatments were equally spread over the area of the coupe and over the range of diameter classes, thus randomising the treatments as far as was practicable.

The treatments were (a) low cutting as near the ground as possible, stools not trimmed, (b) low cutting as near the ground as possible, stools trimmed, (c) high cutting 9 inches to 12 inches above the ground, stools not trimmed and (d) high cutting 9 inches to 12 inches above the ground, stools trimmed.

Treatments were carried out in July 1937 after clear felling of other species (including the non-treated teak) in the coupe. Enumeration in February 1940 showed that mortality of stools had not then been negligible [(a) 1.7 per cent, (b) 1.3 per cent, (c) 1.7 per cent and (d) 1.7 per cent] and coppice shoots averaged 16 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 treatment the main shoots come from the ground level and a few feeble shoots appear from the cut edge but these die off in the first few months.

24. *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.

Mortality of stools has so far been 10 per cent and these stools that died were of the smaller girth classes. The girths experimented with varied from 28 inches to 48 inches at breast-height. The 90 per cent of the stools that did not die produced an average of 11 coppice shoots per stool.

Regeneration by root suckers—Santalum album.

25. An experiment has been done in this subject by the District Forest Officer, Vellore West division. Sandal trees of 27 inches to 49 inches girth at breast-height were trenched round. Ninety-seven per cent of the trees produced an average of 11 root sucker per tree.

Nellore division also reports successful regeneration by root suckers of sandal to the extent of 50 per cent.

Strychnos nuxvomica and Sapindus emarginatus.

Successful production of root suckers by trenching round these species is reported by Nellore division.

Regeneration by layering—Casuarina equisetifolia.

26. Nellore division reports the successful regeneration of *Casuarina equisetifolia* by layering the lower branches in plantations. If continued success is obtained by this method it may have far reaching results by avoiding the replanting every ten years that is at present done with this species.

(iii) SEED.

27. *Seed pre-treatment.*—Routine seed pre-treatment tests were made with 43 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>Givotia rottleriformis.*</i>
<i>Acacia leucophloea.</i>	<i>Glochidion neilgherrense.</i>
<i>Acacia melanorhylon.</i>	<i>Gluta travancorica.</i>
<i>Acacia planifrons.</i>	<i>Gmelina arborea.</i>
<i>Acacia sundra.</i>	<i>Grewia tiliaefolia.</i>
<i>Acrocarpus fraxinifolius.</i>	<i>Hakea saligna.</i>
<i>Aibizzia amara.</i>	<i>Harrisonia bennettii.</i>
<i>Albizia lebbek.</i>	<i>Lagerstræmia lanceolata.</i>
<i>Anacardium occidentale.</i>	<i>Ligustrum neilgherrense.</i>
<i>Azadirachta indica.*</i>	<i>Litsea zeylanica.</i>
<i>Balanocarpus utilis.</i>	<i>Mahonia leschenaultii.</i>
<i>Bauhinia purpurea.</i>	<i>Markhamia platycalyx.</i>
<i>Bauhinia racemosa.</i>	<i>Meliosma wightii.</i>
<i>Berberis tinctoria.</i>	<i>Michelia nilagirica.</i>
<i>Bombax malabaricum.</i>	<i>Neolitsea zeylanica.</i>
<i>Calophyllum elatum.*</i>	<i>Pithecolobium dulce.</i>
<i>Cassia auriculata.*</i>	<i>Pongamia glabra.</i>
<i>Cassia fistula.*</i>	<i>Prosopis juliflora.</i>
<i>Cassia marginata.*</i>	<i>Pterocarpus dalbergioides.</i>
<i>Cassia siamea.</i>	<i>Pterocarpus marsupium.</i>
<i>Chlorophora excelsa.</i>	<i>Quercus incana.</i>
<i>Chloroxylon swietenia.</i>	<i>Sapindus emarginatus.</i>
<i>Chorisia speciosa.</i>	<i>Schleichera trijuga.</i>
<i>Cupressus torulosa.</i>	<i>Sterculia urens.</i>
<i>Dalbergia latifolia.</i>	<i>Tectona grandis.</i>
<i>Dalbergia sissooides.</i>	<i>Terminalia chebula.*</i>
<i>Dendrocalamus strictus.</i>	<i>Terminalia crenulata.</i>
<i>Dolichandrone crista.</i>	<i>Terminalia paniculata.</i>
<i>Dolichandrone falcata.</i>	<i>Thyrostachys oliveri.</i>
<i>Eleocarpus oblongus.</i>	<i>Trema orientalis.</i>
<i>Eugenia arnottiana.</i>	<i>Vateria indica.</i>
<i>Erodia roxburghiana.</i>	<i>Vitex peduncularis.</i>
<i>Feronia elephantum.</i>	<i>Zizyphus incurva.</i>

* See later under special tests.

28. Treatment with boiling water (water 20 times the volume of the seed used is brought to the boil, is 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.

Leucaena glauca.

Myrsine wightiana.

Zizyphus glabrata.

Zizyphus xylopyrus.

29. Soaking in hot water (as hot as the hand can bear) increased the germination of—

Juniperus procera.

Strychnos nux vomica.

30. Soaking in cold water for 24 hours was beneficial in the case of—

Erythroxylon monogynum.

Palaquium ellipticum.

Pinus longifolia.

Pinus insignis.

Poinciana elata.

Pterocarpus santalinus.

Soymida febrifuga.

Strychnos potatorum.

Vitex littoralis.

Wrightia tinctoria.

Xylia xylocarpa.

Zizyphus jujuba.

31. The results of pre-treatment tests are summarized in paragraph 270. 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.

32. *Seed pre-treatment—Obdurate species*.—Twelve species which usually give a very low or variable 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 leucophylla</i> ..	33	14	X	14	0	16	10
<i>Acrocarpus fraxinifolius</i> ..	25	10	6	11	5	X	7
<i>Calophyllum elatum</i> ..	1	1	X	X	X	2	X
<i>Canthium didymum</i> ..	1	1	X	1	X	1	1
<i>Cassia auriculata</i> ..	10	7	X	8	X	25	7
<i>Cassia fistula</i> ..	33	14	9	12	0	35	9
<i>Cassia marginata</i> ..	12	20	13	9	0	35	1
<i>Erythroxylon monogynum</i> ..	3	4	X	2	X	2	3
<i>Givotia rotlieriformis</i> ..	2	2	X	2	X	1	1
<i>Pterocarpus santalinus</i> ..	33	27	X	23	2	10	12
<i>Terminalia chebula</i> ..	33	20	9	35	16	8	17
<i>Trema orientalis</i> ..	4	50	X	X	2	X	X

NOTE.—X test not done.

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

33. *Seed—Seasonal collection within the fruiting season*.—Tests were made of seed collected at fortnightly intervals throughout the fruiting season of 11 species, *Acacia leucophylla*, *Artocarpus hirsuta*, *Cassia fistula*, *Cassia marginata*, *Evodia roxburghiana*, *Hopea parviflora*, *Mesua ferrea*, *Pterocarpus santalinus*, *Sicietenia macrophylla*, *Terminalia chebula* and *Terminalia paniculata*. In each case these seed collections covered a period of six weeks to two months but in no case were there any definite variations in germinative capacity throughout the fruiting season.

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

34. *Method of sowing—Hopea parviflora*.—*Hopea* seed was sown (i) with the wings vertical (in the position it falls through the air), (ii) on its side (in the position it normally lies on the ground) and covered with earth to a depth of $\frac{1}{2}$ inch and (iii) on its side but well covered with $\frac{1}{2}$ inch of soil. Including previous years' results the average germination of 32 tests is (i) 7 per cent, (ii) 16 per cent, (iii) 15 per cent. It therefore appears that *Hopea* seed should be sown on its side and covered with earth to get the best results.

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

The autumn crop seed (collected in October to December) was found considerably better in germinative capacity than spring seed (collected in February to April). In both the spring and autumn crops, the seed from Coorg, North Salem division and the Javadi gave a 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 1937 crops kept quite well for two years and still gave 65 per cent of the original germination.

36. *Weathering of seed—Teak*.—For the fourth 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. This confirms all previous years' results.

37. *Plantation and natural forest teak seed comparison*.—Teak seed was collected from trees of comparable sizes and condition in each of three centres. Germination tests with this seed showed

a slight increase in favour of plantation seed. The average results of the three centres were:—Plantation seed 39 per cent, natural forest seed 33 per cent. These are the first tests of this series.

38. *Removal of seed coat.*—The soft outer coat and the hard outer seed coat of *Givotia rottleriformis* were both removed in testing this species.

Results were—

	Control.	Soft outer coat removed.	Soft outer and hard outer coats removed.
Germination per cent	8	10	40

These two seed coats should therefore be removed before sowing this species.

39. *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 has 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 including those of previous years are—

	Tests.	Seed with pulp.	Seed without pulp.	Seed passed through birds.
Average	4	15	36	57

It appears therefore that it is very beneficial to remove the pulp of *Azadirachta indica* seed before sowing. If possible seed that has passed through birds should be used.

40. *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 35 per cent (control) to 51 per cent (straw covered). This includes previous years' work and now represents four tests.

41. *Seed storage.*—Routine storage tests were made with 42 species with different methods of storage. Results showing the lengths of time that seed of different species remains fertile are given in paragraph 271 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.

42. *Seed weighments.*—Routine seed weighments, germination tests, etc., were carried out. The results are given in paragraph 269 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.)

43. *Supplies of seed, seedlings and stumps.*—As usual the Provincial Silviculturist was in charge of the supplies of seeds, 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 266 indents comprising 93 species and 11½ tons of seed and 36 indents of 16 species, totalling 3¼ lakhs of seedlings and stumps. A large proportion of this stock was collected by the research staff in addition to their ordinary duties.

During the past four years we have been endeavouring to standardise indents in order to reduce 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.

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

- indents should be sent in good time (i.e., before November 30th),
- all species should be referred to by their botanical names and under no circumstances by their local names, and
- indents should be expressed in pounds, 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 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 five years reveals that an appreciable proportion of the increased office work, and delays and difficulties were due to lack of foresight by the district officers concerned and could have been avoided.

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 Part II of this report.

45. *Sorting seed according to size—Teak.*—The five years investigation on the effect on germination of the sorting of the teak seed by size showed that this selection so far as germination is concerned is not economically justified.

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 1940 at the end of the second growing season after planting shows the following:—

Survival percentage.

District.	Experimental plot number.	District sample.	Selected biggest.	Selected medium.	Selected smallest.
Wynaad	55	99	100	99	99
Palghat	166	98	97	99	98
Coimbatore South ..	80	91	95	83	88
Average ..		96	97	95	95

Mean height in feet.

District.	Experimental plot number.	District sample.	Selected biggest.	Selected medium.	Selected smallest.
Wynaad	55	5.1	4.7	4.7	5.1
Palghat	166	11.0	8.7	9.7	10.3
Coimbatore South ..	80	5.6	6.1	6.2	5.5
Average ..		7.2	6.5	6.9	7.0

The above plots are being kept under careful observation.

46. *The effect of the size, age and condition of seed bearers on germination.*—The investigation in this subject went on for five years. Seed for test was collected from seed bearers of the following classes (a) old hollow overmature 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 crenulata</i>	24	27	33

47. 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).

The progress 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.
Wynaad Experimental Plot No. 35 ..	1937	97	97	94	8.6	8.8	8.0
Palghat Experimental Plot No. 155 ..	1936	91	91	87	17.8	16.6	20.7
South Coimbatore Experimental Plot No. 81 ..	1938	81	95	87	5.2	4.7	4.6
Average ..		90	94	89	10.5	10.0	11.1

Dalbergia latifolia.

Experiment.	Year of experiment.	Survival percentage.			Mean height in feet.		
		Over-mature.	Mature.	Under-mature.	Over-mature.	Mature.	Under-mature.
Wynaad Experimental Plot No. 36 ..	1937	98	98	98	3.6	3.9	4.1
Palghat Experimental Plot No. 157 ..	1936	80	73	82	8.7	7.8	5.4
South Coimbatore Experimental Plot No. 78 ..	1938	95	93	95	1.9	2.6	2.8
Average ..		91	90	92	4.7	4.8	4.1

Pterocarpus marsupium.

Experiment.	Year of experiment.	Survival percentage.			Mean height in feet.		
		Over-mature.	Mature.	Under-mature.	Over-mature.	Mature.	Under-mature.
Wynaad Experimental Plot No. 31 ..	1936	97	98	93	9.9	8.8	9.1
Palghat Experimental Plot No. 156 ..	1936	80	87	87	16.2	16.9	16.7
South Coimbatore Experimental Plot No. 77 ..	1938	91	96	94	1.2	1.8	1.6
Average ..		89	94	93	9.1	9.2	9.1

Terminalia crenulata.

Experiment.	Year of experiment.	Survival percentage.			Mean height in feet.		
		Over-mature.	Mature.	Under-mature.	Over-mature.	Mature.	Under-mature.
Wynaad Experimental Plot No. 37 ..	1937	90	84	85	8.0	8.0	7.7
Palghat Experimental Plot No. 158 ..	1936	87	93	92	19.2	19.3	19.8
South Coimbatore Experimental Plot No. 79 ..	1938	76	57	46	5.4	5.5	4.3
Average ..		84	78	74	10.9	10.9	10.6

48. *Seed origin—All-India teak seed origin plots.*—The two long-term plots in Nilambur and South Coimbatore divisions which were established in 1934 were maintained. These plots cover 14

acres and 6 seed origins and consist of 40 sample plots which are properly randomised. In the course of time we shall be able to collect comparable growth data from them.

(iv) NURSERY WORK.

49. *Effect of shade on germination (dry fuel forests).*—Previous years' experiments were repeated at Emmanur experimental garden with 18 species. With 10 of these species the shade had no effect on germination, with seven species it was increased by shade and one species definitely did better in the open.

The species were—

(a) Preferring the open *Zizyphus xylopyrus*.

(b) Preferring the shade —

<i>Canthium didymum.</i>	<i>Sapindus emarginatus.</i>
<i>Erythroxylon monogynum</i>	<i>Strychnos potatorum.</i>
<i>Poinciana elata.</i>	<i>Zizyphus glabrata.</i>
<i>Pterocarpus marsupium.</i>	

(c) Indifferent to the shade or open conditions —

<i>Chloroxylon sictetonia.</i>	<i>Strychnos nux vomica.</i>
<i>Hardwickia binata</i>	<i>Terminalia chebula.</i>
<i>Feronia elephantum.</i>	<i>Vitex altissima.</i>
<i>Mangifera indica.</i>	<i>Zizyphus jujuba.</i>
<i>Pterocarpus santalinus.</i>	<i>Soymida febrifuga</i>

These results in combination with the results of the past five 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.

50. *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" high, (c) complete top shade 2' 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) 55 per cent, (b) 52 per cent, (c) 70 per cent, (d) 62 per cent.

The above figures include the results of previous years and total 17 tests.

51. The experiment was further extended for *Hopea parviflora*, *Dipterocarpus indicus* 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' from the ground, and (c) 100 per cent top shade at 3' 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 beneficial in saving casualties with *Hopea* and *Dipterocarpus* but that *Cedrela* prefers the open.

The shading caused comparatively small differences in height increment with all 3 species.

Treatments were applied from end November 1939 to early May 1940.

The experiments were done both at Chandanathode and at Topslip.

Treatment.	Hopea parviflora.		Cedrela toona.		Dipterocarpus indicus.	
	Mortality.	Height increment.	Mortality.	Height increment.	Mortality.	Height increment.
	PER CENT.	INCHES.	PER CENT.	INCHES.	PER CENT.	INCHES.
(A) Open	33	3.0	33	8.6	37	8.8
(B) 50 per cent shade	46	3.3	48	7.7	32	7.8
(C) 100 per cent shade	44	3.7	70	6.7	25	7.8

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

52. *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. Three species were experimented with—*Albizia amara*, *Acacia planifrons* and *Prosopis juliflora*—and three treatments tried.

(A) Beds watered daily with 10 gallons of water (B) beds watered on alternate days with 10 gallons of water and (C) beds watered on alternate days with 5 gallons of water. The "bed" referred to is a standard nursery bed 40' x 4'.

Results including those of previous years are—

Species.	Treatment.	A	B	C
		10 gallons daily.	10 gallons on alternate days.	5 gallons on alternate days.
<i>Albizia amara</i>	Germination per cent	35	26	26
	Mean height in inches in February	13	10	10
<i>Azadirachta indica</i>	Germination per cent	11	11	11
	Mean height in inches in February	10	10	16
<i>Prosopis juliflora</i>	Germination per cent	18	15	18
	Mean height in inches in February	30	33	27
<i>Acacia planifrons</i>	Germination per cent	54	46	43
	Mean height in inches in February	22	20	19

The above figures show that *within the range of these experiments* watering has comparatively little effect on germination and height growth. It is probable that in these experiments we are still considerably over-watering.

53. *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' x 4' which were allotted to 4 treatments on the basis of their outturn of the best size of stumps in the first year. The treatments are (A) beds sown each year—no manuring, (B) beds to be left fallow in alternate years, (C) a green manure crop to be grown in the beds and dug in, in alternate years and (D) beds to be sown each year but manured with wood ash and leaf mould.

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

54. At the end of the first year the average outturn of stumps per standard 40' x 4' bed sown with 40 lb. of seed for all experiments taken together was as follows:—

Number of usable stumps 0.3" to 0.8" diameter.	Average diameter of usable stumps.	Percentage of stumps usable.	Number of un- usable stumps less than 0.3" diameter.
	INCH.	PER CENT.	
1,688	0.42	42	2,393

The above average figures representing the sowing of 2,560 lb. of seed in 64 standard nursery beds (40' x 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 ft. x 6 ft. espacement and still left a reserve for casualty replacement. *It is particularly to be noted that, at the end of one year, only 42 per cent of the stumps produced were of the best size.*

55. The results up to the end of the fourth 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
Fourth year ..	708	..	..	632

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
Fourth year ..	0.39	..	..	0.41

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

Number of usable stumps per standard bed.

Date.	Centre.	A	D
April 1939 ..	Nilambur ..	659	621
April 1940 ..	Begur ..	215	170
April 1940 ..	Dhoni ..	1,692	1,300
April 1940 ..	Topslip ..	267	437
	Average	708	632

Average diameter of usable stumps produced (in inches).

Date.	Centre.	A	D
April 1939 ..	Nilambur ..	0.42	0.41
April 1940 ..	Begur ..	0.36	0.37
April 1940 ..	Dhoni ..	0.43	0.49
April 1940 ..	Topslip ..	0.36	0.37
	Average	0.39	0.41

It is thus seen that after 4 years the stump production per standard bed has fallen to (A) 42 per cent and (D) 38 per cent in spite of the remedial measure of artificial manuring in the treatment D. It is to be noted that the average diameter of usable stumps produced has also fallen off in all treatments.

It thus appears (as a preliminary indication) that the much talked of raising of teak stumps for the Province 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.

56. The Nilambur experiment has now reached the end of its fifth year and the results of these 5 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	1,703	2,035	1,509
Fourth year ..	659	..	..	621
Fifth year ..	1,107	1,239	1,660	1,049

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
Fifth year ..	0.40	0.42	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 cockchafer) to come in, production very definite 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 No. 136, Wynaad division Experimental Plot No. 34, Palghat division Experimental Plot No. 152, South Coimbatore division Experimental Plot No. 68.)

57. *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.

58. During 1935, 3 experiments were done at Dhoni, Topslip and Begur in which 4 treatments were 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; (D) sowing seed at 20 lb. per bed. Each treatment consisted of 4 sub-beds 10' × 4' the arrangement being randomized. 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, 1938 and 1939. The results of the 1939 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	3,172	2,297	3,158	1,971	9,015
Dhoni	1,692	1,242	1,964	1,104	5,700
Topslip	468	617	688	484	1,934
Average	1,777	1,385	1,937	1,186	*5,550
Average number of unusable stumps below 0.3" diameter	5,942	1,480	3,397	1,510	†1,723

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

Locality.	Number of usable stumps per treatment.				
	A	B	C	D	E
Begur	0.42	0.46	0.42	0.44	0.40
Dhoni	0.40	0.41	0.42	0.43	0.40
Topslip	0.38	0.40	0.38	0.40	0.40
Average	0.40	0.42	0.41	0.42	0.43

* In 12 standard beds or 463 per bed.
† In 12 standard beds or 144 per bed.

The result of the last five 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
1939	1,777	1,385	1,937	1,186	5,550
1938	1,261	720	1,307	1,332	4,081
1937	1,610	933	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 15 experiments over 5 years at 3 centres	1,717	1,068	1,613	1,461	*4,693

* In 8 standard beds or 587 per bed.

Year of experiment.	Average diameter of usable stumps per treatment in inches.				
	A	B	C	D	E
1939	0.40	0.42	0.41	0.42	0.43
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 15 experiments over 5 years at 3 centres	0.43	0.45	0.42	0.44	0.44

Year of experiment.	Average number of unusable stumps per treatment.				
	A	B	C	D	E
1939	5,492	1,480	3,397	1,510	1,723
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 15 experiments over 5 years at 3 centres	3,725	747	2,863	1,636	*1,621

* In 8 standard beds or 203 per bed.

59. Thus (i) the average diameter of usable stumps produced was practically the same with all treatments. (ii) In treatments A, C and D (sowing with 60, 40 and 20 lb. of seed per bed) the average number of usable stumps produced was greatest for A but not very different from C and D. The quantity of seed used in A and C was out of all proportion to the number of good stumps produced. (iii) Treatment B in which after dense sowing, seedlings were pricked out into E beds showed the poorest outturn in the original beds. A large number of seedlings were pricked out into 8 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.

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	24.0	25.3	26.5
Dhoni	33.6	32.5	35.6
Topslip	19.8	18.6	20.8
Average of 1939 experiments ..	25.8	25.5	27.6
Average of 1938 experiments ..	21.0	23.2	21.3
Average of 1937 experiments ..	33.9	40.0	41.5
Average of 1937, 1938 and 1939 experiments	27.2	29.6	30.1

It is thus seen that putting undersized seedlings back in the nursery for a second year produced 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.

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

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

(v) ARTIFICIAL REGENERATION.

(a) *Mixed deciduous timber forests.*

66. *Development of artificial regeneration in gaps.*—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, Wynaad 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' x 30' thus containing roughly 25 plants at 6' x 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:—

			Increment in the last year.
<i>Wynaad Division.</i>			
		FT.	FT.
January 1936 at 3 years old	..	12.1	— 3.1
January 1940 at 7 years old	...	19.2	
<i>South Coimbatore Division.</i>			
January 1936 at 3 years old	..	3.1	+ 0.7
January 1940 at 7 years old	..	6.5	

(The negative increment in the Wynaad experiment is due to breakage by elephant and bison.)

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

67. Last year a further experiment in this subject (Wynaad Experimental Plot No. 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' x 3' espacement and the other half at 6' x 6' espacement.

The average height of the best plant per gap after five growing seasons is—

(A) 3' x 3' 18.6
(B) 6' x 6' 21.0

The plants in the gaps are struggling against the ravages of elephants, 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.

68. 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 Wynaad division at Begur an area definitely not fit for teak was selected and the undergrowth up to 20' felled and burned. Attempts to regenerate it with a different species by various methods were made. At the end of the third 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.	Survival. Per cent.	Mean height in inches.
1 <i>Lagerstroemia flos reginae</i> , sowing	98	13.6
2 <i>Lagerstroemia lanceolata</i> , sowing	99	21.7
3 <i>Terminalia paniculata</i> , sowings	18	10.5
4 <i>Artocarpus hirsuta</i> , stumps	96	16.8
5 <i>Dalbergia sissoo</i> les, stumps	96	15.1
6 <i>Pterocarpus marsupium</i> , stumps	95	14.6
7 <i>Terminalia crenulata</i> , stumps	90	15.9
8 <i>Swietenia macrophylla</i> , transplants	93	50.3
9 Ceylon <i>Chloroxylon swietenia</i> — Transplants	95	29.5
Stumps	90	19.5
10 Madras <i>Chloroxylon swietenia</i> — Transplants	87	16.7
Stumps	79	10.6

Chlorophora excelsa put in as stumps in 1939 also looks promising so far.

69. *Comparison of direct sowing, entire transplanting and stump planting.*—Investigations with the species listed below are concluded. The work which was done over a period of five years in each case shows the following as the most suitable of the three methods of regeneration for each species:—

<i>Tectona grandis</i>	}	Stump planting.
<i>Dalbergia latifolia</i>		
<i>Pterocarpus marsupium</i>		
<i>Terminalia crenulata</i>		
<i>Swietenia macrophylla</i> ..	}	Entire transplanting.
<i>Xylia xylocarpa</i> ..		Direct sowing.

70. *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 four years are included for comparison. Work in this subject with this species is now concluded.

Year.	Survival percentage.			Mean height in inches.		
	Sowing.	Trans-plant-ing.	Stump-ing.	Sowing.	Trans-planting.	Stump-ing.
1939	24	98	40	5.9	28.7	10.8
1938	11	94	7	10.0	38.8	20.6
1937	..	93	6	0	44.7	14.0
1936	6	54	16	6.5	24.3	11.8
1935	..	59	2	0	14.0	6.5
Average of five years' work.	8	80	14	4.5	30.1	12.7

A further experiment (No. 85) was done with this species also at Kannothe in a ponam crop of hill paddy in which the results from transplants (A) 18", (B) 30", (C) 44" and (D) 55" high were compared. As is seen from the table below which gives the results in January 1940 the transplants of the bigger sizes have done the best. This confirms previous years' results.

Treatment.	Survival per-centage.	Mean height in inches.
A. 18-inch transplants	88	27.3
B. 30-inch transplants	90	40.0
C. 44-inch transplants	100	53.9
D. 55-inch transplants	100	61.3

71. *Artocarpus hirsuta*.—Three experiments were done with this species at three centres after clear felling and burning mixed deciduous forest.

Results are given below together with those of the previous five 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.	Trans-plant-ing.	Stump-ing.	Sowing.	Trans-plant-ing.	Stump-ing.
Begur	99	75	94	6.8	4.6	7.4
Dhoni	91	83	79	7.9	7.2	6.4
Topslip	12	0	69	3.5	0	5.5
Average of 1939 experiments	64	53	81	6.1	2.9	6.4
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 six years work	59	35	70	7.5	7.1	7.9

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 the last two years 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.		
	Sowing.	Trans-plant-ing.	Stump-ing.	Sowing.	Trans-plant-ing.	Stump-ing.
Begur	0	62	78	8.8	9.0	11.8
Kannothe	0	84	83	0	12.3	7.6
Dhoni	93	95	94	6.2	6.5	15.6
Topslip	46	28	40	14.3	8.8	16.5
Average of 1939 experiments	37	67	75	7.3	9.2	12.9
Average of 1938 experiments	26	52	73	8.2	9.4	16.6
Average of 1937 experiments	0	53	87	0	8.8	12.7
Average of 1937, 1938 and 1939 experiments	21	57	78	5.2	9.0	14.1

73. *Schleichera trijuga*.—In connexion with lac work, regeneration of this species has become important in recent years. Three experiments were done at three centres. Their results are

given below together with those of the last three years for comparison. Although results have been very variable the indications at present are that stump planting is the best method for this species.

Locality.	Survival percentage.			Mean height in inches.		
	Sowing.	Transplant-ing.	Stumping.	Sowing.	Transplant-ing.	Stumping.
Topslip	91	79	0	5.4	10.1	0
Begur	57	95	56	3.6	8.4	10.5
Dhoni	91	98	91	5.9	8.4	6.5
Average of 1939 experiments ..	80	91	62	5.0	9.0	5.7
Average of 1938 experiments ..	86	69	76	10.6	11.2	11.3
Average of 1937 experiments ..	40	46	64	23.7	17.8	26.6
Average of 1936 experiments ..	40	40	90	8.5	5.4	7.2
Average of 1936, 1937, 1938 and 1939 experiments ..	62	62	73	12.0	10.9	12.7

74. *Artocarpus integrifolia*.—Four experiments were done with this species at four centres and their results are given below together with those of last year for comparison. The evidence so far obtained shows that direct sowing is the best of the three methods for the regeneration of this species.

Locality.	Survival percentage.			Mean height growth in inches.		
	Sowing.	Transplant-ing.	Stumping.	Sowing.	Transplant-ing.	Stumping.
Begur	100	29	72	20.7	17.3	19.4
Kannoth	98	68	90	35.5	21.2	17.0
Dhoni	100	92	32	36.8	29.5	16.2
Topslip	98	68	83	23.2	14.4	21.0
Average of 1939 experiments ..	99	67	69	29.1	20.6	18.6
Average of 1938 experiments ..	100	80	83	40.3	25.8	15.9
Average of 1939 and 1938 experiments ..	100	74	66	34.7	23.2	17.3

75. *Lagerstræmia lanceolata*.—Four experiments were done with this species at four centres and indicated that stump planting is likely to be the best method. Results are given in the table below together with those of last year for comparison.

Locality.	Survival percentage.			Mean height growth in inches.		
	Sowing.	Transplant-ing.	Stumping.	Sowing.	Transplant-ing.	Stumping.
Begur	0	70	98	0	18.6	26.8
Dhoni	75	95	81	13.6	19.6	26.3
Topslip	25	0	97	18.8	0	25.6
Kannoth	0	97	97	0	22.3	25.6
Average of 1939 experiments ..	24	66	93	8.1	15.1	26.1
Average of 1938 experiments ..	72	54	84	16.0	17.4	31.6
Average of 1938 and 1939 experiments ..	48	60	89	12.1	16.3	28.9

76. *Lagerstræmia flos reginae*.—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. Results are given in the table below together with those of last year for comparison:—

Locality.	Survival percentage.			Mean height growth in inches.		
	Sowing.	Transplant-ing.	Stumping.	Sowing.	Transplant-ing.	Stumping.
Begur	29	75	98	7.2	14.4	21.2
Kannoth	2	100	91	6.0	14.3	13.7
Dhoni	94	93	99	12.2	16.6	25.5
Topslip	82	17	91	14.7	10.5	24.7
Average of 1939 experiments ..	52	72	95	10.0	14.0	21.3
Average of 1938 experiments ..	66	72	67	8.5	12.0	20.3
Average of 1938 and 1939 experiments ..	59	72	81	9.3	13.0	20.8

77. *Trema orientalis*.—Four experiments at four 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. Results are given in the table below together with those of last year for comparison.

Locality.	Survival percentage.			Mean height in inches.		
	Sowing.	Transplant-ing.	Stumping.	Sowing.	Transplant-ing.	Stumping.
Begur	16	68	33	81.6	84.0	55.2
Dhoni	95	91	63	52.8	49.2	42.0
Topslip	16	25	9	35.4	51.6	49.2
Kannoth	17	11	8	7.0	29.0	16.4
Average of 1939 experiments ..	37	49	30	45.2	53.5	40.7
Average of 1938 experiments ..	54	83	53	37.9	55.5	46.9
Average of 1938 and 1939 experiments ..	46	66	42	41.6	54.5	43.8

78. *Mangifera indica*.—Four experiments were done with this species at four centres and gave the preliminary indication that direct sowing is the best method of regeneration of this species. In several of the experiments transplanting did quite well. The results should be received with caution and need confirmation by repetition.

Locality.	Survival percentage.			Mean height growth in inches.		
	Sowing.	Transplant-ing.	Stumping.	Sowing.	Transplant-ing.	Stumping.
Begur	100	38	6	17.0	8.3	2.0
Kannoth	74	85	41	17.8	15.8	4.0
Dhoni	82	94	2	10.0	9.1	8.0
Topslip	76	74	0	9.0	9.2	0
Average of 1939 experiments ..	83	73	12	13.6	10.6	3.7

79. *Bombax malabaricum*.—An experiment was done at Dhoni with this species comparing sowing with transplanting. Results showed that the species could be regenerated equally well by either method.

Locality.	Survival percentage.		Mean height in inches.	
	Sowing.	Transplanting.	Sowing.	Transplanting.
Dhoni	94	94	8.0	6.9

80. *Pre-monsoon 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—

- 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.
- 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.
- Success is not dependent on what is generally considered "good planting weather."
- 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.
- 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>	Early May ..	Late April ..	Mid-May ..	Mid-May.	
and <i>sissooides</i> ,		Early May.			
<i>Pterocarpus marsu-</i>	Late April ..	Late April ..	Mid-May ..	Late May.	
<i>pium</i>	Early May.				
<i>Terminalia crenulata</i> ,	Late April ..	Mid-May ..	Late April.	Mid-May.	
			Early May ..		
<i>Artocarpus hirsuta</i> ..	Late May ..	Early June	Mid-May ..	Mid-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.

81. *Kannothe—Wynaad division—Annual rainfall 166 inches—Elevation 300 feet*.—The investigations into premonsoon stump planting at this centre were concluded during the year with the final experiment with *Terminalia crenulata*. Results as judged at the end of the first growing season after planting together with those of the previous four years are given in an abbreviated form as follows:—

Year of experiment.	Survival percentage of stumps planted on				
	1st April.	15th April.	1st May.	15th May.	1st June.
1939	14	100	70	72	88
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 ..	52	78	80	75	79

Year of experiment.	Mean height growth in inches of stumps planted on				
	1st April.	15th April.	1st May.	15th May.	1st June.
1939	41.7	42.9	22.2	17.9	13.5
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 ..	28.9	27.3	22.4	17.3	15.5

The above figures show that very early May or late April 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 61 per cent when compared with normal early June planting.

(For full experimental data see paragraph 272.)

82. *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 was started at this centre in 1938.

Experiments have now been done over two years and in addition, in 1939 a further experiment was done in a ponam crop of paddy.

Abbreviated results as measured at the end of the first growing season after planting are as follows:—

Year of experiment.	Survival percentage of stumps planted on				
	1st April.	15th April.	1st May.	15th May.	1st June.
1939	51	85	71	26	87
1938	98	97	98	100	97
Average ..	75	91	85	63	92

II. Mean height growth in inches.

Year of experiment.	Stumps planted on					
	15th April.	1st May.	15th May.	1st June.	15th June.	1st July.
1935	6.4	5.9	6.1	7.3	9.6	3.9
1936	19.0	22.2	20.4	22.6	12.0	8.8
1937	28.2	17.5	10.7	11.1	16.5	7.2
1938	9.8	12.9	12.2	14.2	7.3	3.0
Average ..	15.9	14.6	12.4	13.8	11.4	5.7

The general conclusion is that stump planting of teak in this division is best done in late May or early June. The great benefits obtained by this early planting as compared with monsoon planting are well demonstrated by the above tables.

86. *General*.—It is once again emphasized that premonsoon planting is a principle that can be applied with benefit to a number of species, a number of places and a number of climates. The best date of planting is essentially a local problem and it is only by such local investigations as those described above that data for the different districts can be obtained. Each district must do its own investigations. The work done by the research branch is to demonstrate the principle and show how each district can help itself.

87. *Stump planting in pits and crowbar holes—Teak—District work—Kurnool West division*.—Experiments in this subject have been done in Kurnool West division each year since 1935.

Results as measured at the end of the first growing season after planting show:—

Year of experiment.	Survival percentage.		Mean height in inches.	
	Pits.	Crowbar holes.	Pits.	Crowbar holes.
1935	99	99	15.2	12.4
1936	96	93	18.6	14.8
1937	97	98	11.9	7.9
1938	100	96	14.5	10.9
Average ..	98	97	15.1	11.5

It is thus seen that there is no appreciable difference in survival percentage but in mean height growth the pit planting shows a superiority over crowbar hole planting of 31 per cent.

It is for the consideration of the district whether this increase in height growth (and hence smaller weeding costs) is commensurate with the extra expense involved in pit planting.

88. *Stump planting—Effect of age and diameter of stumps*.—With the work done with *Artocarpus hirsuta* this year, the investigation is now concluded for teak, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Artocarpus hirsuta*.

89. *Artocarpus hirsuta*.—Experiments were done at three 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.									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1
Begur ..	One year ..	..	..	..	96	96	..	..	..	..	..
	Two years ..	..	..	..	..	22	48	62	33	..	13
	Three years ..	..	..	..	..	..	..	..	..	..	78
Dhoni ..	One year ..	..	..	63	84	90	..	..	..	..	..
	Two years ..	..	..	..	..	61	01	72	..	..	..
	Three years ..	..	..	..	..	..	..	..	..	..	..
Topslip ..	One year ..	62	63	59	83	..	..	..	..	..	..
	Two years ..	..	63	73	87	90	..	..	..	..	..
	Three years ..	..	..	..	..	..	..	..	..	..	..

Mean height growth in inches after one season.

Begur ..	One year ..	..	..	..	7.6	9.2	..	4.5	4.3	5.8	3.8
	Two years ..	..	..	..	..	3.5	4.7	4.5	4.3	5.8	9.4
	Three years ..	..	..	..	..	..	..	..	..	..	..
Dhoni ..	One year ..	..	..	4.6	6.5	7.6	..	..	..	..	..
	Two years ..	..	..	..	..	5.2	5.8	9.3	..	..	..
	Three years ..	..	..	..	..	..	..	..	..	..	..
Topslip ..	One year ..	4.1	5.3	5.2	5.7	..	..	..	..	..	..
	Two years ..	..	4.2	6.1	6.6	8.1	..	..	..	..	..
	Three years ..	..	..	..	..	..	..	..	..	..	..

90. *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 1939 normally, (B) planted on 1st April 1939 buried, (C) planted on 1st June 1939 normally and (D) planted on 1st June 1939 buried. In treatments (B) and (D) the stumps were made normally with 1" of stem and 9" of root and planted in the ground 1" lower than they were originally in the nursery, i.e., planted with the top of the stem flush with the ground.

In the late planting (June) the treatment produced no appreciable difference in survival percentage or in mean height growth from the control.

With the early planted stumps however differences (all in favour of the buried stumps) were much greater. We have now done 19 experiments in this subject at five centres over four 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 8 per cent. It therefore appears that it is decidedly beneficial to plant the stumps with the top of the 1" shoot flush with the ground when doing early planting.

Abbreviated results are as follows:—

Locality.	Survival percentage of stumps planted on				Mean height growth in inches of stumps planted on			
	1st April 1939.		1st June 1939.		1st April 1939.		1st June 1939.	
	Buried.	Normal.	Buried.	Normal.	Buried.	Normal.	Buried.	Normal.
Begur ..	95	88	97	97	31.2	31.1	11.9	12.9
Dhoni ..	99	92	82	84	38.9	34.2	16.0	19.9
Walayar ..	83	44	88	83	16.7	17.5	13.1	12.5
Topslip ..	97	87	92	93	26.4	21.6	16.4	17.5
Kannoth ..	86	82	94	98	21.1	25.6	7.8	8.0
Average ..	92	79	93	92	28.9	26.0	13.0	14.2

94. *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 pre-monsoon 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 and 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 were started at Nilambur in 1938 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 second growing season after planting, the plots showed the following results:—

Experiment number.	Site quality.	Espacement.	Survival.	Mean height.	Relative costs.
			PER CENT.	FEET.	
Experimental Plot No. 149 .. I		6' × 6'	99	13.7	1.0
		8½' × 8½'	100	13.3	0.7
Experimental Plot No. 150 .. II		6' × 6'	99	13.2	1.0
		8½' × 8½'	99	11.9	0.7

It remains to be seen how the plots progress.

95. 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 two years.

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.

96. *Irrigated teak plantations.*—Work in this subject which was started in 1932 at Hulical near Mettupalaiyam was continued. The area has an annual rainfall of 56.2 inches and most of this comes from the north-east monsoon. The natural forest of the locality is mixed deciduous scrub forest of poor quality.

Two methods of irrigation have been tried (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.

We also have indications (that need confirmation) (a) that the effect of irrigation is felt up to and including the fifth year but by the sixth year its effect is very small and (b) that after the first growing season irrigation once a fortnight is as effective as irrigation once a week.

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

The 1932 plantation was thinned in 1938 and is ready for thinning again now. At eight years old this crop has an average height of 46 feet and an average diameter at breast height of 5.5 inches with a stand of 316 stems per acre.

Half of the 1932 plantation was clear felled in 1938 and is being regenerated by irrigated coppice. This coppice is now 14.3 feet in average height and has produced 3.8 shoots per stool on the average. Mortality of stools has been nil so far.

This plantation of 1932 has given us the following rough indications of costs. At six years old half of this plantation which had cost Rs. 68-8-0 per acre was clear felled and fetched Rs. 173 per acre thus showing a profit (excluding overheads) of Rs. 17-8-0 per acre per annum. The unfelled part of the 1932 plantation was thinned by roughly 60 per cent in 1938 and the thinned poles fetched Rs. 98 per acre. Thus this operation of first thinning much more than paid for the cost of the plantation.

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 also be remembered that after the first planting, the subsequent regeneration is by irrigated coppice and this is much cheaper than the original planting.

seven lines of Mahogany in the respective strips. The Mahogany strips consist alternatively of (i) Mahogany and *Trema* at alternate stakes and (ii) Mahogany and *Trema* in alternate lines. Experimental Plot No. 143 Nilambur division, is similar but with Mahogany and Cashew (*Anacardium occidentale*) in alternate strips and Experimental Plot No. 154, Palghat division which is Mahogany and teak in alternate strips.

At the end of the third year these plots are all fully stocked and look very promising. The Wynaad 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, Wynaad 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 feet apart and the Mahogany close planted in its lines.

Work in 1939 consisted in the raising of three further plots in order to confirm the results of the plots described above and also to raise patches of Mahogany seed bearers for the future.

103. *Artificial regeneration of Bambusa arundinacea* (in experimental gardens).—In 1938 experiments were done at Begur and Topslip in which direct sowing, planting of one year old transplants and planting of 1, 2 and 3 years old rhizomes were compared.

Abbreviated results together with those of the previous year are as follows:—

Survival percentage after two seasons.

Experiment number.	Sowing.	One-year seedlings.	One-year rhizomes.	Two-year rhizomes.	Three-year rhizomes.
Begur Experimental Garden Experiment No. 128 ..	1	95	66	83	65
Topslip Experimental Garden Experiment No. 182.	0	18	87	91	*
Average ..	1	57	77	90	65
Average of 1937 experiments.	13	83	61	49	*
Average of 1937 and 1938 experiments.	7	70	69	70	*

* Not done.

Mean height growth in feet after two seasons.

Experiment number.	Sowing.	One-year seedlings.	One-year rhizomes.	Two-year rhizomes.	Three-year rhizomes.
Begur Experimental Garden Experiment No. 128 ..	10.0	15.6	16.4	17.2	16.8
Topslip Experimental Garden Experiment No. 182.	0	8.2	9.4	10.2	*
Average ..	5.0	11.9	12.9	13.7	16.8
Average of 1937 experiments ..	8.5	13.4	13.2	12.6	*
Average of 1937 and 1938 experiments ..	6.8	12.7	13.1	13.2	*

* Not done.

It therefore appears that there is very little to choose between transplanting and rhizome planting.

These experiments were repeated in 1939 with the following results when measured at the end of the first growing season.

Survival percentage.

Experiment number.	Sowing.	One-year seedlings.	One-year rhizomes.	Two-year rhizomes.	Three-year rhizomes.	Four-year rhizomes.
Begur Experimental Garden Experiment No. 147 ..	22	87		88	93	78
Topslip Experimental Garden Experiment No. 206 ..	2	93	88	88	*	*

Mean height growth in feet.

Begur Experimental Garden Experiment No. 147 ..	1.6	4.7	*	5.7	5.6	4.4
Topslip Experimental Garden Experiment No. 206 ..	3.2	2.5	5.1	4.5	*	*

* Treatment not done.

104. In addition an experiment was done comparing multiple rhizomes with separated rhizomes. Results together with those of previous years were as follows:—

Year.	Multiple rhizomes.		Separated rhizomes.	
	Survival percentage.	Mean height in feet.	Survival percentage.	Mean height in feet.
1937	48	2.8	68	2.6
1938	66	3.4	78	3.9
1939	88	4.7	84	4.7
Average ..	67	3.6	77	3.7

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 one or two year old rhizomes rather than to sow or transplant.

Height growth was as follows :—

Nilambur Experimental Plot No. 144.

Sub-plot A.				Sub-plot B.			
FT.				FT.			
<i>Morus indica</i>	..	..	14.8	<i>Morus indica</i>	..	..	14.2
Teak	..	..	8.3	Teak	..	..	2.5
Sub-plot C.-1.				Sub-plot C.-2.			
<i>Morus indica</i>	..	..	15.7	<i>Morus alba</i>	..	..	9.2
Teak	..	..	12.4	Teak	..	..	15.6

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.

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 85 per cent stocked with a mean height growth of 5.9 feet at the end of the second growing season. No shade at all was given in this experiment.

A further plot of *Morus alba* was raised at Nilambur (Experimental Plot No. 152) in a swampy area in the current district teak regeneration area. At the end of the second year this plot was 97 per cent stocked with an average height of 5 feet.

111. *Vitex peduncularis*.—This species has now been introduced successfully into most of our malarial districts. The seed came from Assam. The oldest plants are now four years old and some 12 feet high.

112. *Alcurites fordii*.—Kollegal and North Salem divisions report the introduction of this species. The germination is quite good and the growth of survivals so far is slow but encouraging.

113. *Lagerstræmia flos-reginæ*.—Attempts made at Nilambur and Chandanathode to reproduce this species by means of cuttings from both natural forest trees and from nursery seedlings failed. The method appears unsuitable to the species.

114. Mulberry, *Morus sp.*—Kollegal division reports the successful introduction of *Morus* species.

115. *Givotia rottleriformis*.—This is a species with which we have had great difficulty in the nursery. Kurnool South division (now Kurnool East) reports that satisfactory germination can be obtained if the seeds are sown at a depth of 1 to 2 inches in the nursery bed and covered with straw and thorns and watered copiously each morning till germination takes place. The seedling grows rapidly and develops a thick carrot like root. Three months old stumps have done well on a small scale and the resultant growth was 15 feet in height and 8 inches in girth at the end of two years. One year old stumps are often too big for successful stumping but this needs further experiment.

Fermenting of the seed by soaking them in cold water for 48 hours and then keeping them moist covered with straw out of free air circulation has also been successfully used to germinate this rather difficult species.

116. *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, Wynaad division and No. 82, South Coimbatore division). We thus have nearly $\frac{3}{4}$ 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—

	Stocking.	Mean height in feet.
	PER CENT.	
Experimental Plot No. 38, Wynaad division—3 years ..	50	7.1
Experimental Plot No. 82, South Coimbatore division— 2 years	35	5.2

117. *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).

118. This species is doing very well at Kannothe (Wynaad division) and a number of garden experiments had shown that it was probably suitable at Nilambur in areas unfit for teak. In consequence in 1938 at Nilambur a large-scale experimental plot (No. 146) 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 second growing season after planting it was $\frac{2}{3}$ acre 97 per cent stocked with a mean height of 8.3 feet.

A similar plot at Kannothe raised in 1939 (Wynaad Experimental Plot No. 64) at the end of its first growing season was $\frac{3}{4}$ acre 100 per cent stocked with a mean height of 5.6 feet.

(2) *Dendrocalamus brandisii*.

119. There were a few clumps of this bamboo in the compound of the bungalow of the District Forest Officer, Wynaad at Manantoddy. These clumps seeded in 1935 and the Experimental Plot (No. 57) was planted at Begur in 1938 with three year old rhizomes.

After the second growing season it is $\frac{1}{2}$ acre 97 per cent stocked with plants of an average height of 10.3 feet.

(3) *Bambusa polymorpha*.

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

			Stocked per cent.	Mean height in feet.
Kannothe (Experimental Plot No. 53) $\frac{1}{2}$ acre	..	..	100	12.2
Begur (Experimental Plot No. 56) $\frac{1}{2}$ acre	..	..	98	8.6

(4) *Chlorophora excelsa*.

121. One-fourth acre of this species was raised in 1938 by stump planting at Begur (Experimental Plot No. 54). At the end of the second year it was 96 per cent stocked with plants of an average height of 4.2 feet.

A similar plot $\frac{1}{2}$ acre in extent was raised at Kannothe in 1939 (Experimental Plot No. 62, Wynaad division) and at the end of the first growing season after planting it was 94 per cent stocked with plants of an average height of 25.1 inches.

(5) *Dendrocalamus longispatus*.

122. A few clumps of this bamboo had been introduced at Kannothe many years ago. The clumps seeded in 1938 and in consequence in 1939 two experimental plots of $\frac{1}{2}$ acre each were raised with 1 year old rhizomes of this species. At the end of the first growing season after planting the state of the plots was as follows:—

			Stocked per cent.	Mean height in feet.
Kannothe (Experimental Plot No. 61)	..	..	100	6.0
Begur (Experimental Plot No. 65)	..	..	99	4.7

(6) *Lagerstrœmia flos-reginæ*.

123. Although not an exotic an experimental plot of $\frac{1}{2}$ acre of this species was raised in 1939 in one of the wetter portions of the district regeneration area at Kannothe in order to observe its suitability in plantation under the conditions of wet laterite.

At the end of the first growing season after planting the plot was 99 per cent stocked with a mean height of 3.2 feet.

124. *Teak coppice forest*—Filling in blanks with stumps.—Observation of Experimental Plot No. 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 1940 after 14 years (i.e., nearly $\frac{1}{2}$ of the rotation of 30 years) 52 per cent of the stumps were still surviving but were only approximately $\frac{1}{2}$ the girth and $\frac{3}{4}$ 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.

It is to be noted that 3 per cent of further casualties have occurred during the past year.

125. *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 concluded during the year. The conclusion is that such replacements do not take their place in the crop and are therefore not financially worth while.

The following table shows the results obtained. This table shows that only about 42 per cent of the replacements survive and that these survivals 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 the second year of plantation.			At the end of the third year of plantation.			At the end of the fourth year of plantation.			At the end of the fifth year of plantation.		
				Percentage replacements surviving.	Average height of replacements.	Average height of plantation.	Percentage replacements surviving.	Average height of replacements.	Average height of plantation.	Percentage replacements surviving.	Average height of replacements.	Average height of plantation.	Percentage replacements surviving.	Average height of replacements.	Average height of plantation.			
ACS.																		
Palghat ..	135	2	1933	13	77	0.2	62	0.5	50	0.5	43	0.5						
Do.	140	2	1934	33	48	0.2	26	0.5	23	0.5	23	0.5						
Coimbatore South.	61	1	1934	20	17	0.2	17	0.3	16	0.5	15	0.7						
Palghat— (Flat country.)	145 (1)	$\frac{1}{2}$	1935	19	85	0.2	74	0.5	74	0.9	74	0.9						
(Hill country.)	145 (2)	$\frac{1}{2}$	1935	18	85	0.1	84	0.5	84	0.6	81	0.9						
Palghat ..	149	$\frac{3}{5}$	1936	25	99	0.5	67	0.6	63	0.7	50	0.9						

126. *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 *Lagerstræmia flos-reginæ*. At the end of the third year the plot was 76 per cent stocked and looked quite promising with an average height growth of 2.2 feet.

See also paragraph 123 for this species under the conditions of wet laterite.

127. *Regeneration of semi evergreens after clearing and burning what is now deciduous forest.*—In Experimental Plot No 41, Wynaad division, and No. 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*.

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

- (i) *Artocarpus hirsuta* grows best without such a cover or shade crop.
- (ii) *Hopea* and possibly *Mesua* can probably be raised in such localities under a cover crop of *Tephrosia candida*.
- (iii) The shade crop of *Trema orientalis* is however not sufficient in the first year and it is unlikely that species such as *Hopea* and *Mesua* will survive in this way.

The experiments were repeated in 1938 with *Hopea* and *Mesua* at Kannothe (Wynaad Experimental Plot No. 52) and with *Hopea* and *Cedrela* at Dhoni (Palghat Experimental Plot No. 167). This repetition confirmed the tentative conclusions drawn from the work of 1937 and also showed that *Cedrela* can be raised with certainty on such areas by these methods.

Further work in 1939 was done at both centres with *Hopea parviflora* and *Cedrela toona* (for confirmation of previous work) and also with *Balanocarpus utilis*. This latter species appears promising in these areas by these methods.

Mixed deciduous forest of good quality—Entomological work.

(The following sections consist largely of extracts from the report of the Forest Entomologist, Forest Research Institute, Dehra Dun.)

I. Teak Defoliators.

128. The Forest Entomologist, Dehra Dun, maintained an insectary at Nilambur during the year from April 28th to October 6th, 1939. From March to the end of April the insectary was opened and maintained by Mr. A. H. Khan, Deputy Conservator of Forests. Insectaries were also maintained at Tithimatti in Coorg and Palghar in Bombay and the investigations were combined.

For the study of parasitism, defoliators of teak and of the plants associated with teak were bred extensively and at Nilambur this involved the caging and rearing of 28,500 caterpillars of scores of species.

129. *Season of defoliation (Nilambur).*—In 1939 *Hyblaea puera* was absent in March, a few occurred in April; it was abundant in June and again in August and September. Heavy defoliation occurred in patches in some regeneration areas and young plantations. The older plantations were free.

Hapalia machæralis was fairly numerous at the beginning of the season March, April and reached its greatest abundance in May in regeneration areas and in coupes 12-15 years old everywhere.

From June onwards it was fairly scarce.

130. *Incidence of parasitism of larvæ of Hapalia machæralis and Hyblaea puera.*—The number of species of parasites bred from *machæralis* at Nilambur was 16 and of these 4 were specific to the defoliator and 12 had alternative hosts. The specific parasites were predominant from March to June and were surpassed by the alternative host parasites in July and reached a minimum in September.

Hyblaea puera.—The number of species of parasites bred from *puera* at Nilambur was 7 and of these 1 was specific to the defoliator and 6 had alternative hosts. At the beginning of the period April-May, specific parasites were absent; in the period June-July, they formed 10 to 25 per cent; and in August-September from 50 to 75 per cent of the total larval parasitism.

131. *Seasonal importance of parasites.*—The difference in the seasonal importance of specific parasites and parasites with alternative hosts of *machæralis* and *puera* is striking. In *machæralis*, specific parasites are the main controlling agency at the beginning of the season, in *puera* they are the main control at the end of the season. The parasites with alternative hosts can become responsible for more than half the whole of the total monthly parasitism percentage; nowhere do specific parasites provide 100 per cent of the total monthly parasitism percentage.

This difference is apparently due to the fact that *machæralis* hibernates as a larva and thereby carries over its specific parasites; *puera* hibernates as a moth and its specific parasites are less closely adjusted and relatively scarce at the beginning of the season.

132. *Relative importance of parasites and other control factors of teak defoliators.*—The data collected shows that larval parasites alone are not responsible for the control of teak defoliators. (It would be necessary to have a parasitism percentage of 98 and no further destruction in other stages to keep the population level.) The other destructive forces in the environment are weather, predators and disease.

Weather is the most powerful and determines the population from season to season.

Predators are an unknown quantity that cannot be measured by field investigation. Their value nevertheless must be very high.

Disease is, during the rainy season, responsible for a high percentage of deaths but the value cannot be measured by field investigations.

As parasitism is the only measurable factor, research is directed in the first instance to the improvement of this factor by introducing missing species of parasites. Introductions are also made of missing predators on an empirical basis.

133. *Release of parasites and predators.*—During the year the parasite *Tricoma* sp. and the predator *Sycanus collaris* were despatched from Coorg and introduced at Nilambur.

134. *Other pests of teak.*—Pests derived from field crops grown with teak in taungya attack the young teak plants after the crops are harvested. In North Thana the mealy bug *Icerya aegyptiaca* (Coccidæ), was responsible for infestation and dying back of one-year old teak rabs in May-June. In Coorg *Prodenia litura* (Noctuidæ) defoliated young teak in April and caused dying back and forking. It is clear that the field-grown crops in the regeneration areas are potential sources of defoliators liable to attack teak and will have to be taken into account. It should be noted that taungya regeneration of teak has been introduced at Nilambur in the last two years.

135. *New food plants of Hyblaea puera.*—The following new food plants of *Hyblaea puera* were discovered. *Heterophragma roxburghii*, *Orocylum indicum*, *Stereospermum chelonoides*, *S. suaveolens* (Bignoniaceæ).

136. *Defoliators of species of plants associated with teak.*—An extensive survey of the defoliators of species of trees, shrubs and climbers, etc., was made in natural forests in the neighbourhood of teak plantations. This has added very considerably to our knowledge of the inter-relationship of biological control factors in the teak mixture complex.

II. Mahogany Borers.

137. (1) *The shoot borer, Hypsipyla robusta.*—Bored shoots of mahogany have been received fairly regularly throughout the year from the research stations at Karianshola and Dhoni, Palghat, Madras.

A total of over 2,000 shoots has been examined at Dehra Dun. No parasitism and only 2 cases of predators (*Elatridæ*) were recorded. Enquiries were received from Australia as to the possibility of using Indian parasites for the control of the Cedar tip moth in Queensland. In my opinion there is no prospect whatever of the biological control of the shoot-borer by means of parasites.

The 2,032 shoots pruned as "attacked" contained (on receipt at Dehra Dun) only 290 larvæ and 127 pupæ, i.e., 20 per cent of the shoots contained living borers. This affords further evidence of the uselessness of pruning as a control measure.

138. (2) *The Collar borer Pagiothloceus longiclavis—Biological observations—Seasonal incidence of the beetle.*—The numbers of beetles caught at traps throughout the period May to mid-October 1939 monthly was—

			May.	June,	July.	August.	Sep- tember.	Octo- ber.
Kannoth	..	..	173	368	174	102	15	9
Periya	..	..	..	110	91	74	47	4
Total	..	..	1,167					

The numbers are determined by the numbers of traps put out experimentally but the falling off at the end of the season represents actual reduction of population.

The percentage of females in the trapped population varied from 53 per cent in May to 40 per cent in September.

139. *Longevity.*—Wild beetles of unknown age were caged from June onwards; they lived for various periods, the maximum being 130 days. Wild beetles were captured, marked with paint and released; several of these were caught again at traps, the maximum period of freedom after release being 72 days.

140. *Flight range and dispersal.*—Wild beetles, captured, marked with paint and released at Kannoth and Periya were recovered at traps distant from the site of release at a maximum distance of 3½ miles (in this case after 55 days), it was also ascertained that the beetles travel by flight and cross streams. The proportion of marked beetles recaptured varied from 6 to 46 per cent in the different batches released. Bearing in mind that the beetles were of various ages when first caught and that death must have been accelerated by the painting of the elytra (in one batch the suture was intentionally gummed up), the recoveries indicate the value of the traps, and they also indicate the smallness of the population of beetles in the experimental area. In Periya recaptured painted beetles formed 23 per cent of the total catch at traps, in Kannoth 10 per cent.

141. *Generations.*—A generation may be completed between the third week of June and the third week of September to end of October and between third week of July and mid-October to first week of November.

Records of egg-laying were obtained in June, July and August.

The previous determination of 3 short-cycled generations a year combined with long-cycled broods was confirmed.

142. *Beetle traps*.—Experiments were conducted at Kannothe and Periya from May to October 1939 to determine the most suitable type of trap to attract beetles of *Pagiophloeus longiclavis*.

Cedrela toona freshly felled was found to be the most attractive material. It was tested in the form of twigs 2 feet long, billets 2 to 5 feet long and from 3 inches to 20 inches girth, either untreated, or with the bark loosened, or blazed, or scratched; logs 5 to 7½ feet long and 30 to 45 inches girth; strips and slabs of bark. The various types were exposed singly or in various combinations of numbers up to 80 in one heap.

All these types attracted beetles except twigs and stuff of very small dimensions. The attractive power of the larger pieces was greater and lasted longer than that of the smaller pieces, and that of heaps was greater than that of single pieces on the average. Reduced to a common criterion of size it is found that the best trap to use is a billet of 2 feet in length, and 6 to 10 inches in girth, but anything a little smaller or larger is efficient. The attractive power of a billet exposed singly is almost as great as if combined with others in a heap; actually a combination of two billets produced the maximum number per billet; hence for most economical use of trap material and to cover the greatest area billets should be put out singly.

The experiments with treatment of the bark showed that in the dry weather (May) the billets are more attractive if the bark is loosened causing a release of sap. In the monsoon cross-cut billets with the bark intact are best as they remain attractive longer and do not ferment.

A billet functions for about a fortnight the maximum catch per billet per week is 45 beetles. Oviposition takes place on billets but not on large logs with thick bark.

The data obtained by experiments with painted beetles show that it is possible to catch at least half the local beetle population with traps, and one may expect a well distributed series of traps to clean up an area sufficiently to give a practical amount of protection.

The following control measures are recommended.

143. *Control measures for the collar borer of Mahogany—Pagiophloeus longiclavis*.—The natural food plant of the collar borer *Pagiophloeus longiclavis* (Curculionidae) is *Cedrela toona*, it breeds in greater abundance in *C. toona* than in young *Swietenia macrophylla* in mahogany plantations. The most important control measure is reduction or elimination of the breeding grounds in natural forest in the neighbourhood of plantations, and regeneration areas.

Felled trees of C. toona.—The bark should be removed from the smaller bole logs, and from all the branchwood over about 3 inches girth shortly after felling. Alternatively the branches may be cut up into billets and used as traps (see below).

Dying or stagheaded trees of C. toona.—These should be located and felled and disposed of as above, the width of the danger zone may be put at 4 miles if a complete clean up is contemplated.

Traps.—The most suitable form of trap is a billet of freshly felled *C. toona* about 2 feet long and 6 to 10 inches in girth, but all available branchwood or small pole wood may be used; twigs are not worth using; bark slabs stripped from large logs are useful for a short period which is not more than a few days in the monsoon. The trap billets should be laid on the ground in shade distributed singly over a wide area in the neighbourhood of regeneration areas and mahogany plantations. They should be inspected at frequent intervals for a fortnight and the beetles which shelter underneath them should be destroyed by squashing (at a distance from the trap). Billets which are no longer attractive should be replaced by fresh ones. In the dry weather (May) billets are more attractive if the bark is loosened; this is unsuitable during the rains.

Single distribution of billets is the most economical way of using the trap material. Heaps of several billets can be used if there is plenty of material, or if inspection cannot be organized except along routes daily frequented by the labourers. Some form of report or counting of the catches is desirable as a check on the inspection.

The period during which trapping operations can be carried out is May to September inclusive. The population is most abundant, i.e., the biggest catches will be obtained, after the monsoon has set in. *The greatest benefit will be obtained from trapping operations that are started before planting up with mahogany and during the first two years of its life.*

Removal of attacked mahogany.—There is practically no advantage in pulling up mahogany plants attacked by the collar borer unless the infestation is exceptionally heavy, as very few of the plants recognized as attacked contain living borers. The population of borers inside a mahogany plantation is only a small fraction of that in the area as a whole.

Plantation sites.—Liability to attack is greater in mahogany plantations in open sites than in those with overhead shade given by tree canopy or by undergrowth or by cover-plants.

Deep undergrowth sheltering mahogany in clear felled sites prevents increase of attack more effectively than does overhead shade of tree canopy.

In some localities the collar borer does not occur. It is extremely probable that these localities have no dead or felled trees of *Cedrela toona*.

Other food plants.—Other species of *Meliaceae* are likely to be food plants of the collar borer. At present it is known that *Aglaia roxburghiana* does not support it and this species is useless for traps.

Shoot borer attack.—The attack of the shoot borer, *Hypsipyla robusta*, is very probably one of the factors attracting the collar borer to mahogany plantations. Hence reduction in shoot borer attack is likely to be accompanied by reduction in collar borer attack.

The protective effect of overhead and lateral shade works equally against both pests.

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 that 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.

144. The paragraphs on the mahogany shoot and collar borers should be read with paragraphs 101 and 102 which give accounts of the large scale practical attempts that we are making to raise mahogany as free as possible from these 2 pests the control measures being purely silvicultural. These attempts have so far been remarkably successful.

III. Bamboo Borers.

145. A severe insect attack occurred in *Dendrocalamus strictus* in Salem North division in the north-east monsoon of 1938. Material was sent to Dehra Dun and during the deputation of the Research Ranger, Denkanikota, in 1939 a study of this material was included in his entomological work under Dr. Beeson.

The material came from the All-India Bamboo Experimental Plot and showed evidence of attack by—

- | | |
|---------------------------------------|------------------------|
| 1. <i>Cyrtotrachelus longipes</i> Fl. | <i>Curculionidae</i> . |
| 2. <i>Estigmene chinensis</i> E. | <i>Chrysomelidae</i> . |
| 3. <i>Pyralidae</i> . | |
| 4. <i>Hypothenemus</i> sp. | <i>Scolytidae</i> . |
| 5. <i>Cossoninae</i> . | <i>Curculionidae</i> . |
| 6. <i>Anthrribidae</i> . | |
| 7. <i>Lamiidae</i> (2 species). | |
| 8. <i>Trypetidae</i> . | |

The primary attack is due to the large beetle *Cyrtotrachelus longipes* which bores the newly growing culms and causes the terminal portion to die and break off, or causes arrested growth of the internodes or greatly reduces the vigour of the culms according to the severity of the attack. All the other species are secondary pests which come in afterwards due to the unhealthy conditions of the culms caused by the primary attack. Only thick culms are usually attacked when they are fairly short and culms of full grown size generally escape.

Estigmene chinensis attacks the culms when the internodes are made most of their growth. The characteristic attack of this species is the distortion of the internodes with fissures and holes.

Pyralidae.—The caterpillars of this family appear in the fermented sap of the growing shoots immediately they are killed. They also live in the sheaths between the culms and the sheath. The moths emerge through holes in the sheaths.

Hypothenemus sp. *Scolytidae*.—The larvae of these live in between the different leaves of the sheath or between the sheath and the culm, as soon as the young shoots attacked by *C. longipes* are weakened and start dying out.

Cossoninae—Curculionidae.—Their attack is detected by the presence of small holes of about 0.1 of an inch in diameter on the internodes.

The other species all come in weakened culms and are not very important.

(b) Evergreen rain forests.

146. All the artificial regeneration experiments done in evergreen rain forests with the exception of one set (Experimental Plot No. 27, Wynad and Experimental Plot No. 70, South Coimbatore division, raising of evergreens after clear felling and burning with and without cover crops) have been planting under shade and are therefore reported in part (ix) of this chapter "Underplanting" below. (Paragraphs 194 to 209.)

(c) Dry fuel forest.

147. Direct sowing in a burned-over area—Best season.—Emmanur Experimental Garden Experiments Nos. 189 to 195, 205 to 208, 217 and 246 which were started in 1938 were finally measured. With these measurements, the investigations in this subject is concluded as we have now got data from five years' work.

The results of this investigation are best seen from the tables below in which are given the averaged percentages of survivals and averaged mean heights for each year as measured at the end of the second growing season after planting when the plants may be considered to be established.

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	40	22	Average of 4 species.
1935	..	..	24	48	60	37	37	22	Average of 6 species.
1936	..	31	33	33	33	46	21	25	Average of 6 species.
1937	32	25	40	40	37	40	51	40	Average of 11 species.
1938	23	40	67	75	85	72	23	28	Average of 11 species.
Average ..	23*	32*	36	43	47	43	35	27	38 experiments.

* Corrected averages.

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	8.6	11.7	12.4	12.9	12.3	Average of 4 species.
1935	..	..	39.0	34.6	35.6	32.2	33.5	18.5	Average of 6 species.
1936	..	..	55.7	48.9	43.3	40.6	37.6	31.5	Average of 6 species.
1937	..	64.0	45.0	35.2	37.3	35.6	36.5	33.4	Average of 11 species.
1938	..	46.4	46.4	42.6	43.0	48.1	37.7	27.4	Average of 11 species.
Average	..	45.4*	40.3*	34.5	33.4	34.3	31.3	27.7	38 experiments.

* Corrected averages.

The species used in this investigation are *Acacia arabica*, *Acacia auriculiformis*, *Acacia ferruginea*, *Acacia planifrons*, *Acacia sundra*, *Anacardium occidentale*, *Albizia amara*, *Albizia lebbek*, *Azadirachta indica*, *Cassia auriculata*, *Cassia siamea*, *Prosopis juliflora*, *Pterocarpus santalinus*, *Terminalia chebula* and *Wrightia tinctoria*.

(Vide paragraph 275 for full experimental details of 1938 experiments.)

148. 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. Measurements are given at the end of the second growing season after planting as at this stage plants are established and this time also coincides with the time at which in most districts tending of rab plots is discontinued.

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.

1938—79 per cent.

Average 30 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 1).

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 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 June, July or August according to locality and resowing at reasonable intervals until full stocking is obtained. This method is followed by most districts doing really successful rab work.

149. These results have all been obtained at Emmanur in North Coimbatore division and in order to give other districts a climatic comparison, below is given the average monthly rainfall of the place for as long as we have records (i.e., 47 years) together with the monthly rainfall during the years in which the experiments have been conducted. It will be seen that the rainfall of Emmanur corresponded 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	3.01	2.68	0.16
February	0.59	0.71	0.25	2.51	0.33	0.45
March	0.80	1.43	4.06	0.93	4.02	1.53
April	2.13	3.43	1.19	2.61	2.56	0.22
May	3.42	1.37	1.61	2.04	1.26	0.18
June	1.42	0.64	0.10	1.05	1.53	3.49
July	1.32	1.46	2.93	1.43	1.74	4.40
August	2.62	..	1.54	5.57	3.14	3.94
September	3.60	8.80	8.52	6.76	6.42	0.23
October	7.83	4.70	1.17	2.63	2.91	0.69
November	4.70	0.72	1.53	1.90	0.23	2.43
December	..	..	..	..	..	..
Total	29.82	26.07	23.04	31.44	26.82	17.94
Number of rainy days	..	53	56	70	70	50

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

150. Best date of sowing—District work.—The investigation in this subject with *Acacia planifrons* at Ayyalur in Madura district was continued.

Remeasurement of the 1938 experiment showed that the effects of early sowing were still very appreciable. Abbreviated results were—

Survival percentage.

Date of measurement.	Survival percentage of sowings done on							
	1st April 1938.	1st May 1938.	1st June 1938.	1st July 1938.	1st August 1938.	1st September 1938.	1st October 1938.	1st November 1938.
January 1940 ..	82	100	59	61	60	71	75	70

Date of measurement.	Mean height in inches of sowings done on							
	1st April 1938.	1st May 1938.	1st June 1938.	1st July 1938.	1st August 1938.	1st September 1938.	1st October 1938.	1st November 1938.
January 1940 ..	38.8	43.4	39.4	35.3	41.6	28.6	31.6	30.3

The first year measurements of the 1938 experiment together with those of the 1939 experiment were—

Year of experiment.	Survival percentage of sowings done on							
	1st April.	1st May.	1st June.	1st July.	1st August.	1st September.	1st October.	1st November.
1938	82	100	60	61	67	73	83	74
1939	75	57	63	63	59	82	91	41
Average ..	79	79	62	62	63	78	87	58

Year of experiment.	Mean height growth in inches of sowings done on							
	1st April.	1st May.	1st June.	1st July.	1st August.	1st September.	1st October.	1st November.
1938	17.4	20.3	15.7	13.0	14.1	6.2	6.3	4.6
1939	10.8	7.0	7.9	5.9	5.7	5.2	4.3	2.4
Average ..	14.1	13.7	11.8	9.5	9.9	5.7	5.3	3.5

Thus although at present we have only the evidence of two years work for this centre, yet the success of early sowings (April to June) is very striking indeed when compared with late sowings (September to November) for the height growth resulting from the former average nearly three times the height from the latter. It should also be noted that the casualties that occurred in the hot weather after sowing are those of the late sowings.

151. 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 and 1939 rainfall of Ayyalur together with that of Emmanur Experimental Garden—

Rainfall in inches.

	Ayyalur.			Emmanur Experimental Garden—Normal.
	1938.	1939.	Normal.	
January ..	..	1.60	1.47	0.07
February ..	0.40	..	0.08	2.08
March ..	2.40	0.80	0.10	1.26
April ..	1.80	0.80	1.97	2.57
May ..	..	..	1.20	1.19
June ..	..	2.20	0.68	1.61
July ..	0.60	..	0.24	0.37
August ..	7.20	2.80	2.52	2.20
September ..	4.00	3.80	2.12	0.77
October ..	3.80	6.80	9.80	8.66
November ..	..	15.40	6.38	3.33
December ..	1.60	0.60	1.85	0.77
Total ..	21.80	34.80	28.41	24.88

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

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

152. Emmanur Experimental Garden Experiments Nos. 230 to 236 which were started in 1938 were finally remeasured at the end of their second growing season. With these measurements, this investigation is now concluded as five years' work has been completed.

In each of the experiments of this investigation (and there have been 29 experiments during the five years) 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 inches by 9 inches by 6 inches at each patch before sowing, and in the other only enough soil working to sow the seed was done.

The general results of the investigation can best be judged from the tables given below which give the averaged survival percentages and averaged mean heights for each year's work as measured at 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
1938	7	26	25	76	71
Average ..		16	14	49	47

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
1938	7	9.5	10.0	32.9	27.2
Average ..		12.3	10.1	22.9	19.7

The species used were *Acacia planifrons*, *Acacia arabica*, *Acacia leucophlœa*, *Albizzia amara*, *Cassia auriculata*, *Dolichandrone crisa*, *Tamarindus indica*, *Wrightia tinctoria* and *Zizyphus jujuba*.

Combining all the above data we get the following :—

Treatment.	Survival per cent.	Mean height in inches.
Burning	48	21.3
No burning	15	11.2
Worked pits	33	17.6
No soil working before sowing	31	14.9

The investigation has thus given us the definite conclusions that burning before sowing is essential and that soil working before sowing is decidedly beneficial.

(For full experimental data of the 1938 experiments see paragraph 276.)

153. *Comparison of sowing, entire transplanting and stump planting.*—In experiments Nos. 224 to 229, six species were experimented with by these 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 1940 (at the end of the second growing season) showed that *Dolichandrone crisa* had done best by sowing, *Pterocarpus santalinus* by stump planting, *Hardwickia binata* and *Soyimida febriifuga* by both sowing and stump planting and *Wrightia tinctoria* and *Azadirachta indica* had done well by all three methods.

(For full experimental data see paragraph 277.)

The experiment was repeated in 1939 in Emmanur Experimental Garden Experiments Nos. 260 to 265 with six species all of which either stump or transplant well or which often do not do well by sowing.

Measurements at the end of the first growing season showed that *Azadirachta indica* and *Bauhinia purpurea* had done best by sowing, *Pterocarpus santalinus* by stump planting and *Wrightia tinctoria* by transplanting. *Dolichandrone crisa* and *Hardwickia binata* had done well by both transplanting and stump planting.

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 277 (a).]

154. *Comparison of stump planting and transplanting.*—Experiments Nos. 221 to 223 Emmanur Experimental Garden had as their objects (a) to find the best season for stump planting, (b) to compare stump planting and transplanting and (c) to compare transplanting at the commencement of the south-west and north-east monsoons.

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

Remeasurement at the end of the second growing season after planting showed with all species that transplanting in the north-east monsoon in early October was better than transplanting in the south-west monsoon. Two-year old stumps were better than one-year old stumps and August 1 was the best date for stump planting in 1938.

(For full experimental data see paragraph 278.)

The experiment was repeated in 1939 (Emmanur Experimental Garden Experiments Nos. 257 to 259) with *Azadirachta indica*, *Pterocarpus santalinus* and *Wrightia tinctoria*. Measurements in January 1940 showed that transplanting could be done in either the south-west or the north-east monsoon in 1939. They also again showed that two-year old stumps are better than one-year old stumps.

The best time for stump planting was October.

[For full experimental data see paragraph 278 (a).]

155. *The effect of the burn and the ash on survivals and development.*—An investigation has been started to study the effect of the burn and the ash in dry fuel regeneration work

The arrangement of the experiments is in randomized blocks and three species *Acacia planifrons*, *Cassia siamea* and *Prosopis juliflora* have been used. Four treatments were applied (A) a normal burn and the ash mixed in with the soil before sowing, (B) a normal burn and the ash removed outside the area, (C) no burn and the ash from (B) mixed into the soil before sowing and (D) no burn and no ash mixed in.

At the end of the first growing season the treatments show little difference in survival percentage but treatment D is very much poorer than the others in mean height growth. Treatments A, B and C are not significantly different from each other.

It must however be remembered that this is only the start of the investigation and in this work differences usually develop in the first hot weather after sowing and hence will show in next year's measurements. In the first growing season also effects of differences in the burn are to some extent masked by the intensive soil working that is done.

(Emmanur Experimental Garden Experiment No. 266 of 1939.)

156. *The effect of the period that elapses between burning and sowing on survivals and development.*—For some years the opinion has been growing that the lapse of time between the date of burning and the date of sowing has an important effect on survivals and development in the artificial regeneration of dry fuel forests.

In consequence last year an investigation was started to determine this effect (if any).

The arrangement of the experiments is that of randomised blocks and three species *Acacia planifrons*, *Cassia siamea* and *Prosopis juliflora* were used. Five treatments were applied, burning and working the ash into the soil in (A) mid March, (B) mid April, (C) mid May, (D) mid June and (E) mid July. All treatments were sown in mid July.

Measurements at the end of the first growing season show that differences in both survivals and mean height growth are small but in favour of burning about two months before sowing. It must however be remembered that this is only the start of the investigation and in this work differences usually develop in the first hot weather after sowing and hence will show in next year's measurements. In the first growing season also effects of differences in the time of the burn are to some extent masked by the intensive soil working that is done.

(Emmanur Experimental Garden Experiment No. 267 of 1939.)

157. *The effect of kumri crops on the forest crop.*—An investigation has been started into the effect of the agricultural crops on the forest crops in rab-cum-kumri work in dry fuel forest. The arrangement of the experiment is a latin square of 25 sub-plots. In each sub-plot four forest species are being raised (*Prosopis*

juliflora, *Azadirachta indica*, *Acacia planifrons* and *Acacia sundra*) in dense line sowings. Five treatments are applied (A) Ragi (*Eleusine coracana*), (B) Tenai (*Sctaria italica*), (C) Cholam (*Andropogon sorghum*), (D) Cumbu (*Pennisetum typhoideum*) and (E) Control—no crop.

The same field crops will be sown in the same sub-plots year after year for four years or until the forest crop grows up and makes a field crop impossible or until the soil will no longer support a field crop. Normal rab tending, thinning and soil working is being done.

The object of the investigation is to find out the relative merits of the different field crops and to endeavour to work out a succession of field crops which will give the best result in both forest crop and money yield.

The experiment is only in its initial stages but the general observations of the first growing season are that (i) cholam and cumbu give too dense a shade in the first year and are bad for the forest crop, (ii) the root competition of the field crop is hardly felt by the forest crop in the first year and (iii) the light shade of ragi and tenai is apparently beneficial to the forest crop in the first year.

(North Coimbatore Division Experimental Plot No. 19 of 1939.)

158. *District Work—Rab notes.*—Chittoor division reports that in 1939 May-June sowings did much better than July-August sowings.

Chittoor division again reports damage by porcupine to *Cassia siamea* and by browsing to *Albizia amara*, *Pterocarpus santalinus* and *Pterocarpus marsupium* but also states that these last three species can be raised if intimately mixed with such thorny species as *Acacia ferruginea*, *Acacia sundra* and *Prosopis juliflora*.

Guntur division reports browsing damage to *Albizia lebbek*, *Albizia odoratissima* and *Albizia amara*. This division also reports that *Prosopis juliflora*, *Soyimida febrifuga*, *Sapindus emarginatus*, *Cassia fistula* and *Chloroxylon swietenia* are not browsed.

Salem North division reports the successful regeneration of large areas of fire burned *Lantana* with *Cassia siamea*, *Anacardium occidentale* and bamboos. There were however general fairly heavy casualties by weeds and damage to the *Anacardium* and bamboos by porcupines and rodents.

In Nellore division the work on the regeneration of charcoal pits was continued and again showed the regeneration on the periphery was very good indeed but the middle of the pits had been baked too well to produce good regeneration.

159. *Kumri notes.*—Regeneration by the rab-cum-kumri method continues to spread and reports of successful work on quite a large scale come from many districts. Many variations of

species are being introduced by this method and below are listed some of the variations of the general method and species reported.

Guntur division.—*Casuarina equisetifolia* and field crop Korra (*Setaria italica*). *Acacia arabica* and various crops.

Chittoor division and Salem South division.—*Cassia auriculata* and various crops. The *Cassia* was however somewhat retarded by the defoliation of the caterpillar of a butterfly. The best of these kumris was raised with horsegram (*Dolichos biflorus*).

Chittoor division.—Bamboo kumris in a number of centres. Bamboo—*Cassia auriculata* kumri. The bamboo is introduced as internal and external demarcation lines. A number of species of crops were raised such as ragi (*Eleusine coracana*) redgram (*Cicer sp.* probably *arietinum*) horsegram (*Dolichos biflorus*) Castor (*Ricinus communis*). In addition Kollukattai grass (*Pennisetum cenchroides*) was also introduced after the field crops.

Madura division.—In this division the crown spread of the mature tree at the end of the fuel rotation averages 22' diameter. Therefore in kumri work the forest crop lines are raised 22' apart. Measurement of the 1935 kumri in A. Kombai series (Ayyalur range) showed that in January 1940 the forest crop was a complete crop 8' to 12' high with a crown spread of 8' to 10'. Thus nearly half of the 22' space between the lines had been covered up in the first few years of the kumri.

Cumbu (*Pennisetum typhoideum*) is not considered a good first-year crop as it is too high and is liable to be beaten on to the forest crop by wind and rain. It is however a satisfactory second-year crop.

Castor (*Ricinus communis*) appears to take too much out of the soil and forest crop to be spaced nearer than about 12'. It is best placed in the middle of the kumri strip and not near the forest crop lines.

160. *Notes on other species.*—*Bambusa polymorpha* is reported to be doing well in Salem North division.

Eucalyptus naudiniana is fair in Chittoor division.

Canthium didymum and *Pleurostyliia wightii* are being regenerated artificially in Chittoor division where they are important. These species both germinate well and *Pleurostyliia* stumps quite well but both species fade out later in the hot weather. We have not yet learned how to raise these species satisfactorily.

Shorea talura has been successfully raised by direct sowings in Salem North division and after two years shows 60 to 70 per cent survivals. It is however damaged by pig and growth though slow is encouraging. With this species Chittoor division reports fair success with its artificial regeneration and also successful natural regeneration by soil raking under parent trees. This operation resulted in the production of 5,759 seedlings under 89 trees (i.e.,

65 per tree), but it was noticed that the seedlings soon need more light than was necessary for successful germination and early development.

A number of districts report the successful raising of *Cassia auriculata* plantation both with and without kumri.

161. *Plantations for manure leaves.*—Regeneration of *Poinciana elata* by cuttings. In the past four 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 60 per cent to 75 per cent stocking at the end of the second growing season and looks very promising.

In consequence, in 1937 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 first of each month from June to October.

Results in January 1940 at the end of the second growing season together with those of the 1937 experiments are as follows:—

Locality.	Survival percentage of cuttings planted on				
	1st June 1938.	1st July 1938.	1st August 1938.	1st September 1938.	1st October 1938.
Emmanur Experimental Garden.	34	30	20	70	52
South Salem division	*..	*..	38	72	74
Average of 1938 experiments ..	34	30	29	71	63
Average of 1937 experiments ..	43	21	28	29	53
Average of 1937 and 1938 experiments	39	26	29	50	58

* Not done through lack of stock.

In the experiments on the best depth of planting, cuttings 4 feet long and 8 inches mid girth were planted on 30th June 1938 to 3 depths (a) 9 inches deep, (b) 18 inches deep and (c) 3 feet deep. Results in January 1940 together with those of the 1937 experiments are as follows:—

Locality.	Survival percentage of cuttings planted to depths of		
	9 inches.	18 inches.	3 feet.
Emmanur Experimental Garden.	36	62	52
South Salem division	44	54	37
Average of 1938 experiments ..	40	58	45
Average of 1937 experiments ..	10	31	47
Average of 1937 and 1938 experiments	25	45	46

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 1st July 1938. Results in January 1940 together with those of 1937 experiments were as follows:—

Locality.	Survival percentage of cuttings of the following sizes.		
	Big.	Medium.	Small.
Emmanur Experimental Garden.	76	34	6
South Salem division	56	42	8
Average of 1938 experiments ..	66	38	7
Average of 1937 experiments ..	63	10	1
Average of 1937 and 1938 experiments	65	24	4

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 September-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.

The experiments were repeated in 1939 and results in January 1940 were as follows:—

I. Best date of planting.

Locality.	Survival percentage of cuttings planted on				
	1st June 1939.	1st July 1939.	1st August 1939.	1st September 1939.	1st October 1939.
Emmanur Experimental Garden	4	14	48	78	82
South Salem division	40	72	100	100	88
Average	22	43	74	89	85

II. Best depth of planting.

Locality.	Survival percentage of cuttings planted to depths of		
	9 inches.	18 inches.	3 feet.
Emmanur Experimental Garden.	48	60	82
South Salem division	82	88	96
Average	65	74	89

III. Best size of cutting.

Locality.	Survival percentage of cuttings of the following sizes.		
	Big.	Medium.	Small.
Emmanur Experimental Garden.	40	18	8
South Salem division	84	78	28
Average	62	48	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 and 1938 experiments.

162. *Manure leaf plantations—district work.*—Several districts report the raising of manure leaf plantations. A typical list of species is that of Salem North division which is *Cassia siamea*, *Pongamia glabra*, *Poinciana elata*, *Cassia auriculata*, *Azadirachta indica*, *Anona squamosa*, and *Dodonaea viscosa*.

163. *Santalum album—comparison of sowing, transplanting and stump planting.*—Experiments in this subject have been done at Emmanur for the past two years and show the following results in survival percentage.

	Sowing.	Transplanting.	Stumping.
1938	17	33	19
1939	12	9	25
Average	15	21	22

In this connexion it should be noted that at Denkanikota in Salem North division for the purposes of spike research some 5,000 sandal plants are raised each year. This is invariably done by stump planting as under experimental garden conditions it gives the most certain results and the quickest growth. In this work another great advantage of stump planting is that if the shoot portion of the stump is left about 4 inches long the plant is in a fit state for artificial grafting at a very early age.

164. *Introduction of bamboos in dry districts.*—A great deal of work has been done during the year on the introduction of bamboos in a number of divisions on a large scale in the following types of areas:—

- Areas where bamboo has flowered and died and not regenerated itself well naturally;
- areas where bamboo is naturally either scanty or absent (and hence is valuable). Valuable introductions have been done not only in open forests but in rest house compounds and near subordinates quarters
- in *Lantana* areas to suppress the pest;
- in fire burned areas;
- in *Strobilanthes* area to reclaim them; and
- in sandal areas to increase the sandal host ratio and to make the sandal as resistant to spike disease as possible.

165. In general, results vary from about 50 to 90 per cent. The lessons learned in this work have been summarized by Chittoor division which reports:—

- One or two year old rhizome planting is much more successful and reliable than direct sowings. In 5 areas

taken together sowings averaged 41 per cent and rhizome planting 78 per cent success.

(b) If direct sowing is being done it is best to soak the seed for 48 hours in cold water before sowing. This causes much quicker germination and hence less damage by rodents.

(c) Areas liable to inundation and also sandy soil should be avoided.

(d) Sow or plant early in the south-west monsoon showers. This gives the plants a good start and allows for replacement of casualties in the north-east monsoon.

(e) Avoid getting plants from distant places. It is much better to have a nursery near the planting site because then we can make much better use of good planting weather. In getting plants from distant places one cannot regulate the date of arrival of the plants with the right state of the weather.

166. Chittoor division also discusses a local practice of regenerating bamboos by planting offsets. This is done by the local ryots with fair success. The offsets are made from the south-west monsoon culms of the previous year and they must have a bushy bunch of roots and a good rhizome. They are cut 5 feet long for *Dendrocalamus strictus* and 3 feet long for *Bambusa arundinacea*. They are planted in pits 1½ feet deep and usually two nodes are buried. Mature culms are ready about the fifth year. The possibilities of this method for *Lantana* and *Strobilanthes* areas are discussed by the division but its disadvantages are that the offsets will not stand a drought after planting unless watered; and unless they are made from young clumps they are liable to flower and die at an early age.

167. *Clear felling of bamboos*.—An experiment of clear felling bamboos was done in Vellore West division in 1935. The results of this experiment have been upset by the flowering and dying of the bamboos in the plot and its vicinity.

168. *Grass introduction*.—Several districts report the successful introduction of fodder grasses such as Kollukattai (*Pennisetum cenchroides*) and Nendra (*Ischnum luxm*).

Notable progress has been made in the introduction of such grasses with or just after the final crop in kumris.

169. *Live fences*.—Largely as a result of the deliberations of the Fodder and Grazing Committee and also because of the disappearance of the prickly-pear due to the cochineal bug a number of districts are interested in growing live fences.

Chittoor division reports good results with *Agave americana* and *Prosopis juliflora* but very poor results with *Euphorbia nerifolia*.

170. *Teak in dry districts*.—Several districts report the successful introduction of teak in small suitable areas in dry districts. This work is only possible in these districts in small areas near little hill streams and in moister pockets. Although such areas are small they are important and short rotation teak poles in such districts are a paying product. This work shows a stage of intensive utilization of the ground and follows on the advances made in recent years by the large scale introduction of rab and kumri work.

South Salem is one of the divisions developing this work and has already found that thinnings are remunerative at an early age.

171. *Soil working*.—Experiments in recent years in our good teak areas have shown that soil working by forking (the mis-called soil "aeration") is of great expense and very doubtful utility. In the past five 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.

172. 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 5 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 considerably 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 very much better at the end of the second growing season after sowing.

It should be noted that the operation of soil working is done in lines between the plants care being taken that the soil within 3 inches of each plant is not disturbed. The first operation is a scratching of the soil to a depth of about 1 inch to 2 inches and each further soil working proceeds deeper and slightly farther away from the plant line until a depth of about 9 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.

The abbreviated results of these experiments are given in the tables below. The results of the experiments of 1935, 1936, 1937 and 1938 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 1939 experiments 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 per cent.	Mean height in inches.	Survival per cent.	Mean height in inches.	
1935	29	15.7	48	31.5	Seven experiments and seven species.
1936	70	48.3	83	60.0	Two experiments and two species.
1937	59	31.8	71	34.6	Three experiments and three species.
1938	97	49.2	98	64.0	Four experiments and four species.
Average of 1935, 1936, 1937 and 1938 experiments.	64	36.3	76	49.0	Sixteen experiments with eight species over four years.

Measurements at the end of the first growing season after sowing (1939 experiments).

Species.	Control.		Soil worked.		Remarks.
	Survival per cent.	Mean height in inches.	Survival per cent.	Mean height in inches.	
<i>Acacia arabica</i>	100	29.2	100	30.5	Emmanur Experimental Garden experiments Nos. 250 to 253.
<i>Acacia ferruginea</i>	97	15.4	97	14.0	
<i>Cassia siamea</i>	97	17.4	99	20.6	
<i>Azadirachta indica</i>	93	7.1	99	7.7	
Average of all species	98	17.3	99	18.2	

The above figures show that soil working averaged over the four years of the experiments has produced by the end of the second growing season after sowing an increase in survival percentage of 12 per cent and in mean height growth of 35 per cent.

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

174. *Grassland catchment areas—General.*—The experiments started in 1934 to examine the possibility of reafforesting 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 grassland, 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 exceptionally difficult.

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.		Brook lands.	
Rainfall in inches from 1st April 1939 to 31st March 1940	58.13"		73.53"	
Number of rainy days	85		99	
First frosty night	25th Nov. 1939.		25th Nov. 1939.	
Lowest temperature on above date	30 degrees F.		29 degrees F.	
Last frosty night	24th Feb. 1940.		17th Mar. 1940.	
Lowest temperature on above date	32 degrees F.		32 degrees F.	
Total number of frosty nights during the period	56.		73.	
Lowest temperature recorded	22 degrees F.		16 degrees F.	
Date of above reading	16th Jan. 1940.		15th Jan. 1940.	

175. *Jacko's Nulla Experimental Garden No. 1.*—The work done in previous years has been summarised in the corresponding annual reports. In general the observations reported in last year's annual report have received further confirmation.

The following statements give an idea of the stocking in this garden at present.

Of the sowings, transplants, stumps and cuttings put in in 1938 and previous years, we have the following survivals in April 1940:—

	PER CENT.		PER CENT.
(i) Transplants—			
<i>Casuarina montana</i>	42	<i>Symplocos foliosa</i>	14
<i>Cupressus torulosa</i>	36	<i>Rapanea wightiana</i>	5
<i>Cupressus macrocarpa</i>	46	<i>Acacia dealbata</i>	35
<i>Zizyphus incurva</i>	13	<i>Acacia mollissima</i>	
<i>Eugenia arnottiana</i>	9	(South Africa)	47
<i>Neolitsaea zeylanica</i>	9		

	PER CENT.		PER CENT.
(i) Transplants—cont.		(ii) Stumps and cuttings—cont.	
<i>Acacia decurrens</i> (South Africa)	33	<i>Berberis tinctoria</i> ..	48
<i>Acacia baileyana</i> ..	64	<i>Buddleia variegata</i> ..	61
<i>Litsea wightiana</i> ..	5	<i>Morus indica</i> (Ootacamund origin)	41
<i>Viburnum erubescens</i> ..	16	<i>Morus indica</i> (Planted in Nilambur. Cuttings taken from there and planted in gardens ..	36
<i>Ligustrum neilgherrense</i> ..	57	<i>Morus indica</i> (Punjab origin)	28
<i>Hakea saligna</i> ..	65		
<i>Juniperus procera</i> ..	10	(ii.) Direct sowings—	
<i>Cinnamomum wightii</i> ..	12		
<i>Rhododendron arboreum</i> ..	8		
<i>Mahonia leschenaultii</i> ..	37		
<i>Meliosma wightii</i> ..	33		
<i>Eurya japonica</i> ..	34		
<i>Pinus longifolia</i> ..	54		
<i>Pinus insignis</i> ..	51		
(ii) Stumps and cuttings—			
<i>Acacia melanoxylon</i> ..	21		
<i>Acacia dealbata</i> ..	10		
<i>Mahonia leschenaultii</i> ..	20		
<i>Casuarina montana</i> ..	3		
<i>Glochidion neilgherrense</i> ..	11		
<i>Viburnum erubescens</i> ..	7		
<i>Symplocos foliosa</i> ..	26		
<i>Cinnamomum wightii</i> ..	24		
<i>Litsea wightiana</i> ..	9		
<i>Eurya japonica</i> ..	2		
<i>Rubus moluccanus</i> ..	43		
<i>Rubus lasiocarpus</i> ..	27		
<i>Hypericum mysorense</i> ..	29		

Of the sowings, transplants, stumps and cuttings put in in 1939, we have in April 1940 the following:—

	PER CENT.		PER. CENT.
(i) Transplants—		(i) Transplants—cont.	
<i>Casuarina montana</i> ..	50	<i>Litsea wightiana</i> ..	13
<i>Pinus longifolia</i> ..	55	<i>Symplocos foliosa</i> ..	16
<i>Pinus insignis</i> ..	29	<i>Viburnum erubescens</i> ..	7
<i>Eugenia arnottiana</i> ..	3	<i>Rapanea wightiana</i> (Myrsine)	24
<i>Ligustrum neilgherrense</i> ..	16		
<i>Callitris rhomboidea</i> ..	23	(ii) Stumps—	
<i>Hakea saligna</i> ..	29	<i>Acacia dealbata</i> ..	24
<i>Acacia decurrens</i> (South Africa)	33	<i>Acacia mollissima</i> (South African origin) ..	51
<i>Acacia mollissima</i> (South Africa)	36	<i>Ilex wightiana</i> ..	20
<i>Mahonia leschenaultii</i> ..	41	<i>Vaccinium leschenaultii</i> ..	17
<i>Cupressus macrocarpa</i> ..	35	<i>Acacia melanoxylon</i> ..	41
<i>Meliosma wightii</i> ..	24	<i>Mahonia leschenaultii</i> ..	48
<i>Cinnamomum wightii</i> ..	34	<i>Morus indica</i> tall cuttings (Nilambur)	53
<i>Neolitsa zeylanica</i> ..	17	<i>Glochidion neilgherrense</i> ..	24

	PER CENT.		PER CENT.
(ii) Stumps—cont.		(ii) Stumps—cont.	
<i>Symplocos foliosa</i> ..	25	<i>Cinnamomum wightii</i> ..	28
<i>Litsea wightiana</i> ..	11	<i>Rhododendron arboreum</i> ..	14
<i>Neolitsa zeylanica</i> ..	14	<i>Eurya japonica</i> ..	10
<i>Meliosma wightii</i> ..	20	<i>Viburnum erubescens</i> ..	7
<i>Daphniphyllum glaucescens</i> ..	14	<i>Photinia notoniana</i> ..	12
<i>Rapanea wightiana</i> (Myrsine)	47		

NOTE.—Treatment with "Feradix" of stumps and cuttings of *Acacia decurrens* gave no significant difference in sprouting or survival.

	Number of plants.		Number of plants.
(iii) Sowings—		(iii) Sowings—cont.	
<i>Mahonia leschenaultii</i> ..	62	<i>Cupressus torulosa</i> ..	48
<i>Eugenia arnottiana</i> ..	29	<i>Pinus insignis</i> ..	29
		<i>Pinus longifolia</i> ..	37

On about 50 per cent of this plot, we have succeeded in establishing a crop of *Citrus scoparius*. Under this we have in 1939 put in various species. The idea is that the broom (*Citrus*) will serve by itself as a sufficient protection against frost, without any other comparatively costly frost protection. In general the operation has been successful. We have succeeded in raising through the frost the following:—

	PER CENT.		PER CENT.
(i) Stump plants—		(ii) Transplants—	
<i>Neolitsa zeylanica</i> ..	15	<i>Pinus insignis</i> ..	40
<i>Litsea wightiana</i> ..	8	<i>Litsea wightiana</i> ..	31
<i>Photinia notoniana</i> ..	57	<i>Neolitsa zeylanica</i> ..	28
<i>Glochidion neilgherrense</i> ..	48	<i>Zizyphus incurva</i> ..	38
<i>Cinnamomum wightii</i> ..	53	<i>Ligustrum neilgherrense</i> ..	68
<i>Rhodomyrtus tomentosa</i> ..	4	<i>Cinnamomum wightii</i> ..	44
<i>Rapanea wightiana</i> (Myrsine)	84		

Eucalyptus maculata (1937 transplants) 9 survivals, tallest 20 feet.

(iii) Direct sowings—

Eucalyptus ficifolia and *Eugenia arnottiana* have given fair results.

In general it may be said that as a result of the past work this experimental garden is now well stocked. The garden was extended during 1939 by adding 0.8 acre. In this extension slightly larger scale experiments are being done with *Acacia decurrens*, *Acacia mollissima*, *Quercus incana*, and transplants and stumps of most of the shola species enumerated above. Though the results are so far encouraging it is premature to report results.

176. *Jacko's Nulla Experimental Garden No. 2.*—The fifteen patches opened in the district experimental garden in 1937-38 have been maintained. No covering against frost was done during the year. All the *Eugenia arnottiana* plants have suffered from frost. This species has in all cases proved rather disappointing, as it is easily frosted in spite of the most careful covering, and even if saved, is exceedingly slow in growth, requiring protection against frost for a longer period than the other plants tested. Survivals in April 1940 were as follows:—

	PER CENT.		PER CENT.
(i) Transplants—		(ii) Stumps and cuttings—cont.	
<i>Hakea saligna</i> ..	96	<i>Mahonia leschenaultii</i> ..	79
<i>Cupressus macrocarpa</i> ..	73	<i>Rubus lasiocarpus</i> ..	30
<i>Acacia melanoxylon</i> ..	49	<i>Hypericum mysorense</i> ..	8
<i>Acacia dealbata</i> ..	64	<i>Buddleia variegata</i> cuttings ..	23
(ii) Stumps and cuttings—		<i>Morus indica</i> cuttings (Nilambur) ..	55
<i>Acacia dealbata</i> ..	54		
<i>Acacia melanoxylon</i> ..	61		

Though the plot has not reached a stage for statistical measurements, the following information is of interest.

General height in feet of some of the species in Jacko's Nulla Experimental Garden No. 2:—

Species—	Height in feet.	Species—cont.	Height in feet.
<i>Buddleia variegata</i> ..	4	<i>Hypericum mysorense</i> ..	3
<i>Acacia dealbata</i> ..	8	<i>Rubus lasiocarpus</i> ..	4
<i>Acacia melanoxylon</i> ..	6	<i>Mahonia leschenaultii</i> ..	3
<i>Hakea saligna</i> ..	5	<i>Cupressus torulosa</i> ..	5

The achievement of the above percentages and heights in just over two years in this frosty region indicates that we have evolved a satisfactory technique for the afforestation of these grassland catchment areas.

177. *Brooklands Experimental Gardens.*—The work was continued with such changes as further experience has suggested. In this garden we have experiments in raising various species by the three methods in worked patches in the open, but covered by pandals during the frosty season, raising species similarly under the cover of the broom that we have artificially established, and raising species similarly under cover of *Acacia dealbata* that has come in naturally because of our protection, and *Acacia dealbata* that we have artificially established. One corner of this plot receives a very severe frost and every attempt except with conifers has been so far a failure. Here transplants of *Pinus insignis*, *Pinus longifolia*, and *Cupressus torulosa* and direct sowings of *Pinus longifolia* and *Cupressus torulosa* alone appear hopeful.

Survivals in April 1940 of transplants stumps and cuttings planted in 1938 and previous years in open beds (protected during the frosty weather by bracken, etc.) are as follows:—

	PER CENT.		PER CENT.
(i) Transplants—		(ii) Stumps and cuttings—	
<i>Callitris rhomboidea</i> ..	19	<i>Mahonia leschenaultii</i> ..	30
<i>Cupressus macrocarpa</i> ..	40	<i>Eugenia arnottiana</i> ..	1
<i>Acacia melanoxylon</i> ..	30	<i>Acacia dealbata</i> ..	19
<i>Acacia dealbata</i> ..	27	<i>Acacia melanoxylon</i> ..	2
<i>Acacia decurrens</i> (South Africa) ..	58	<i>Viburnum erubescens</i> ..	14
<i>Acacia mollissima</i> (South Africa) ..	4	<i>Eurya japonica</i> ..	5
<i>Eugenia arnottiana</i> ..	2	<i>Rapanea wightiana</i> (Myrsine) ..	3
<i>Pinus longifolia</i> ..	31	<i>Litsaea wightiana</i> ..	3
<i>Pinus insignis</i> ..	38	<i>Casuarina montana</i> ..	7
<i>Symplocos foliosa</i> ..	4	<i>Symplocos foliosa</i> ..	2
<i>Litsaea wightiana</i> ..	3	<i>Cinnamomum wightii</i> ..	5
<i>Hakea saligna</i> ..	36	<i>Daphniphyllum glaucescens</i> ..	3
<i>Ligustrum neilgherrense</i> ..	6	<i>Photinia notoniana</i> ..	4
<i>Rhododendron arboreum</i> ..	5	<i>Rubus moluccanus</i> ..	36
<i>Cupressus torulosa</i> ..	17	<i>Rubus lasiocarpus</i> ..	28
<i>Cinnamomum wightii</i> ..	5	<i>Hypericum mysorense</i> ..	34
<i>Neolitsea zeylanica</i> ..	9	<i>Berberis tinctoria</i> ..	36
<i>Daphniphyllum glaucescens</i> ..	3	<i>Morus alba</i> (Nilambur) ..	16
<i>Photinia notoniana</i> ..	3	<i>Morus indica</i> (Nilambur) ..	57
		<i>Buddleia variegata</i> ..	29

(iii) Sowings done in 1938 and previous years have given *Hakea saligna* 308 plants; *Acacia melanoxylon* 137; *Acacia dealbata* 237; *Mahonia leschenaultii* 11; *Acacia decurrens* (South Africa) 572; *Acacia mollissima* 232; *Pinus longifolia* 168; and *Acacia baileyana* 28; but it should however be noted that direct sowing in the gardens is wasteful of seed in practically all cases.

Survivals in April 1940 of transplants stumps and cuttings planted in 1939 in open beds, which were protected during the frosty season by bracken, etc., are as follows:—

	PER CENT.		PER CENT.
(i) Transplants—		(ii) Stumps and cuttings—cont.	
<i>Pinus insignis</i> ..	45	<i>Acacia mollissima</i> (South Africa) ..	31
<i>Pinus longifolia</i> ..	35	<i>Viburnum erubescens</i> ..	8
<i>Cinnamomum wightii</i> ..	7	<i>Neolitsea zeylanica</i> ..	10
<i>Neolitsea zeylanica</i> ..	14	<i>Cinnamomum wightii</i> ..	10
<i>Ligustrum neilgherrense</i> ..	5	<i>Litsaea wightiana</i> ..	11
<i>Litsaea wightiana</i> ..	8	<i>Mahonia leschenaultii</i> ..	44
<i>Casuarina montana</i> ..	22	<i>Symplocos foliosa</i> ..	10
<i>Symplocos foliosa</i> ..	8	<i>Rapanea wightiana</i> (Myrsine) ..	14
<i>Acacia decurrens</i> (South Africa) ..	37	<i>Glochidion neilgherrense</i> ..	23
<i>Acacia mollissima</i> (South Africa) ..	32	<i>Meliosma wightii</i> ..	5
(ii) Stumps and cuttings—		<i>Morus indica</i> (Nilambur, Tall cuttings) ..	28
<i>Eugenia arnottiana</i> ..	3		
<i>Photinia notoniana</i> ..	8		

(iii) Sowings done in 1939 have given *Quercus incana* 7 plants; *Eugenia arnottiana* 12; *Pinus longifolia* 113; *Cupressus macrocarpa* 200; *Callitris rhomboidea* 200; *Mahonia leschenaultii* 15; and *Juniperus procera* 15 plants.

Survivals in April 1940 of transplants and stumps, planted under the protection of the artificially introduced broom are as follows:—

	PER CENT.	(ii) Stump plants—	PER CENT.
(i) Transplants—			
<i>Litsaea wightiana</i> ..	52	<i>Litsaea wightiana</i> ..	42
<i>Cupressus torulosa</i> ..	67	<i>Symplocos foliosa</i> ..	54
<i>Symplocos foliosa</i> ..	32	<i>Mahonia leschenaultii</i> ..	58
<i>Mahonia leschenaultii</i> ..	50	<i>Cinnamomum wightii</i> ..	45
<i>Cinnamomum wightii</i> ..	42	<i>Neolitsea zeylanica</i> ..	64
<i>Neolitsea zeylanica</i> ..	56	<i>Rapanea wightiana</i> ..	72
<i>Rapanea wightiana</i> ..	52	(Myrsine) ..	6
(Myrsine) ..	..	<i>Eugenia arnottiana</i> ..	..
<i>Acacia mollissima</i> (South Africa) ..	35		
<i>Pinus insignis</i> ..	52		

Survivals in April 1940 of transplants planted under the protection of *Acacia dealbata* (mostly root suckers, which have established themselves in the garden, as a result of the protection against fire and grazing).

	PER CENT.		PER CENT.
<i>Litsaea wightiana</i> ..	46	<i>Symplocos foliosa</i> ..	17
<i>Mahonia leschenaultii</i> ..	50	<i>Neolitsea zeylanica</i> ..	74
<i>Cinnamomum wightii</i> ..	11	<i>Pinus longifolia</i> ..	15

The above results indicate that we have reasonable prospects of success in afforesting these grass lands provided the conditions are not too severe. The indications are that the area must be rigorously protected against fire, grazing and such damage. Fencing and fire protection are necessary. All grass must be dug up and removed, so that there is no root competition and the plants to be introduced should be put in as transplants or stump plants, and in a very few cases as cuttings. Though direct sowing does give fair results it is wasteful of seed, and doubtful. It is possible to give the beds protection against frost artificially, but in the long run it will be more economical to raise host plants first. Experiments indicate that *Citrus scoparius* is pre-eminently the best host plant to raise, and it can be raised by direct sowing, about two years previous to introducing the tree species. *Acacia dealbata* is also fairly satisfactory as a nurse, though it is not so good as Broom. As for the species to be introduced, some of the local shola species can be successfully raised by transplanting entire plants and stump plants, the method depending on the species; but exotics such as the Wattles, Pines, Cupresses, grow better, faster and can be established at a smaller cost.

178. *Regeneration of tree species in patches of natural gorse.*—In paragraph 204 of the annual report for 1938-39 it was stated that *Gaultheria* had proved itself unsatisfactory, and patches of natural broom of sufficient extent did not exist. Hence the experiments started in trying tree species under patches of natural gorse have been continued; and one small broom patch under which *Hakea saligna* was planted in the year 1937-38 has also been continued.

Under the Gorse (*Ulex europaeus*), of the plants put in in 1938-39 we have the following survivals.

	PER CENT.		PER CENT.
<i>Symplocos foliosa</i> ..	55	<i>Hakea saligna</i> ..	5
<i>Neolitsea zeylanica</i> ..	46	<i>Eugenia arnottiana</i> ..	47
<i>Cupressus macrocarpa</i> ..	28	<i>Photinia notoniana</i> ..	47
<i>Cinnamomum wightii</i> ..	27		

Under the gorse, of the plants put in in 1939-40, we have the following survivals. In one of the patches *Photinia notoniana* 70 per cent; in another patch we have *Neolitsea zeylanica* 65 per cent.

The indications are that natural gorse serves as a good protection against frost, and after the frosty season, plants which received overhead light thrive better than those under shade. It should however be remembered that as gorse burns fiercely in a fire, rigorous fire protection of such areas is essential if we are to succeed in using it as a natural nurse.

179. *Willows—Salix alba* var. *saxatilis*.—Sets of this species were got from England in 1935. In spite of the very adverse conditions that these sets have gone through some are still alive. They are existing but not flourishing. It should however be noted that this cannot be considered a fair trial of the species.

Salix babylonica.—Trials with this species have been made since 1936. It has been found to be rather particular with regard to soil conditions and although it stands periodic flooding quite well yet it needs a well drained soil and will not tolerate dryness or stagnation. It is fairly frost hardy. Small cuttings about 2 feet long appear to do best.

Salix tetrasperma.—This local willow is very tolerant of soil conditions, is frost hardy, and is very successful from small sets about 2 feet long, planted with about two-thirds of their length in the ground.

180. *Mulberry*.—Experiments with *Morus alba* and *Morus indica* were continued. This species, planted by cuttings, is fairly frost tender and is difficult to protect successfully by artificial means. It is not killed outright but only as far as ground level and sprouts again after the frost. When planted under a natural nurse such as broom this frosting back only occurs to a very small extent.

181. *Rhododendron* plot.—The experimental plot to study the effect of protection of *Rhododendron* from fire and grazing where it occurs scattered in grass land was continued. Enumerations and measurements since 1936 show that more clumps have appeared in the plot and that the average diameter of the tallest shoot per clump has steadily increased. The number of shoots per clump has decreased. The plot has thus definitely advanced.

182. *Tan barks*.—Experiments in growing the wattles including *Acacia decurrens* and *Acacia mollissima* from South Africa were continued. Direct sowing of both species has been successful in experiments in the Nilgiris in spite of heavy frosts.

Phenological observations and the habits of these species are being observed and recorded. Evidence of the hybridization of *Acacia decurrens* and *Acacia dealbata* is growing year by year and now appears reasonably definitely established.

Small scale experiments of treating stumps and cuttings of *Acacia decurrens* with the plant hormone seradix A failed to produce significant results.

183. *District work*.—Work was done with *Acacia decurrens* in a number of districts. The Nilgiris and Palnis each raised some 30 to 40 acres which survived the frost with 50 per cent to 90 per cent stocking. In the Palnis direct sowing was very successful with an expenditure of approximately 1 lb. of seed per acre. In the Nilgiris direct sowing was not nearly so successful as transplanting. This work shows that on a district scale the species is comparatively easy to raise. It is gratifying to note that the conclusions drawn in the pamphlet written by the Assistant Silviculturist on wattle planting some two years ago are being borne out in practice. The germination and plant percentage of the seed is turning out better than was anticipated and it appears that the possible difficulties of the work mentioned in the pamphlet were rather overestimated.

Wattle planting failed in several districts including Vizagapatam and Kollegal. This was to be expected and it is again emphasized that wattle is unlikely to be successful in South India at an elevation lower than about 5,000 feet.

(vii) TENDING, THINNING, CLEANING, ETC.

184. *Weeding practice—Teak plantations*.—The investigation into weeding methods, their effects and costs in teak plantations in areas having a west coast type of climate has been concluded, written up and published in Indian Forest Records (New Series) Silviculture—Vol. IV, No. 2.

It should be noted that these results on weeding practice showing 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 171 to 173.

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.

185. *Effect of thinning teak coppice shoots*.—In Experimental Plot No. 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 one shoot per stool,
- (B) reduction to two shoots per stool,
- (C) reduction to four shoots per stool, and
- (D) control, unthinned.

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

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

The growth of the coppice can be judged by the table below, which is the abstract of measurements taken when the coppice was seven years old. It remains to be seen which treatment will give the greatest money yield at the end of the rotation (30 years). There is however a definite indication that the coppice should be thinned to two shoots per stool. The shoots of more than two per stool are rapidly dying off.

Treatment.	Number of shoots per stool left.	Type of shoot considered.	Number of stems.	Mortality of shoots.	Average height in feet.	Average diameter in inches.
				PER CENT		
A	1	Biggest	33	3	26.0	4.4
B	2	Biggest	35	7	26.2	4.2
		Second biggest	31		21.3	3.0
C	4	Biggest	33	11	27.6	3.0
		Second biggest	33		22.5	2.9
		Remainder	59		16.9	2.0
D	Unthinned	Biggest	33	20	28.2	4.3
		Second biggest	32		23.1	2.8
		Remainder	137		13.7	1.5

186. *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 plantation and hence quickly spot centres of *Calycopterus floribunda* (a climbing pest at Nilambur) in their initial stages, and
- (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 No. 151) was laid out in the 1937 plantation at Walluvasseri and it was pruned in May 1938 at one year old.

In February 1940, i.e., at the end of two growing seasons after treatment, it was found that the control trees had put on a height increment during the two years of 13.4 feet per tree as compared with the 11.7 feet per tree of the treated plots. An enumeration of branches showed that the control had 7.4 branches per stem.

The experiment was repeated in 1938 plantation at the same centre (Nilambur Experimental Plot No. 158). At the end of the first growing season after treatment, in this plot the controls had put on a height increment of 8.7 feet per tree as compared with the 8.1 feet per tree of the treated plots. An enumeration of branches showed that the control had 5.9 branches per stem as compared with the 3.0 branches per stem of the treated plots.

The treatment has thus definitely not produced any increase in height growth and its usefulness must be judged from other aspects.

187. The work on the pruning of teak plantations was further extended by Experimental Plot No. 154 of Nilambur which was laid out last year in a plantation of 1934. The object of the plot is to determine the efficacy or otherwise of pruning in teak and to compare the effects of pruning up to the crown at the time of first thinning and at the time of the first and third thinnings with an unpruned control. Results will be assessed by a saw-mill analysis of the timber produced in another 20 to 25 years.

188. *Effect of pruning young Swietenia macrophylla.*—An experiment (Experimental Plot No. 135 of Nilambur division) was started in 1935 to determine whether the pruning of eight-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 ten years old was heavily thinned and has been converted into a sample plot. It is 0.15 acre in extent and contains 46 stems with an average height of 47 feet and an average diameter at breast height of 6.0 inches. Its age is now 13 years.

189. *Loranthus in teak plantations.*—Experiments were carried out at Dhoni and Nilambur to test the efficacy of the current district practice of cutting the pest at the time of thinning.

The pest was identified by the Forest Botanist, Dehra Dun, as *Loranthus longiflorus* Desp. var. *falcata*. It flowered and fruited from May to December.

The branches affected by the pest (which were under observation) were cut one foot above the pest in mid March to mid April, laid in the middle of the nearest fire line and observed daily. They were completely dried up in ten days and did not flower or fruit after cutting. The pest did not re-appear on the cut ends of the branches.

Hence this method of dealing with the *Loranthus* appears to be satisfactory.

190. *Thinning research—Teak.*—The plots at Nilambur and in the Wynaad the objects of which are to determine (a) the best date of first thinning, (b) the best intensity of thinning and (c) the best periodicity of thinning in teak plantations of different qualities were maintained.

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 reduced as far as possible to normality 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 six sample plots, three 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 at 4 years old and each of these thinnings was 50 per cent. It is probable that all these plots (both treated and control) will receive a further 50 per cent thinning about August 1940.

191. *Tending to increase the sandal/host ratio and to introduce spike resistance imparting hosts—Santalum album.*—Chittoor division again reports the successful thinning out of too profuse natural sandal combined with the removal of "susceptible" hosts and the introduction of resistance imparting hosts such as bamboos and *Cassia siamea*.

The operation was successful and inexpensive and at 2 years old the *Cassia siamea* was thinned and realized appreciable revenue as manure leaf.

(vii) MIXTURES—Nil.

(ix) UNDERPLANTING.

(a) Teak plantations.

192. *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.

Two new plots were laid out at Nilambur during the year and were established successfully. They are Experimental Plot No. 155 with *Dendrocalamus longispathus* and Experimental Plot No. 156 with *Swietenia macrophylla*. They were both planted under 8-year old teak. The Mahogany was established by dense line planting as this has been shown to be the best way of establishing the species.

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

Experi- mental plot num- ber.	Species.	Date of under- planting.	Age of teak at under- plant- ing.	Survival per cent of under- planted crop.	Mean height growth in Jan- uary 1940.	Incre- ment during the year.
			YEARS.	PER CENT.	FEET.	FEET.
NILAMBUR DIVISION.						
98	<i>Swietenia macrophylla</i>	.. 1930	37	5	10.2	+ 2.9
102	Do.	.. 1930	37	6	5.6	+ 0.7
158	Do.	.. 1930	8	91	5.5	+ 5.5
99	<i>Cedrela toona</i>	.. 1930	37	23	8.5	+ 1.1
103	Do.	.. 1930	37	13	7.6	+ 0.0
101	<i>Bambusa arundinacea</i>	.. 1930	37	85	26.2	+ 10.4
100	<i>Cephalostachyum pergracile</i>	.. 1930	37	74	15.0	+ 0.5
104	Do.	.. 1930	37	53	42.6	+ 2.6
105	Do.	.. 1931	38	100	46.4	+ 4.8
106	Do.	.. 1931	38	73	43.8	+ 3.1

Experi- mental plot num- ber.	Species.	Date of under- planting.	Age of teak at under- plant- ing.	Survival per cent of under- planted crop.	Mean height growth in Jan- uary 1940.	Incre- ment during the year.
			YRS.	PER CENT.	FEET.	FEET.
WYNAAD DIVISION.						
8	<i>Cephalostachyum pergracile</i> ..	1932	33	84	20.2	+
NILAMBUR DIVISION.						
138	<i>Hopea parviflora</i> ..	1929	..	68	11.1	+ 1.7
145	<i>Bambusa polymorpha</i> ..	1937	6	98	12.5	+ 6.9
PALGHAT DIVISION.						
159	<i>Bambusa polymorpha</i> ..	1937	7	94	4.7	+ 3.3
NILAMBUR DIVISION.						
155	<i>Dendrocalamus longispathus</i> ..	1939	8	100	3.2	+ 3.2

193. In addition to the above, a further plot was laid out in 1937 at Nilambur (Experimental Plot No. 146). This is of *Cephalostachyum pergracile* which was raised by the district by direct sowing in 1929 under teak which was at that time 27 years old and varies from 1st to 2nd quality. The plot is 100 per cent stocked with the bamboo which has an average height of 55 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.

194. *Under-planting under shade.*—Palghat division Experimental Plots Nos. 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 16 years old and measure in mean height *Mesua* 6.25 feet and *Calophyllum* 6.95 feet showing a height increment during the year of 0.47 feet and 0.61 feet respectively.

Nine similar plots which were laid out in 1937 at Chandanathode (Wynaad division) in old experimental gardens were remeasured. Details of these plots are as follows:—

Experi- mental plot number.	Species.	Canopy.	Age.	Average height in inches.	Height incre- ment during the year.
			YRS.		
WYNAAD DIVISION.					
42	<i>Mesua ferrea</i> ..	Full evergreen cover.	8	33.0"	+ 3.6"
43	<i>Artocarpus hirsuta</i> ..	Do.	8	38.5"	+ 5.4"
44	<i>Gluta travancorica</i> ..	Do.	7	59.7"	+ 15.4"
45	<i>Hopea parviflora</i> ..	Top canopy only	6	118.7"	+ 32.4"
46	<i>Artocarpus hirsuta</i> ..	Do.	6	94.7"	+ 25.7"
47	<i>Cedrela toona</i> ..	Do.	6	63.6"	+ 2.4"
48	<i>Gluta travancorica</i> ..	Do.	6	91.4"	+ 24.5"
49	<i>Swietenia macrophylla</i> ..	Do.	5	81.6"	+ 19.3"
50	<i>Dipterocarpus indicus</i> ..	Do.	6	60.6"	+ 15.6"

It should be noted that Experimental Plot No. 49 has suffered 65 per cent casualties during the last two years due to the mahogany collar borer.

195. *Regeneration of evergreens after clearfelling.*—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 No. 27, Wynad division, was started in 1935 and was regenerated in 1936. It has the following treatments for the regeneration of evergreens :—

- (A) Clearfelling and burning—no cover crop.
- (B) Clearfelling and burning—with cover crop.
- (C) Clearfelling—no burning—no cover crop.
- (D) Clearfelling—no burning—with cover crop.
- (E) Felling all but the undergrowth—no burning.

Measurements at the end of January 1940 at the end of the fourth 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—no cover crop.		Burn—no 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.
		INS.		INS.		INS.		INS.		INS.	
1 <i>Artocarpus hirsuta</i> .	Stumps, 0.3"/0.4"	29	19.9	23	27.5	24	19.3	17	23.4	43	11.6
2 <i>Saccolenia macrophylla</i> .	Transplants, 22"	11	45.8	2	47.8	2	27.0	7	40.9	63	38.3
3 <i>Hopea parviflora</i> .	Sowing	85	37.4	80	24.4	81	18.1	67	18.3	97	15.7
4 Do.	Transplants, 22"	82	51.7	82	50.8	83	33.9	83	30.5	78	49.2
5 <i>Cedrela toona</i> ..	Cuttings, 18"	10	39.4	24	35.3	7	36.7	15	25.3	17	74.4
6 Do.	Stumps, 0.2"/0.3"	9	45.6	14	41.3	3	45.7	8	25.4	20	63.0
7 <i>Chikrasia tabularis</i> .	Stumps	11	30.6	7	31.8	1	15.5	10	24.7	8	42.2
8 <i>Dipterocarpus indicus</i> .	Transplants, 31"	13	72.1	12	53.3	3	65.5	5	66.5	10	41.9
9 <i>Dysoxylum malabaricum</i> .	Transplants, 13"	2	41.3	3	46.0	1	49.0	1	18.0	7	24.5
10 <i>Mesua ferrea</i> ..	Transplants, 14"	14	57.6	12	49.0	1	46.0	7	49.7	22	21.8
Average of all species together.		27	44.1	23	41.3	21	36.0	22	32.9	37	33.3

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.

196. A similar experiment (Experimental Plot No. 70, South Coimbatore division) was started in 1937 in Karianshola and promises to be successful. Results are given in the following table at the end of the third 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 of Chandanathode.

Species.	Stock used.	No burn—no cover crop.		Burn—no cover crop.		No burn—no cover crop.		Burn—no 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.
		INS.		INS.		INS.		INS.		INS.	
<i>Hopea parviflora</i> ..	Transplants, 31"	82	14.5	62	11.7	92	10.8	98	10.4	88	10.5
<i>Saccolenia macrophylla</i> .	Transplants, 30"	92	66.0	91	70.8	93	61.2	97	64.8	96	81.6
<i>Mesua ferrea</i> ..	Transplants, 61"	10	7.7	9	9.0	85	11.2	89	10.9	16	8.6
<i>Paltaquium ellipticum</i> .	Transplants, 51"	15	5.3	4	6.5	83	9.5	85	8.8	16	6.0
<i>Artocarpus hirsuta</i> .	Stumps, 0.4"/0.8"	95	44.4	87	46.8	93	25.2	97	30.0	74	25.2
<i>Hopea parviflora</i> ..	Sowing	42	4.8	41	3.9	9	5.2	91	5.3	85	5.2
<i>Cedrela toona</i> ..	Cuttings 10"	87	70.8	90	66.0	62	62.4	69	63.6	73	97.2
Average of all species		60	30.5	55	30.7	86	26.5	89	27.8	64	33.5

197. *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 Karianshola and Chandanathode, evergreens do much better under top canopy shade than after clearfelling 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 worthwhile 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 Wynaad) and Karianshola (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 Karianshola gets 62 inches each year and this is fairly evenly distributed between the two monsoons (vide paragraph 268 for rainfall statement).

198. *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 No. 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 randomized lines and 4 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.
- IV. Complete evergreen shade.

Durnig 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 } II (slightly more than top canopy).
Hopea parviflora }
Gluta travancorica III (slightly less than full evergreen shade).

The experiment was repeated in 1936 using three shade conditions—

- I. Clearfelling,
- II. Top canopy.
- III. Full evergreen shade.

and is showing similar results.

199. *Direct sowing—Best date (under top canopy only).*—Experiments were done at each of two centres. In Chandanathode Experimental Garden, Experiments Nos. 177 to 179, *Acrocarpus fraxinifolius*, *Cedrela toona* and *Swietenia macrophylla* were experimented with.

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

In Karianshola Experimental Garden, Experiments Nos. 137, 139 and 140, *Mesua ferrea*, *Swietenia macrophylla* and *Acrocarpus fraxinifolius* were experimented with. All three species showed late May as the best date 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 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 279.)

200. *Entire transplanting—Best date (under top canopy only).*—Nine experiments with seven 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> .	Early September.
	<i>Swietenia macrophylla</i> .	
	<i>Hardwickia pinnata</i> .	
	<i>Chikrassia tabularis</i> .	

Bischofia javanica and *Mesua ferrea* showed little preference over the period. In Karianshola, *Swietenia macrophylla*, *Hopea parviflora*, and *Calophyllum elatum* all showed mid-June to early July.

It is thus seen that in general (in confirmation of previous years' results) the heavy rain of 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. In occasional years transplanting before this period of heavy rain is successful as was the case last year at Karianshola—

Chandanathode Experimental Garden Experiments Nos. 180 to 185.

Karianshola Experimental Garden Experiments Nos. 147 to 149.

(For full experimental data see paragraph 280.)

201. *Stump planting—Best date (top canopy only).*—Three experiments were done at Chandanathode and four at Karianshola to find the best date for stump planting of *Cedrela toona*, *Artocarpus hirsuta*, *Chickrassia tabularis* 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 mid-June.

Chickrassia at Chandanathode and *Artocarpus* and *Acrocarpus* at Karianshola however both did reasonably well in mid-July which was after the period of heavy rain—

Chandanathode Experimental Garden Experiments Nos. 186 to 188, Karianshola Experimental Garden Experiments Nos. 141 to 144.

(For full experimental data, see paragraph 281.)

202. *Comparison of sowing, transplanting small medium and large transplants, and stumping with small and large stumps (under top canopy cover).*—Thirty-six experiments were done with 15 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 *Artocarpus integrifolia*, stumping was best for *Artocarpus hirsuta* while for *Acrocarpus fraxinifolius*, *Aglala roxburghiana*, *Balanocarpus utilis*, *Chickrassia tabularis*, *Gluta travancorica*, *Mangifera indica*, *Bischofia javanica*, *Cedrela odorata*, *Cedrela toona*, *Swietenia macrophylla*, *Hopea parviflora*, *Mesua ferrea* and *Michelia champaca* transplants do best.

203. 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>Aglala roxburghiana</i>	..	..	..	..	6
<i>Artocarpus integrifolia</i>	..	..	..	..	10 (but sowing best).
<i>Artocarpus hirsuta</i>	..	..	..	..	10 (but stumps best),
<i>Acrocarpus fraxinifolius</i>	..	..	..	..	12 (but sowing best).
<i>Balanocarpus utilis</i>	..	..	..	..	12
<i>Bischofia javanica</i>	..	..	..	..	12
<i>Calophyllum elatum</i>	..	..	..	..	8
<i>Cedrela odorata</i>	..	..	..	..	8
<i>Cedrela toona</i>	..	..	..	..	12
<i>Chickrassia tabularis</i>	..	..	..	..	6
<i>Dysoxylum malabaricum</i>	..	..	..	..	12
<i>Gluta travancorica</i>	..	..	..	..	8 (does well—if basketed).
<i>Hopea parviflora</i>	..	..	..	..	6 to 12
<i>Mangifera indica</i>	..	..	..	..	14
<i>Mesua ferrea</i>	..	..	..	..	10
<i>Michelia champaca</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 282.)

204. *Transplanting (under top canopy cover)—Comparison of natural forest seedlings and nursery transplants.*—Experiments Nos. 108 and 110 of Karianshola Experimental Garden were remeasured. In Experiment No. 108 with *Mesua ferrea* nursery transplants had succeeded better than forest transplants while in experiment 110 with *Hopea parviflora* the reverse was the case.

In 1939, 4 experiments with 3 species *Calophyllum elatum*, *Aglala roxburghiana* and *Palaquium ellipticum* were done at Karianshola and at Chandanathode.

Measurements at the end of the first growing season after planting (in January 1940) 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 283.)

205. *Comparison of direct sowing, entire transplanting with naked transplants and basketed plants (under top canopy only).*—At Chandanathode and Karianshola, three experiments of 1938 were remeasured and two new experiments were started in 1939 in this subject.

In all these five experiments, with the species *Dysoxylum malabaricum*, *Valeria indica* and *Dipterocarpus indicus*, the basketed plants are doing the best, showing a much higher survival percentage and a generally greater height increment 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 Nos. 138, 141 and 167 and Karianshola Experimental Garden Experiments Nos. 124 and 154.

(For full experimental data see paragraph 284.)

206. *Comparison of stumps and cuttings from nursery transplants and natural forest trees (under top canopy only).*—In Chandanathode experiment 156 and Karianshola experiments 113, 114, 155 and 156 stumps and cuttings from nursery transplants and natural forest seedlings and trees were compared for the species *Cedrela toona*, *Chickrassia tabularis* and *Cedrela odorata*.

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

With *Chickrassia 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.

With *Cedrela odorata* cuttings made from nursery seedlings proved the best of the 3 methods of propagating the species.

(For full experimental data see paragraph 285.)

207. *The attempted raising of exotics in evergreen forest—Araucaria cunninghamii.*—In 1936 seedlings of *Araucaria cunninghamii* 18 months old which had been in bamboo tubes for 10 months and which were 2 inches to 6 inches high were planted out at Karianshola under the top canopy cover.

In January 1940 these plants showed a survival percentage of 90 per cent and a mean height of 5.5 feet having put on a height increment of +2.2 feet during the year. The species is however very tender to damage by deer.

208. *Chlorophora excelsa.*—At Chandanathode in 1938 two experiments were done in raising this species by stump planting. Stumps of (a) 0.2 inch to 0.3 inch diameter and (b) 0.4 inch to 0.5 inch diameter (made from 1 year old nursery seedlings) were planted, (i) under top canopy cover and (ii) after clear felling evergreens. In both cases the larger stumps have done 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.

209. *Artificial regeneration of the more tender species under top canopy cover.*—A certain amount of difficulty has been experienced in the artificial regeneration of some of the more tender of the evergreen species. Top canopy cover has been found to be the most suitable light condition but at the same time expensive methods such as basketing have had to be used.

During the year an experiment was started at Karianshola in which a cover crop of *Tephrosia candida* in lines has been grown under top canopy cover and the more tender evergreens introduced in between the *Tephrosia* lines.

This experiment so far shows great promise but it is of course too early to judge results.

(Karianshola Experimental Garden Experiment No. 163.)

(x) SILVICULTURAL SYSTEMS—Nil.

(xi) MISCELLANEOUS.

(a) *Sandal spike disease research.*

210. *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, Salem North Division, in consultation with the Conservators of Forests, Salem and Ootacamund Circles. The entomological works were carried out on the lines suggested by the Entomologist, Forest Research Institute, Dehra Dun.

Work during the year was somewhat restricted by the Research Ranger, Denkanikota, being on deputation at Dehra Dun and Ranchi from May 14th, 1939 to November 29th, 1939 to study the entomology of the sandal spike suspected insects and lac cultivation and products.

Progress was also made during the year in re-establishing co-operation in this work with the Mysore Forest Department and the Indian Institute of Science, Bangalore.

211. *I. Nature and spread of the disease.*—It is again brought to notice that spike spread from an infected area is usually of two kinds. Firstly there is radial spread. This is the commonest type and is fairly continuous and often very rapid. Secondly there is *isolated distant* spread. This is comparatively rare and consists of what may be termed new outbreaks at a distance from the infected area. These are generally within a few miles of the main area and only a very few trees are affected at a time. They occasionally occur many miles away from the nearest known spike. They are presumed to be caused by abnormal wind currents (such as wind devils), etc., transporting a single insect or a few infected insects to a distance.

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.

216. *Insect group transmission cages at Kenilworth Castle area.*—In accordance with Dr. Beeson's suggestions, the ten cages at Kenilworth Castle were allotted to different species or groups of insects as detailed below:—

1 cage for *Pentatomidae* and *Cercopidae*.

1 Do. *Capsidae*.

1 Do. *Fulgoridae*.

1 Do. *Jassidae*, and

6 cages for individual *Jassids*.

The change of plants was effected once in two months. The releases are tabulated:—

Period of exposure.	Natural order.	Species.	Number of healthy plants exposed.	Number of insects released.	Days of release.	Date of defoliation of plants.	Number defoliated.
10th March to 10th May 1939.	<i>Jassidae</i>	..	3	635	49/61	10-12	3
10th May to 10th July 1939.	Do.	..	3	544	47/62	10-2	3
11th July to 10th September 1939.	Do.	..	3	758	52/62	10-4	3
10th September to 10th November 1939.	Do.	..	3	601	48/62		
12th November 1939 to 11th January 1940.	Do.	..	3	278	48/61		
11th January to 11th March 1940.	Do.	..	3	314	44/60		
10th March to 10th May 1939.	Do.	<i>Nesdarius scutellatus</i> .	3	74	35/61	10-12	3
10th May to 10th July 1939.	Do.	Do.	3	33	20/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	27	18/62	10-4	3
10th September to 10th November 1939.	Do.	Do.	3	3	3/62		
10th March to 10th May 1939.	Do.	<i>Moonia albimaculata</i> .	3	46	22/61	10-12	3
10th May to 10th July 1939.	Do.	Do.	3	92	38/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	37	23/62	10-4	3
10th September to 10th November 1939.	Do.	Do.	3	20	14/62		
12th November 1939 to 11th January 1940.	Do.	Do.	3	15	12/61		
11th January to 11th March 1940.	Do.	Do.	3	14	9/60		
12th November 1939 to 11th January 1940.	Do.	<i>Nirvana pallida</i> .	3	223	44/61		
11th January 1940 to 11th March 1940.	Do.	Do.	3	183	45/60		
12th November 1939 to 11th January 1940.	Do.	<i>Nirvana suturalis</i> .	3	233	49/61		
11th January to 11th March 1940.	Do.	Do.	3	145	45/60		
12th November 1939 to 11th January 1940.	Do.	<i>Deltacephalus</i> sp.	3	88	28/61		
11th January to 11th March 1940.	Do.	Do.	3	34	18/60		
10th May to 10th July 1939.	Do.	<i>Nirvana longitubinolis</i> .	3	121	27/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	230	40/62	10-4	3
10th September to 10th November 1939.	Do.	Do.	3	184	41/62		
12th November 1939 to 11th January 1940.	Do.	Do.	3	115	30/61		

Period of exposure.	Natural order.	Species.	Number of healthy plants exposed.	Number of insects released.	Days of release.	Date of defoliation of plants.	Number defoliated.
11th January to 11th March 1940.	<i>Jassidae</i>	<i>Nirvana longitubinolis</i> .	3	121	34/60		
3rd March to 10th May 1939.	Do.	<i>Nephotettix bipunctatus</i> .	3	50	21/61	10-12	3
10th March to 10th May 1939.	Do.	<i>Nephotettix apicalis</i> .	3	194	44/61	10-12	3
10th May to 10th July 1939.	Do.	Do.	3	185	28/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	193	30/62	10-4	3
10th September to 10th November 1939.	Do.	Do.	3	183	33/62		
10th March to 10th May 1939.	Do.	<i>Nephotettix</i> sp.	3	246	42/61	10-12	3
10th May to 10th July 1939.	Do.	Do.	3	266	28/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	243	30/62	10-4	
10th September to 10th November 1939.	Do.	Do.	3	319	32/62		
10th March to 10th May 1939.	Do.	(New J type not identified).	3	116	32/61	10-12	3
10th May to 10th July 1939.	Do.	<i>Eutettix</i> sp.	3	144	37/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	242	45/62	10-4	3
10th September to 10th November 1939.	Do.	Do.	3	207	42/62		
12th November 1939 to 11th January 1940.	Do.	Do.	3	180	43/61		
11th January to 11th March 1940.	Do.	Do.	3	42	17/60		
10th March to 10th May 1939.	<i>Pentatomide and Cercopidae</i> .	<i>Pentatomide and Cercopidae</i> .	3	518	49/61	10-12	3
10th May to 10th July 1939.	Do.	Do.	3	341	47/62	10-2	3
10th September to 10th November 1939.	Do.	Do.	3	1,025	51/62		
12th November 1939 to 11th January 1940.	Do.	Do.	3	833	50/61		
11th January to 11th March 1940.	Do.	Do.	3	753	48/60		
11th July to 10th September 1939.	<i>Pentatomide</i> .	<i>Pentatomide</i> .	3	720	53/62	10-4	3
10th March to 10th May 1939.	<i>Fulgoridae</i> .	<i>Fulgoridae</i> .	3	297	47/61	10-12	3
10th May to 10th July 1939.	Do.	Do.	3	286	47/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	238	52/62	10-4	3
10th September to 10th November 1939.	Do.	Do.	3	210	48/62		
12th November 1939 to 11th January 1940.	Do.	Do.	3	265	46/61		
11th January to 11th March 1940.	Do.	Do.	3	143	45/60		
10th March to 10th May 1939.	<i>Capsidae</i> .	<i>Capsidae</i> .	3	55	24/61	10-12	3
10th May to 10th July 1939.	Do.	Do.	3	68	32/62	10-2	3
11th July to 10th September 1939.	Do.	Do.	3	122	45/62	10-4	3
10th September to 10th November 1939.	Do.	Do.	3	47	24/62		
12th November 1939 to 11th January 1940.	Do.	Do.	3	55	23/61		
11th January to 11th March 1940.	Do.	Do.	3	9	8/60		

No transmission of the disease or of suspicious symptoms took place, in these cages.

217. *Group transmission cages at Denkanikota and Javalagiri.*—Twenty-seven group experiments with individual families were carried out at Denkanikota 5 experiments in each group of *Jassidae*, *Pentatomidae*, *Fulgoridae* and *Membracidae* 4 experiments with *Lygaeidae* and a single experiment in each family of *Cercopidae*, *Capsidae* and *Aphididae*.

At Javalagiri centre, 29 group experiments 5 in each of *Fulgoridae*, *Membracidae* and *Jassidae*, 8 in *Lygaeidae* and 6 in *Pentatomidae* were done.

No case of transmission occurred in either centre.

218. *Transmission experiments with individual species of insects.*—The work carried out during the year with individual species is summarized below:—

In *Jassidae*, 20 species, viz., *Neodartus scutellatus*, *Neodartus acocephaloides*, *Jassid* sp., *Divus bipunctatus*, *Tettigoniella* sp., *Jassus indicus*, *Jassus pauperculus*, *Ledramutica*, *Ledropsis* sp., *Moonia albimaculata*, *Idiocerus clypealis*, *Petaloccephala granulosa*, *Nephotettix bipunctatus*, *Nephotettix apicalis*, *Nirvana* sp., *Eutettix* sp., *Penthimia subniger*, *Typhlocyba* sp., *Orosius* sp. and *Cicadula* sp. have been tested in 47 experiments, 18 at Denkanikota utilizing 550 insects from 9 in *Orosius* sp. to 327 in *Moonia albimaculata* and 29 experiments at Javalagiri utilizing 1,236 insects from 3 in *Ledra mutica* to 606 in *Moonia albimaculata*. The number of experiments has varied from 1 to 8 comprising in all 1,786 individuals of *Jassidae*, 550 at Denkanikota and 1,236 at Javalagiri. Four Experiments with *Neodartus acocephaloides*, 1 with *Jassus pauperculus* and 1 with *Petaloccephalus granulosa* to which fair trials were given previously were again carried out.

In *Pentatomidae*, 9 species, viz., *Hotea nigrorufa*, *Potca* sp., *Pentatomid* sp., *Nezara viridula*, *Nezara* var *torquata*, *Sastragala heterospila*, *Dolichoris indicus*, *Brachycerocoris camelus*, have been tested in 23 experiments 10 at Denkanikota utilizing insects from 2 (in *Sastragala heterospila*) to 94 (in *Hotea nigrorufa*), and 13 experiments utilizing insects from 4 (in *Sastragala heterospila*) to 23 (in *Nezara viridula*). The number of experiments per species has varied from 1 to 3 comprising in all 860 individuals of *Pentatomids* 310 at Denkanikota and 550 at Javalagiri.

In *Fulgoridae*, 7 species, viz., *Brahmaloka fletcheri*, *Saliza* near *partite*, *Tambinia verticalis*, *Coinquinda nigrorufa*, *Saliza* sp., *Eurybrachys tomentosa* and *Fulgorid* sp. have been tested in 17 experiments, 8 at Denkanikota utilizing 277 insects from 23 (in *Tambinia verticalis*) to 117 (in *Brahmaloka fletcheri*) and 9 experiments at Javalagiri utilizing 416 insects from 20 (in *Brahmaloka fletcheri*) to 175 (in *Tambinia verticalis*). The number of experiments

per species has varied from 1 to 3 comprising in all 693 individuals of *Fulgoridae*, 277 at Denkanikota and 416 at Javalagiri.

In *Membracidae*, 3 species, viz., *Tricentrus transversus*, *Coccosterphus tuberculatus*, and *Oxyrhachis mangiferana* have been tested in 11 experiments, 6 at Denkanikota utilizing 125 insects for 3 experiments with *Tricentrus transversus* and 153 insects for 3 experiments with *Coccosterphus tuberculatus* and 5 experiments at Javalagiri utilizing 90 insects for 4 experiments with *Tricentrus transversus* and 9 insects for 1 experiment with *Oxyrhachis mangiferana*.

In *Lygaeidae*, 3 experiments at 1 for each of the species *Aphanus sordidus*, *Cletus bipunctatus* and *Graptostethus serrus* utilizing 24, 3 and 11 insects respectively at Javalagiri centre only.

Similarly at Javalagiri centre 2 experiments with *Lucinatus punctatus* of *Capsidae* comprising 57 and 48 insects, 1 experiment with 16 insects of *Poophilus costalis* of *Cercopidae* 1 experiment with 46 individuals of *Letana inflata* of *Tettigoniidae* have also been carried out.

No positive results were obtained in any of the above experiments.

219. *Transmission of suspicious symptoms.*—Suspicious symptoms appeared on one plant fed with *Flatta ferrugata*—*Fulgoridae* on 29th June 1939 but the plant subsequently returned to normal before any grafting tests were made.

All plants reported to have had suspicious symptoms as a result of feeding with different species of insects during 1938-39 have returned to their normal healthy state.

220. *Experiments with Aphids, thrips and Red spiders.*—One experiment with 47 individuals of Red spider at Javalagiri and one experiment with *Aphids* at Denkanikota were carried out with no positive results.

221. *Transmission experiments with insects collected from field crops.*—The association of cultivation with almost all cases of isolated spike infection suggests that the vector is possibly a species not entirely dependent on a forest environment but is able to exist in localities containing little sandal or other tree growth. A careful examination of such associated cultivated areas has also revealed the existence of other plant virus diseases. The insect fauna was collected in such localities from field crops adjoining newly spiked areas and the collections made from January to May 1939 have been analysed and identified by Dehra Dun the details of which are given below:—

A total of 972 insects in 187 species have been caught. The *Jassidae* is represented by 232 specimens in 26 species of which *Acropona walkeri*, *Bythoscopus indicus*, *Jassus pauperculus*, *Neodartus acocephaloides*, *Petaloccephala*

granulosa and *Petaloccephala nigrilinea* form 73 per cent of the total. The above six species have been experimented with for transmission tests in the past.

The remaining 20 species are poorly represented in individual numbers, but some of the suspected vectors like *Eutettix* sp., *Deltoccephalus* sp., *Thamnotettix* sp. are present.

With the exception of *Bella apicalis*, *Goniagnathus*, *Nehela bimaculicollis*, *Paralimnus confusus*, and *Selanocephalus disparatus*, the rest have been obtained in the sticky paper catches.

The list of insects collected from January to May 1939 identified by Dehra Dun Institute will be found in paragraph 287 in Part II of this report.

Transmission experiments with the insects collected in field crops will be done in the future as opportunity occurs.

222. Insect collections in the Denkanikota potculture plot.—

The potculture experiments were started in 1929 and although diseased and healthy plants have remained side by side for 11 years no natural case of spike transmission has occurred in the area indicating that the fauna present are not likely to be the vectors. In past years insect collections were made in the area periodically and such of those species found suspected from the collections done in diseased areas but found in the potculture were eliminated as of no primary importance.

During the year collections made from April to July 1939 were identified at Dehra Dun. One hundred and thirty-six species in 444 specimens were caught. In the *Jassids* 15 specimens in April, 29 in May, 9 in June, and 22 in July, in all 75 belonging to 20 species were found. The list will be found in paragraph 286 of Part II. All these species were among those already collected in the area and eliminated from the list of suspects. The indication is that the fauna in the plot has not changed appreciably in the last few years.

223. Insect collections by different methods.—All the earlier work of insect transmission was done on the hypothesis that the vector was probably a species commonly found on sandal. Later deductions eliminated mandibulate groups and admitted the possibility of uncommon species of sucking groups. The conclusion arrived at from previous experiments was that the vector was likely to be a species not commonly collected on sandal and not necessarily permanently associated with it. Into such a group (of *Jassids*) fall our present suspects. The next difficulty that arose was to collect a large number of individuals of such uncommon species. Different methods suggested by the Imperial Entomologist were tried during the year.

224. Insect collections from different levels.—(a) On the ground, (b) at bush height, and (c) at tree height. The collections were done only once during the year between the 10th and 21st July 1939 and were identified by Dehra Dun. One hundred and eleven

species have been caught at tree height, 222 at ground level and 406 at bush height; in all 739 specimens. Among the *Jassids* 40 specimens in 15 species have been obtained at tree height, 46 specimens also in 15 species at bush height, and 76 specimens in 12 species (of which 46 are of *Chiasmus* sp.) have been got at ground level. This confirmed the previous indication that height is no great factor in the quantity or quality of the yield in *Jassid* species. These collections gave 5 new genera and 3 new species, viz., *Aglaia* sp., *Chiasmus* sp., *Dinomachus* sp., *Doratulina* sp., *Goniagnathus* sp., *Leofa* sp. and *Paralimnus confusus*, *Parabolacratulus arcuata* and *Selanocephalus disparatus* indicating that our current methods of collection are not sufficiently successful.

225. Collection of insects by light attraction.—While at Dehra Dun the research ranger carried out collection trials with different coloured lights under the guidance of Dr. Beeson. The colours used were yellow, white (ordinary uncoloured electric light), day, light blue, and neon lights. The following were the results:—

- (a) Yellow light did not attract any insects.
- (b) Ordinary bright light attracted a large number of insects but only a few species of *Jassids*.
- (c) Day light blue attracted a large number of different species of insects including 15 species of *Jassids*. The difficulty experienced was that the bulb got so hot that the mortality of insects was very high. This coloured light has been largely used by the United States Department of Agriculture. A 200-watt day light blue gave 28 species of *Empoasca* sp. consisting of 10,695 females and 17,276 males.
- (d) The neon light attracted almost all *Jassids* attracted by the day light blue with an increased numerical strength.

The *Jassids* (and especially the suspects) were not obtained in large numbers. The light and other traps can however be used as additional accessories to collect and increase certain types of *Jassids*. To collect all suspects in large numbers two practical methods have been suggested—

- (i) To mark a number of more or less isolated groups of host plants with and without sandal, e.g., 10 to 15 groups of sandal associated with *Canthium didymum*, 10 to 15 groups of sandal with *lantana*, etc. The insect fauna on these individual species should be collected separately and examined. The presence of nymphs of any *Jassid* species will indicate that the particular species is its main food plant as the nymphs have generally got no tendency for migration. If the food plants for various species are established in this manner, when any species is required in large numbers for experimental purposes, collections can be concentrated on its food plants.

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(ii) The second method is to collect the species and breed them in cloth sleeves in the potculture pot on its favourite hosts or food plants.

226. *Further identification work.*—The research ranger when he was at Dehra Dun got all the specimens of insects incriminated in the transmission of spike in the mass infection cages at Denkanikota and Javalagiri identified and a complete list is given in paragraph 288 of Part II.

III. Control of spike disease.

227. This is dealt with under two main headings, viz., (a) prevention and (b) cure of which prevention is more important than curative treatments under field conditions.

The experiments under prevention aim mainly at improving the sandal forests by the provision of suitable hosts which build up resistance in sandal against the disease and at increasing the host sandal ratio both qualitatively and quantitatively where necessary.

Isolation of resistant strains also forms part of the work.

Building up resistance due to the association of host plants is termed "Acquired resistance" and is worked out by raising sets of sandal plants in combination with each species not experimented already under controlled conditions in pots at the potculture plot at Denkanikota, infecting them artificially with a normal dose of spike tissue and working out the percentage of spike infection.

In this connexion 17 species, namely, *Ocimum sanctum*, *Toddalia aculeata*, *Chloroxylon swietenia*, *Carissa carandas*, *Atalantia monophylla*, *Miliusa eriocarpa*, *Olea glandulifera*, *Bambusa arundinacea*, *Acacia auriculiformis*, *Terminalia arjuna*, *Breynia rhamnoides*, *Strychnos potatorum*, *Semecarpus anacardium*, *Pithecolobium dulce*, *Gyrocarpus jacquini*, *Strychnos nux vomica* and *Melia indica* were raised during 1938-39 as detailed in the last Administration Report. The plants were not suitable for grafting during the year under report. In these combinations attempts are made to repeat the experiments with hosts which give more than 50 per cent resistance as often as possible to confirm the results already obtained.

The second stage of this experiment is to raise all these combinations of sandal with various species of hosts on big earth mounds in the field in a diseased area at Javalagiri, exposing them to natural infection prevalent in the area and working out the percentage of resistance imparted by each host.

This removes effectively all factors uncommonly introduced in the work done under controlled conditions and gives us a practical field average. The number of combinations that got spiked on mounds during the year is detailed below:—

<i>Terminalia arjuna</i>	..	..	3/25	<i>Canthium didymum</i>	..	..	3/25
<i>Murraya koenigii</i>	..	..	12/25	<i>Anogeissus latifolia</i>	..	..	1/25
<i>Premna tomentosa</i>	..	..	5/25	<i>Chloroxylon swietenia</i>	..	..	1/25
<i>Ixora parviflora</i>	..	..	3/23				

Other combinations with *Memecylon edule*, *Bambusa arundinacea*, *Melia indica*, *Erythroxylon monogynum*, *Strychnos nux vomica* and *Semecarpus anacardium* continue healthy. Some of the plants in old mounds where sandal had grown quite big and made attachments with various hosts outside the mounds got the infection suggesting the necessity to work the optimum proportion of resistant and susceptible hosts to maintain the parasite free from infection.

In accordance with the Chief Conservator's orders, in order to make the results of these experiments carried out for the past ten years available to the District and Working Plans Officers a short note on the hosts most suitable for sandal was prepared by the Provincial Silviculturist and circulated to all district officers.

228. *Practical application of the acquired resistance in the forest.*—In the forest it is impossible to ensure that a sandal tree has only a particular species as a host and in consequence, in order to try and test the applicability of the above work to practical forestry a large-scale experiment was started with 5-acre sub-plots in the line of spread of a virulent form of the disease. In this experiment three treatments were used—

(A) Resistant hosts retained, susceptible hosts removed and further resistant hosts introduced.

(B) Susceptible hosts retained, resistant hosts removed and further susceptible hosts introduced.

(C) Control plots—no treatment.

After seven years the proportion of manifestation of the disease was

A : B : C : 0 : 32 : 12.

At the present time after nine years the proportion is A : B : C : 1 : 6 : 4.

This well demonstrates the benefit obtained by such operations.

229. *Autogenic resistance.*—The term is applied to sandal plants which resist spike in spite of artificial infection introduced in 4 normal doses at intervals of one per year. The plants which resisted 4 infections were planted in a virulently diseased area exposed to natural infection, in Javalagiri Reserved Forest. During the year there was a high mortality among these plants due to natural causes and only 14 out of 75 plants planted in 1937, 22 out of 75 plants planted in 1932 in Javalagiri Reserved Forest and 9 out of 10 planted in 1932 in Sanamavu Reserved Forest (a healthy area) are now healthy. The interval of about 8 years from the date of planting to the end of the current year during which the grafted plants planted in Sanamavu Reserved Forest

continuing perfectly healthy functioning normally in all their physiological activities indicates that the virus introduced has not remained dormant in the plants but has been destroyed or made innocuous by virtue of some constituent present in the plants.

Among the plants planted in the spike area at Javalagiri Reserved Forest, 6.6 per cent of those planted in 1932 and 9.3 per cent of those planted in 1937 are spiked so far, indicating that even autogenic resistance manifested by the species is not a *real immunity* but only a comparative resistance. The behaviour of the progeny got from such plants is being studied.

230. *Peculiar strain of sandal*.—The parent plant in Noganur Reserved Forest which continued to remain healthy in a virulently spiked area for over 10 years is dead. Two plants of the parent type have been raised in the potculture plot and a dozen plants under the parent tree in the Reserved Forest. One of the potted plants is now suitable for artificial infection.

Recently the Working Plans Officer, Madanapalle, reported a similar case. This was found from the morphological characters to be apparently the same peculiar strain as that of Noganur Reserved Forest. Arrangements have been made to watch its behaviour and test its transmissibility if any by grafting.

231. *Attempts to build up resistance by sub-lethal doses of infection*.—All the plants 24 in number referred to in last year's report were divided into four sets in April 1939, 6 were infected with a normal dose, 6 with half a normal and 6 with quarter of a normal dose, keeping the remaining six as controls.

The plants have been defoliated recently to see if any of them manifest the disease.

232. *Injection experiments*.—These experiments were continued but there is nothing definite to report about them.

(b) *Cure and control of spike.*

233. As a practical result of the rather academic work done for many years in studying spike disease a method of control of new outbreaks was worked out some years ago. This was described in Indian Forest Records (New series) Silviculture Vol. III No. 7 "A note on the control and eradication of new outbreaks of the spike disease of sandal" by the Research Ranger, Denkanikota and the Provincial Silviculturist.

These measures were intended to deal with new outbreaks only and were never meant to be applied to old large areas of disease except under very special circumstances. An explanatory note of this aspect of the work was prepared during the year by the Provincial Silviculturist and circulated by the Chief Conservator of Forests to all district officers.

The essence of this control work is speed and thoroughness in removing the sources of infection and this is perfectly possible in the case of new outbreaks.

The two general methods of spread of the disease have been discussed in paragraph 211.

234. A typical example of these methods of spread and of the effect of control operations is that of our experimental spike control area, in Denkanikota Reserved Forest. Its history is as follows :—

Spike was first noticed in 1926 when 5 acres were affected. The disease was allowed to spread unchecked until 1932-33 when vigorous control measures were adopted not only in the forest area but also in 25 acres of patta land adjoining it. The lopping in the first application of the control measures showed the infected area to be then about 350 acres. There was no other spike near and we were thus dealing with one large source of infection.

Since then we have had five isolated distant outbreaks which were easily checked. They were :—

1934	One tree at a distance of	..	Half a mile.
1935	Seven trees		2½ miles.
	One tree		Half a mile.
1936	Four trees		2½ miles.
1937	One tree		2 miles.

Slight radial spread occurred in 1938 and 1939 which has increased the main area by about 45 acres.

Thus in six years when the disease was allowed to spread unchecked it increased from 5 acres to 350 acres and in eight years under control measures all new distant outbreaks were easily controlled and eradicated and the main area only increased from 350 acres to 395 acres. The cause of this start of radial spread six years after the application of control measures are under investigation.

235. *Technique to identify disease-masking trees*.—One of the sources of infection in a spike area is that of disease-masking trees. Our great difficulty is that these cannot be recognized until they cease to be disease masking and actually manifest the disease. In control operations all trees suspected of being possibly disease masking are lopped in order to force out the symptoms of the disease if any. This although effective in a comparatively short time is expensive and involves the lopping of very many trees that eventually turn out to be healthy.

Under the direction of Dr. Beeson, the Research Ranger while at Dehra Dun, did a number of experiments with both infra red and ultra violet light in order in endeavour to obtain a method of identification of disease-masking tissue.

These experiments showed that work in this subject is unlikely to lead to results of practical value.

236. IV. General.—Experiments in electro culture.—In February 1939 experiments were started to determine whether treatment by electro-culture was likely to be beneficial in work on this disease.

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 was treated.
- (b) In order to determine whether it can cure spike in the disease masking stage, a set of plants was 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 electro culture as a preventive measure, a set of healthy plants was treated and then grafted with spiked tissue.
- (d) A further set of healthy plants was treated to see whether the treatment caused any marked beneficial effects in height, girth, foliage, etc.
- (e) A fifth set of healthy plants was 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.

Under (a) two plants died, one plant became borer attacked, and in the remainder the disease progressed normally thus showing that the treatment had not cured the disease.

Under (b) disease has manifested itself in some of the disease-masking plants thus showing that the treatments had not cured the disease even when in its early stages.

Under (c) spike has developed in some of the plants thus showing that the treatment has not had any effect as a preventive measure.

Under (d) and (e) the general appearance and development of the treated plants is better than that of the controls but the differences are not significant.

There thus does not appear to be any indication that this method of approach is worth continuing further.

237. Annual spike infection.—As in 1938-39, the annual spike infection was worked out by selecting 100 healthy sandal plants and defoliating them in April 1939.

Those that showed the disease were rejected and fresh plants were taken and infection for the year recorded.

In April 1940, the plants were again defoliated and watched for complete infection during 1939-40.

The spike infection worked out on the above basis in different localities from 1937 is tabulated :—

Year.	Per cent of spike infection.			Results.
	Aiyur.	Javalagiri.	Naganur.	
1937-38	4	35	Not started.	
1938-39	4	87	82	
1939-40 (up to March 1940).	5	7	12	Complete figures will be available only in May 1940.

(b) Periodicity of height growth.

238. 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.

(i) Chandanathode.

239. All species grew fairly steadily throughout the year, but growth was more appreciable in the cases of *Hopca parviflora* and *Dipterocarpus bourdillonii* during October and November 1939 than the remainder of the period. *Cedrela toona* exhibited a spurt of growth during February 1940. April 1939 and March 1940 were periods of comparative quiescence.

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

In addition to the above species a new set of periodicity measurements was started in October 1939 for the following species :—

<i>Acrocarpus fraxinifolius</i> .	<i>Chickrassia tabularis</i> .
<i>Aglaiia roxburghiana</i> .	<i>Gluta travancorica</i> .
<i>Artocarpus hirsuta</i> .	<i>Hardwickia pinnata</i> .
<i>Balanocarpus utilis</i> .	<i>Mangifera indica</i> .
<i>Bischofia javanica</i> .	<i>Mesua ferrea</i> .
<i>Cedrela odorata</i> .	<i>Palaquium ellipticum</i> .

Of these species, *Acrocarpus fraxinifolius*, *Aglaiia roxburghiana*, *Artocarpus hirsuta*, *Balanocarpus utilis*, *Cedrela odorata*, *Hardwickia pinnata* and *Palaquium ellipticum* exhibited practically no growth through the period. *Mesua ferrea* required more casualty replacements than the other species. The best increment through practically the entire period was exhibited by *Artocarpus integrifolia*, *Bischofia javanica*, *Chickrassia tabularis*, and some increment during the latter half of the period by *Gluta travancorica* and *Mangifera indica*. Even for these species, the rate of growth has been exceedingly slow.

(ii) Karianshola.

240. In Karianshola experimental garden No. 2 all species were quiescent up to the middle of April, when growth began. Growth was in general very active from June to September. October was a period of comparatively slow growth while it was

followed by fairly rapid growth in November and the first half of December. Growth, slowed down through January 1940, until rest was exhibited in early February 1940.

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

In Karianshola Experimental Garden Experiments Nos. 131 to 136 study of the periodicity of height growth has been continued. All species grew fairly steadily from April to September. October was a month of comparative quiescence; November and December again exhibited rapid growth. Through January growth slowed down, till in early February 1940, growth practically stopped. *Bischofia javanica* has exhibited particularly rapid growth through the periods mentioned. *Artocarpus hirsuta* and *Vateria indica* ranked second.

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

B. Mixed Deciduous Forests.

(i) Nilambur.

241. Teak grew actively from early April to the middle of January. From the middle of January it was a period of comparative rest. The most active growth was from the middle of June to the middle of December.

Swietenia macrophylla exhibited active growth in April, May, end of August, September, to the middle of December, the end of January, and early February. The graphs indicate that, in general, plants in the 6 feet by 6 feet espacement give consistently a more uniform height growth increment than the 3 feet by 3 feet espacement or than the 9 feet by 9 feet espacement. For all the three espacements the most active growth was in April-May 1939, and the middle of September to early December 1939. In addition the 6 feet by 6 feet espacement exhibited short periods of activity in June 1939, the end of August 1939 and the latter half of January and early half of February 1940.

Pterocarpus dalbergioides exhibited active growth from early April to the middle of June 1939 and a period of comparatively slower growth from the middle of July to the end of November 1939.

Bambusa polymorpha exhibited vigorous growth during July August, September and November 1939, with a short spurt of growth in January 1940. Towards the end of February 1940 rest commenced.

Species.—*Tectona grandis*, *Swietenia macrophylla*, *Pterocarpus dalbergioides* and *Bambusa polymorpha*.

In addition to the above, observations on periodic height increment have been commenced on *Tectona grandis* in taungya and non-taungya areas, on *Dendrocalamus longispathus*, and *Swietenia macrophylla*, in November 1939. As we have not yet got a full year's measurements for these, it is premature to draw conclusions.

(ii) Kannothe.

242. All species grew throughout the period from early April 1939 to the end of February 1940 and very vigorous growth was exhibited from July to early December 1939. *Bambusa* exhibited very vigorous growth during June and July, followed by a period of fairly vigorous growth from August to December. By early March all species had come to rest.

Species.—*Artocarpus hirsuta*, *Bambusa polymorpha*, *Dalbergia latifolia*, *Pterocarpus dalbergioides*, *Pterocarpus marsupium*, *Swietenia macrophylla*, *Tectona grandis*, *Terminalia crenulata* and *Terminalia paniculata*.

In addition to the above a new series of periodic height measurements of the following species have been started at Kannothe :—

Species.—*Artocarpus integrifolia*, *Balanocarpus utilis*, *Cassia siamea*, *Cedrela toona*, *Chlorophora excelsa*, *Dendrocalamus longispathus*, *Hopea parviflora*, *Lagerstroemia flos reginae*, *Lagerstroemia lanceolata*, *Mangifera indica*, *Pterocarpus dalbergioides*, *Swietenia macrophylla*, *Tectona grandis* and *Terminalia crenulata*.

The series of periodic height measurements started in October 1938 was continued. All the species showed very vigorous height growth during the period from April 1939 to December 1939. By the end of January 1940 most species had come to rest.

Species.—*Artocarpus hirsuta*, *Chlorophora excelsa*, *Lagerstroemia flos reginae*, *Lagerstroemia lanceolata*, *Schleichera trijuga*, *Swietenia macrophylla*, *Tectona grandis*, *Terminalia paniculata* and *Trema orientalis*.

Bamboos.—*Bambusa arundinacea*, *Bambusa polymorpha*, *Dendrocalamus brandisii* and *Dendrocalamus strictus*.

A new series has been started in October 1939.

Species.—*Mangifera indica* and *Artocarpus integrifolia*.

(iii) Dhoni.

243. The new series of periodic height measurements started in October 1938, were continued during the year. All species exhibited growth from early April to early January, when a period of comparative quiescence supervened.

The species exhibiting fastest growth were *Tectona grandis*, *Lagerstroemia lanceolata* and *Trema orientalis*.

Species.—*Artocarpus hirsuta*, *Lagerstroemia flos reginae*, *Lagerstroemia lanceolata*, *Swietenia macrophylla*, *Tectona grandis*, *Terminalia paniculata* and *Trema orientalis*.

(iv) Topsip.

244. At this centre *Pterocarpus marsupium* and *Terminalia crenulata* exhibited active growth from the end of April to early January. *Dalbergia latifolia* exhibited much slower growth for a shorter period, i.e., from the end of April to early October.

Species.—*Pterocarpus marsupium*, *Dalbergia latifolia* and *Terminalia crenulata*.

(v) Anaipadi.

245. The new series of periodic height measurements started in October 1938 was continued. All species exhibited growth from about the middle of April to early May and again from the end of May to the end of September 1939, and finally from about the middle of October 1939 to early January 1940.

Species.—*Dalbergia latifolia*, *Lagerstræmia flos reginae*, *Lagerstræmia lanceolata*, *Pterocarpus marsupium*, *Swietenia macrophylla*, *Tectona grandis*, *Terminalia crenulata* and *Terminalia paniculata*.

C. Dry fuel forests.

246. *Emmanur*.—The series of periodic height measurements started in July 1938 were continued. *Albizzia amara* exhibited growth during the months of April to September and early November. *Acacia sundra* grew steadily from April to the end of September, and at an accelerated rate through October, November and early December. *Prosopis juliflora* grew steadily from April to August, and after a very short period of very slow growth in early September, exhibited very rapid growth during November, and early December. The remaining species exhibited two periods of active growth (1) during April to early June and (2) from the latter half of September to early January. Practically all species reached a very slow growth bordering on rest in early January. The second period of growth mentioned above was in practically all the cases the period of fastest growth.

Species.—*Acacia auriculiformis*, *Acacia ferruginea*, *Acacia sundra*, *Albizzia amara*, *Albizzia lebbek*, *Azadirachta indica*, *Cassia siamea* and *Prosopis juliflora*.

A new series of periodic height measurements was started on 30th October 1939. It is yet too early to report results of observations.

Species.—*Acacia arabica*, *Acacia auriculiformis*, *Acacia ferruginea*, *Acacia sundra*, *Albizzia amara*, *Albizzia lebbek*, *Azadirachta indica*, *Cassia siamea*, *Prosopis juliflora*, *Pterocarpus santalinus* and *Wrightia tinctoria*.

(c) Weeds.

Lantana control.

247. *Lantana control*.—*Biological methods*.—Observation of the *Lantana* seed fly was continued in a number of different localities.

248. *Chemical methods*.—Work in the control of *Lantana* by sodium chlorate spraying was continued.

The whole work done so far was reviewed and a detailed report on the work and its cost was written. This report was circularized to all district officers by the Chief Conservator of Forests.

Complete control by spraying costs approximately Rs. 10 per acre for large-scale work.

This review of the work and its costs was necessary as owing to the war it is almost impossible to obtain sodium chlorate. This work must thus therefore be temporarily suspended.

249. *Silvicultural methods*.—As reported last year, in February 1939 very fierce fires swept through all the plots in which *Lantana* had been underplanted with bamboos since 1933. The above ground portions of the bamboos were completely charred and it was feared that great damage had been done. Enumeration in March 1940 however showed the following results:—

Plot number.	Year of plot.	Area.	Bamboo plants with height surviving in March 1940.			
			0-6'	6'-12'	Above 12'	Total.
		ACS.				
I	(a) 1933	1½	31	33	17	81
	(b) "		72	69	28	169
	(c) "		33	47	13	93
	(d) "		116	61	26	203
	(e) 1934		38	36	10	84
	(f) "		40	47	7	94
II	1934	2	230	64	72	366
III	1935	3	40	14	16	70
III A	(i) "	1½	98	7	1	106
	(ii) "		146	28	..	174
	(iii) "		77	5	..	82
	(iv) "		132	27	..	159
IV	1935	1	30	31	14	75
V	1936	3	66	4	1	71
VI	1937	5	690	140	20	850
VII	1938	5	171	13	..	184

It is thus seen that the resulting damage is small and that all areas are sufficiently stocked with bamboos to achieve their purpose. This is very surprising in view of the intensity of the fires and the youth of the bamboos.

250. *General*.—The general results of this *Lantana* control 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.

251. In order to test the capability of *Bambusa arundinacea* to suppress *Lantana* in mixed deciduous forest of good quality 4 experiments are in progress. (Experimental Plot No. 32, Wynaad division Experimental Plot No. 67, South Coimbatore division and Experimental Plots Nos. 150-A and 150-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 one year old transplants and

rhizomes at 15 feet by 15 feet 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 in the third year a little clearing of the *Lantana* was done just over each bamboo plant. This clearing has had the desired effect.

At the end of the fourth year the establishment is as follows :—

Division.	Experimental plot number.	Survival percentage.	Mean height in feet.
Wynaad	32	89	4.2
Coimbatore South	67	91	1.5
Palghat	150 A	87	5.1
	150 B	87	3.8
Average ..		89	3.7

252. *Strobilanthes* eradication.—Experimental Plots Nos. 1, 2 and 22, Wynaad division had as their object the eradication of *Strobilanthes*. The first two of these plots were started in 1932, one year after the *Strobilanthes* flowering and the last one in 1934, i.e., three years after. The following four treatments were applied (a) control—nothing done, (b) cutting above the aerial root, (c) cutting flush with the ground and (d) pulling out by hand. Practically no *Strobilanthes* plants appeared in the treated plots. In August 1938 the *Strobilanthes* flowered in all three plots.

They were identified by the Forest Botanist, Dehra Dun, as 75 per cent *Strobilanthes tristis*—T (growing about 15 feet high) and 25 per cent *Strobilanthes decurrens* Nees (growing about 10 feet high).

The investigation is now concluded.

253. Attempted suppression of *Eupatorium* in the Nilgiris.—The weed *Eupatorium glandulosum* 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.

There is no doubt that in important areas the pest can be replaced by this grazing grass at a small cost.

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. Further experiments in this subject were impossible owing to the war making it impossible to get sodium chlorate.

Small-scale experiments were also done with "Atlacide" but results were inconclusive.

254. *Climber poisoning*.—Two district experiments in this subject are reported this year. In Nellore division 608 climbers of 10 species were poisoned, all died and none produced basal shoots. In Upper Godavari division a similar operation failed as nearly all the climbers poisoned subsequently produced basal shoots.

II. WORKING PLANS AND STATISTICS.

255. (i) *Working Plans*.—The Provincial Silviculturist continued to be in touch through the Working Plans Personal Assistant to the Chief Conservator of Forests 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	(1) Vellore West, Harur Range.	Nilambur ..	..	(1) Field work completed. Drafting nearly completed.
	(2) Salem South..	..	..	(2) Preliminary stock mapping in progress.
II	(1) Chittoor ..	Chittoor ..	..	..
	(2) Anantapur ..	..	..	(2) Enumeration work started. Reconnaissance report approved.
III	Wynaad ..	Wynaad ..	Coimbatore South.	Preliminary stock mapping started. Reconnaissance report approved.
IV	Kurnool East ..	..	..	Field work completed. Drafting nearly completed.
V	Guntur ..	Guntur ..	Vizagapatam.	Field work started. Reconnaissance report is pending approval.

Working Plans for the Godavari Upper and Vellore West divisions were sanctioned during the year. The cost of preparation of these plans was 2.8 annas and 5 pies per acre respectively.

256. (ii) *Yield, volume and form factor tables—Sample plots.*—No new sample plots were opened during the year. One teak sample plot in Nilambur division was closed. We thus have now 183 sample plots representing 17 species in 7 forest divisions. All sample plots due for remeasurement were remeasured.

The standing sample tree measurement apparatus including the swing seat apparatus and the sectional ladder have again been successfully used for the measurement of a number of standing sample trees. Based on recent experience the ladder is being further improved.

257. 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 1940 after three growing seasons measurements showed them to be—

Sample plot.	Survival percentage.	Mean height in feet.
17	98	15.6
18	99	13.8
19	99	11.6

These plots are part of a series which in the course of time will give us definite information whether there is any soil deterioration due to a crop of pure teak.

258. *Permanent preservation plots.*—Six new plots were opened during the year. We thus now have 23 plots representing 26 species in 13 divisions. The four linear tree increment plots for evergreen species and 5 protected trees of specially large dimensions reported last year were maintained.

259. *Tree increment plots.*—Including one *Xylia dolabriformis* and *Pterocarpus marsupium* permanent preservation plot in Upper Godavari division which also serves as a tree increment plot we have now 38 plots; 5 of these plots have a total base line length of five miles and the remaining 33 plots aggregate an area of 386 acres.

III. MISCELLANEOUS.

260. *Tours, records and staff.*—The Provincial Silviculturist and the Assistant Silviculturist toured for 176 and 107 days respectively during the year under report.

The sandal spike research works in Salem North division were inspected by the Provincial Silviculturist as usual during the year.

The Provincial Silviculturist and the District Forest Officer, Nilambur, were deputed to the Fifth Silvicultural Conference held at Dehra Dun in October-November 1939.

In order to obtain as close co-operation as possible in the research on the spike disease of sandal, the Provincial Silviculturist, Assistant Silviculturist, and the Research Ranger, Denkanikota, all visited Bangalore at various times during the year in order to confer with the workers of the Mysore Forest Department and the Indian Institute of Science. The Mysore Forest Department research workers also visited our works in North Salem division.

These visits and discussions were of great mutual benefit.

The Research Ranger, Denkanikota, was deputed for six months to the Forest Research Institute, Dehra Dun, and the Lac Research Institute at Ranchi to study the entomology of the insects particular to spike research work and lac cultivation and products.

The Inspector-General of Forests of French Cochinchina visited our research works in Wynad and in the Nilgiris in May 1940.

The Forest Entomologist, Dehra Dun, paid a short visit to the entomological works at Chandanathode during the year.

The Indian Forest College, Dehra Dun, visited this Province during the year. Besides seeing work in some forest divisions they also saw research experimental works at Chandanathode, Kannothe, Nilambur, Nilgiris, Emmanur and the irrigated teak plantations at Hulicaldrug.

261. *Books and publications.*—"The note on the cultivation of the green wattle (*Acacia decurrens*), and the financial aspect of wattle planting," referred to in paragraph 295 of the last year's report, and the note on *Cassia auriculata* were published during the year.

The following notes were prepared by the Provincial Silviculturist, and circularized by the Chief Conservator of Forests among the forest officers in this province:—

- (1) A short note on spike control.
- (2) A short note on *Lantana* control by sodium chlorate spraying.
- (3) A short note on the host plants most suitable for sandal.

In addition, a popular note on wattle cultivation and its possibilities was prepared by the Assistant Silviculturist for the information of the general public.

262. *Records.*—The specific and general ledger files now number 503 and 213, respectively, 33 new specific and 21 new general ledger files having been opened during the year.

Twenty-one experimental plots and 162 experimental garden experiments were opened and six experimental plots and 175 experimental garden experiments were closed during the year. In consequence 139 experimental plots and 358 experimental garden experiments were open at the close of the year.

Sixty-seven photographs were added to the collection during the year, and the total number of photographs now ledgered is 708 under specific and 430 under general ledger files.

263. *Office inspections.*—The three research range offices of this division were inspected by the Provincial Silviculturist during the year.

The annual inspection of this office and its ledger files was made by the Conservator of Forests, Ootacamund Circle.

264. *Administration.*—Mr. A. L. Griffith, I.F.S., Deputy Conservator of Forests, continued to hold charge of the division up to 24th May 1939 and again from 14th October 1939 to the close of the year. During his absence on home leave, Sri Rao Bahadur M. S. Raghavan, B.A., Assistant Conservator of Forests, was in charge of the division.

The post of Assistant Silviculturist was held by Rao Bahadur M. S. Raghavan from the beginning of the year to 24th May 1939 and again from 14th October 1939 to the close of the year. He was on short leave however from 26th February 1940 to 9th March 1940.

Mr. A. H. Khan, I.F.S., Deputy Conservator of Forests, remained as Assistant to the Provincial Silviculturist from 25th May 1939 to 13th October 1939 and he was attached to this division from 14th October 1939 to 5th November 1939.

265. *Staff.*—The subordinate staff consisted of 3 research rangers, 11 foresters and 1 forest guard.

One ranger, and one forester continued to be on foreign service throughout the year.

The office establishment consisted of 1 head clerk, 2 clerks and 1 typist. For typing the annual report however the Government were pleased to sanction the post of a temporary typist for six weeks during the year.

266. *Discipline.*—The general discipline of the staff was satisfactory.

267. *General.*—The library of the Madras Forest College was transferred to this division during the year in order to start a central forest library for the province.

In paragraph 301 of the last year's report mention was made of the increase of work in this division. The work is still increasing day by day and the position is getting still more difficult. Proposals have been made for an increase of our office staff.

OOTACAMUND,
16th May 1940.

A. L. GRIFFITH,
Silviculturist.

PART II.

Experimental Data.

208. Rainfall in inches and number of rainy days (vide paragraph 7)—

Locality.	(1)	Average of five years only for number of rainy days.												Total for year from 1st April 1939 to 1st April 1940.	Average of years.			
		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)		(14)	(15)	(16)	INCHES. (17)
Topdip (Karianshola).	..	4.10	3.20	9.80	17.50	12.00	0.50	7.80	12.30	..	..	..	..	5.50	10.80	07.80	61.66	14
Chandanathode	..	4	4	19	19	13	2	12	11	..	..	..	..	5	10	84	103	21
		6.00	2.10	40.45	92.20	49.00	13.70	17.45	4.50	..	..	..	..	5.10	11.85	226.00	156.45	
		10	9	26	31	31	21	20	9	..	..	..	..	5	20	157	144	
Mixed deciduous forests.																		
Nilambur	..	3.67	..	16.05	23.78	20.34	3.30	16.52	6.12	0.05	..	..	..	2.66	4.79	95.52	112.21	63
Regur	..	8	8	23	30	23	17	19	9	1	..	..	..	7	14	130	112	21
		4.07	0.66	4.51	15.43	11.32	1.11	6.87	4.74	..	..	..	..	7.09	2.35	48.71	71.49	
Kannoth	..	9	6	21	26	23	7	16	9	..	..	..	..	9	8	117	77	21
		4.39	1.17	27.33	49.55	24.78	3.27	11.22	6.02	..	..	..	..	3.73	5.48	127.78	166.39	22
Dhoni	..	7	5	31	30	30	16	17	12	..	..	..	..	5	16	143	136	22
		7.17	2.90	15.29	23.83	21.66	5.31	15.35	7.53	..	..	..	..	6.15	10.18	105.63	104.72	11
Walayar	..	8	8	25	23	22	15	20	9	..	..	..	..	7	14	135	135*	11
		1.30	0.60	4.40	19.70	21.70	0.21	5.70	4.70	..	..	..	..	5.90	5.90	58.31	52.75	18
		4	3	17	23	18	5	9	7	..	..	..	..	6	7	80	82	

* Average of five years only for number of rainy days.

• 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 pound of seed.
		Ounce.	Pound.						
<i>Acacia arabica</i> ..	XII-III	151	2,416	10	75	75	6	6,000	1,812
<i>Acacia auriculiformis</i> .	III-IV	1,210	19,360	15	65	80	30	14,000	12,584
<i>Acacia baileyana</i> ..	VIII	966	15,456	5	14	53	5	2,000	2,164
<i>Acacia cyanophylla</i> ..	IV	2,010	32,160	5	93	94	12	4,300	29,909
<i>Acacia dealbata</i> ..	XII-IV	2,336	37,376	5	33	45	14	3,200	12,334
<i>Acacia decurrens</i> ..	XII-I	1,737	27,732	6	14	53	7	5,000	3,891
<i>Acacia ferruginea</i> ..	XII-IV	167	2,672	25	80	90	36	18,000	2,138
<i>Acacia leucophlea</i> ..	XII-IV	1,030	17,280	33	30	42	40	20,000	5,184
<i>Acacia melanoxylon</i>	IV	2,034	33,544	5	78	83	14	3,000	25,384
<i>Acacia mollissima</i> ..	XII-II	1,785	28,560	6	15	57	6	4,000	4,284
<i>Acacia planifrons</i> ..	VI-VIII	727	11,632	9	35	42	18	16,000	4,071
<i>Acacia sundra</i> ..	XI-V	745	11,920	16	90	90	45	20,000	10,728
<i>Acrocarpus frazini-</i> <i>folius</i> .	III-VI	890	14,240	65	21	25	75	72,000	2,930
<i>Aglais roxburghiana</i> .	IX	57	912	4	56	57	2	7,000	511
<i>Alangium lamarkii</i> .	V & XII	48	768	2	0	1	2	1,000	0
<i>Albizia amara</i> ..	XII-II & V	400	6,400	30	74	83	50	63,000	4,736
<i>Albizia lebbek</i> ..	XII-I & VI	315	5,040	31	49	65	13	9,000	2,470
<i>Albizia stipulata</i> ..	II-IV	1,997	31,952	2	1	8	10	1,000	320
<i>Anacardium occiden-</i> <i>tale</i> .	III-V	53	85	14	98	98	60	20,000	83
<i>Antiaris toxicaria</i> ..	..	18	288	1	35	39	1	500	101
<i>Araucaria excelsa</i> ..	..	16	256	1	0	0	1	1,000	0
<i>Artocarpus hirsuta</i> ..	IV-VI	61	976	100	81	97	80	65,000	791
<i>Azadirachta indica</i> ..	V-X	132	2,112	15	89	90	10	21,000	1,880
<i>Balanocarpus utilis</i> ..	X	7	112	4	69	72	4	4,000	77
<i>Bambusa arundinacea</i> .	II-IV	2,325	37,200	17	37	38	9	4,000	13,764
<i>Bambusa polymorpha</i> .	III	1,398	22,336	5	32	40	22	7,000	7,148
<i>Bambusa tulda</i> ..	..	455	7,280	2	1	2	3	3,000	73
<i>Bauhinia purpurea</i> ..	II-III	23	400	3	95	93	3	3,000	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	46,080	2	23	56	2	2,000	10,538
<i>Bischofia javanica</i> ..	X-II	1,835	29,360	10	75	79	4	4,000	22,020
<i>Bombax malabaricum</i> .	III-V	855	13,680	6	8	9	2	4,000	1,694
<i>Broussonetia papyri-</i> <i>fera</i> .	VI	16,900	..	5	28	47	4	5,000	75,712
<i>Callitris rhomboidea</i> .	IV-VI	4,850	77,600	4	18	45	7	1,500	13,985
<i>Calophyllum elatum</i> .	V-IX	4	64	23	67	89	26	11,000	43
<i>Canthium didymum</i> .	III-VII	325	5,200	14	12	42	7	7,000	624
<i>Cassia auriculata</i> ..	I-III	890	14,240	5	51	59	9	9,000	7,262
<i>Cassia fistula</i> ..	II-VI	176	2,816	30	47	55	65	35,000	1,324
<i>Cassia marginata</i> ..	II-VI	130	2,080	24	47	65	32	20,000	978
<i>Cassia siamea</i> ..	II-VI	1,040	16,640	30	87	93	44	22,000	14,477
<i>Cassia tomentosa</i> ..	II-IV	1,933	16,528	4	8	13	15	1,50	

Species.	Month in which to collect seed.	Number of seeds per		Number of weighments.	Plant per cent.	Germinative capacity.	Number of tests.	Number of seeds tested.	Plants per pound of seed.
		Ounce.	Pound.						
<i>Cellis tetrandra</i> ..	VI	420	6,720	1	5	5	1	400	336
<i>Chlorophora excelsa</i> ..	..	10,870	173,920	4	29	33	6	70,000	50,437
<i>Chloroxylon swietenia</i> ..	III-VIII	2,500	40,000	50	64	69	70	60,000	25,600
<i>Chloroxylon swietenia</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>Cinnamomum camphora</i> ..	..	176	2,816	2	0	0	2	800	0
<i>Cinnamomum zeylanicum</i> ..	..	105	1,680	2	1	1	2	2,000	17
<i>Citrus scoparius</i> ..	III-IV	3,188	51,008	2	24	30	5	5,000	12,242
<i>Cupressus macrocarpa</i> ..	IV-VI	4,394	70,304	5	8	8	7	2,000	5,624
<i>Cupressus torulosa</i> ..	V-VI	5,060	80,960	4	5	9	9	1,500	4,048
<i>Dalbergia latifolia</i> ..	I-VI	525	8,400	30	55	65	68	52,000	4,620
<i>Dalbergia sissooides</i> ..	XII-III	454	7,264	90	51	70	75	50,000	3,705
<i>Daphniphyllum glaucescens</i> ..	V-VI	136	2,176	6	5	10	12	3,000	109
<i>Dendrocalamus brandisii</i> ..	II	3,475	55,600	1	1	2	2	1,000	556
<i>Dendrocalamus longispathus</i> ..	III-IV	2,367	37,872	8	1	2	4	4,000	379
<i>Dendrocalamus strictus</i> ..	III-IV	1,269	20,304	16	47	48	5	1,500	9,543
<i>Dipterocarpus indicus</i> ..	III-VIII	5	78	12	26	41	12	1,500	20
<i>Dodonaea viscosa</i> ..	I-IV	3,220	51,520	2	12	12	5	500	6,542
<i>Dolichandrone crispata</i> ..	I-IV	855	13,680	14	48	54	14	10,000	6,182
<i>Dolichandrone falcata</i> ..	III-V	730	11,680	3	7	13	3	3,000	818
<i>Dysoxylum malabaricum</i> ..	VII-VIII	5	80	10	85	85	35	4,000	68
<i>Ekeocarpus oblongus</i> ..	II-V	903	154	4	3	6	4	2,000	5
<i>Erythroxylon monogynum</i> ..	IX-III	905	14,480	18	34	46	14	11,000	4,923
<i>Eucalyptus ficifolia</i> ..	V	2,170	34,720	1	4	53	1	1,000	1,389
<i>Eucalyptus maculata</i> ..	..	6,112	97,792	2	12	13	2	200	11,735
<i>Eugenia arnottiana</i> ..	V-VII	110	1,760	10	71	73	25	6,000	1,250
<i>Eugenia calophyllifolia</i> ..	V	146	2,336	1	16	20	1	1,000	374
<i>Eurya japonica</i> ..	IV	25,600	409,600	2	0	0	2	10,000	0
<i>Evodia roxburghiana</i> ..	IV, V, XI & XII.	2,400	38,400	10	21	66	6	10,000	8,064
<i>Feronia elephantum</i> ..	X-IV	1,425	22,800	8	63	66	10	10,000	14,364
<i>Givotia rotleriformis</i> ..	X-V	11	176	14	40	43	14	12,000	70
<i>Glochidion neilgherrense</i> ..	III-IV	1,293	20,768	4	4	29	4	2,100	831
<i>Gluta travancorica</i> ..	IV-VIII	2	32	12	90	96	38	12,000	29
<i>Gmelina arborea</i> ..	III-VI	42	672	3	56	64	25	8,500	376
<i>Grewia lilacifolia</i> ..	V-VI	130	2,080	3	76	84	3	7,000	2,189
<i>Ilakea saligna</i> ..	IX-XII	2,276	36,416	10	68	78	20	4,000	24,763
<i>Hardwickia binata</i> ..	III-VII	145	2,320	8	0.1	0.2	6	6,000	23
<i>Hardwickia pinnata</i> ..	V-VI	46	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	30	54	63	60	65,000	708
<i>Jacaranda mimosaefolia</i> ..	V	3,635	58,960	3	6	18	3	2,000	3,538
<i>Juniperus procera</i> ..	XII-I	1,380	22,080	10	5	12	18	2,500	1,104

* With pulp; without pulp 173 to the ounce. † With corky layer; without corky layer 43 per ounce.
‡ Kernel only. Pods 83 per ounce.

Species.	Month in which to collect seed.	Number of seeds per		Number of weighments.	Plant per cent.	Germinative capacity.	Number of tests.	Number of seeds tested.	Plants per pound of seed.
		Ounce.	Pound.						
<i>Lagerstroemia flos reginae</i> ..	XII-II	4,400	70,400	16	53	60	18	50,000	38,720
<i>Lagerstroemia lanceolata</i> ..	XII-III	6,600	105,600	10	13	20	27	70,000	13,728
<i>Lantana camara</i> ..	VIII	*1,302	20,832	5	2	3	2	2,000	417
<i>Leucaena glauca</i> ..	I	840	13,440	7	33	38	4	8,000	4,435
<i>Ligustrum neilgherrense</i> ..	XII-III	† 851	13,616	5	60	74	12	1,500	8,987
<i>Litsea wightiana</i> ..	IV-VI	150	2,400	3	18	18	3	3,000	432
<i>Maba burxifolia</i> ..	XI-I	286	4,576	2	88	92	2	300	4,027
<i>Mahonia leschenaultii</i> ..	II-IV	1,747	27,952	8	48	53	7	4,000	13,417
<i>Mangifera indica</i> ..	V-VI	25	40	3	20	24	3	2,500	8
<i>Markhamia platycalyx</i> ..	..	1,140	18,240	4	1	1	4	4,000	182
<i>Meliosma wightii</i> ..	III-V	140	2,240	2	10	14	3	100	224
<i>Melocanna bambusaoides</i> ..	..	2	32	1	5	56	2	500	2
<i>Memecylon umbellatum</i> ..	XI-XII	216	3,456	2	90	94	2	300	3,110
<i>Mesua ferrea</i> ..	XI-III	28	448	20	68	70	26	10,000	305
<i>Michelia nilagirica</i> ..	IV-VI	373	5,968	5	23	24	13	4,000	1,373
<i>Morus alba</i> ..	..	26,015	416,240	4	6	13	4	5,000	20,812
<i>Mundulea suberosa</i> ..	IV	958	15,328	2	35	54	2	2,000	5,365
<i>Myrsine wightiana</i> (Rapaia) ..	IV-VI	1,432	22,912	5	20	20	5	4,000	4,582
<i>Neolitsea zeylanica</i> ..	V-VII	210	3,360	5	53	53	5	2,500	1,781
<i>Palaquium ellipticum</i> ..	V-VIII	7	112	20	68	69	33	10,000	76
<i>Photinia notoniana</i> ..	V-VII	10,830	173,280	3	0	21	3	7,000	0
<i>Pinus insignis</i> ..	V-VI	1,807	28,912	3	4	8	5	5,000	1,156
<i>Pinus insularis</i> ..	II	3,680	58,880	1	1	3	1	500	589
<i>Pinus longifolia</i> ..	IV	236	3,776	5	40	80	5	3,000	1,737
<i>Pithecolobium dulce</i> ..	II-V	186	2,976	7	33	46	12	1,200	982
<i>Psecciloneuron indicum</i> ..	V	1	12	1	20	31	1	500	3
<i>Poinciana elata</i> ..	XII	244	3,904	1	3	65	2	2,000	117
<i>Poinciana regia</i> ..	IV	80	1,280	2	5	5	2	2,000	64
<i>Polyalthia fragrans</i> ..	V	12	192	1	0	0	1	500	0
<i>Polyalthia longifolia</i> ..	IV-IX	21	336	2	2	3	2	2,000	7
<i>Pongamia glabra</i> ..	III-V & X	23	368	3	12	15	3	3,000	44
<i>Prosopis juliflora</i> ..	V	920	14,720	26	78	89	40	110,000	11,482
<i>Prosopis spicigera</i> ..	II-VII	686	10,976	14	88	88	10	7,000	9,659
<i>Pterocarpus dalbergioides</i> ..	II-IV	53	848	40	20	40	52	17,000	† 246
<i>Pterocarpus marsupium</i> ..	I-VI	60	960	80	90	97	104	50,000	864
<i>Pterocarpus santalinus</i> ..	II-VII	30	475	24	65	88	70	47,000	209
<i>Quercus incana</i> ..	II	14	228	3	51	60	5	3,000	116
<i>Rapanea</i> (see <i>Myrsine</i>) ..	IV	4,152	66,432	1	1	9	1	1,000	604
<i>Rhodomyrtus tomentosa</i> ..	II-IV	70	1,120	4	62	67	4	4,000	694
<i>Sapindus emarginatus</i> ..	IV-VI	55	880	3	60	72	3	400	528
<i>Sapindus trifoliatus</i> ..	X-XI & III-IV	† 148	2,368	70	58	85	70	70,000	1,373
<i>Santalum album</i> ..	..	59	944	20	72	76	23	17,000	680
<i>Schleichera trijuga</i> ..	II-VIII	..	..	..	..	..	..	..	..

* With pulp; 2,092 per oz. without pulp. ‡ Seed from the Andamans.
† Without pulp; with pulp 500 to the ounce. § With pulp; without pulp 195 per ounce.

Species.	Month in which to collect seed.	Number of seeds per		Number of weighments.	Plant per cent.	Germinative capacity.	Number of tests.	Number of seeds tested.	Plants per pound of seed.
		Ounce.	Pound.						
<i>Semecarpus anacardium</i> ..	II-IV	13	208	2	53	57	2	2,000	110
<i>Shorea talura</i> ..	V	* 23	464	25	55	64	10	6,500	255
<i>Sileroxylon tomentosum</i> ..	VI	95	1,520	2	10	10	2	1,000	152
<i>Soyimila febrifuga</i> ..	II-VII	378	6,048	12	25	28	12	11,000	1,512
<i>Sterculia urens</i> ..	V	130	2,080	1	13	17	1	1,500	270
<i>Stipa tenassima</i> ..	..	13,200	211,200	2	2	3	2	5,000	4,224
<i>Strychnos nux vomica</i> ..	XII-V	18	283	6	22	25	9	9,000	63
<i>Strychnos potatorum</i> ..	III-VII	36	576	4	10	14	4	4,000	54
<i>Swietenia macrophylla</i> ..	XII-III	60	960	55	71	78	75	75,000	632
<i>Symplocos foliosa</i> ..	III-VII	† 80	1,280	2	0	0	2	2,000	0
<i>Tamarindus indica</i> ..	II-V	41	656	12	40	75	7	12,000	262
<i>Tectona grandis</i> ..	XI-V	52	832	60	53	63	70	90,000	483
<i>Tephrosia candida</i> ..	XI-I	1,300	20,800	1	45	53	1	1,000	9,360
<i>Terminalia arjuna</i> ..	XI-XII & IV-VI	22	352	2	17	19	2	2,000	60
<i>Terminalia belerica</i> ..	II	6	96	1	53	62	1	500	51
<i>Terminalia chebula</i> ..	XI-IV	16	263	24	50	60	58	33,000	† 132
<i>Terminalia crenulata</i> ..	I-VI	22	352	70	58	72	90	85,000	204
<i>Terminalia paniculata</i> ..	XI-IV	1,010	16,160	115	5	10	110	180,000	808
<i>Ternstroemia japonica</i> ..	II-VII	260	3,200	3	0	4	4	4,000	0
<i>Thyroclachys oliveri</i> ..	V	1,890	30,240	4	22	25	4	4,000	6,653
<i>Trema orientalis</i> ..	I-VI	5,010	89,160	30	5	7	20	50,000	4,008
<i>Tsuga brunoniana</i> ..	..	10,000	..	1	4	4	1	1,000	6,400
<i>Vateria indica</i> ..	VII-VIII	14	22	14	76	80	9	4,000	17
<i>Viburnum coriaceum</i> ..	VII	566	9,056	2	4	4	2	2,000	362
<i>Viburnum erubescens</i> ..	VII	1,005	16,680	5	7	7	5	3,000	1,126
<i>Vitex altissima</i> ..	XII-IV	345	5,520	6	2	2	6	7,000	110
<i>Vitex littoralis</i> ..	V-VII	83	1,408	2	0	30	3	230	0
<i>Vitex peduncularis</i> ..	VII-VIII	273	4,368	14	15	28	12	12,000	655
<i>Wrightia tinctoria</i> ..	II-V	800	12,944	11	26	42	5	5,000	3,365
<i>Xylia xylocarpa</i> ..	I-V	95	1,520	23	80	99	65	53,000	1,216
<i>Zizyphus glabrata</i> ..	X-II	244	3,904	4	12	19	4	4,000	463
<i>Zizyphus iacurra</i> ..	I	§ 118	1,888	8	33	69	7	4,000	717
<i>Zizyphus jujuba</i> ..	I-VII	59	800	12	82	95	10	12,000	656
<i>Zizyphus zeylapyrus</i> ..	III	612	9,792	1	40	52	2	2,000	3,017

* 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.

270. Seed pre-treatment (vide paragraph 27 to 32)—

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> ..	1	1	1	8	24

Species.	Number of tests made.	Average germinative capacity with			
		Un-treated.	Cold water.	Hot water.	Boiling water.
<i>Acacia ferruginea</i> ..	9	50	43	49	39
<i>Acacia leucophloea</i> ..	13	22	12	17	23
<i>Acacia melanoxylon</i> ..	1	83	81	91	90
<i>Acacia mollissima</i> ..	5	5	2	11	29
<i>Acacia planifrons</i> ..	4	19	17	17	13
<i>Acacia sundra</i> ..	10	34	28	30	25
<i>Acrocarpus fraxinifolius</i> ..	25	8	8	9	6
<i>Albizia amara</i> ..	21	42	36	31	36
<i>Albizia lebbek</i> ..	2	19	14	19	22
<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> ..	3	14	16	15	17
<i>Berberis tinctoria</i> ..	2	56	0	0	0
<i>Bombax malabaricum</i> ..	1	8	8	8	6
<i>Calophyllum elatum</i> ..	5	17	16	13	0
<i>Cassia auriculata</i> ..	13	9	8	9	5
<i>Cassia fistula</i> ..	15	12	11	8	7
<i>Cassia marginata</i> ..	12	17	22	13	5
<i>Cassia siamea</i> ..	16	50	37	47	5
<i>Chlorophora excelsa</i> ..	15	18	15	12	0
<i>Chloroxylon swietenia</i> ..	12	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 crispa</i> ..	4	17	14	15	1
<i>Dolichandrone falcata</i> ..	3	8	7	5	1
<i>Eleocarpus oblongus</i> ..	2	5	0	0	0
<i>Erythroxylon monogynum</i> ..	1	11	16	13	1
<i>Eugenia arnottiana</i> ..	3	53	51	40	42
<i>Evodia roxburghiana</i> ..	2	17	15	3	0
<i>Feronia elephantum</i> ..	3	14	17	15	2
<i>Givotia rotleriformis</i> ..	3	2	2	1	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>Grewia tilicefolia</i> ..	1	12	7	11	5
<i>Hakea saligna</i> ..	2	45	0	0	0
<i>Harrisonia bennetii</i> ..	4	10	14	7	2
<i>Juniperus procera</i> ..	4	2	4	5	1
<i>Lagerstroemia lanceolata</i> ..	30	5	4	4	0
<i>Leucaena glauca</i> ..	11	25	28	33	35
<i>Ligustrum neilgherrense</i> ..	2	66	21	13	2
<i>Litsea zeylanica</i> ..	2	15	9	7	0

Species.	Number of tests made.	Average germinative capacity with.			
		Un-treated.	Cold water.	Hot water.	Boiling water.
<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 nilagirica</i>	1	5	0	0	0
<i>Myrsine wightiana</i> (Rapanea) ..	2	10	14	11	20
<i>Neollisea zeylanica</i>	2	16	18	0	0
<i>Palaquium ellipticum</i>	13	40	51	41	0
<i>Pinus longifolia</i>	4	34	54	27	49
<i>Pinus insignis</i>	3	4	9	2	0
<i>Pithecolobium dulce</i>	8	43	13	38	5
<i>Poinciana elata</i>	1	17	31	23	61
<i>Pongamia glabra</i>	3	10	9	5	7
<i>Prosopis juliflora</i>	5	71	72	61	54
<i>Pterocarpus dalbergioides</i>	5	15	18	13	5
<i>Pterocarpus santalinus</i>	13	23	66	31	18
<i>Pterocarpus santalinus*</i>	3	14	18	17	4
<i>Pterocarpus marsupium</i>	94	40	31	32	12
<i>Quercus incana</i>	2	81	0	0	0
<i>Sapindus emarginatus</i>	3	16	10	16	13
<i>Schleichera trijuga</i>	17	31	29	27	0
<i>Soymida febrifuga</i>	10	1	3	1	0
<i>Sterculia urens</i>	1	13	3	3	0
<i>Strychnos nux vomica</i>	3	2	7	9	5
<i>Strychnos potatorum</i>	1	4	6	3	0
<i>Tamarindus indica</i>	1	90	54	42	40
<i>Tectona grandis</i>	40	28	27	24	8
<i>Terminalia chebula</i> —					
(1) (Whole fruit)	13	21	16	24	9
(2) (Fleshy covering removed) ..	3	4	6	5	7
(3) (Kernel)	4	6	1	2	0
<i>Terminalia crenulata</i> —					
(1) Fresh seed	83	28	30	24	6
(2) Stored 14 months	10	9	8	7	8
<i>Terminalia paniculata</i>	26	10	8	9	0
<i>Thyrostachys oliveri</i>	1	10	11	4	2
<i>Trema orientalis</i>	2	1	1	1	1
<i>Vateria indica</i>	3	58	57	58	0
<i>Vitex littoralis</i>	2	30	38	11	0
<i>Vitex peduncularis</i>	3	7	8	3	0
<i>Wrightia tinctoria</i>	2	15	26	14	2
<i>Xylia xylocarpa</i>	42	20	26	25	13
<i>Zizyphus glabrata</i>	1	5	5	6	8
<i>Zizyphus incurva</i>	5	31	24	24	22
<i>Zizyphus jujuba</i>	12	19	23	13	15
<i>Zizyphus xylopyrus</i>	1	13	14	17	20

* Seed coat removed.

271. *Seed storage* (vide paragraph 41).—Tests made at intervals with the 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) Stopped 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) Stopped bottle.	21	6	No falling off up to eight months.
	(2) Earthen pot ..	21	6	
	(3) Gunny bag ..	21	6	
	(4) Air-tight tins ..	28	8	
<i>Acacia ferruginea</i> ..	(1) Stopped bottle.	34	24	Seed good up to sixteen months and then rapidly deteriorates; keeps best in (2).
	(2) Earthen pot ..	50	24	
	(3) Gunny bag ..	50	24	
	(4) Air-tight tins ..	48	24	
<i>Acacia leucophloea</i> ..	(1) Air-tight tins ..	20	12	Seed good after ten months.
	(2) Earthen pot ..	12	12	
	(3) Gunny bag ..	12	12	
	(4) Air-tight tins ..	24	12	
<i>Acacia planifrons</i> ..	(1) Air-tight tins ..	24	12	Seed good after one year; keeps best in (3).
	(2) Earthen pot ..	24	12	
	(3) Gunny bag ..	24	12	
	(4) Air-tight tins ..	24	12	
<i>Acacia sundra</i> ..	(1) Stopped bottle.	45	24	Seed good after fifteen months; does not keep in (1).
	(2) Earthen pot ..	55	24	
	(3) Gunny bag ..	55	24	
	(4) Mud pot with wood ash.	60	24	
<i>Acrocarpus frazini-folius</i> .	(1) Gunny bag ..	125	25	Seed after nineteen months as good as fresh seed.
	(2) Air-tight tins ..	30	18	
	(3) Air-tight tins ..	2	6	
	(4) Gunny bags ..	2	6	
<i>Aylia roxburghiana</i> .	(1) Air-tight tins ..	35	12	Seed good up to two months; keeps best in (1).
	(2) Gunny bags ..	2	6	
	(3) Air-tight tins ..	35	12	
	(4) Mud pot with wood ash.	65	20	
<i>Albizia amara</i> ..	(1) Air-tight tins ..	35	12	Seed good up to two and a half years; keeps best in (2).
	(2) Mud pot with wood ash.	65	20	
	(3) Gunny bag ..	35	12	
	(4) Air-tight tins ..	55	24	
<i>Anacardium occidentale</i> .	(1) Air-tight tins ..	55	24	Seed good up to eighteen months; keeps best in (1) or (3).
	(2) Gunny bag ..	75	24	
	(3) Earthen pot ..	55	24	
	(4) Air-tight tins ..	55	24	
<i>Artocarpus hirsuta</i> ..	(1) Gunny bag ..	55	12	Seed good up to three months and then rapidly deteriorates; keeps best in pit covered with 2 inches of dry earth.
	(2) Dry earth ..	30	12	
	(3) Puddled mud ..	30	12	
	(4) Air-tight tins ..	30	12	
<i>Bischofia javanica</i> ..	(1) Gunny bag ..	3	6	Keeps for four months and then rapidly deteriorates.
<i>Calophyllum elatum</i> .	(1) Gunny bag ..	4	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 ..	65	24	Seed good up to two years except in (1), keeps best in (3).
	(2) Earthen pots ..	55	24	
	(3) Gunny bag ..	55	24	
	(4) Air-tight tins ..	28	12	
<i>Cassia marginata</i> ..	(1) Air-tight tins ..	12	12	Seed good after ten months.
	(2) Gunny bag ..	36	12	
	(3) Air-tight tins ..	56	12	
	(4) Mud pots with wood ash.	36	12	
<i>Cassia siamea</i> ..	(1) Air-tight tins ..	36	12	Seed good after three years; keeps best in (1).
	(2) Mud pots with wood ash.	56	12	
	(3) Gunny bag ..	36	12	
	(4) Air-tight tins ..	32	6	
<i>Celreia toona</i> ..	(1) Gunny bag ..	32	6	Seed good up to three months; falling to 50 per cent at five months.
<i>Chloroxylon suietenia</i> .	(1) Air-tight tins ..	90	12	Good up to three months and then rapidly deteriorates; No difference between Ceylon and Madras seed.
	(2) Earthen pots ..	50	12	
	(3) Gunny bags ..	90	12	
	(4) Air-tight tins ..	90	12	
<i>Dalbergia latifolia</i> ..	(1) Gunny bags ..	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	
	(4) Gunny bag ..	15	12	
<i>Dalbergia sisoides</i> ..	(1) Gunny bag ..	15	12	Good up to six months and then rapidly deteriorates; keeps best in (1).
	(2) Air-tight tins ..	15	12	
	(3) Wood ash ..	15	12	
	(4) Air-tight tins ..	3	6	
<i>Dendrocalamus longepedatus</i> .	(1) Air-tight tins ..	3	6	Good up to three months and then rapidly deteriorates.
<i>Dipterocarpus indicus</i> .	(1) Gunny bag ..	3	6	Good up to one month and then rapidly deteriorates.
<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	
	(3) Air-tight tins.	3	12	
	(4) Earthen pot ..	3	12	
<i>Erythroxylon monogynum</i> .	(1) Air-tight tins.	3	12	Seed good after one year; keeps best in (2).
	(2) Earthen pot ..	3	12	
	(3) Gunny bag ..	3	12	
	(4) Air-tight tins.	3	12	

Species.	Method of storage.	Number of individual tests.	Number of series of the same sample of seed.	Remarks.
<i>Gluta travancorica</i> ..	(1) Gunny bag ..	44	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>Grewia tileaifolia</i> ..	(1) Air-tight tins ..	2	6	Seed good up to three months.
	(2) Gunny bag ..	2	6	
<i>Hopea parviflora</i> ..	(1) Gunny bags ..	54	6	Seed good after twenty days; falling to 0 after forty days.
<i>Lagerstroemia flos reginae</i> .	(1) Gunny bags ..	60	10	Seed good up to eight months; by all three methods and then rapidly deteriorates.
	(2) Gunny bags with wood ash ..	60	10	
	(3) Air-tight tins ..	60	10	
<i>Lagerstroemia lanceolata</i> .	(1) Gunny bags ..	38	6	Seed good up to six months; keeps best in (1).
	(2) Air-tight tins ..	38	6	
	(3) Wood ash ..	14	6	Seed good up to three months.
<i>Mesua ferrea</i> ..	(1) Gunny bags ..	19	6	Seed good up to four months; dropping to 30 per cent at six months.
<i>Palaequium ellipticum</i> .	(1) Gunny bags ..	26	6	Variable—usually good up to about two months.
<i>Prosopis juliflora</i> ..	(1) Stoppered bottle.	66	12	Seed good after one year; keeps best in (2).
	(2) Earthen pot ..	70	12	
	(3) Gunny bag ..	70	12	Seed good up to twenty-eight months.
	(4) Air-tight tins ..	70	12	
<i>Pterocarpus dalbergioides</i> .	(1) Gunny bags ..	18	12	Variable—usually good up to six months; sometimes good up to one year.
<i>Pterocarpus marsupium</i> .	(2) Air-tight tins ..	53	12	
<i>Pterocarpus santalinus</i> .	(1) Gunny bags ..	66	12	Good up to eight months.
	(2) Earthen pot ..	50	12	
	(3) Stoppered bottle.	50	12	
<i>Santalum album</i> ..	(1) Air-tight tins ..	50	24	Seed good up to two years; keeps best in gunny.
	(2) Gunny bags ..	40	24	
<i>Schleichera trijuga</i> ..	(1) Gunny bag ..	10	12	Seed kept by all methods for six months without any deterioration.
	(2) Gunny with wood ash ..	10	12	
	(3) Air-tight tins ..	10	12	
<i>Strychnos nux vomica</i> .	(1) Air-tight tins ..	2	12	Seed good up to ten months; keeps best in (3).
	(2) Earthen pots ..	2	12	
	(3) Gunny bags ..	2	12	
<i>Suaeda macrophylla</i> .	(1) Gunny bags ..	66	12	Seed good up to five months; falling to 0 at seven months.
<i>Tectona grandis</i> ..	(1) Gunny bags ..	210	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 ..	100	10	
<i>Terminalia chebula</i> ..	(1) Gunny bags ..	52	12	Seed good up to two years; keeps best in (1).
	(2) Stoppered bottle.	28	12	
	(3) Earthen pot ..	28	12	
<i>Terminalia crenulata (tomentosa)</i> .	(1) Gunny bag ..	170	22	Seed good up to one year.
	(2) Stoppered bottle.	45	12	
	(3) Air-tight tins ..	40	12	
<i>Terminalia paniculata</i> .	(1) Gunny bags ..	50	12	Seed often good up to five months but very variable.
	(2) Stoppered bottle.	40	12	
	(3) Air-tight tins ..	50	12	
<i>Trema orientalis</i> ..	(1) Gunny bags ..	72	12	Seed kept by all methods for six months and then rapidly deteriorated.
	(2) Gunny bags with wood ash ..	70	12	
	(3) Air-tight tins ..	70	12	
<i>Vateria indica</i> ..	(1) Gunny bag ..	10	6	Seed kept for one month and then rapidly deteriorated.
<i>Vitex pedunculata</i> ..	(1) Gunny bags ..	8	6	We have not been able to keep this seed longer than six weeks.
	(2) Air-tight tins ..	8	6	
<i>Xylia xylocarpa</i> ..	(1) Gunny bags ..	168	20	Very variable—usually good up to three months.
	(2) Stoppered bottle.	55	12	
	(3) Air-tight tins ..	55	12	

NOTES.—(1) The above results are indications of the probable longevity of the seed. Many more tests are necessary in most cases before reliable results can be obtained.

(2) The periods in column 5 are the times between collection and sowing and not between collection and germination which are often much longer.

(3) Generally 100 seeds were used for each treatment, date and test.

(4) In many cases the remark is given as "Seed good up to X months." Often this is the maximum period tested and not necessarily the maximum period the seed remains fertile.

272. Premonsoon stump planting—Kannoth Experimental Garden (vide paragraph 81)—

Experiment No. 76 of 1939.—Species—*Terminalia crenulata*. Arrangement—ABCDE EDCBA repeated 10 times in single lines of 5 plants (i.e., 50 plants per treatment). Espacement—6' x 3'. Soil preparation—Crowbar holes. Stock used—Stumps from one year old nursery plants. Dates of stump planting—Fortnightly from 1st April 1939 to 1st June 1939. Size of stumps—0.5" to 0.6" diameter. Tending—Normal district weeding.

Measurements in January 1940.

Date of planting.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
1st April 1939	14	41.7 ± 8.41	+ 28.2 ± 8.51	S.
15th April 1939	100	42.9 ± 2.81	+ 29.4 ± 3.03	S.
1st May 1939	70	22.2 ± 2.42	+ 8.7 ± 2.73	S.
15th May 1939	72	17.9 ± 1.75	+ 4.4 ± 2.16	..
1st June 1939	88	13.5 ± 1.27	Control.	..

273. Premonsoon stump planting—Nilambur Experimental Garden (vide paragraph 82)—

Experiment No. 10 of 1938.—Species—*Tectona grandis*. Arrangement, etc., as above but for 100 plants per treatment. 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	93	43.05 ± 2.23	+ 7.63 ± 3.12	S.
B 15th April 1938	97	43.23 ± 1.87	+ 2.87 ± 2.83	N.S.
C 1st May 1938	98	41.44 ± 2.03	+ 1.08 ± 2.03	N.S.
D 15th May 1938	100	47.30 ± 1.85	+ 6.94 ± 2.88	E.
E 1st June 1938	97	40.30 ± 2.18	Control.	..

Measurements in January 1940 in feet.

Date of planting.	Survival percentage.	Mean height in feet.	Difference of means.	Significance.
A 1st April 1938	90	13.6 ± 0.29	+ 1.5 ± 0.50	S.
B 15th April 1938	95	12.8 ± 0.32	+ 0.7 ± 0.52	N.
C 1st May 1938	95	12.3 ± 0.37	+ 0.2 ± 0.55	N.
D 15th May 1938	100	13.0 ± 0.32	+ 0.9 ± 0.52	N.
E 1st June 1938	95	12.1 ± 0.41	Control.	..

Experiment No. 12 of 1939.—Species—*Tectona grandis*. Arrangement, etc., as above. Dates of stump planting.—Fortnightly from 1st April 1939 to 1st June 1939. Stock used—Stumps 0.5" to 0.6" diameter from one year old nursery plants. Tending—Normal district practice.

Measurements in January 1940 in inches.

Date of planting.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A 1st April 1939	51	30.7 ± 2.76	+ 14.4 ± 2.91	S.
B 15th April 1939	85	33.0 ± 2.24	+ 21.7 ± 2.42	S.
C 1st May 1939	71	20.1 ± 1.30	+ 3.8 ± 1.59	S.
D 15th May 1939	26	14.8 ± 1.71	- 1.5 ± 1.04	N.S.
E 1st June 1939	87	16.3 ± 0.92	Control.	..

Experiment No. 13 of 1939.—Species—*Tectona grandis*.

All details as in the experiment above except that this experiment was done in a ponam crop of paddy sown on 7th May 1939 and re-sown on 29th May 1939.

Measurements in January 1940 in inches.

Date of planting.	Survival percentage.	Mean height in inches.	Difference of means.	Significance.
A 1st April 1939	36	42.3 ± 5.43	+ 27.4 ± 5.43	S.
B 15th April 1939	85	44.6 ± 2.61	+ 20.7 ± 2.71	S.
C 1st May 1939	72	22.0 ± 1.81	+ 7.1 ± 1.93	S.
D 15th May 1939	54	11.7 ± 0.69	- 3.2 ± 1.00	S.
E 1st June 1939	95	14.9 ± 0.73	Control.	..

274. Effect of depth of stump planting—Teak (vide paragraph 90).—

Begur Experimental Garden Experiment No. 145.—Arrangement—ABCD DCBA repeated 10 times in single lines of 10 plants, i.e., 100 per treatment. *Espacement*—6' × 6'. *Treatment*—(A) planted on 1st April 1939 buried; (B) planted on 1st April 1939 normal, (C) planted on 1st June 1939 buried, (D) planted on 1st June 1939 normal. *Stock used*—One year old stumps 0.5" to 0.6" diameter. *Weeding*—Normal district practice.

Dhoni Experimental Garden Experiment No. 180.—Arrangement, etc., as above. *Stock used*—One year old stumps 0.5" to 0.6" diameter.

Walayar Experimental Garden Experiment No. 10.—Arrangement, etc., as above. *Stock used*—One year old stumps 0.6" to 0.7" diameter.

Topslip Experimental Garden Experiment No. 196.—Arrangement, etc., as above. *Stock used*—One year old stumps 0.4" to 0.6" diameter.

Kannoth Experimental Garden Experiment No. 77.—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 29th April 1939.

Locality.	Date of planting.	Treatment.	Survival percentage.	Mean height in inches.	Difference means.	Significance.
Begur Experimental Garden—	1st April 1939.	Buried.	95	31.2 ± 1.61	+ 0.1 ± 2.54	N.S.
Experiment No. 145.	1st June 1939.	Normal.	83	31.1 ± 1.95	Control.	..
Dhoni Experimental Garden—	1st April 1939.	Buried.	97	11.9 ± 0.51	- 1.0 ± 0.76	N.S.
Experiment No. 180.	1st June 1939.	Normal.	97	12.9 ± 0.57	Control.	..
Walayar Experimental Garden—	1st April 1939.	Buried.	99	33.9 ± 2.52	+ 4.7 ± 3.24	N.S.
Experiment No. 10.	1st June 1939.	Normal.	92	34.2 ± 2.16	Control.	..
Topslip Experimental Garden—	1st April 1939.	Buried.	82	16.0 ± 1.20	- 3.9 ± 1.80	S.
Experiment No. 196.	1st June 1939.	Normal.	84	19.9 ± 1.32	Control.	..
Kannoth Experimental Garden—	1st April 1939.	Buried.	83	16.7 ± 0.94	- 0.8 ± 1.41	N.S.
Experiment No. 77.	1st June 1939.	Normal.	44	17.5 ± 1.06	Control.	..
		Buried.	83	13.1 ± 0.62	+ 0.6 ± 0.83	N.S.
		Normal.	86	12.5 ± 0.56	Control.	..
		Buried.	97	26.4 ± 1.15	+ 4.8 ± 1.52	S.
		Normal.	87	21.6 ± 1.00	Control.	..
		Buried.	93	16.4 ± 0.83	- 1.1 ± 0.93	N.S.
		Normal.	92	17.5 ± 0.75	Control.	..
		Buried.	86	21.1 ± 1.23	- 4.5 ± 2.34	N.S.
		Normal.	82	25.6 ± 2.02	Control.	..
		Buried.	94	7.8 ± 0.41	- 0.2 ± 0.54	N.S.
		Normal.	98	8.0 ± 0.36	Control.	..

275. Direct sowing in a burned over area—Best season (vide paragraphs 147 to 149).—

Experiments Nos. 189 to 195, 205 to 208, 217 and 246—Emmanur Experimental Garden.—Species—As shown in the table below. *Arrangement*—ABCDEFGH HG FEDCBA repeated ten times in single lines of 20 patches, i.e., 200 of each treatment. *Espacement*—2' × 2'. *Soil preparation*—9" cube pits ash from the burn being worked into each pit. *Stock used*—10 seeds per patch. *Dates of sowing*—On the 1st of each month from April to November 1938. *Treatment*—Clean weeded in 1' diameter circles round the plants.

Experiment number.	Species.	Measurements on 8th January 1940.	Date of sowing (10 seeds per patch).							
			1st April 1938.	1st May 1938.	1st June 1938.	1st July 1938.	1st Aug. 1938.	1st Sep. 1938.	1st October 1938.	1st November 1938.
189	<i>Acacia arabica</i> ..	Percentage survivals.	39	69	71	62	85	62	17	11
		Mean height in inches.	70.0	65.0	65.5	61.9	63.7	63.0	20.8	26.3
190	<i>Acacia ferruginea</i> .	Percentage survivals.	6	25	28	93	100	85	42	17
		Mean height in inches.	39.7	36.1	25.2	25.2	47.2	18.8	16.9	16.9
191	<i>Acacia sundra</i> ..	Percentage survivals.	16	50	65	83	87	68	23	37
		Mean height in inches.	43.0	46.3	33.0	40.3	42.1	30.7	21.4	24.7
192	<i>Albizia amara</i> ..	Percentage survivals.	7	47	90	91	92	53	24	27
		Mean height in inches.	23.0	25.3	22.8	22.8	24.3	15.2	12.6	13.6
193	<i>Albizia lebbek</i> ..	Percentage survivals.	23	50	72	91	76	60	23	13
		Mean height in inches.	19.6	26.0	19.1	20.3	20.3	17.4	7.0	3.4

Experi- ment num- ber.	Species.	Measurements on 8th January 1940.	Date of sowing (10 seeds per patch).								
			1st April 1938.	1st May 1938.	1st June 1938.	1st July 1938.	1st August 1938.	1st Sep- tember 1938.	1st Octo- ber 1938.	1st Nov- ember 1938.	
194	<i>Cassia auriculata.</i>	Percentage survivals.	78	88	91	96	98	80	63	87	
		Mean height in inches.	35.8	32.9	32.2	33.6	36.2	24.3	14.6	18.4	
195	<i>Pterocarpus santalinus.</i>	Percentage survivals.	0	3	13	5	25	11	0	0	
		Mean height in inches.	0	12.2	9.3	10.0	9.0	7.6	0	0	
205	<i>Acacia auriculiformis.</i>	Percentage survivals.	*	22	27	19	37	37	3	1	
		Mean height in inches.	*	75.3	77.8	72.0	76.3	67.6	66.0	71.0	
206	<i>Acacia planifrons.</i>	Percentage survivals.	*	66	87	93	98	85	29	34	
		Mean height in inches.	*	42.3	37.8	39.4	45.3	32.7	24.0	23.5	
207	<i>Cassia siamea</i> ..	Percentage survivals.	*	73	94	59	97	78	28	16	
		Mean height in inches.	*	44.8	44.2	46.2	50.8	41.8	40.7	43.9	
208	<i>Wrightia tinctoria.</i>	Percentage survivals.	*	52	77	81	88	91	6	14	
		Mean height in inches.	*	32.9	32.2	34.5	32.2	28.8	24.4	20.3	
217	<i>Prosopis juliflora.</i>	Percentage survivals.	*	*	38	54	81	91	49	44	
		Mean height in inches.	*	*	73.2	77.1	84.8	74.2	53.1	49.7	
246	<i>Azadirachta indica.</i>	Percentage survivals.	*	*	*	*	95	76	1	0	
		Mean height in inches.	*	*	*	*	58.9	55.7	42.5	0	
Average survival percentage ..			24	49	63	69	80	67	26	26	
Average mean height ..			33.0	39.9	39.9	40.3	44.9	35.2	25.1	26.0	

* 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.

276. Direct sowing—Comparison of burning and no burning, soil working and no soil working before sowing (vide paragraph 152)—

Experiments Nos. 230 to 236—Emmanur Experimental Garden.—Species—As shown in the table below. Arrangement—A plot 120' x 120' divided into 30 sub-plots of which 10 were burned and 10 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—A and C worked pits 9" cube. C and D burned—B and D soil loosened just enough to sow seed. Espacement—2' x 2'. Soil preparation—In the soil worked area 9" x 9" x 6". Ash mixture with the soil. In the non-soil-worked area just enough soil working to be able to sow. Stock used—10 seeds per patch. Date of sowing—16th July 1938. Treatment—Kept clean weeded throughout.

NOTE.—In the burned areas brushwood was piled 6' high and beaten down to 4' high before burning.

Experi- ment number.	Species.	Measurements on 16th January 1940.	Area not burned.		Area burned.	
			Worked pits.	No soil working.	Worked pits.	No soil working.
230	<i>Acacia arabica</i> ..	Percentage survivals ..	15	13	45	29
		Mean height growth in inches.	32.3	32.6	57.9	43.2
231	<i>Albizia amara</i> ..	Percentage survivals ..	46	45	83	73
		Mean height growth in inches.	8.8	8.3	20.2	15.9
232	<i>Acacia planifrons</i> ..	Percentage survivals ..	59	64	95	95
		Mean height growth in inches.	14.0	14.5	35.4	26.8
233	<i>Cassia auriculata</i> ..	Percentage survivals ..	48	47	87	75
		Mean height growth in inches.	7.3	9.0	37.6	33.2
234	<i>Cassia siamea</i> ..	Percentage survivals ..	0	0	95	77
		Mean height growth in inches.	0	0	39.7	38.5
235	<i>Dolichandrone crispata</i> .	Percentage survivals ..	11	3	73	96
		Mean height growth in inches.	2.4	2.3	17.2	14.8
236	<i>Zizyphus jujuba</i> ..	Percentage survivals ..	3	3	51	56
		Mean height growth in inches.	1.7	3.0	22.1	18.2
Average of all species ..		Percentage survivals ..	26	25	76	71.2
		Mean height growth in inches.	9.5	10.0	32.9	27.2

277. Comparison of sowing, entire transplanting and stump planting (vide paragraph 153)—

Experiments Nos. 224 to 229—Emmanur Experimental Garden.—Species—As in the table below. Arrangement—ABC CBA repeated 10 times in single lines of 10 plants, i.e., 100 per treatment per species. Espacement—2' x 2'. Soil preparation—Area burned and ash mixed with the soil, soil worked 9" x 9" x 6" for sowing, 9" crowbar holes for stump planting and soil worked 9" x 9" x 9" for transplanting. Stock used—Sowing 10 seeds per patch, transplanting and stump planting one year old plants from Emmanur nursery. Date of sowing—15th July 1938. Date of transplanting—14th November 1938. Date of stump planting—27th September 1938. Treatment—Clean weeding in one foot diameter circles round the plants.

Measurements in January 1940.

Experi- ment number.	Species.	Percentage survivals.			Mean height in inches.		
		Sowing.	Trans- planting.	Stump- ing.	Sowing.	Trans- planting.	Stump- ing.
224	<i>Dolichandrone crispata</i> .	48	34	41	41.2	22.0	30.4
225	<i>Hardwickia binata</i> ..	34	5	41	25.8	14.6	19.4
226	<i>Pterocarpus santalinus</i> .	22	18	61	12.1	9.3	9.6
227	<i>Scoymila febrifuga</i> ..	48	17	62	22.8	7.5	12.7
228	<i>Wrightia tinctoria</i> ..	74	48	63	23.5	18.4	23.4
229	<i>Azadirachta indica</i> ..	61	41	76	67.5	45.0	60.3

277-A. Comparison of sowing, entire transplanting and stump planting (vide paragraph 153)—

Experiments Nos. 260 to 265—Emmanur Experimental Garden.—Species—As in the table below. Arrangement, etc., as above. Date of sowing—7th August 1939. Date of transplanting—6th October 1939. Date of stump planting—20th September 1939.

Experiment number.	Species.	Percentage survivals.			Mean height in inches.		
		Sowing.	Trans-planting.	Stump-ing.	Sowing.	Trans-planting.	Stump-ing.
260	<i>Azadirachta indica</i> ..	80	35	65	5·4	10·4	5·6
261	<i>Bauhinia purpurea</i> ..	78	16	23	30·5	7·8	12·4
262	<i>Dolichandrone crispata</i> .	4	66	65	10·8	4·5	3·8
263	<i>Hardwickia binata</i> ..	1	23	19	2·0	7·1	4·2
264	<i>Pterocarpus santalinus</i> .	29	13	87	3·5	6·6	3·7
265	<i>Wrightia tinctoria</i> ..	48	81	38	7·0	5·0	4·8

Experiments Nos. 221 to 223—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 10 times; i.e., 100 plants per treatment. *Espacement*—2' x 2'. *Soil preparation*—Crowbar holes for stumps, pits 6" x 6" x 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 years 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 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 15th January 1940.	1st July 1933.					1st August 1933.		1st September 1933.		1st October 1933.
			A-1.	A-2.	C-1.	C-2.	D-1.	D-2.	E-1.			
221	<i>Pterocarpus santalinus</i> .	Percentage survivals ..	3	12	37	85	21	24	11			
		Mean height in inches ..	28.0	17.5	8.6	12.8	10.6	10.8	10.3			
222	<i>Azadirachta indica</i> ..	Percentage survivals ..	20	1	80	64	13	2	5			
		Mean height in inches ..	78.7	44.0	67.4	62.2	63.8	56.0	70.5			
		Percentage survivals ..	5	9	19	82	50	46	0			
223	<i>Wrightia tinctoria</i> ..	Mean height in inches ..	48.8	36.2	33.3	39.4	33.9	37.2	0			

278-A. Experiments Nos. 257 to 259—*Emmanur Experimental Garden* (vide paragraph 154)—

Species.—As in the table below. *Arrangement, etc.*, as above. *Stock used*.—As above. *Dates of stump planting*.—1st July 1939, 1st August 1939, 1st September 1939 and 1st October 1939. *Dates of transplanting*.—9th August 1939 and 6th October 1939.

1957 to 1959—*Experimental*

246-A. Department of Agriculture, New Zealand.
Garden (vide paragraph 154)—
Species.—As in the table below. *Arrangement, etc.*, as above. *Stock used*.—As above. *Dates of stump planting*.—1st July 1939, 1st August 1939, 1st September 1939 and 1st October 1939. *Dates of transplanting*.—9th August 1939 and 6th October 1939.

Experiment number.	Species.	Measurement on 15th January 1940.	Stump planting on						Transplanting on			
			1st July 1933.	1st August 1933.	1st September 1933.	1st October 1933.	18th July 1933.	5th November 1933.	9th August 1939.	6th October 1939.		
			A-1.	A-2.	C-1.	C-2.	D-1.	D-2.	E-1.	E-2.	B.	F.
221	<i>Pterocarpus santalinus</i> .	Percentage survivals ..	3	12	37	85	21	24.5	11	9	20	19
		Mean height in inches ..	28.0	17.5	88.6	12.8	10.6	10.8	10.3	2	13.0	6.8
222	<i>Azadirachta indica</i> ..	Percentage survivals ..	20	1	80	64	13	2	2	56.5	4	26
		Mean height in inches ..	78.7	44.0	67.4	62.2	63.8	56.0	70.5	0	64.0	60.5
223	<i>Wrightia tinctoria</i> ..	Percentage survivals ..	5	9	19	85	50	46	0	35.3	26	43
		Mean height in inches ..	48.8	39.2	38.3	39.4	33.9	37.2	0	35.3	40.2	29.2

278-A. Experiments Nos. 257 to 259—*Emmanur Experimental Garden* (vide paragraph 154)—

Species.—As in the table below. Arrangement, etc., as above. Stock used—As above. Dates of stump planting—1st July 1939, 1st August 1939, 1st September 1939 and 1st October 1939. Dates of transplanting—9th August 1939 and 6th October 1939.

Experiment number.	Species.	Measurement on 15th January 1940.	Stump planting on						Transplanting on			
			1st July 1939.	1st August 1939.	1st September 1939.	1st October 1939.	9th August 1939.	6th October 1939.				
			A-1.	A-2.	C-1.	C-2.	D-1.	D-2.	E-1.	E-2.	B.	F.
257	<i>Azadirachta indica</i> ..	Percentage survivals ..	16	33	0	1	0	5	30	69	27	55
		Mean height in inches ..	15.3	16.6	0	8.0	6.1	5.0	4.3	5.0	11.9	8.7
258	<i>Pterocarpus santalinus</i> ..	Percentage survivals ..	67	57	22	43	62	64	39	81	40	33
		Mean height in inches ..	66.1	7.5	5.3	6.4	6.3	6.7	3.4	4.1	8.1	8.7
259	<i>Wrightia tinctoria</i> ..	Percentage survivals ..	20	31	5	19	39	24	69	80	76	50
		Mean height in inches ..	5.3	7.4	5.2	5.9	6.8	6.7	5.0	5.6	9.6	5.8

279. Direct sowing—Best date (under top canopy only) (vide paragraph 199)—

Chandanathode Experimental Garden, Experiment No. 179.—
Species—*Acrocarpus fraxinifolius*. Arrangement—ABCD
DCBA repeated ten times in single lines of ten plants
(i.e., 100 per treatment). Espacement— $3' \times 1\frac{1}{2}'$. Soil
preparation—Patches 1' diameter worked 6" deep. Stock
used—Ten seeds per patch. Dates of sowing—(A) 1st
May 1939, (B) 1st June 1939, (C) 1st July 1939, (D)
1st August 1939. Weeding—Normal district practice.

Chandanathode Experimental Garden Experiment No. 178.—
Species—*Cedrela toona*. Arrangement as above. Dates of
sowing—As above.

Chandanathode Experimental Garden Experiment No. 177.—
Species—*Swietenia macrophylla*. Arrangement, etc., as
above. Dates of sowing—(A) 1st April 1939, (B) 1st
May 1939, (C) 1st June 1939, (D) 1st July 1939, (E) 1st
August 1939.

Karianshola Experimental Garden Experiment No. 140.—
Species—*Mesua ferrea*. Arrangement, etc., as above.
Dates of sowing—(A) 15th May 1939, (B) 1st June 1939,
(C) 15 June 1939, (D) 1st July 1939, (E) 15th July 1939.

Karianshola Experimental Garden Experiment No. 137.—
Species—*Swietenia macrophylla*. Arrangement, etc., as
above. Dates of sowing—(A) 1st April 1939, (B) 15th
April 1939, (C) 1st May 1939, (D) 15th May 1939, (E) 1st
June 1939.

Karianshola Experimental Garden Experiment No. 139.—
Species—*Acrocarpus fraxinifolius*. Arrangement, etc., as
above. Dates of sowing—(A) 15th May 1939, (B) 1st June
1939, (C) 15th June 1939, (D) 1st July 1939, (E) 15th
July 1939.

Survival percentage in January 1940.

Locality.	Species.	Experi- ment number.	1st April 1939.	15th April 1939.	1st May 1939.	15th May 1939.	1st June 1939.	15th June 1939.	1st July 1939.	15th July 1939.	1st August 1939.	15th August 1939.	1st Sep- tember 1939.
Chandanathode	<i>Acrocarpus fraxinifolius</i> .	179	..	..	8	..	..	..	33	..	8	..	..
	<i>Cedrela toona</i> ..	178	..	..	13	..	..	..	15	..	3	..	..
Karianshola	<i>Swietenia macrophylla</i> ..	177	..	..	48	..	..	..	3	..	1	..	..
	<i>Mesua ferrea</i> ..	140	..	..	..	..	..	..	55	..	..	..	..
	<i>Swietenia macrophylla</i> ..	137	..	..	82	..	..	..	..	..	..	..	..
	<i>Acrocarpus fraxinifolius</i> .	139	..	..	..	..	..	..	32	..	..	..	..

Mean height growth in January 1940 in inches.

Chandanathode	<i>Acrocarpus fraxinifolius</i> .	179	..	..	5.6	..	..	..	4.0	..	3.4	..	..
	<i>Cedrela toona</i> ..	178	..	..	6.4	..	..	..	2.9	..	3.7	..	..
Karianshola	<i>Swietenia macrophylla</i> ..	177	..	..	7.2	..	..	..	6.0	..	6.0	..	..
	<i>Mesua ferrea</i> ..	140	..	..	..	..	..	..	5.9	..	..	..	..
	<i>Swietenia macrophylla</i> ..	137	..	..	8.6	..	..	..	..	..	..	..	..
	<i>Acrocarpus fraxinifolius</i> .	139	..	..	..	..	..	..	9.7	..	..	..	..

280. Entire transplanting—Best date (under top canopy only) (vide paragraph 200)—

Chandanathode Experimental Garden Experiment No. 180.—*Species*—*Hopea parviflora*. *Arrangement*—ABCDEFGF GFEDCBA repeated ten times in single lines of ten plants (i.e., 100 plants per treatment). *Espacement*—3' × 1½'. *Soil preparation*—1' cube pits. *Stock used*—One year old plants 12 inches to 18 inches high. *Dates of transplanting*—(A) 15th June 1939, (B) 1st July 1939, (C) 15th July 1939, (D) 1st August 1939, (E) 15th August 1939, (F) 1st September 1939, (G) 15th September 1939. *Weeding*—Normal district practice.

Chandanathode Experimental Garden Experiment No. 181.—*Species*—*Swietenia macrophylla*. *Arrangement, etc.*, as above. *Stock used*—One year old plants 18 inches to 24 inches high.

Chandanathode Experimental Garden Experiment No. 182.—*Species*—*Hardwickia pinnata*, *Arrangement, etc.*, as above. *Stock used*—One year old plants 6 inches to 12 inches high.

Chandanathode Experimental Garden Experiment No. 183.—*Species*—*Chickrassia tabularis*. *Arrangement, etc.*, as above. *Stock used*—One year old plants 6 inches to 12 inches high.

Chandanathode Experimental Garden Experiment No. 184.—*Species*—*Bischofia javanica*. *Arrangement, etc.*, as above. *Stock used*—One year old plants 4 inches to 8 inches high.

Chandanathode Experimental Garden Experiment No. 185.—*Species*—*Mesua ferrea*. *Arrangement, etc.*, as above. *Stock used*—One year old plants 6 inches to 12 inches high.

Karianshola Experimental Garden Experiment No. 147.—*Species*—*Swietenia macrophylla*. *Arrangement, etc.*, as above. *Stock used*—One year plants 9 inches to 12 inches high. *Dates of transplanting*—(A) 15th June 1939, (B) 1st July 1939, (C) 15th July 1939, (D) 1st August 1939, (E) 15th August 1939, (F) 1st October 1939, (G) 15th October 1939.

Karianshola Experimental Garden Experiment No. 148.—*Species*—*Hopea parviflora*. *Arrangement, etc.*, as above. *Stock used*—One year old plants 6 inches to 12 inches high.

Karianshola Experimental Garden Experiment No. 149.—*Species*—*Calophyllum elatum*. *Arrangement, etc.*, as above. *Stock used*—One year old plants 6 inches to 12 inches high.

Measurements in January 1940.

Experiment number.	Locality.	Species.	Survival percentage of plants transplanted on							Mean height growth in inches of plants transplanted on						
			15th June 1939.	1st July 1939.	15th July 1939.	1st August 1939.	15th August 1939.	1st September 1939.	15th September 1939.	1st October 1939.	15th October 1939.	1st July 1939.	1st August 1939.	1st September 1939.	1st October 1939.	15th October 1939.
180	Chandanathode	<i>Hopea parviflora</i>	97	93	96	98	93	98	88	..	..	14.8	13.9	12.7	..	..
181		<i>Swietenia macrophylla</i>	89	30	81	93	78	100	97	..	..	18.0	20.0	16.9	..	..
182		<i>Hardwickia pinnata</i>	50	27	53	70	69	91	76	..	..	18.6	20.0	17.4	..	..
183		<i>Chickrassia tabularis</i>	90	53	77	88	89	100	98	..	..	13.6	7.9	4.4	..	..
184		<i>Bischofia javanica</i>	96	93	99	95	96	97	96	..	..	13.6	7.9	8.2	..	..
185	Karianshola	<i>Mesua ferrea</i>	76	85	73	85	65	70	71	..	..	6.5	6.1	5.3	..	..
147		<i>Swietenia macrophylla</i>	93	100	99	18	93	..	..	..	..	4.0	8.4	5.8	..	..
148		<i>Hopea parviflora</i>	96	73	77	13	64	..	..	..	..	11.2	8.7	..	9.9	10.8
149		<i>Calophyllum elatum</i>	14	8	16	0	5	..	..	..	..	7.2	0	..	9.3	6.0
180	Chandanathode	<i>Hopea parviflora</i>	15.2	14.8	14.3	13.9	13.3	12.7	12.2	..	..	15.2	13.9	12.7	..	..
181		<i>Swietenia macrophylla</i>	19.5	18.6	18.0	20.0	16.9	17.4	18.6	..	..	18.0	20.0	16.9	..	..
182		<i>Hardwickia pinnata</i>	4.6	4.1	3.6	7.9	3.1	4.4	3.4	..	..	4.6	7.9	4.4	..	..
183		<i>Chickrassia tabularis</i>	10.8	11.6	13.6	7.9	8.7	8.2	7.2	..	..	10.8	7.9	8.2	..	..
184		<i>Bischofia javanica</i>	7.1	5.6	6.5	6.1	6.1	5.3	4.2	..	..	7.1	6.1	5.3	..	..
147	Karianshola	<i>Mesua ferrea</i>	7.4	7.5	6.0	8.4	4.0	5.8	5.6	..	..	7.4	8.4	5.8	..	..
148		<i>Swietenia macrophylla</i>	13.9	14.1	14.1	11.2	11.2	..	..	..	..	13.9	14.1	..	12.5	10.8
149		<i>Hopea parviflora</i>	11.3	10.3	10.3	8.7	9.6	..	..	..	..	11.3	8.7	..	9.3	10.8
149		<i>Calophyllum elatum</i>	8.3	7.4	5.6	0	7.2	..	..	..	..	8.3	0	..	9.3	6.0

281. *Stump planting—Best date (under top canopy only) (vide paragraph 201)—*

Chandanathode Experimental Garden Experiment No. 186.—
Species—Artocarpus hirsuta. Arrangement—ABCDE
EDCBA repeated ten times in single lines of ten plants
(i.e., 100 plants per treatment). Espacement—3' × 1½'
Soil preparation—Crowbar holes. Stock used—One year
old plants, stumps 0.3" to 0.4" diameter. Dates of stump
planting—(A) 15th May 1939, (B) 1st June 1939, (C) 15th
June 1939, (D) 1st July 1939 and (E) 15th July 1939
Weeding—Normal district practice.

Chandanathode Experimental Garden Experiment No. 187.—
Species—Cedrela toona. Arrangement, etc., as above
Stock used—One year old plants, stumps 0.3" to 0.4'
diameter.

Chandanathode Experimental Garden Experiment No. 188.—
Species—Chickrassia tabularis. Arrangement, etc., a
above. Stock used—One year old plants, stumps 0.2" to
0.3" diameter.

Karianshola Experimental Garden Experiment No. 141.—
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. 142.—
Species—Cedrela toona. Arrangement, etc., as above
Stock used—One year old plants, stumps 0.3" to 0.9'
diameter.

Karianshola Experimental Garden Experiment No. 143.—
Species—Acrocarpus fraxinifolius. Arrangement, etc., a
above. Stock used—One year old plants, stumps 0.3" t
0.9" diameter.

Karianshola Experimental Garden Experiment No. 144.—
Species—Chickrassia tabularis. Arrangement, etc., a
above. Stock used—One year old plants, stumps 0.3" t
0.7" diameter.

Measurements in January 1940.

Locality.	Experi- ment num- ber.	Species.	Survival percentage of stumps planted on				
			15th May 1939.	1st June 1939.	15th June 1939.	1st July 1939.	15th July 1939.
Chandanathode.	186	<i>Artocarpus hirsuta.</i>	75	70	61	8	0
	187	<i>Cedrela toona</i> ..	73	44	45	28	33
	188	<i>Chickrassia tabu- laris.</i>	76	64	65	80	73
Karianshola ..	141	<i>Artocarpus hirsuta.</i>	83	73	83	87	71
	142	<i>Cedrela toona</i> ..	75	54	53	23	23
	143	<i>Acrocarpus</i> <i>fraxinifolius.</i>	13	4	29	19	26
	144	<i>Chickrassia tabu- laris.</i>	83	87	82	24	21

Locality.	Experi- ment num- ber.	Species.	Mean height growth in inches of stumps planted on				
			15th May 1939.	1st June 1939.	15th June 1939.	1st July 1939.	15th July 1939.
Chandanathode.	186	<i>Artocarpus hirsuta.</i>	2.4	2.5	2.0	1.1	5.3
	187	<i>Cedrela toona</i> ..	11.6	8.3	8.7	7.6	9.3
	188	<i>Chickrassia tabu- laris.</i>	5.7	4.2	4.7	5.4	5.8
Karianshola ..	141	<i>Artocarpus hirsuta.</i>	3.3	2.7	3.0	2.5	2.3
	142	<i>Cedrela toona</i> ..	12.8	11.4	9.8	7.8	7.5
	143	<i>Acrocarpus</i> <i>fraxinifolius.</i>	6.0	6.5	6.1	6.4	4.7
	144	<i>Chickrassia tabu- laris.</i>	8.0	7.7	5.5	5.6	5.0

282. *Comparison of sowing; transplanting small, medium and large transplants; and stumping with small and large stumps under top canopy cover) (vide paragraph 203)—*

Arrangement—For all experiments ABC, etc., CBA repeated ten times in single lines of ten plants (i.e., 100 per treatment). Espacement—For all experiments 3' × 1½'. Soil preparation—For all experiments—Sowing—One foot diameter patches worked 6 inches deep. Transplanting—One foot cube pits. Stumping—Crowbar holes. Weeding for all experiments—Clean weeding.

I. *Acrocarpus fraxinifolius.*

Chandanathode Experimental Garden Experiment No. 139.—
Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants 7½" 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).

Chandanathode Experimental Garden Experiment No. 168.—
Stock used—

- (A) Sowing ten seeds per patch (26th May 1939).
- (B) Transplants 13½" high, one year old (18th August 1939).
- (C) Stumps 0.3" to 0.6" diameter, one year old (18th August 1939).

Karianshola Experimental Garden Experiment No. 146.—
Stock used—

- (A) Sowing twenty seeds per patch (31st May 1939).
- (B) Transplants 2" high, six months old (9th June 1939).
- (C) Transplants 35" high, one year old (9th June 1939).
- (D) Stumps 0.3" to 0.5" diameter, one year old (8th June 1939).
- (E) Stumps 0.8" to 1.0" diameter, one year old (8th June 1939).

II. Aglaia roxburghiana.

Chandanathode Experimental Garden Experiment No. 175.—
Stock used—

- (A) Sowing five seeds per patch (11th September 1939).
- (B) Transplants 4" high, one year old (18th August 1939).
- (C) Stumps 0.1" to 0.2" diameter, one year old (18th August 1939).

III. Artocarpus hirsuta.

Chandanathode Experimental Garden Experiment No. 135.—
Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants 10½" 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).

Karianshola Experimental Garden Experiment No. 138.—
Stock used—

- (A) Sowing ten seeds per patch (30th May 1939).
- (B) Transplants 2½" high, two months old (17th June 1939).
- (C) Transplants 12" high, one year old (17th June 1939).
- (D) Transplants 32" high, two years old (17th June 1939).
- (E) Stumps 0.2" to 0.3" diameter, one year old (17th June 1939).
- (F) Stumps 0.4" to 0.5" diameter, two years old (17th June 1939).

IV. Artocarpus integrifolia.

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, 17 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, 17 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).

Chandanathode Experimental Garden Experiment No. 166.—
Stock used—

- (A) Sowing five seeds per patch (23rd June 1939).
- (B) Transplants 8" high, one year old (16th August 1939).
- (C) Transplants 17" high, one year old (16th August 1939).
- (D) Transplants 30" high, two years old (16th August 1939).
- (E) Stumps 0.3" to 0.4" diameter, one year old (16th August 1939).
- (F) Stumps 0.6" to 0.8" diameter, one year old (16th August 1939).

Karianshola Experimental Garden Experiment No. 145.—
Stock used—

- (A) Sowing three seeds per patch (12th June 1939).
- (B) Transplants 10½" high, two months old (16th June 1939).
- (C) Transplants 27" high, one year old (16th June 1939).
- (D) Transplants 45" high, one year old (16th June 1939).
- (E) Stumps 0.2" to 0.4" diameter, one year old (16th June 1939).
- (F) Stumps 0.5" to 0.9" diameter, one year old (16th June 1939).

V. Balanocarpus utilis.

Chandanathode Experimental Garden Experiment No. 176.—
Stock used—

- (A) Sowing ten seeds per patch (11th October 1939).
- (B) Transplants 6½" high, nine months old (18th August 1939).
- (C) Stumps 0.1" to 0.2" diameter, nine months old (18th August 1939).

VI. *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).

Chandanathode Experimental Garden Experiment No. 174.—Stock used—

- (A) Sowing ten seeds per patch (7th October 1939).
- (B) Transplants 6" high, one year old (17th August 1939).
- (C) Stumps 0.4" to 0.9" diameter, one year old (17th August 1939).

Karianshola Experimental Garden Experiment No. 152.—Stock used—

- (A) Transplants 9" high, one year old (28th June 1939).
- (B) Transplants 24" high, one year old (28th June 1939).
- (C) Transplants 50" high, one year old (28th June 1939).

VII. *Cedrela odorata*.

Chandanathode Experimental Garden Experiment No. 172.—Stock used—

- (A) Sowing ten seeds per patch (26th May 1939).
- (B) Transplants 21½" high, two years old (19th August 1939).
- (C) Transplants 42" high, two years old (19th August 1939).
- (D) Stumps 0.3" to 0.6" diameter, two years old (19th August 1939).
- (E) Stumps 0.8" to 1.0" diameter, two years old (19th August 1939).
- (F) Short cuttings 9" long, two years old (19th August 1939).

VIII. *Cedrela toona*.

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).

IX. *Chickrassia tabularis*.

Chandanathode Experimental Garden Experiment No. 171.—Stock used—

- (A) Sowing ten seeds per patch (28th May 1939).
- (B) Transplants 10½" high, one year old (17th August 1939).
- (C) Transplants 39" high, one year old (17th August 1939).
- (D) Stumps 0.2" to 0.3" diameter, one year old (17th August 1939).
- (E) Stumps 0.4" to 0.7" diameter, one year old (17th August 1939).

Karianshola Experimental Garden Experiment No. 161.—Stock used—

- (A) Sowing ten seeds per patch (31st May 1939).
- (B) Transplants 5½" high, three months old (18th June 1939).
- (C) Transplants 20" high, one year old (18th June 1939).
- (D) Transplants 45" high, one year old (18th June 1939).

X. *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).

Chandanathode Experimental Garden Experiment No. 169.—Stock used—

- (A) Transplants 6½" high, one year old (16th August 1939).
- (B) Transplants 13½" high, one year old (16th August 1939).
- (C) Transplants 19" high, one year old (16th August 1939).
- (D) Transplants 6½" high, one year old, basketed on 19th July 1939 (16th August 1939).
- (E) Stumps 0.4" to 0.6" diameter, one year old (16th August 1939).

Karianshola Experimental Garden Experiment No. 157.—Stock used—

- (A) Transplants 4½" high, one year old (22nd July 1939).
- (B) Transplants 10½" high, one year old (22nd July 1939).
- (C) Transplants 19½" high, one year old (22nd July 1939).
- (D) Transplants 7½" high, one year old, basketed on 6th June 1939 (22nd July 1939).

XI. *Hopea parviflora*.

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).

Karianshola Experimental Garden Experiment No. 162.—Stock used—

- (A) Transplants 10½" high, one year old (17th June 1939).
- (B) Transplants 10½" high, two years old (17th June 1939).

Karianshola Experimental Garden Experiment No. 151.—Stock used—

- (A) Sowing ten seeds per patch (9th June 1939).
- (B) Transplants 2" high, one year old (3rd July 1939).
- (C) Transplants 7½" high, one year old (3rd July 1939).
- (D) Transplants 20" high, two years old (3rd July 1939).

XII. *Mangifera indica*.

Chandanathode Experimental Garden Experiment No. 173.—Stock used—

- (A) Sowing three seeds per patch (23rd June 1939).
- (B) Transplants 12½" high, one year old (17th August 1939).
- (C) Stumps 0.2" to 0.5" diameter, one year old (17th August 1939).

XIII. *Mesua ferrea*.

Chandanathode Experimental Garden Experiment No. 142.—Stock used—

- (A) Sowing ten seeds per patch (4th June 1938).
- (B) Transplants 6" high, 18 months old (4th August 1938).
- (C) Transplants 15" high, 18 months old (4th August 1938).

Chandanathode Experimental Garden Experiment No. 170.—Stock used—

- (A) Sowing ten seeds per patch (28th May 1939).
- (B) Transplants 7" high, two years old (18th August 1939).
- (C) Transplants 14" high, two years old (18th August 1939).

Karianshola Experimental Garden Experiment No. 153.—Stock used—

- (A) Sowing five seeds per patch (15th July 1939).
- (B) Transplants 3" high, three months old (25th July 1939).
- (C) Transplants 8" high, two years old (25th July 1939).

XIV. *Michelia champaka*.

Chandanathode Experimental Garden Experiment No. 145.—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).

XV. *Swietenia macrophylla*.

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, 18 months old (1st August 1938).
- (D) Transplants 35" high, 18 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, 16 months old (3rd June 1938).
- (D) Transplants 35" high, 18 months old (3rd June 1938).

Karianshola Experimental Garden Experiment No. 150.—Stock used—

- (A) Sowing ten seeds per patch (31st May 1939).
- (B) Transplants 10½" high, five months old (7th June 1939).
- (C) Transplants 27" high, 14 months old (7th June 1939).
- (D) Transplants 42" high, two years old (7th June 1939).

Species.	Locality.	Experiment number.	Year of formation.	Percentage survivals in January 1940.						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 frazinifolius</i>	Chandanathode	139	1938	9	11	48	15	0	8	Small transplants best.
	Karianshola	105	1938	35	44	15	15	13	23	Do.
	Chandanathode	169	1939	0	58	24	44	14	37	Stumps best but sowing often successful.
<i>Aglia roxburghiana</i>	Karianshola	146	1939	36	58	24	44	14	37	Small transplants best.
<i>Artocarpus hirsuta</i>	Chandanathode	175	1939	10	84	45	44	7	37	Do.
	Do.	135	1938	55	47	45	42	3	54	Stumps best but sowing often successful.
<i>Artocarpus integrifolia</i>	Do.	103	1938	64	67	16	6	44	32	Do.
	Chandanathode	133	1939	87	45	61	92	69	87	Small transplants best.
	Karianshola	138	1938	85	69	69	75	40	34	Sowing best.
<i>Indiacarpus utilis</i>	Chandanathode	125	1938	80	30	94	16	87	70	Small transplants best.
<i>Bischofia javanica</i>	Karianshola	145	1939	100	75	37	29	73	80	Medium transplants best.
	Chandanathode	176	1939	26	80	80	75	0	10	Do.
	Karianshola	123	1938	1	83	89	75	0	73	Transplanting best although stumping good.
<i>Cedrela odorata</i>	Chandanathode	174	1939	65	97	99	97	16	24	Small transplants best.
<i>Cedrela toona</i>	Karianshola	152	1939	0	0	74	66	16	23	Small transplants best.
	Chandanathode	172	1939	0	0	74	66	16	23	Small transplants best.
	Do.	143	1938	3	0	93	98	84	73	Transplanting best.
<i>Clitracaria tubularis</i>	Karianshola	109	1938	0	0	82	83	45	24	Small transplants best.
	Chandanathode	171	1939	41	56	93	76	16	23	Small transplants best.
<i>Gluta travancorica</i>	Karianshola	161	1939	0	0	82	83	45	24	Small transplants best.
	Do.	107	1938	94	70	4	0	0	7	Transplanting best.
<i>Hopea parviflora</i>	Chandanathode	169	1939	0	82	81	65	0	7	Small transplants best.
	Karianshola	157	1939	0	10	12	3	0	7	Small transplants best.
	Do.	137	1938	9	91	92	86	0	7	Transplanting best.
<i>Mangifera indica</i>	Chandanathode	104	1938	91	68	66	66	0	7	Transplanting best.
<i>Mesua ferrea</i>	Do.	162	1939	100	54	55	55	0	7	Transplanting best.
	Do.	151	1939	100	77	87	29	0	7	Transplanting best.
	Chandanathode	173	1939	46	0	97	0	29	0	Do.
	Do.	142	1938	7	7	49	0	0	0	Do.
<i>Mitchelia champaka</i>	Karianshola	170	1939	21	66	89	0	0	0	Medium best.
<i>Scaevola macrophylla</i>	Chandanathode	153	1939	14	92	35	0	0	0	Medium best.
	Do.	145	1938	0	0	100	0	0	0	Medium best.
	Karianshola	140	1938	0	20	72	69	0	0	Medium best.
	Do.	106	1938	8	83	85	86	0	0	Medium best.
	Do.	150	1939	80	95	100	95	0	0	Medium best.

283. Transplanting under top canopy shade—Comparison of natural forest seedlings and nursery transplants (vide paragraph 204)—

1938 Experiments.

Karianshola Experimental Garden Experiment No. 108.—*Species*—*Mesua ferrea*. Arrangement, etc., ABBA, repeated ten times in single lines of 10 plants (i.e., 100 plants per treatment). *Espacement*—3' × 1½'. *Soil preparation*—1' cube pits. *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.

Measurements in January 1940.

Experiment number.	Species.	Survival percentage.		Mean height in inches.	
		Nursery plants.	Forest plants.	Nursery plants.	Forest plants.
108	<i>Mesua ferrea</i>	18	3	14.2	17.0
110	<i>Hopea parviflora</i>	54	80	13.1	12.5

1939 Experiments.

Karianshola Experimental Garden Experiment No. 158.—*Species*—*Calophyllum elatum*. Arrangement, etc., as above. *Stock used*—(A) Nursery transplants 4" to 12" high, one year old; (B) forest transplants 4" to 12" high. *Date of planting*—24th June 1939.

Karianshola Experimental Garden Experiment No. 159.—*Species*—*Aglia roxburghiana*. Arrangement, etc., as above. *Stock used*—(A) Nursery transplants 4" to 9" high, one year old; (B) forest transplants 4" to 9" high. *Date of planting*—24th June 1939.

Karianshola Experimental Garden Experiment No. 160.—*Species*—*Palaquium ellipticum*. Arrangement, etc., as above. *Stock used*—(A) Nursery transplants 9" to 15" high, one year old; (B) forest transplants 9" to 15" high. *Date of planting*—25th June 1939.

Chandanathode Experimental Garden Experiment No. 189.—*Species*—*Palaquium ellipticum*. Arrangement, etc., as above. *Stock used*—(A) Nursery transplants 7" to 12" high, one year old; (B) forest transplants 7" to 12" high. *Date of planting*—23rd June 1939.

Measurements in January 1940.

Locality.	Experi- ment number.	Species.	Survival per cent.		Mean height in inches.	
			Nursery plants.	Forest plants.	Nursery plants.	Forest plants.
Karianshola ..	158	<i>Calophyllum elatum</i> ..	30	43	6.2	8.9
	159	<i>Aglaia roxburghiana</i> ..	86	75	6.6	4.9
	160	<i>Palaequium ellipticum</i> ..	37	49	12.4	11.1
Chandanathode ..	180	<i>Palaequium ellipticum</i> ..	64	37	8.5	6.6

284. Comparison of direct sowing, naked root transplanting and basket planting (vide paragraph 205).—

Chandanathode Experimental Garden Experiment No. 138.—
Species—*Dysoxylum malabaricum*. Arrangement—ABC
CBA repeated 10 times in single lines of 10 plants (i.e.,
100 plants per treatment). Espacement—3' × 1½'. Soil
preparation 1' cube pits. Stock used—(A) Sowing three
seeds per patch (23rd July 1938); (B) transplants 12½" high,
one year old (4th August 1938); (C) transplants 12½"
high, one year old basketed on 29th June 1938 (17th
August 1938). Treatment—Kept clean weeded.

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 inches transplants one year old (4th
August 1938); (C) 14" transplants, one 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 ten seeds per patch (14th July
1938); (B) 12" transplants, one year old (22nd June)
1938); (C) 8" transplants, one year old basketed on 12th
May 1938 (22nd June 1938).

Chandanathode Experimental Garden Experiment No. 167.—
Species—*Dysoxylum malabaricum*. Arrangement, etc., as
above. Stock used—(A) Sowing three seeds per patch
(29th August 1939); (B) 9" transplants, one year old
18th August 1939); (C) 9" transplants, one year old,
basketed on 19th July 1939 (18th August 1939).

Karianshola Experimental Garden Experiment No. 151.—
Species—*Vateria indica*. Arrangement, etc., as above.
Stock used—(A) Sowing 10 seeds per patch (13th August
1939); (B) 16" transplants, one year old (22 July 1939);
(C) 10" transplants, one year old, basketed on 6th June 1939
(22nd July 1939).

Measurements in January 1940.

Locality.	Experi- ment number.	Species.	Treatment.	Survival	Mean
				per- centage.	height in inches.
Chandanathode.	138/1938.	<i>Dysoxylum malabaricum</i> .	(A) Sowing	8	7.6
			(B) 12½" transplants.	4	8.0
			(C) 12½" basketed transplants.	13	9.1
	141/1938.	<i>Dipterocarpus indicus</i> .	(A) Sowing	1	18.0
			(B) 14" transplants ..	34	15.0
			(C) 14" basketed transplants.	63	9.3
Karianshola ..	124/1938.	<i>Vateria indica</i> ..	(A) Sowing	80	12.7
			(B) 12" transplants ..	86	10.8
			(C) 8" basketed transplants.	69	11.8
Chandanathode.	167/1939.	<i>Dysoxylum malabaricum</i> .	(A) Sowing	1	5.0
			(B) 9" transplants ..	34	9.6
			(C) 9" basketed transplants.	93	5.1
Karianshola ..	154/1939.	<i>Vateria indica</i> ..	(A) Sowing	88	6.8
			(B) 16" transplants.	96	14.5
			(C) 10" basketed transplants.	100	11.8

285. Comparison of stumps and cuttings from nursery transplants and natural forest trees (vide paragraph 206).—

1938 Experiments.

Chandanathode Experimental Garden Experiment No. 156.—
Species—*Cedrela toona*. Arrangement, etc., as above.
Stock used—(A) Stumps from nursery seedlings, one year
old and 0.2" to 0.3" diameter; (B) cuttings from nursery
seedlings, one year old, 18" long 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, one year
old and 0.4" to 0.5" diameter; (B) cuttings from nursery
seedlings, one 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 ten seeds per
patch; (B) stumps from forest seedlings, 0.4" to 0.7"
diameter; (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.

1939 Experiments.

Karianshola Experimental Garden Experiment No. 155.—
Species—*Chickrassia tabularis*. Arrangement, etc., as
above. Stock used—(A) Stumps from nursery seedlings,
one year old, 0.3" to 0.4" diameter; (B) cuttings from

nursery seedlings, one year old, 9½" long, 0.4" to 0.5" diameter; (C) cuttings from forest seedlings, 9½" long, 0.4" to 0.5" diameter. Date of planting—27th June 1939.

Karianshola Experimental Garden Experiment No. 156—
Species—*Cedrela odorata*. **Arrangement, etc.,** as above.
Stock used—(A) Sowing ten seeds per patch; (B) stumps from nursery seedlings, one year old, 0.5" to 0.8" diameter; (C) cuttings from nursery seedlings, one year old, 10" long and 0.4" to 0.6" diameter. Date of planting—12th June 1939. Date of sowing—31st May 1939.

Measurements in January 1940.

Locality.	Experi- ment number.	Species.	Treatment.	Survival percent age.	Mean height growth in inches.
Chandanathode ..	156/1938	<i>Cedrela toona</i> ..	(A) Stumps ..	61	16.3
			(B) Nursery cuttings ..	72	23.5
			(C) Forest cuttings ..	0	0
Karianshola ..	113/1938	<i>Cedrela toona</i> ..	(A) Stumps ..	23	42.0
			(B) Nursery cuttings ..	27	54.0
			(C) Forest cuttings ..	0	0
Karianshola ..	114/1938	<i>Chickrassia tabula- ris.</i>	(A) Sowing ..	43	27.0
			(B) Forest stumps ..	68	23.0
			(C) Forest cuttings ..	20	26.9
Karianshola ..	155/1939	<i>Chickrassia tabula- ris.</i>	(A) Stumps ..	82	5.1
			(B) Nursery cuttings ..	45	7.1
			(C) Forest cuttings ..	41	7.8
Karianshola ..	156/1939	<i>Cedrela odorata</i> ..	(A) Sowing ..	1	11.0
			(B) Stumps ..	4	9.0
			(C) Nursery cuttings ..	23	13.2

286. Insects collected from Potculture plot at Denkanikota (vide paragraph 222).

Name of species.	April.	May.	June.	July.
PENTATOMIDÆ.				
<i>Canthecoma parva</i> Dist. ..	..	..	..	..
<i>Chrysocoris stockerus</i> Linn. ..	..	..	..	..
<i>Chrysocoris stockerus</i> sp. (nymph) ..	..	1	1	2
<i>Coptosoma cribrarium</i> Fabr. ..	..	3	..	..
<i>Cyclopelta sicciifolia</i> Westw. ..	1	1	..	..
<i>Halys dentatus</i> Fabr. ..	..	..	..	..
<i>Plantia fimbriata</i> Fabr. ..	..	..	..	1
<i>Pentatomidae</i> ..	1	..	1	..
CORIIDÆ.				
<i>Aschistus</i> sp. ..	..	..	..	..
<i>Cleatus</i> sp. ..	1	..	..	..
<i>Homocerus</i> sp. ..	..	..	..	2
<i>Riptortus linearis</i> Fabr. ..	..	..	..	1
<i>Riptortus pedestris</i> ..	..	..	1	..
LYGAIDÆ.				
<i>Geocoris</i> sp. ..	..	..	..	2
<i>Graptostethus argentatus</i> Fabr. ..	..	1	1	1
<i>Lygaeid</i> (nymph) ..	..	..	..	1
<i>Oxocarynus laetus</i> ..	..	..	1	1
<i>Dysdercus cingulatus</i> ..	..	..	1	1
REDUVIDÆ.				
<i>Cydnoecoris gilvus</i> Burm. ..	1	..	..	..
CAPSIDÆ.				
<i>Adelphocoris retutum</i> ..	..	1	..	..
<i>Capsid</i> ..	..	..	..	7
<i>Lucinatus punctatus</i> Kirby ..	1	..	..	1
PSYLLIDÆ.				
<i>Psyllidæ</i> ..	25	45*	1	3

* 1 damaged.

Name of species.	April.	May.	June.	July.
JASSIDÆ.				
<i>Acropoma walkeri</i> ..	..	..	1	5
<i>Bythoscopus indicus</i> ..	..	..	2	2
<i>Bythoscopus piceatus</i> ..	..	..	..	1
<i>Eudettiz</i> sp. ..	..	1	..	1
<i>Idiocerus clypealis</i> ..	..	4	..	..
<i>Idiocerus</i> sp. ..	..	..	..	1
<i>Jassus elegans</i> ..	..	2	..	1
<i>Jassid</i> ..	..	6	..	..
<i>Jassida</i> (nymph) ..	1	1	..	..
<i>Ledra</i> sp. ..	..	..	..	1
<i>Moonia</i> sp. ..	2	1	..	1
<i>Moonia</i> sp. (nymph) ..	..	1	..	..
<i>Nehala</i> sp. ..	3	5	1	..
<i>Nirvana pallida</i> Melich ..	..	1	..	..
<i>Neodartus arocephaloides</i> ..	..	..	1	..
<i>Petalocephala nigrilinea</i> (nymph) ..	1	..	..	1
<i>Petalocephala nigrilinea</i> Walk. ..	..	..	1	..
<i>Petalocephala granulosa</i> Dist. ..	..	..	..	1
<i>Paralimnus confusus</i> ..	..	1	..	..
<i>Penthimia compacta</i> ..	..	..	..	1
<i>Selanocephalus disparatus</i> Melich ..	..	..	..	4
<i>Selanocephalus</i> sp. ..	..	..	1	..
<i>Typhlocyba</i> sp. ..	1	6	2	1
<i>Scaphoideus festivus</i> ..	..	..	..	1
FULGORIDÆ.				
<i>Coinquinda nigroclavata</i> Fish ..	..	..	..	1
<i>Eurybrachys tomentosa</i> Fabr. ..	..	..	..	3
<i>Flata ferrugata</i> Fabr. ..	..	..	..	1
<i>Fulgorid</i> ..	..	..	..	3
<i>Fulgorid</i> (nymph) ..	1	..	1	3
<i>Sarima subfasciata</i> Mel. ..	..	..	..	1
<i>Sarima nigroclavata</i> Mel. ..	..	2	..	5
<i>Sarima</i> sp. ..	1	..	1	..
<i>Sarima</i> sp. (nymph) ..	..	..	..	1
<i>Tambinia verticalis</i> ..	1	..	..	..
ACRIDIDÆ.				
<i>Acridiidae</i> ..	..	..	1	..
<i>Acridiidae</i> nymph. ..	..	2	..	..
<i>Orthocaris</i> sp. ..	8	4	5	2
GRYLLIDÆ.				
<i>Oecanthus bilineatus</i> ..	..	..	1	..
BLATTIDÆ.				
<i>Blattida</i> (nymph) ..	2	..	..	..
MEMBRACIDÆ.				
<i>Cocosterphus tuberculatus</i> ..	1	..	..	..
<i>Gargara</i> sp. ..	..	..	..	2
<i>Leptocentrus taurus</i> ..	..	1	1	1
<i>Membracidae</i> ..	..	..	..	1
<i>Membracidae</i> (nymph) ..	..	..	1	..
<i>Otinotus oneratus</i> Walk. ..	..	..	1	2
<i>Oxyrhachis</i> sp. ..	..	..	..	1
<i>Parayas</i> sp. ..	..	..	..	5
<i>Tricentrus transversus</i> Dist. ..	..	1	1	..
TETTIGONIDÆ.				
<i>Letana inflata</i> ..	..	..	2	..
<i>Tettigonidae</i> (nymph) ..	..	1	..	1
COCCIDÆ.				
<i>Coccidae</i> ..	2	..	..	..
CURCULIONIDÆ.				
<i>Amblyrhinus pericollis</i> ..	..	..	2	..
<i>Curculionidae</i> ..	2	2	..	..
<i>Dereodius</i> sp. ..	..	..	1	2
<i>Dereodius mastos</i> ..	..	..	1	1
<i>Episomus laceria</i> ..	1	..	..	..
<i>Lixus truncatulus</i> ..	..	..	..	1
<i>Myloborus curvicornis</i> ..	2	6	..	..
<i>Myloborus dorsatus</i> ..	1	1	..	..
<i>Myloborus fabrici</i> ..	..	..	..	1
<i>Myloborus tenuiclavus</i> ..	3	3	3	..
<i>Myloborus viridanus</i> ..	1	3	2	2
<i>Myloborus</i> sp. ..	6	1	13	..
<i>Peltotrachelus pubes</i> ..	1	3	..	1
<i>Pemphres affinis</i> ..	..	..	1	..
<i>Phylaxis</i> sp. ..	1	..	..	1
<i>Xanthochelus fannus</i> ..	..	..	1	1
<i>Zeugeni</i> sp. ..	..	..	1	..

Name of species.	April.	May.	June.	July.
ANTHRIBIDÆ.				
<i>Zygænodes horni</i>	1	..	2	..
CHRYSOMELIDÆ.				
<i>Aethomorpha nigropicta</i>	1	..	..	..
<i>Aspidolopha distincta</i>	1	..	..	..
<i>Chirida binaudata</i> M.	..	..	1	..
<i>Cryptoccephalus vahlæi</i>	..	1	..	1
<i>Cryptoccephalus sexsignatus</i>	..	1	..	1
<i>Cryptoccephalus sp.</i>	..	..	1	2
<i>Coloposoma sp.</i>	..	..	1	1
<i>Eurypetia modesta</i>	1	..	..	1
<i>Gynandrophthalma sp.</i>	1	..	..	..
<i>Hispela brachycera</i>	2	..	..	..
<i>Halticina</i>	..	..	..	..
<i>Seymouria sp.</i>	..	1	..	1
<i>Rhyparida sp.</i>	..	1	..	5
<i>Chrysomelidæ</i>	1	..	..	..
<i>Galerucini</i>	..	1	3	..
LAMIDÆ.				
<i>Polyzonus prasina</i>	1	..	..	5
<i>Purpuricenus sanguinolentus</i>	..	..	..	..
ELATERIDÆ.				
<i>Trachilacon santali</i>	..	..	..	1
COCCINELLIDÆ.				
<i>Argopistes sp.</i>	..	..	..	1
<i>Jauravia sp.</i>	1	..	1	..
<i>Rodolia sp.</i>	..	1	1	..
<i>Thea cincta</i>	..	1	5	1
<i>Veramoia cardoni</i>	..	1	1	1
BRUCHIDÆ.				
<i>Bruchus chinensis</i>	..	..	..	..
<i>Bruchus nalandus</i>	1	..	..	1
<i>Bruchus maculipya</i>	2	3	..	..
<i>Bruchus theobromæ</i>	2	..	..	..
<i>Bruchus sp.</i>	3	..	..	..
<i>Pachymarus lineaticollis</i>	1	..	..	..
<i>Pachymarus gonagra</i>	..	2	1	2
BUPRESTIDÆ.				
<i>Agilus</i>	1	..	1	1
<i>Nelanda sp.</i>	..	5	..	..
<i>Sphenoptera sp.</i>	5	..	..	..
DERMESTIDÆ.				
<i>Dermestida</i>	1	..	..	..
LYCIDÆ.				
<i>Lycostomus praxustus</i>	..	..	..	..
CISTELIDÆ.				
<i>Cistelike</i>	..	..	1	..
MELOLONTINÆ.				
<i>Sericini</i>	..	..	1	..
<i>Schizonycha ruficollis</i>	1	1	..	..
RUTELINÆ.				
<i>Adoretus sp.</i>	..	..	1	..
CATONINÆ.				
<i>Oryctonoma versicolor</i>	..	..	1	..
CUPRIDÆ.				
<i>Onthopagus sp.</i>	1	..	..	..
CLERIDÆ.				
<i>Orthrius fœs</i>	1	..	..	..
CLAVICORNIA.				
<i>Clavicornia</i>	1	..	..	..
ANTHICIDÆ.				
<i>Anthicidæ</i>	1	..	..	..
VESPIDÆ.				
<i>Icaria variegata</i>	1	..	..	..
DIPTERA.				
<i>Diptera</i>	4	1	..	..
	115	133	81	115

287. List of insects collected at Denkanikota from field crops adjoining newly spiked areas (vide paragraph 221).

Name of species.	January.	February.	March.	April.	May.
PENTATOMIDÆ.					
<i>Agonoscelis femoralis</i> Wlk.	1	..	..	..	..
<i>Brachycerocoris camelus</i> Cost.	..	..	..	..	2
<i>Coptosoma eribrarium</i> Fabr.	14	7	2	..	3
<i>Coptosoma siamicum</i> Wlk.	..	..	..	..	2
<i>Coptosoma sp.</i>	3	4	3	2	..
<i>Eusarcocoris guttiger</i> Thumb.	..	..	..	1	..
<i>Eusarcocoris sp.</i>	..	..	..	..	2
<i>Hetera curculionoides</i> Herrsch.	..	..	..	..	1
<i>Hetera nigrofusa</i> Wlk.	..	..	..	..	1
<i>Hetera sp. (nymph)</i>	1	2	..	..	1
<i>Plautia fimbriata</i>	3	3	3	1	2
<i>Plautia viridicollis</i> Westw.	1	1	..	..	..
<i>Pentatomid sp.</i>	1	1	1	1	2
<i>Pentatomid sp. (nymph)</i>	1	1	..	..	2
<i>Nezara sp.</i>	4	1	..	..	2
<i>Macrostyptus subaeneus</i> Dall.	..	1	..	..	..
<i>Tolumnia immaculata</i> Dist.	..	1	..	2	1
<i>Tolumnia sp.</i>	..	..	..	..	2
COREIDÆ.					
<i>Acanthocoris sp.</i>	..	..	..	1	3
<i>Cletus trigonus</i> Thumb.	..	1	..	..	3
<i>Coreidæ (nymph)</i>	..	..	..	3	..
LYGIDÆ.					
<i>Arocatus contractus</i> Dist.	..	..	1	..	..
<i>Blissus latus</i>	..	..	..	..	2
<i>Graptostethus argentatus</i> Fabr.	5	1	..	2	5
<i>Graptostethus servus</i> Fabr.	..	..	..	..	1
<i>Geocoris sp.</i>	1	..	..	1	3
<i>Geocoris sp. (nymph)</i>	..	..	..	..	1
<i>Lygaeus equestris</i> Linn.	..	1	2	2	2
<i>Lygaeidæ</i>	..	..	..	..	1
<i>Lygaeidæ sp. (nymph)</i>	..	..	..	..	1
REDUVIDÆ.					
<i>Rhinocoris nilgiriensis</i> Dist.	..	..	..	..	2
<i>Sphaeroclestes alerrimus</i> Dist.	..	..	..	..	1
<i>Reduvidae</i>	..	..	..	..	1
CAPSIDÆ.					
<i>Adelphocoris relatum</i>	..	..	..	2	4
<i>Capsidæ</i>	..	1	..	..	2
<i>Lucinatus punctatus</i>	..	..	..	..	..
TINGIDIDÆ AND PSYLLIDÆ.					
<i>Tingitidæ</i>	..	..	..	..	1
<i>Psyllidæ</i>	..	1	..	4	..
JASSIDÆ.					
<i>Acropoma walkeri</i>	..	4	11	10	..
<i>Bythoscopus indicus</i>	7	..	1	3	2
<i>Bythoscopus sp.</i>	1	..	..	..	..
<i>Belia apicalis</i>	..	..	..	1	..
<i>Deltoccephalus sp.</i>	..	..	..	..	1
<i>Eutettix</i>	2	1	..	..	..
<i>Goniagnathus sp.</i>	1	..	..	..	..
<i>Idiocerus clypealis</i>	..	..	2	..	1
<i>Idiocerus sp.</i>	..	..	..	..	1
<i>Jassidæ</i>	2	3	..	2	1
<i>Jassidæ (nymph)</i>	3	5	2	1	1
<i>Jassus pauperulus</i>	..	..	..	..	1
<i>Lebra sp. (nymph)</i>	..	1	4	5	1
<i>Mooria sp.</i>	6	6	1	1	6
<i>Neodartus acocephaloides</i>	1	7	..	1	4
<i>Neodartus sp.</i>	..	..	..	..	1
<i>Nehala bipuncticollis</i>	2	..	..	..	2
<i>Nirvana pallida</i>	1	2	..	..	1
<i>Nirvana longitudinalis</i>	2	2	..	..	1
<i>Nephotettix bipunctatus</i>	..	..	..	..	1
<i>Paratimnus confusus</i>	..	2	..	1	2
<i>Petaloccephala nigritinea</i>	..	..	1	1	..
<i>Petaloccephala nigritinea (nymph)</i>	12	10	12	21	1
<i>Petaloccephala granulosa</i>	5	3	2	7	2
<i>Penthimia sp. (nymph)</i>	..	..	..	..	1
<i>Penthimia sp.</i>	..	2	..	..	1
<i>Selenocephalus disparatus</i>	..	..	..	..	2
<i>Thamnotettix sp.</i>	..	..	..	1	3
<i>Typhlocyba sp.</i>	..	..	..	..	2
<i>Nirvana sp. (nymph)</i>	1	..	..	..	..

Name of species.	January.	February.	March.	April.	May.
FULGORIDÆ.					
<i>Coinquinda nigroclava</i> Dist.	..	3	2	1	2
<i>Centromeria</i> sp.	..	..	..	1	..
<i>Eurybrachys tomentosa</i> ..	..	..	..	..	1
<i>Flata ferrugata</i> Fabr.	1	..	..	..	..
<i>Fulgorida</i> sp.	1	2	1	..	1
<i>Fulgorida</i> sp. (nymph)	1	2	3	3	1
<i>Sarina subfasciata</i> Mel.	3	5	9	10	5
<i>Sarina nigrocypta</i> Mel.	1	1	..	..	1
<i>Sarina</i> sp.	..	..	1	..	1
<i>Sarina</i> sp. (nymph)	..	..	..	2	1
<i>Tambinia verticalis</i> ..	..	1	..	1	1
CERCOPIDÆ.					
<i>Clovina puncta</i> ..	1	..	..	..	1
<i>Poophilus costalis</i> ..	..	..	..	..	1
<i>Machærota</i> sp.	..	1	..	..	..
MEMBRACIDÆ.					
<i>Cocosterphus</i> sp.	..	1	..	..	1
<i>Gargara</i> sp.	..	..	..	1	1
<i>Leptocentrus taurus</i> ..	..	2	..	1	1
<i>Olinotus oneratus</i> Walk	4	4	4	1	..
<i>Oxyrhachis</i> sp.	..	1	3	..	..
<i>Membracidae</i> (nymph)	..	..	3	..	1
ACRIDIDÆ.					
<i>Acrididae</i> ..	2	..	1	1	5
<i>Acrididae</i> (nymph)	..	..	1	5	22
<i>Cratogeomys</i> ..	4	1	..	..	..
<i>Tetralodeo monticollis</i> (nymph)	..	1	..	..	..
<i>Orthacris</i> sp.	5	2	1	..	..
GRYLLIDÆ.					
<i>Gryllidae</i> ..	2	..	2	1	2
<i>Ornebius querini</i> ..	..	..	..	1	1
<i>Gryllid</i> (nymph)	..	..	..	..	1
TETTIGONIDÆ.					
<i>Letana inflata</i> ..	4	1	..	..	1
<i>Tettigonia</i> ..	..	1	..	..	..
<i>Tettigonia</i> (nymph)	7	4	..	..	11
MANTIDÆ.					
<i>Eumantissa pulchra</i> ..	..	1	..	..	..
<i>Mantida</i> (nymph)	1	..	1	..	..
BLATTIDÆ.					
<i>Blattidae</i> (nymph)	..	2	..	1	..
<i>Blattella humbertia</i> ..	..	..	..	1	..
<i>Mareta</i> sp.	..	..	..	2	..
<i>Pycnocelus</i> sp.	..	..	..	1	..
COCCIDÆ.					
<i>Coccidae</i> ..	..	..	..	1	..
CURCULIONIDÆ.					
<i>Apion</i> sp.	1	..	..	..	..
<i>Blospyrus inaequalis</i> ..	..	1	..	..	1
<i>Curculionidae</i> ..	..	2	1	1	1
<i>Dereodus sparsus</i> ..	6	9	8	10	4
<i>Dereodus mastos</i> ..	..	..	..	..	6
<i>Episomus lacerta</i> ..	5	1	..	1	3
<i>Episomus</i> sp.	1	..	..	..	1
<i>Lixus tinctulus</i> ..	..	2	..	..	1
<i>Lixus</i> sp.	..	..	..	..	1
<i>Myllocerus discolor</i> ..	13	7	9	9	4
<i>Myllocerus tenuiclavus</i> ..	2	2	..	..	1
<i>Myllocerus subfasciatus</i> ..	..	..	..	..	1
<i>Myllocerus</i> sp.	7	2	2	3	5
<i>Sympiezonia</i> sp.	1	..	..	..	2
<i>Rhynchitini</i> sp.	..	..	..	1	..
<i>Xanthochelus faunus</i> oe.	..	..	..	1	..
<i>Myllocerus viridanus</i> ..	..	..	..	..	1
ANTHRIDIDÆ.					
<i>Zygadenodes horni</i> ..	..	1	..	3	..
<i>Zygadenodes</i> sp.	..	..	..	1	..
CHRYSOMELIDÆ.					
<i>Aspilomorphus sanctæ-crucis</i> F.	1	2	1	..	2
<i>Aspilomorphus miliaris</i> ..	..	..	..	..	3
<i>Chirida ventralis</i> ..	6	8	6	3	3
<i>Chirida bindula</i> M	..	..	..	..	1

Name of species.	January.	February.	March.	April.	May.
CHRYSOMELIDÆ—cont.					
<i>Cryptocephalus</i> sp.	1	1	..	..	..
<i>Clytrasoma palliata</i> ..	..	..	..	..	1
<i>Cassida</i> sp.	..	..	2	..	..
<i>Euryptela modesta</i> ..	..	..	..	2	1
<i>Ezena</i> sp.	..	5	1	..	..
<i>Hispella brachycera</i> ..	..	..	..	..	1
<i>Haltica</i> sp.	2	..	..	..	..
<i>Cocassida pudibunda</i> Boh.	1	..	..	..	..
<i>Scymnus</i> sp.	3	3	1	2	1
<i>Scymnus indigator</i> ..	..	..	..	..	1
<i>Psylla signata</i> ..	..	..	..	..	1
<i>Chrysomelidae</i> (nymph)	..	..	..	..	2
<i>Colaspoma</i> sp.	..	..	..	5	14
<i>Halticini</i> ..	..	..	..	1	..
<i>Brunnus suturalis</i> ..	..	..	..	1	..
LAMIIDÆ.					
<i>Platyzori hisperatigata</i> Fist.	..	2	..	..	2
<i>Pothyma</i> sp.	..	..	..	..	1
<i>Lamiidae</i> ..	..	..	..	1	..
ELATERIDÆ.					
<i>Singhalensis</i> sp.	..	..	..	1	..
<i>Singhalensis taprobanicus</i> ..	..	..	..	1	..
<i>Cardiophorus</i> sp.	..	..	..	2	1
<i>Trachylacon santali</i> ..	..	..	..	..	1
BUPRESTIDÆ.					
<i>Agrilus</i> sp.	..	2	..	..	..
<i>Habrocoma</i> sp.	..	..	1	..	..
<i>Ptosima</i> sp.	..	..	..	1	..
<i>Sphenoptera</i> ..	3	3	3	10	2
<i>Trachys</i> sp.	..	..	1	..	..
MELYRIDÆ.					
<i>Melyridæ</i> ..	..	..	..	1	..
CARABIDÆ.					
<i>Labia dichroma</i> ..	..	..	..	..	1
<i>Lachnothorax biguttatus</i> ..	..	..	..	1	..
<i>Risophilus euproctoides</i> ..	..	..	..	..	3
COCCINELLIDÆ.					
<i>Adalia tetraspilota</i> ..	..	..	..	1	..
<i>Argopistes</i> sp.	..	..	..	..	3
<i>Chilocoris nigrifus</i> ..	..	..	..	1	..
<i>Chilocoris sermuculata</i> alb. undulata	6	1	1	..	6
<i>Epilachna</i> sp.	..	..	..	1	..
<i>Jauraria</i> sp.	8	9	10	6	..
<i>Illis cineta</i> ..	..	1	..	..	3
<i>Pharus horni</i> ..	..	..	..	2	..
<i>Verania cardoni</i> ..	..	2	2	..	..
<i>Coccinellidae</i> ..	..	2	..	..	..
BRUCHIDÆ.					
<i>Bruchus chinensis</i> ..	..	..	..	..	1
<i>Bruchus maculipygga</i> champ.	..	..	..	1	1
<i>Bruchus theobromæ</i> ..	4	1	3	1	2
<i>Bruchus</i> sp.	1	2	2	..	..
<i>Pachymerus</i> sp.	..	1	3	..	..
<i>Sphenomorphus abdominalis</i> ..	..	..	..	1	..
<i>Sphenomorphus</i> sp.	1	..	..	..	..
MELALONTHIDÆ.					
<i>Sericini</i> ..	2	1	..	..	..
<i>Schizonychia xanthodera</i> ..	..	..	..	2	..
<i>Apegonia</i> sp.	..	..	..	..	1
RUTELINÆ.					
<i>Anomala bengalensis</i> ..	..	..	..	1	..
COPRIDÆ.					
<i>Cnitiopius spinipes</i> Roth	..	..	..	1	..
EROTYLIDÆ.					
<i>Macromelus longicornis</i> ..	..	..	..	1	..
LANGURIDÆ.					
<i>Ctenolanguaria bipartita</i> ..	..	..	..	1	..
<i>Ctenolanguaria</i> near bipartita	..	..	..	1	..
TENEBRIONIDÆ.					
<i>Himanticonus fasciculatus</i> ..	..	..	..	1	1
MELOIDÆ.					
<i>Mylabris</i> sp.	3	..	..	1	1

Name of species.	January.	February.	March.	April.	May.
DERMESTIDÆ.					
<i>Attagenus gloriolæ</i>	1			1	1
<i>Dermestidæ</i>					
CISTELLIDÆ.					
<i>Cistellidæ</i>					1
MORDELLIDÆ.					
<i>Mordellidæ</i>			1		1
<i>Clavicorn</i>				1	1
<i>Chrysopa</i>					
<i>Coleoptera</i>					
	210	179	139	197	247
Grand total					972

288. List of insects introduced into the Mass infection cages (vide paragraph 226).

Type number.	Name of insect.	Family.
1	<i>Catacanthus incarnatus</i>	Pentatomidæ.
2	<i>Rhynchocoris plagiatus</i> Wlk.	Do.
3	<i>Halyomorpha picus</i> Fabr.	Do.
4	<i>Plautia fimbriata</i>	Do.
5	<i>Homæocerus</i> sp.	Coreidæ.
5-A	<i>Homæocerus</i> sp.	Do.
6	<i>Protatia cupripes</i> Wied.	Cetoniidæ.
7	<i>Adoretus</i> sp.	Rutelidæ.
8	Not identified	Notodontidæ.
9	<i>Dereodus sparsus</i> Boh.	Curculionidæ.
9-A	<i>Dereodus mastos</i> Hbst.	Do.
10	<i>Xanthochelus faunus</i> Ol.	Do.
10-A	? <i>Neocleus</i> sp.	Do.
11	<i>Sympiezomias cretaceus</i> Fst.	Do.
12	<i>Myllocerus discolor</i> Boh.	Do.
13	<i>Myllocerus denticulatus</i> Boh.	Do.
13-A	<i>Myllocerus viridanus</i> Fabr.	Do.
13-B	<i>Myllocerus</i> sp.	Pentatomidæ.
14	<i>Menida labecula</i> Dist.	Coccinellidæ.
15	<i>Chilocerus nigrinus</i> Fabr.	Pentatomidæ.
16	<i>Coptosoma indicum</i> Deth.	Coccinellidæ.
17	<i>Scymus</i> sp.	Do.
17-A	<i>Scymus nubilus</i> Muls.	Do.
17-B	<i>Scymus</i> sp.	Chrysomelidæ.
17-C	<i>Pagria signata</i> Mots.	Curculionidæ.
17-D	<i>Curculionidæ</i> sp.	Jassidæ.
18	<i>Petaloccephala nigrilinea</i> Wlk.	Do.
18-A	Do.	
and D.	Do.	
18-B	Do.	Do.
18-C	<i>Petaloccephala granulosa</i> Dist.	Do.
19	<i>Acropona walkeri</i> Kirk	Do.
20	<i>Rythocopus indicus</i> Leth	Do.
20-A	<i>Parabolocerus porrectus</i>	Do.
21	<i>Jassus indicus</i> Wlk.	Do.
21-A	<i>Jassus pauperculus</i> Spang	Membracidæ.
22	<i>Coccostrophus tuberculatus</i> Motch.	Do.
22-A	<i>Gargara prob-penangi</i> Funk	Fulgoridæ.
23	<i>Sarima nigroclypeata</i> Mel.	Do.
23-A	<i>Coinquenda nigroclara</i> Dist.	Do.
23-B	<i>Sarima subsaccata</i> Mel.	Do.
23-C	<i>Brahmaloka fletcheri</i>	Membracidæ.
24	<i>Leptocentrus taurus</i> Fab.	Do.
24-A	<i>Otinotus oneratus</i> Wlk.	Do.
24-B	<i>Ozyrhachis mangiferana</i> Dist.	Do.
24-C	<i>Tricentrus transversus</i> Dist.	Pentatomidæ.
25	<i>Coptosoma cribrarium</i> F.	Do.
25-A	<i>Coptosoma fuscumaculatum</i> Dist.	Cercopidæ.
26	<i>Poophilus costalis</i> Wlk.	

pe number.	Name of insect.	Family.
26-A	<i>Aprophara</i> sp.	Cercopidæ.
27	<i>Idiocerus clypealis</i> Leth.	Jassidæ.
27-A	<i>Idiocerus</i> sp.	Do.
27-B	<i>Membracid</i> sp.	Membracidæ.
28	<i>Moonia albimaculata</i> Dist.	Jassidæ.
29	<i>Neodartus acocephaloides</i> Mel.	Do.
29-A	<i>Neodartus scutellatus</i> Dist.	Do.
29-B	<i>Neodartus</i> sp.	Do.
29-C	Do.	Do.
29-D	Do.	Do.
30	<i>Sphenoptera</i> sp.	Buprestidæ.
31	<i>Chlorophorus</i> sp.	Cerambycidæ.
31-A	<i>Decapotoma</i> sp.	Cantharidæ.
31-B	<i>Hymenoptera</i> sp.	Hymenoptera.
32	<i>Bruchus theobromæ</i> L.	Bruchidæ.
32-A	<i>Pachymerus languidus</i> G.	Do.
32-B	<i>Bruchus</i> sp.	Do.
32-C	Do.	Do.
32-D	Do.	Do.
33	<i>Drosicha</i> sp.	Coccidæ.
34	<i>Colosposoma splendidum</i> F.	Chrysomelidæ.
35	<i>Lema</i> sp.	Do.
35-A	<i>Aulacophora atripennis</i> F.	Do.
35-B	<i>Chrysomelid</i> sp.	Do.
36	<i>Micromelea longicornis</i>	Lamiidæ.
37	<i>Halticina</i> sp.	Chrysomelidæ.
37-A	<i>Cleoporus</i> sp.	Do.
38	<i>Machacera</i> sp.	Cercopidæ.
39	Nymphs of <i>Blattid</i>	Blattidæ.
40	<i>Glenea Multiguttata</i>	Cerambycidæ.
41	<i>Chrysopa</i> sp.	Neuroptera.
42	Nymphs of <i>Letana inflata</i> Brum.	Tettigonidæ.
42-A	<i>Allodapa alieana</i> Brum.	Do.
43	<i>Halticini</i> sp.	Chrysomelidæ.
44	<i>Colasposoma</i> sp.	Do.
45	<i>Fulgorid</i> sp.	Fulgoridæ.
46	<i>Dysdercus cingulatus</i> Fabr.	Pyrrhocoridæ.
47	<i>Phanacoccus</i> sp.	Coccidæ.
48	<i>Apion Benignum</i> Fst.	Curculionidæ.
48-A	<i>Apion</i> sp.	Do.
48-B	Do.	Do.
49	<i>Centorrhynchinae</i> sp.	Do.
49-A	<i>Bruchus</i> sp.	Bruchidæ.
50	<i>Amacta lactinea</i> Cram.	Arctidæ.
51	Nymphs of <i>Chrysocoris</i> sp.	Pentatomidæ.
52	<i>Jassid</i> sp.	Jassidæ.
53	<i>Menida varipennis</i> Westw.	Pentatomidæ.
54	<i>Colasposoma semicostatum</i> Jac.	Chrysomelidæ.
54-A	Do. <i>clavicorni</i> Jac.	Do.
55	<i>Alleculea</i> sp.	Cistellidæ.
56	<i>Onthophagus</i> sp.	Coprinæ.
56-A	<i>Spermophagus</i> sp.	Bruchidæ.
57	<i>Oecanthus bilineatus</i>	Gryllidæ.
58	<i>Galerucini</i> sp.	Chrysomelidæ.
59	<i>Mareta</i> sp.	Blattidæ.
59-A	<i>Blattella humbertiana</i> Sans.	Do.
60	<i>Acridiid</i> sp.	Acridiidæ.
61	<i>Aserica</i> sp.	Meialonthidæ.
62	<i>Schizonychia xanthodera</i> Blanch.	Do.
63	<i>Aserica</i> sp.	Do.
63-A	<i>Apogonia</i> sp.	Do.
63-B	<i>Ceropria intuta</i> Wied.	Tenebrionidæ.
64	<i>Chilomenes scarmaculatus</i> ab-undulata Sch.	Coccinellidæ.
65	<i>Agryphus modestus</i> Cand.	Elateridæ.
65-A	<i>Gonocephalum tuberculatum</i> Hopo	Tenebrionidæ.
66	<i>Euantissa pulchra</i>	Mantidæ.
66-A	<i>Humbertiella indica</i>	Do.

Type number.	Name of insect.	Family.
67	<i>Jauravis sorror</i> Ws.	Coccinellidae.
68	<i>Pachymerus gonager</i> Fabr.	Bruchidae.
69	<i>Myllocerus dorsatus</i> F.	Curculionidae.
69-A	<i>Myllocerus</i> sp.	Do.
70	<i>Flatta ferrugata</i> Fabr.	Fulgoridae.
71	<i>Chrysocoris stockerus</i> Linn	Pentatomidae.
72	Nymphs of <i>Membracid</i> sp.	Membracididae.
73	<i>Anoplocnemis phasiana</i> Fabr.	Coreidae.
74	<i>Orthacris</i> sp.	Acridiidae.
75	<i>Letana inflata</i> Br.	Tettigonidae.
75-A	<i>Xipidiopsis straminula</i> Wlk.	Do.
75-B	<i>Elimaecia securigara</i> Br.	Do.
76	<i>Syntomis cyseca</i> Stal.	Syntomidae.
76-A	<i>Syntomis passalis</i> F.	Do.
77	<i>Ledra mutica</i> Fabr.	Jassidae.
77-A	<i>Ledropsis</i> sp.	Do.
78	<i>Gonocephalum</i> sp.	Tenebrionidae.
79	<i>Lagria</i> sp.	Lagridae.
80	<i>Coptosoma siamicum</i> Wlk.	Pentatomidae.
81	<i>Aulacophora foveicollis</i> Lucas	Chrysomelidae.
82	<i>Brachycerocoris camelus</i> Costa	Pentatomidae.
83	<i>Gryllid</i> sp. nymph	Gryllidae.
84	<i>Menida lebeculla</i>	Pentatomidae.
85	<i>Verania cardoni</i> Ws.	Coccinellidae.
85-A	<i>Chilomenes sexmaculatus</i> Fabr.	Do.
86	<i>Allecula</i> sp.	Cistellidae.
87	<i>Psiloptera fastuosa</i> F.	Buprestidae.
88	<i>Jassid</i> sp.	Jassidae.
89	<i>Graptostethus servus</i> Fabr.	Lygaeidae.
89-A	<i>Graptostethus argentatus</i> Fabr.	Do.
90	<i>Lycostomus similis</i> Hopo	Lycidae.
90-A	<i>Lycostomus praestus</i> F.	Do.
91	<i>Irantha armipes</i> Stal.	Reduviidae.
92	<i>Dictyophara</i> sp.	Fulgoridae.
92-A	<i>Centromeria</i> sp.	Do.
92-B	<i>Tambinia verticalis</i> Dist.	Do.
92-C	<i>Fulgorid</i> sp.	Do.
92-D	<i>Coccosterphus tuberculatus</i>	Membracididae.
93	<i>Allecula</i> sp.	Cistellidae.
94	<i>Cephanodes hylas</i> Linn	Sphingidae.
94-A	<i>Macroglossum</i> sp.	Do.
95	<i>Monolepta</i> sp.	Chrysomelidae.
95-A	<i>Platypria hysteric</i>	Do.
96	<i>Eurybrachys tomentosa</i> Fabr.	Fulgoridae.
97	<i>Orycaenus lactus</i> Kirby	Lygaeidae.
98	<i>Euantissa pulchra</i> F.	Mantidae.
98-A	<i>Tropidomantis</i> sp.	Do.
99	<i>Chrotogonus</i> sp.	Acridiidae.
100	<i>Stibara nigricornis</i>	Lamiidae.
101	<i>Curculionid</i> sp.	Curculionidae.
102	<i>Brachyzenia</i> sp.	Acridiidae.
103	<i>Syntomidae</i> sp.	Syntomidae.
104	<i>Macrochellus trimaculatus</i>	Carabidae.
104-A	<i>Jassid</i> sp.	Jassidae.
105	<i>Ceuthorrhynchus asperulus</i> Fish	Curculionidae.
105-A	<i>Curculionid</i> sp.	Do.
106	<i>Petalocnemis obscura</i> Dall	Coreidae.
107	<i>Madasumma varipennis</i>	Gryllidae.
108	<i>Ceuthorrhynchus asperulus</i> Fst.	Curculionidae.
109	<i>Nephotettix bipunctatus</i> Dist.	Jassidae.
109-A	<i>Nephotettix apicalis</i> Dist.	Do.
109-B	<i>Nephotettix</i> sp.	Do.
109-C	<i>Parabolocratus</i> sp.	Do.
110	<i>Tribolium castaneum</i> F.	Tenebrionidae.
111	<i>Capsid</i> sp.	Capsidae.
112	<i>Satapa granulosa</i> Dist.	Fulgoridae.
112-A	<i>Seliza near partita</i> Mel.	Do.

Type number.	Name of insect.	Family.
112-B	<i>Seliza</i> sp.	Fulgoridae.
113	<i>Aserica</i> sp.	Melolonthidae.
113-A	<i>Siricini</i> sp.	Do.
114	<i>Coccinellid</i> sp.	Coccinellidae.
115	<i>Bruchus nalandus</i> Pic.	Bruchidae.
116	<i>Chrysolena madraee</i> Jac.	Chrysomelidae.
116-A	<i>Tenebrionid</i> sp.	Tenebrionidae.
117	<i>Baris 5-maculata</i> Fst.	Curculionidae.
118	<i>Oecanthus bilineatus</i> Chop.	Gryllidae.
119	<i>Pachymerus gonagra</i>	Bruchidae.
120	<i>Ceuthorrhynchus asperulus</i> Fst.	Curculionidae.
121	<i>Cistellid</i> sp.	Cistellidae.
122	<i>Dysdercus cingulatus</i> Fabr.	Pyrrhocoridae.
123	<i>Brassivola hysteric</i> Dist.	Reduviidae.
123-A	<i>Harpactor costalis</i> Stal	Do.
124	<i>Dieuches uniguttatus</i> Thumb.	Lygaeidae.
124-A	<i>Aphanus sordidus</i> Fabr.	Do.
125	<i>Elancon bipartitus</i> Kirby.	Forficulidae.
126	<i>Tettigoniid</i> sp.	Tettigonidae.
127	<i>Cletomorpha</i> sp.	Coreidae.
128	<i>Rhinocoris nilgiriensis</i> Dist.	Reduviidae.
129	<i>Nalanda saundersi</i> Kerr.	Buprestidae.
129-A	<i>Nalanda</i> sp.	Do.
130	<i>Dolycoris indicus</i> Stal.	Pentatomidae.
130-A	<i>Agonoscelis nubila</i> Fab.	Do.
131	Larva of bag worm	Psychidae.
132	<i>Hispella romosa</i> Gyl.	Chrysomelidae.
132-A	<i>Hispahalliscus</i> Guer.	Do.
133	<i>Episomus lacerta</i> F.	Curculionidae.
134	<i>Teratodes</i> sp.	Acridiidae.
135	<i>Cletus bipunctatus</i>	Coreidae.
135-A	<i>Tettigoniid</i> nymph.	Tettigonidae.
136	<i>Idgia melanura</i> Koll-Redt.	Melyridae.
136-A	<i>Tylocerus</i> sp.	Lamproyidae.
136-B	Do.	Cleridae.
137	<i>Pseudocophora</i> sp.	Chrysomelidae.
138	<i>Platynotus disper</i> Hub.	Tenebrionidae.
138-A	<i>Rhytinota pubens</i> Frm.	Do.
138-B	<i>Rhytinota impolita</i> Frm.	Do.
139	<i>Oecophylla samaragdina</i>	Formicidae.
139-A	<i>Colasposoma</i> sp.	Chrysomelidae.
140	<i>Lema lacordairei</i> Baly.	Do.
141	<i>Holotricha</i> sp.	Melolonthidae.
142	<i>Colasposoma</i> sp.	Chrysomelidae.
143	<i>Protaetia squamipennis</i>	Cetoninae.
144	<i>Cistelomorpha</i>	Cistellidae.
145	<i>Aserica</i> sp.	Scarabidae.
146	<i>Cassidinae</i> sp.	Chrysomelidae.
147	<i>Platyzorilispe variegata</i> Fish	Lamiidae.
148	<i>Sthrophyllia rugosa</i> Linn	Tettigonidae.
149	<i>Platynotus excavatus</i> F.	Tenebrionidae.
150	<i>Salurnis marginellus</i> Guer.	Fulgoridae.
150-A	<i>Tambinia verticalis</i> Mel.	Do.
150-B	<i>Sarima nigroclypeata</i> Mel.	Do.
150-C	<i>Bythoscopus indicus</i> Leth.	Jassidae.
151	<i>Aserica</i> sp.	Scarabidae.
152	<i>Nezara viridula</i>	Pentatomidae.
152-A	<i>Nezara viridula</i> L. var. <i>torquata</i> F.	Pentatomidae.
153	<i>Stibara nigricornis</i> F.	Lamiidae.
154	<i>Rhytinota</i> sp.	Tenebrionidae.
155	<i>Riptortus pedestris</i>	Coreidae.
155-A	<i>Riptortus fuscus</i> F.	Do.
156	<i>Gonocephalum</i> sp.	Tenebrionidae.
157	<i>Cryptocephalus sexsignatus</i> F.	Chrysomelidae.
157-A	<i>Ceratobasis nair</i> Lac var.	Do.
157-B	<i>Cryptocephalus</i> sp.	Do.
158	<i>Cryptocephalus sandrocottus</i> Suff.	Do.
158-A	Do. <i>sandrocottus</i> Suff. var.	Do.

Type number.	Name of insect.	Family.
159	<i>Reduviid</i> sp.	<i>Reduviidæ</i> .
160	<i>Serinetia abdominalis</i> Fabr.	<i>Coreidæ</i> .
161	<i>Rhytinota pubens</i> Frm.	<i>Tenebrionidæ</i> .
162	<i>Aschistus sulcatus</i> Dist.	<i>Coreidæ</i> .
162-A	<i>Aschistus</i> sp.	<i>Do.</i>
163	<i>Myillocerus lineatocollis</i> var. <i>frontalis</i>	<i>Curculionidæ</i> .
163-A	<i>Myillocerus</i> sp.	<i>Do.</i>
163-B	<i>Ptochus</i> sp.	<i>Do.</i>
163-C	<i>Ptochus</i> sp.	<i>Do.</i>
164	<i>Peltotrachelus cognatus</i> Mshl.	<i>Do.</i>
165	<i>Alcides pictus</i> Boh.	<i>Do.</i>
165-A	<i>Trigonocolus brachmanae</i> Fst.	<i>Do.</i>
165-B	<i>Alcides collaris</i> Pasco	<i>Do.</i>
165-C	<i>Alcides porrectorostri</i> Mshl.	<i>Do.</i>
165-D	<i>Curculionid</i> sp.	<i>Do.</i>
166	<i>Chinteria coerulea</i> Hbst.	<i>Cetoniinæ</i> .
166-A	<i>Popillia schizonycha</i> Arr.	<i>Rutelinae</i> .
167	<i>Desera geniculata</i> Klug.	<i>Carabidæ</i> .
167-A	<i>Calceida splendidula</i> F.	<i>Do.</i>
168	<i>Lucinatus punctatus</i> Kirby	<i>Capsidæ</i> .
169	<i>Cryptocephalus sexsignatus</i> Fabr.	<i>Chrysomelidæ</i> .
170	<i>Apogonia ? villosella</i> BI	<i>Melolonthidæ</i> .
171	<i>Clytra succinta</i> Lac.	<i>Chrysomelidæ</i> .
172	<i>Phlebonotus pallens</i> Serv.	<i>Blattidæ</i> .
173	<i>Coccinella 7 punctata</i> Wied	<i>Coccinellidæ</i> .
174	<i>Occasida cruenta</i> F.	<i>Chrysomelidæ</i> .
174-A	<i>Chirida prob. promiscus</i> Boh.	<i>Do.</i>
174-B	<i>Chirida ventralis</i> Boh.	<i>Do.</i>
175	<i>Fulgorid</i> sp.	<i>Fulgoridæ</i> .
176	<i>Geocoris tricolor</i> Fabr.	<i>Lygaeidæ</i> .
176-A	<i>Geocoris tituratus</i> Fieb.	<i>Do.</i>
177	<i>Anthrivid</i> sp.	<i>Anthrividæ</i> .
177-A	<i>Bolbocerid</i> sp.	<i>Geotropinæ</i> .
178	<i>Penthimia</i> sp.	<i>Jassidæ</i> .
178-A	<i>Penthimia subniger</i> Dist.	<i>Do.</i>
179	<i>Aspidolopha distincta</i> Duv. var.	<i>Chrysomelidæ</i> .
179-A	<i>Gynandrophthalma cribellata</i> Jac.	<i>Do.</i>
179-B	<i>Cryptocephalus obscurumaculatus</i> Jac.	<i>Do.</i>
180	<i>Trachys bicolor</i> Kerr.	<i>Buprestidæ</i> .
180-A	<i>Habroloma</i> sp.	<i>Do.</i>
180-B	<i>Trachys</i> sp.	<i>Do.</i>
180-C	<i>Habroloma</i> sp.	<i>Do.</i>
181	<i>Brachylacon</i> sp.	<i>Elatridæ</i> .
181-A	<i>Dicronychus multus</i> Ft.	<i>Do.</i>
181-B	<i>Dicronychus</i> sp.	<i>Do.</i>
181-C	<i>Cardiophorus</i> sp.	<i>Do.</i>
182	<i>Hotea nigrorufa</i> Wlk.	<i>Pentatomidæ</i> .
183	<i>Platymetopius</i> sp.	<i>Jassidæ</i> .
183-A	<i>Phymatid</i> sp.	<i>Phymatid.</i>
184	<i>Cletus pugnator</i> Fabr.	<i>Coreidæ</i> .
185	<i>Hotea nigrorufa</i> Wlk.	<i>Pentatomidæ</i> .
186	<i>Dalpada clavata</i> Fabr.	<i>Do.</i>
186-A	<i>Canthecona furcellata</i> Wolff. a predator bug.	<i>Do.</i>
186-B	<i>Dalpada</i> sp.	<i>Do.</i>
186-C	<i>Do.</i>	<i>Do.</i>
187	<i>Forculus viridus</i> Dist.	<i>Fulgoridæ</i> .
188	<i>Hotea</i> sp.	<i>Pentatomidæ</i> .
189	<i>Cleonaria bicolor</i> Th.	<i>Lamiidæ</i> .
190	<i>Acridiid</i> nymph	<i>Acridiidæ</i> .
191	<i>Endochus mornatus</i>	<i>Reduviidæ</i> .
192	<i>Risophilus euproctoides</i>	<i>Carabidæ</i> .
193	<i>Eusarcocoris</i> sp.	<i>Pentatomidæ</i> .
194	<i>Nirvana longitudinalis</i> Dist.	<i>Jassidæ</i> .
195	<i>Mereta</i> sp.	<i>Blattidæ</i> .
196	<i>Macromela longicornis</i>	<i>Languriidæ</i> .
197	<i>Ricania fenestrata</i> F.	<i>Fulgoridæ</i> .
198	<i>Protactia cinerea</i> Kr.	<i>Cetoniinæ</i> .
199	<i>Aspidomorpha miliaris</i> F.	<i>Chrysomelidæ</i> .

Type number.	Name of insect.	Family.
200	<i>Stenozygum speciosum</i> Dall	<i>Pentatomidæ</i> .
201	<i>Coccosterphus tuberculatus</i> Motsch	<i>Membracidæ</i> .
202	<i>Chlamys</i> sp.	<i>Curculionidæ</i> .
203	<i>Salurnis marginellus</i> Guer.	<i>Fulgoridæ</i> .
204	<i>Coptosoma ostensum</i>	<i>Pentatomidæ</i> .
204-A	<i>Coptosoma fuscomaculatus</i> Dist.	<i>Do.</i>
205	<i>Capsid</i> sp.	<i>Capsidæ</i> .
206	<i>Aserica</i> sp.	<i>Melolonthidæ</i> .
206-A	<i>Eurypta modesta</i> F.	<i>Chrysomelidæ</i> .
207	<i>Centhorrhynchinae</i> sp.	<i>Curculionidæ</i> .
207 A	<i>Baridinae</i> sp.	<i>Do.</i>
207-B	<i>Balaninae</i> sp.	<i>Do.</i>
207-C	<i>Anthrivid</i> sp.	<i>Anthrividæ</i> .
208	<i>Micromelia longicornis</i>	<i>Lamiidæ</i> .
209	<i>Bruchus cobromae</i>	<i>Bruchidæ</i> .
210	<i>Nalanda</i> sp.	<i>Buprestidæ</i> .
211	<i>Curculionid</i> sp.	<i>Curculionidæ</i> .
212	<i>Antestia cruciata</i>	<i>Pentatomidæ</i> .
213	<i>Cryptocephalus</i> sp.	<i>Chrysomelidæ</i> .
213-A	<i>Gynandrophthalma longicornis</i> Jac.	<i>Do.</i>
213-B	<i>Galerucini</i> sp.	<i>Do.</i>
214	<i>Coptosoma</i> sp.	<i>Pentatomidæ</i> .
215	<i>Niphona</i> sp.	<i>Lamiidæ</i> .
215-A	<i>Apomyccyna 4-fasciata</i> Tb.	<i>Do.</i>
215-B	<i>Pterolophia</i> sp.	<i>Do.</i>
215-C	<i>Apomyccyna neglecta</i> Pasc.	<i>Do.</i>
215-D	<i>Blepharphaeus modicus</i> Gah.	<i>Do.</i>
215-E	<i>Celosterna scabra</i> tor F.	<i>Do.</i>
215-F	<i>Lamiid</i> sp.	<i>Do.</i>
216	<i>Blattidæ</i> nymph.	<i>Blattidæ</i> .
217	<i>Cryptocephalus</i> sp.	<i>Chrysomelidæ</i> .
218	<i>Membracid</i> sp.	<i>Membracidæ</i> .
218-A	<i>Forficulidæ</i>	<i>Do.</i>
219	<i>Monophlebus</i> sp.	<i>Coccidæ</i> .
220	<i>Nodostoma dimidiatus</i> Jac.	<i>Chrysomelidæ</i> .
220-A	<i>Tettigonid</i> nymph	<i>Tettigonidæ</i> .
221	<i>Phlebonotus pallens</i> Sev.	<i>Blattidæ</i> .
222	<i>Atractomorpha</i> sp.	<i>Acridiidæ</i> .
222-A	<i>Neodartus scutellatus</i>	<i>Jassidæ</i> .
223	<i>Gryllid</i> sp. (nymph)	<i>Gryllidæ</i> .
224	<i>Agrilus acutus</i> Thumb.	<i>Buprestidæ</i> .
225	<i>Callimerus</i> sp.	<i>Cleridæ</i> .
226	<i>Corynodes pergrinus</i> Fues.	<i>Chrysomelidæ</i> .
226-A	<i>Colasposoma coromandeliana</i> Jac.	<i>Do.</i>
227	<i>Sarima</i> sp. Nymph	<i>Fulgoridæ</i> .
228	<i>Pentatomid</i> sp.	<i>Pentatomidæ</i> .
228-A	<i>Do.</i>	<i>Do.</i>
229	<i>Gargara varicolor</i> Stol.	<i>Membracidæ</i> .
230	<i>Chelidonium cinctum</i> Gur.	<i>Lamiidæ</i> .
231	<i>Hyphosoma tenuilimbatus</i>	<i>Chrysomelidæ</i> .
232	<i>Cyrtacanthacris tetrica</i> Linn	<i>Acridiidæ</i> .
233	<i>Chrotopogon</i> sp.	<i>Do.</i>
234	<i>Trilophidia annulata</i> Thun.	<i>Do.</i>
234-A	<i>Oedaleus abruptus</i> L.	<i>Do.</i>
234-B	<i>Acridiid</i>	<i>Do.</i>
234-C	<i>Acrotylus</i> sp.	<i>Do.</i>
234-D	<i>Acrotylus prob. humbertianus</i> Saus	<i>Acridiidæ</i> .
234-E	<i>Acridiid</i> sp.	<i>Do.</i>
235	<i>Chirida ventralis</i>	<i>Chrysomelidæ</i> .
236	<i>Tettigonid</i> nymph	<i>Tettigonidæ</i> .
237	<i>Coptosoma indicum</i>	<i>Pentatomidæ</i> .
238	<i>Chrysocoris</i> sp.	<i>Do.</i>
239	<i>Bruchus</i> sp.	<i>Bruchidæ</i> .
240	<i>Pentatomidæ</i> nymph	<i>Pentatomidæ</i> .
241	<i>Macromelia longicornis</i> Wied.	<i>Languriidæ</i> .
242	<i>Adelphocoris relatum</i> Dist.	<i>Capsidæ</i> .
242-A	<i>Capsid</i> sp. No. 1	<i>Do.</i>

Type number.	Name of insect.	Family.
242-B	<i>Capsid</i> sp. No. 2	Capsidæ
243	<i>Zygadenodes</i> sp.	Anthribidæ.
244	<i>Acridella nasuta</i> L.	Acrididæ.
245	<i>Labia</i> sp.	Carabidæ.
246	<i>Antestia cruciata</i>	Pentatomidæ.
247	<i>Epilachna circularis</i> Kors.	Coccinellidæ.
247-A	<i>Epilachna</i> sp.	Do.
248	<i>Hotea curculionides</i> Hs.	Pentatomidæ.
249	<i>Idgia</i> sp.	Melyridæ.
250	<i>Scutellera nobilis</i> Fabr.	Pentatomidæ.
251	<i>Plautia</i> sp.	Do.
252	<i>Acanthaspis subrufa</i> Dist.	Reduviidæ.
253	<i>Buprestid</i> sp.	Buprestidæ.
254	<i>Catantops</i> sp.	Acrididæ.
255	<i>Lycaenid</i> sp.	Lycaenidæ.
256	<i>Myiobris pustulata</i> F.	Cantharidæ.
257	<i>Rhytinota</i> sp.	Tenebrionidæ.
258	<i>Sagra femorata</i> Dr.	Chrysomelidæ.
259	<i>Lixus truncatulus</i> F.	Curculionidæ.
260	<i>Aserica</i> sp.	Scarabidæ.
261	<i>Acridid</i> nymph	Acrididæ.
262	<i>Syntomidae</i> sp.	Syntomidæ.
263	<i>Sastragala heterospila</i> Wlk.	Pentatomidæ.
264	<i>Physomerus grossipes</i> Fab.	Coreidæ.
264-A	<i>Coreidae</i> nymphs	Do.
265	<i>Nirvana</i> sp.	Jassidæ.



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