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PRELIMINARY INVESTIGATION INTO THE CAUSE AND CURE OF THE SPIKE DISEASE IN SANDAL *(SANTALUM ALBUM)* IN THE NORTH SALEM DIVISION, MADRAS PRESIDENCY.

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Introduction.

The first indications of the spike disease in sandal in the North Salem Division were noticed at the time Mr. McCarthy was the District Forest Officer, in the year 1913 in the Javalagiri R. F., in two small areas—(1) In Bamboo Block V north-east of the Sinnei Guntai Tank, about 30 acres, (2) near Parathavadi Bail about three miles south-east of the above area and within a mile east of the Forest Bungalow, a single spiked sandal.

In January 1915 a single spiked tree was noticed by Mr. C. C. Wilson, Working Plans Officer near Mahadeswarangudi in the Tholuvabetta R. F., about 20 miles south-east of the Javalagiri R. F. and later in the same year the enumeration surveys revealed the existence of a few spiked sandal about four miles east of the Mahadeswarangudi area.

In about May 1915 spiked sandal was observed near Batchecheruvu, in the middle of the Thalli R. F. close to the Mysore frontier and about eight miles north of the Javalagiri R. F. Considering that the disease was first recorded in Mysore and Coorg in 1898, and probably existed there several years before that, it is obvious that the spread of spike has taken an east-

north-eastern direction towards the Salem District, corresponding to the general direction of the south-west monsoons. The accompanying map will show to what an alarming extent the disease has spread in North Salem from 1913 to date. It is surprising how the disease, besides spreading outwards from a nucleus, has jumped large areas of sandal and appeared in isolated patches miles away. Whereas in 1913 spiked sandal in North Salem occurred in two small patches, probably not more than 30 acres in extent, it is now estimated to cover about 20,000 acres in twelve patches, some of them comparatively large. The number of trees extracted, their outturn and the revenue realised, have increased proportionately from 1917 onwards, as shown in the following statement :—

Year.	No. of trees extracted.			Outturn in tons.	Revenue in rupees.	Remarks.
	Heartwood.	Sapwood.	Total.			
1917-18	8,363	3,210	11,573	39⅛	63,731	There is no record of the actual extent of the spiked areas in each year from 1913 to 1924, though from 1924 onwards a record has been kept.
1918-19	10,342	2,527	12,869	53½	70,547	
1919-2	7,189	1,524	8,713	63⅜	88,502	
1920-21	6,448	1,910	8,358	73⅜	112,087	
1921-22	13,686	1,608	15,294	130¾	146,126	
1922-23	16,508	790	17,298	130⅛	151,824	
1923-24	8,274	7,337	15,611	220	214,089	
1924-25	22,546	31,422	53,968	235	276,032	
1925-26	23,273	48,406	71,679	275¾	306 889	
Total ...	116,629	98 734	215,363	1,221	1,429,827	

It will be observed that the percentage of the extracted sapwood trees to the total is about 46. Obviously, as the same areas are being worked year after year and the younger age classes are considerably greater in numbers than those yielding heartwood, we should be draining more and more our reserve fund of

saplings, and if no sure method of permanently freeing an area of spike is discovered, we shall reach a stage when sandal will disappear completely from these areas.

Mr. H. A. Latham, Conservator of Forests, in his Madras Forest Bulletin No. IV of 1922-23 has worked out a loss to the Government of $2\frac{1}{3}$ lakhs of rupees on every 4,960 spiked sapwood trees uprooted. Therefore the total loss incurred by the Government of Madras from 1917 to 1925 in the North Salem Division alone, by the extraction of these trees, is calculated by simple proportion at Rs. 47 lakhs nearly.

As a spiked sandal tree has never been known to recover, it may as well be uprooted, in the hopes of minimising the spread of infection. Up to date, extraction of diseased trees appears to be the only possible means whereby an area can be temporarily ridded of spike, as is evidenced by two areas in the Noganur R. F. and near the Irupal Naicken Tank bund respectively, where spiked trees were noticed in 1922 and were removed promptly, resulting in no recrudescence of the disease. There is nothing, however, to prevent the fresh infection of these areas.

Much has been written previously on this subject by various Forest Officers, as Messrs. P. M. Lushington, H. A. Latham, T. N. Hearsey and Dr. Coleman, Director of Agriculture, Bangalore, but there was no continuity of action owing to the inevitable transfers which Government service involves. It is true that Mr. Hearsey was for three years on special duty in this work, but he restricted his observations to certain insects, particularly the red spider—which by the way is very scarce in these spike areas now—and sowing seeds from partially spiked trees. Mr. Hearsey's period of special duty on spike investigation terminated in the middle of 1919, with the conclusion that "all observations, *i.e.*, spread, distance, isolated attacks, etc., point to a carrier." Then several Rangers were placed by Mr. Latham, Conservator of Forests, on special duty, one after the other, on recording observations in spiked areas in the Javalagiri R. F. near cairn No. 53, in the Javalagiri Bungalow area, and in the Mahadeswarangudi area (Tholuvabetta R. F.). Also, the Nelkundi spike area and Batchecheruvu area were ordered to be inspected regu-

larly and spiked trees removed as soon as found. Grafting and pruning experiments with spike sandal were also to be carried out, but the work appears to have been neglected, owing probably to frequent changes of Rangers, and their probable apathy towards a work carrying no perquisites.

We must endeavour to find out the real cause of infection and a surer and easier means than extraction of combating the scourge. With this object in view the experiments detailed below were started from May 1924 onwards. They can be added to considerably, and suggestions from, and the co-operation of others similarly interested, are welcomed.

These experiments are divided into the following groups :—

I. Observation of demarcated spike areas.

II. Experiments to determine the cause and cure of spike.

III. Germination tests of sandal.

These will be dealt with in order.

I.—Observation of demarcated spike areas.

The object is to test the rapidity and direction of the spread of the disease, and the approximate minimum age or girth when plants get diseased. Also to determine the effect of lantana growth on the spread of spike, as lantana has been suggested as a possible contributing agent to the malady.

(*a*) *The Javalagiri Bungalow area.*—This is 4·6 acres in extent, and was kept under observation from January 1916. 444 sandal trees had been marked for observation. By 1924 all these trees had developed spike and were removed at the time infection was noticed. But the area is stocked now with a fresh crop of healthy seedlings, coming up under a dense growth of lantana ; 6 spiked saplings were removed in the middle of 1925, but no attacks were observed since.

(*b*) *Cairn No.* 53 *observation area* (*Javalagiri R. F.*)—The area, about 4·5 acres in extent, was opened by Mr. Hearsey in 1916. 513 trees were selected in the area and kept under observation. But in 1922 the area was divided into 3 plots A, B and C, the extent of each being 3, 0·85 and 0·85 acres respectively. In B and C lantana was uprooted and A was left with lantana. Also in plot B,

spiked trees were left to die, whereas in C they were removed promptly.

At the time of this report, there are only 10 healthy trees in the area, 9 in plot C and 1 in plot B, but it is not known how many trees were observed in a healthy condition in 1922, when the area was divided into plots, and so it is not possible to deduce any conclusions now.

In January and February 1925, the area was reduced to 4 acres by omitting the unreserve portion ($\frac{1}{2}$ acre) from plot A, and the area was re-enumerated and fenced with barbed wire as a protection against cattle and deer. All saplings above $1\frac{1}{2}$ ft. in height were numbered and the distribution was as follows :—

Plot A 878, Plot B 252 and Plot C 167. The main objects of re-enumerating and continuing the periodical observations are:—

(1) to test the effect of the removal of lantana on the incidence of spike.

(2) to note the direction of the spread of disease.

(3) to find out the minimum size at which sandal becomes attacked, and

(4) to test the effect of non-removal of infected trees.

Regarding the first object, 46 out of 878 in plot A, 4 out of 252 in plot B and 9 out of 167 in plot C were observed to be spiked by March 1926 ; *i.e.*, 13 out of 419 in the lantana cleared area and 46 out of 876 in the area not cleared of lantana, iving the approximate proportion of 3 : 5.

(2) From the map of the plots maintained, the distribution of the spiked trees shows the spread from south-west to north-east.

(3) The minimum size so far found spiked in this area had a girth of half an inch at base.

(4) No definite conclusion can be arrived at now as some more time must elapse.

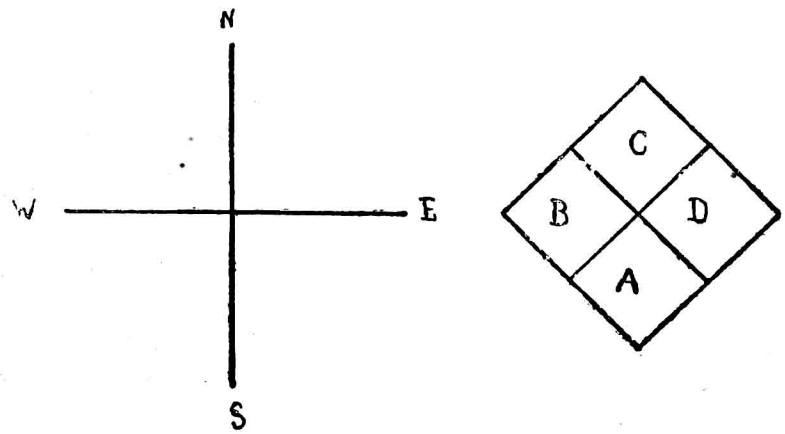
The results given above cannot be taken as conclusive and further observations are being recorded.

(*c*) *Mahadeswarangudi area.*—This was started in 1916, and 341 healthy sandal trees were ticketed and kept under observation in 30 acres. It was within this plot that the single spiked tree was found by Mr. Wilson in 1915. At the present time there are only 21 healthy trees in this area. No further attacks have been noticed during the past 2 years. It is very strange that between January 1922 and December 1922, 312 out of the above 341 trees were taken out, spiked, which indicates that the work was neglected previously by the Special Duty Ranger.

(*d*) *Hanumantharayangudi area.*—Eighteen sandal trees were selected by Mr. Hearsey in 1916 as having what he termed "Lanky Degeneration," which he believed was the first symptom of spike. One of the trees was found naturally dead and removed in 1920. In 1924 spike appeared in the unreserve adjacent to this area, and on 25th September 1925 one of the remaining 17 trees was observed to be infected. The other trees look perfectly healthy and present no difference in appearance from normal trees in non-spiked areas. So the one spiked tree of the 18 "Lanky Degeneration" ones probably received infection from the adjacent spike area. These trees will continue to be kept under observation with the object of seeing whether the prompt killing of infected branches by Atlas solution will stay the spread of infection to the remainder of the tree.

(*e*) *The Nyamasandiram Agraharam Observation Area.*—This is a new one opened in July 1925, 4 acres in extent, and divided into four sections, diagonally, facing south-west and north-east Two diagonal sections B and D are kept clear of lantana, and spiked trees are removed as soon as noticed. Of the other two diagonal sections A and C, section C will be cleared of lantana and A left as it is, while in both, the spiked trees will be left to die. This will give us data on the direction of spread of the disease and the efficacy or otherwise of removing lantana. All round the plot a belt of 100 yards will always be kept clear of spiked sandal. The whole plot has been fenced with barbed wire. The enumeration and ticketing of trees and saplings (above 1½ feet high) in the four sections has given 295 in section A, 180 in B,

155 in C and 690 in D, *i.e.*, a total of 1,320 sandal plants over 1½ feet high in four acres. The number of smaller seedlings is considerable. This is a common type of spiked sandal area, and it will be noticed how fully it is stocked with natural regeneration.



The results of observations up to date show that here also as in the cairn 53 area, the direction of the spread appears to be that of the prevailing monsoons at the time sandal is flowering, *i.e.*, the south-west monsoons from south-west to north-east. The significance of a reference to the flowering of sandal will be explained later in this report.

II.—Experiments to Determine the Cause and Cure of the Disease.

(a) Whether sandal is cross fertilised.—We require this knowledge to ascertain whether an attempt to isolate a resistant strain of sandal will meet with any serious difficulties.

683 inflorescences of sandal were stripped of everything but one un-opened bud; 485 inflorescences were chosen before any bud had opened, and also 325 inflorescences containing buds and flowers. Each inflorescence was covered over with muslin. In the first instance no fruit was obtained, in the second four

resulted, and in the last, two fruits. These results were obtained three months after tying the muslin, when all the inflorescences were dead.

Again, 170 inflorescences were ticketed and observed, without being covered over, and yielded 139 fruits.

This result indicates that not only is sandal cross fertilised, but that the main agency of fertilization of the flowers of one tree is through the agency of pollen from the flowers of other trees. It may be that a covering of muslin retards the development of buds and fruits, which needs further investigation.

(b) Whether plants raised from the seed of healthy sandal trees found in areas which have long been spiked are more or less immune from the disease.—It is observed that certain mature trees though situated in severely spiked areas, have not been infected and appear to be apparently immune from the disease. Seeds were collected from such trees of the Javalagiri 1913 area and sown, resulting only in two surviving seedlings, which are now about 9″ high. These will be watched carefully and attempts will be made to infect them when they grow larger.

As the trees from which such seeds were obtained in this Division are not sufficiently mature, it cannot be presumed that they have long been immune from spike. Therefore, seeds have now been obtained from big healthy trees in very old spiked areas of North Coorg and sown. The result will be watched.

(c) What insects feed on sandal or attend sandal flowers.—Insects of the following natural orders were collected from spiked and healthy sandal trees in spiked areas, and sent to the Imperial Forest Entomologist, Dehra Dun, for identification.

Two species of LYCIDAE, red winged insects, found feeding on the pollen and nectar.

The larvæ of Terias Hecabe in three stages, found feeding on sandal leaves.

A species of Cryptocephalus of the order Chrysomelidæ. This also is a red winged insect found on sandal flowers.

A species of Sympiezomias of the order Curculionidæ, which defoliates sandal from May to November.

A species of Sphenoptera, natural order Buprestidæ, a violet coloured insect that frequents the petioles and tender twigs.

Monophlebus, natural order Coccidæ, found boring into a healthy sandal sapling.

Larvæ of probably Pyralids, Cerambicids and Lasiocampidæ which feed on sandal leaves at night and remain on the bark by day time.

Larvæ of Lepturinæ and Buprestidæ, the former of which is said by the Imperial Forest Entomologist to be of considerable interest. These larvæ were boring in living spiked sandal sapwood.

Another borer recently sent in a live condition in a living stem it was found in, has not been identified as yet, but is being reared at Dehra Dun. Practically all the above species are new to Dehra Dun.

Specimens are also being collected for a professional Entomologist in Austria, who is in touch with the British Museum, and has sent at his own expense entomological apparatus.

(d) Can sândal be infected by grafting on it spiked Zizyphus and vice versa ?—This experiment was suggested by Dr. Coleman and 40 grafts were tried, with no success. This is what might reasonably be expected.

(e) Pruning and tarring spiked branches.—Sixteen spiked trees were selected for experiment, and the spiked branches pruned from time to time, the scars being treated with tar from 19th July 1924. At the same time 16 spiked trees with no branches pruned were kept under observation. Out of the first lot, three trees still contain healthy branches, whereas the other set of trees became completely spiked in every twig; most of them were dead by 13th September 1925 and consequently removed. Further investigation is needed.

There were plenty of infected trees nearby and we could not say whether the recrudescence on the pruned trees was due to reinfection, or to the original infection. Hence 8 more spiked trees were selected on 28th February 1925 and pruned. To lessen the possibilities of reinfection, all spiked trees to a radius of 100 ft. around each tree selected for pruning were uprooted. These 8 trees were kept pruned from time to time as new spiked

branches appeared. Out of these, only two contain healthy branches now, and the advantages of the removal of the adjacent trees are not perceptible. Possibly, the width of the cleared strip was not sufficient to stop reinfection.

If the original infection is through the atmosphere, a tree newly spiked, if coppiced, should give healthy coppice shoots. To test this, coppicing of several trees was done, 5 in the early and 19 in the later stages of spike. None of the former threw up shoots but three trees of the latter produced shoots which were spiked. Mr. Latham suggested that the attacked branches might be pruned at different distances from the point of infection and the result noted. This was done, but still spiked shoots continued to spring from behind the pruned surfaces. As the area is full of spiked trees, this experiment had better be repeated in a newly spiked area, to escape the possibilities of reinfection from outside.

(f) To test whether infection takes place from the remains of spiked trees.—Two experiments have been started.

(1) Fully spiked living trees were uprooted and attached to four healthy sandal trees in the Range compound at Denkanikota The experiment was started on 5th February 1925, and in order to increase the chances of infection, several instalments of freshly spiked trees were brought and attached to these healthy ones. None of the trees have exhibited clear indications of spike as yet, though one looked suspicious six months ago. As spiked sandalwood has been coming into this Range compound (which is also the depôt) for the past 13 years, it is time infection reached the trees in the depôt, if such were possible.

(2) With the same object in view, a plot of one acre has been demarcated in the Nyamasandiram Agraharam R. F., and all trees and saplings in the plot, amounting to 1,201 in number, have been numbered with the aid of tickets. All around this plot a belt of 100 ft. wide is kept free from spiked trees. All trees, immediately they are found spiked, are uprooted thoroughly, and branches, twigs, sapwood, etc., excluding the heartwood portion if any, collected in the respective pits and burnt immediately after extraction. The surrounding areas will be subjected to the usual

method of promptly extracting spiked trees but not burning every scrap of a tree in its pit. This area was started in February 1926 and results are awaited. The comparative rate of infection in the interior plot and in the areas outside will give us an idea of the efficacy of taking out and burning every bit of residue from spiked trees. Here, too, we have the danger of reinfection from outside agencies.

(g) To find out whether we are able to get healthy regeneration from the seeds obtained from the healthy branches of spiked trees.— This experiment is being conducted within a spiked and non-spiked area and the results will be watched. It is unlikely that any conclusion can be arrived at till several years. Healthy seedlings have been obtained up to date, but the question is, will they become spiked later in life? The Javalagiri R. F., which is completely spiked contains an average of at least 200 seedlings per acre, all apparently healthy.

(h) To see if there is a virus in the soil on which spiked trees grow.—Seedlings raised from seeds obtained from healthy trees at the Hosur Cattle Farm were transplanted on 21st August 1924 in fresh pits from which spiked trees were removed. The plants are all thriving and are about a foot in height now.

(*i*) Partially spiked saplings and trees were treated both around the roots and by injecting into the stem with—

(1) Brown sugar, (2) Magnesium sulphate, (3) Bone meal, (4) Potassium nitrate, (5) Sub-chloride of mercury, (6) Metal mercury, (7) Liquor arsenicalis and (8) Tincture of iodine.

A good effect was noticed in the case of those trees treated with mercury, sub-chloride of mercury, liquor arsenicalis, and tincture of iodine, in that there was no further spread of spike in the tree though some of the saplings died in their former spiked condition. This experiment is being repeated, using the above and other chemicals normally used in human ailments.

(*j*) The attempt to get rootshoots from newly spiked trees by trenching round them was a failure as none of the ten trees treated gave any shoots. The experiment will be repeated.

(k) Dusting of pollen.—Observations regarding the direction f the spread of spike lead one to imagine that a possible means of infection is the transference of pollen from the flowers of spiked trees to those of healthy ones in the process of fertilisation.

In support of this theory, we have not as yet seen a spiked seedling, that did not show indications of having previously flowered. There is no means at present of finding out at what age a sandal plant flowers, as the oldest plant in this Division, of known age is two years old, having been obtained from seed sown in May 1924 in a fenced area in suitable soil. These plants are 1 to 2 ft. in height. From actual records made in observation plots, the smallest seedling known to be spiked was 2′ 7″ in height and $\frac{1}{2}$″ girth at ground level. There were other spiked seedlings in the same area 3′, 4′ and 5′ in height, with girths varying from 1″ to $1\frac{1}{4}$″ at ground level. There is no means of ascertaining the age of these plants, as in the struggle for existence, against drought, hard soil, fires, cattle and deer, the shoot of a natural sandal seedling dies down year after year, and only seems to establish itself when conditions are rendered favourable.

To obtain more reliable data, therefore, on whether a sandal plant will not show indications of spike until after it has flowered we must watch the seedlings of known age referred to above sown in a fully spiked area.

Two tests of this pollen theory have been carried out already.

(1) Six healthy saplings from 2″ to 3″ in girth in a heavily spiked area (Javalagiri) are prevented regularly from forming flowering buds—at least the buds are removed promptly. None have so far, during a period of one year, shown signs of spike.

(2) Ten healthy trees in the Bungalow compound at Aiyur and 6 in a private garden 3 miles from Javalagiri (non-spiked areas) had their flowers dusted with the flowers from spiked trees so as to transfer the pollen from one to the other and aid fertilisation and possibly infection. This was done on 25th July 1925 and results are awaited. The period of incubation of spike is not known.

(l) Introduction of new hosts.—It is just possible that spike in sandal might be caused by want of a change of diet, or an

insufficient number of hosts, on account of a super-abundance of natural sandal regeneration. So the Bungalow observation area at Javalagiri, over which spike had passed and exterminated every sandal tree and sapling, was chosen for this experiment. The whole area, 4·6 acres, was overgrown with a very luxuriant growth of lantana, and this lantana was uprooted in parallel strips about 5′ to 6′ broad. Along both sides of each cleared strip, seeds of sandal, mixed with those of a new host not growing naturally in the Javalagiri R. F., were sown at intervals in patches. Details of the sowings and results obtained up to the present are shown in the tabular statement on page 387.

The sowings carried out in May 1924, *i.e.*, at the time of the first rains after the dry weather, and the strips sown with *Pongamia* and *Tamarind* seem to have given the best results, particularly the former, where many of the sandal seedlings, though only two years old, have grown to a height of 2 ft. and over-topped the *Pongamia* in certain cases.

In the first hot weather (1925) there were many casualties in sandal and the hosts, due chiefly to the subordinates doing too heavy a weeding in the strips, and also due to the strips being cut from east to west, instead of north to south, affording less protection from the sun. It is very noticeable that the greatest percentage of success in the sandal sowings is to be found under dense shade trees, and in the absence of trees, under lantana. It has been observed throughout the sandal growing areas of this Division, that lantana is extremely useful to sandal in its early stages in affording protection from the sun, cattle and deer, though, as a host, it is of little use once the sandal passes the seedling stage. We can best realise the value of lantana to sandal by clearing an area of the former and attempting to raise a crop of the latter under a thin canopy of trees The sandal germinates well enough, but the first hot weather spells disaster, and the first rains invite deer and cattle to the open space created. The best way to regenerate a lantana area appears to be to clear it in strips about 4 ft. wide and 18 ft. apart, and to regenerate these strips, taking

care to put obstacles at the ends of the strips to prevent the promenading of deer.

In the area referred to above, for the introduction of new hosts, all the sandal seedlings have been ticketed, showing the year of sowing, and annual measurements of height and girth are recorded.

With the same object in view, natural seedlings in the adjoining spiked area have been selected, and cuttings of *Jatropha Curcas, Erythrina indica, Moringa pterygosperma* and *Bombax malabaricum* planted alongside. These are sprouting successfully and as they will form fast growing hosts the results will be watched with interest.

Again, the following plants were raised in the nursery at Javalagiri, and successfully transplanted in a spiked area. When they are well established, sandal will be raised under them.

1.	*Shorea Talura*	257 plants.
2.	*Melia dubia*	10 „
3.	*Strychnos Nux-Vomica*	78 „
4.	*Bombax insignis*	186 „
5.	*Albizzia Lebbek*	2 „
6.	*Dalbergia Sissoo*	412 „
7.	*Tectona grandis*	241 „
8.	*Albizzia odoratissima*	16 „
9.	*Bombax malabaricum*	209 „
10.	*Pterocarpus santalinus*	243 „
11.	*Artocarpus integrifolia*	60 „

As sandal has been proved to be capable of imbibing strychnine from *Strychnos Nux-Vomica*, it will be interesting to see if the strychnine will act as a tonic to the sandal or an antidote to spike.

(*m*) *Whether spike is due to drought.*—Six spiked saplings and 6 healthy saplings have been kept profusely watered once a week from 25th October 1925. No improvement is noticed on the spiked saplings but the healthy ones continue healthy.

Results of sowings of sandal with new hosts in the Javalagiri Bungalow Observation Area.

Serial No.	Species sown with sandal.	1924.				1925.			
		No. of patches sown.	Date of sowing.	No. of hosts now alive.	No. of sandal now alive.	No. of patches sown.	Date of sowing.	No. of hosts now alive.	No. of sandal now alive.
1	*Jatropha Curcas* ...	134	23-8-24	69	12	62	28-4-25	19	31
2	*Pithecolobium dulce* ...	200	21-7-24	24	16	169	do.	67	29
3	*Tamarindus indica* ...	140	28-5-24	18	27	101	do.	6	12
4	*Melia dubia and indica* ...	174	28-5-24	32	49	105	do.	4	15
5	*Pongamia glabra* ...	140	24-5-24	61	49	63	do.	19	17
6	*Jatropha Curcas* ...	134	24-8-24	47	10	84	do.	39	45
7	*Tamarindus indica* ...	100	24-5-24	35	10	60	do	13	10
8	*Pterocarpus santalinus* ...	183	18-9-24	...	9	175	29-4-25	...	19
9	*Tamarindus indica* ...	100	24-5-24	45	17	56	do.	19	8
10	*Bassia longifolia* ...	130	23-8-24	...	3	127	do.	...	9
11	*Pongamia glabra* ...	92	24-5-24	54	20	35	do.	10	10
12	*Pterocarpus and Bassia* ...	139	18-9-24	...	4	135	do.	...	17
13	*Pongamia glabra* ...	70	24-5-24	49	14	21	do.	16	10
14	*Shorea Talura*	80	21-7 24	...	5	75	do.	...	8
15	*Pithecolobium dulce* ...	40	21-7-24	7	3	31	do.	22	6

(*n*) *Treatment of spiked trees with Atlas Solution.*—On 22nd December 1925, 33 spiked sandal trees were girdled at about a foot from ground level, and the portion coated with Atlas solution, four other trees were girdled and left without the application of the solution. The trees were inspected on 22nd January 1926. All those treated with Atlas solution were dead above the portion coated and those merely girdled remain unaffected. As Atlas solution is useful in rapidly killing spiked trees, and if the pollen theory proves correct, this will be of great help in killing the trees before the flowering season and before actual extraction, to gain time.

This solution is now promptly applied to all spiked trees in the newly spiked area in the Gulhatti R. F. Ninety trees have been girdled and treated, of which the biggest trees, 30 in number, have also been treated on the roots by boring holes, to see if the root system can also be killed. The results will be watched.

(*o*) *To see if spiked Zizyphus Oenoplia is the cause of infection.*—

Half a dozen spiked *Zizyphus* plants were transplanted near healthy sandal saplings in October last, but all the *Zizyphus* died and no change in the sandal is noticed so far.

Half a dozen spiked *Zizyphus* plants were selected and sandal seedlings were transplanted around them at six plants to each. Only two of the sandal plants survive. The experiment must be repeated on a larger scale.

III.—GERMINATION TESTS OF SANDAL.

(*i*) *How long sandal seed will remain fertile.*— For this 6 or 7 measures of seeds were obtained in September 1924 and sowings are being carried out every month for the past 18 months and are to be continued for three years. Sowings are done at ½″ and 1″ depths under heavy and light shade conditions. The percentage of germination obtained up to date is given in the following tabular statement. The beds are watered :—