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Studies on the *Pinus* Species Growing in Sri Lankan Plantations

I. Tapping of *Pinus caribaea* (Erabedde) for Oleoresin

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Abstract : The *Pinus caribaea* plantation at Erabedde, (Gurutalawa), was investigated for suitability for utilisation for oleoresin production. Studies showed that the trees varied markedly from one another with respect to oleoresin output. This marked variation between trees resulted in difficulty in interpreting data on different techniques of tapping. Studies showed that girth of tree was not related to oleoresin yield. Based on these studies the trees may be divided into 3 categories: (1) Trees that produce good yields at all times, (2) trees that produce little or no oleoresin and (3) the majority (75) of trees which produce average yields of oleoresin only under favourable conditions. The favourable conditions were difficult to define but appeared to be related to rainfall. Conclusions reached from the study are that although systematic tapping of the trees of the plantation may not be feasible, selected slaughter tapping could form the basis for an industry for producing rosin and turpentine.

1. Introduction

Species of *Pinus* had been introduced to Sri Lanka on a plantation scale only in the last 15 to 20 years.[3] However, with the paper industry in mind, the acreage under cultivation of the plant was rapidly increased and at the present time there are about 28,000 acres of *Pinus* in this country.[4] This is mainly located in the Central Province; while the Southern, Western and North Western Province have a smaller acreage.[4] The main species in these plantations is the tropical pine *Pinus caribaea* which accounts for a total acreage of about 22,000 acres.[4] The remainder is mainly plantations of *Pinus patula* which is present to the extent of about 5,000 acres.[4]

Pinus species on tapping produce an exudate (oleoresin) which can be steam-distilled to form two separate components, the volatile turpentine and the residual rosin, both of which have considerable application in industry.

* Most of this work forms a part of the M. Phil. Thesis, University of Colombo, Sri Lanka, of L. A. Goonetilleke.

Although *Pinus caribaea* can produce oleoresin in commercially extractable quantity, there is very little data available on this subject in the literature. The aim of the study is threefold. (1) To select a method of tapping which is compatible with the local plantations. (2) To accumulate data on the oleoresin output of local plantations. (3) To determine whether these plantations could be commercially exploited for the manufacture of turpentine and rosin.

2. Experimental

2.1. Tapping Technique

2.1.1. *Tapping implements*

The following implements were used in order to make tapping easier and more efficient : (a) Tapper (b) Bark remover (c) Chisels (d) Hammer (e) Cup and lip and (f) Stencils.

(*a*) *The Tapper.* The implement for tapping includes a holder attached to yokes, a head, a cutter, and a recuperator spring. The head and the cutter constitute the main part of the instrument. It consists of an assembly plate, the front part of which (crest) serves as a regulator when making cuts on the tree. On the back part of the plate there are two lugs (a clapper box) in which the cutter is fixed with the help of bolts. Head and holder are connected with the help of hinge bolt. Recuperator spring embraces the handle (made of wood) of the instrument and during the work it can be pulled at the maximum deviation of the head; its pull must be approximately 5 or 6 kgs.

(*b*) *The bark remover.* This implement includes two handles made of wood and the cutter. The instrument is dragged down the tree so that the cutter always embraces the outer bark which is to be removed.

2.1.2 *Tapping of Trees*

The trees that were tapped for these experiments were about 12 years old. The general procedure adopted was to remove the bark at a height of either 20 cm or 1 meter from the ground. In all about 1 to 2 cm of tissue was removed which is composed of two distinct zones (1) the outer dead bark and (ii) the inner live bark (phloem and cambium).

The following types of incisions were employed to reach the sapwood by removal of the exposed live bark. These were : (*a*) V-cut (*b*) Straight cut (*c*) Herring-bone cut (*d*) Drain cut (figure 1).

The V-cut, Draincut, Straight cut and the Herring-bone cut were carried out by using a chisel and hammer. Stencils (approximately 20 sq cm in area) were used in order to maintain uniformity. For more details see legend of figure 1.

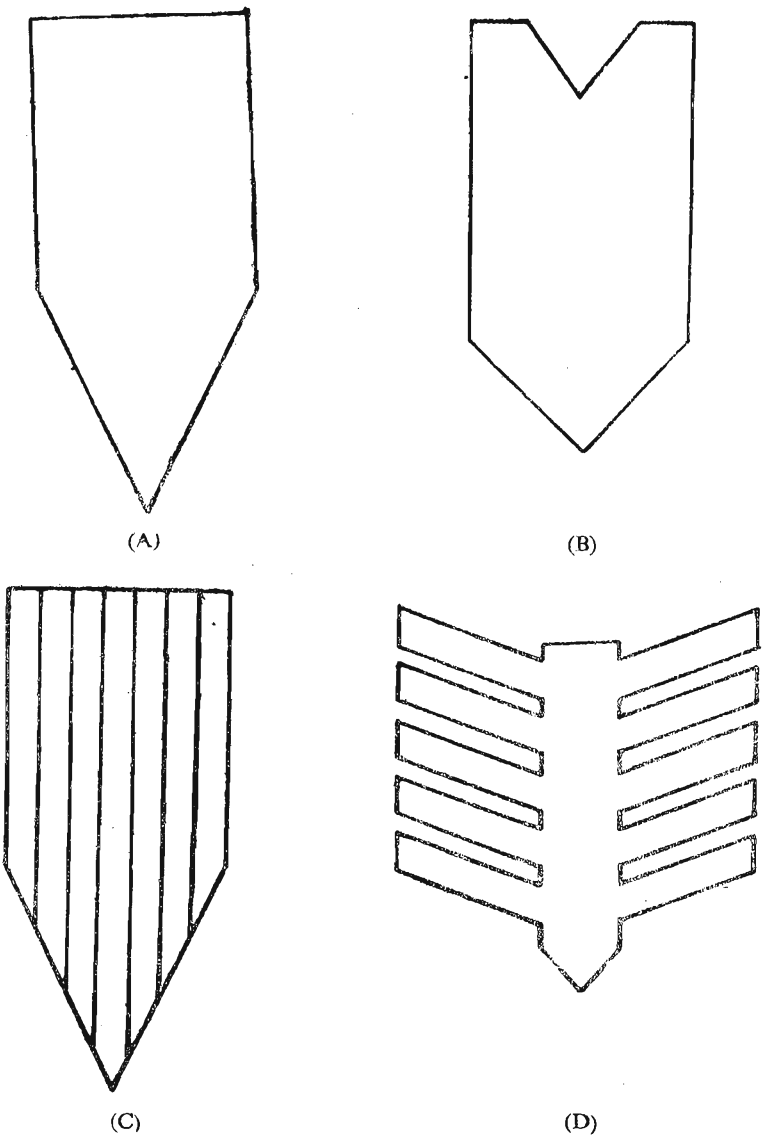

Figure 1. Diagrammatic representations of incisions used.

A. The Straight cut
B. The V-cut
C. The Drain cut. Vertical lines represent deeper drains cut into the tissue.
D. The Herring-bone cut.

All incisions have the same surface area exposed and except for the drain cut, the same depth.

In addition, in the case of the Herring-bone cut, a cutter (or tapper) designed and made in the CISIR workshop was also used.

In order to collect the oleoresin which flowed from the incisions, a cup and lip constructed of aluminium was placed at the tip of the V-cut, Straight cut and Herring-bone cut.

Every other day ("tapping day") the cup and lip were removed and weighed to determine oleoresin content. The wounds were also enlarged by removing bark from the top and the side of the original incision a further $\frac{1}{2}$ to 1 cm each day. The old wound is also freshened by removing a thin slice of bark (2 m) and the cup and lip were replaced in order to collect the flowing oleoresin. This method of tapping was carried out for 2 to 3 weeks at a time. This is referred to here as a "tapping cycle."

The method of tapping had the following advantages:

1. At the end of the tapping period, the trees have a greater lumbervalue due to lesser damage caused by the surface wounds.

2. Even young trees were tappable.

3. The oleoresin needed to traverse only a short distance before reaching the container.

The disadvantages of the procedure were the evaporation of turpentine and solidification of oleoresin while travelling to the container. The prevention of this was attempted by covering the cut with a polythene film, but it was found out that the polythene lining had no effect.

Another disadvantage was the disturbance of the cup and lip (caused by wind), but this was prevented by fastening them with string.

In these studies, 4 tapping cycles (6 to 10 tapping days) were carried out in Sept. 1978, Dec. 1978, March 1979 and June 1979 respectively.

2.2. Weight of Oleoresin

The portable Buthoft silicane damped balance designed by W. B. Nicolson (Scientific instruments), Glasgow. was found to be useful for weighing the oleoresin in the field. The instrument consists of a calibrated scale, sensor and pan, and has a capacity of 1 kg with a sensitivity of 0.5 g.

3. Results

3.1. Type of Cut

As no previous experiments have been carried out on local *Pinus* species, preliminary studies were directed towards determining the best method of obtaining the maximum output of resin with minimum damage to the tree.

As described in the experimental section four types of cuts (wounds or incisions) were made, and the results showed that the drain cut was very unsatisfactory. The V-cut, Herring-bone cut and the Straight cut gave promising results but further work was not carried out on the latter two as the factors affecting yield were very complicated and it was decided to limit variables to a bare minimum. It must be noted that a direct comparison of the different methods of tapping could not be made as tapping dates were different. A comparison between the V-cut and the Straight cut showed that the dominating influence was the variation between trees. This variation considerably reduced the value of data obtained concerning comparison of these two tapping methods. However, despite this variation, the total yield of oleoresin from 10 trees each by the V-cut and Straight cut techniques was 395 g and 350 g respectively, showing no significant difference between the two methods.

3.2. Position of cut

It was next decided to determine the best height for tapping. Two positions of the tree were tapped :

(*a*) one meter from the ground,

(*b*) twenty centimeters from the ground.

Here again results showed that the dominant factor was the variation between trees rather than the height of tapping incision. The conclusion reached was that tapping position was not of much significance. The results were further complicated by a possible 'seasonal variation', although the term is not strictly justifiable as data was collected over the period of a single year.

3.3. Effect of Girth of Tree

Studies to determine whether the girth of tree had any effect on oleoresin yield, showed that there was no relation between the two factors even when trees at exactly the same elevation were used (Table 1). Studies on elevation of tree (on hill) using trees of constant girth, gave similar results.

3.4. General Observations on Yield of Oleoresin

As previously mentioned, the dominant factor appeared to be variation between trees. In fact, one tree (No. 5) gave a yield of 550 g during a tapping cycle of 6 tapping days, while many other trees did not yield any oleoresin.

TABLE 1. Effect of Girth on Oleoresin flow.

Code No. of Tree	Girth (cm)	Yield of Oleoresin (g)
1	71	41
2	59	24
3	94	24
5	109	212
7	125	15
8	76	16
9	117	07
10	112	81

Yield was calculated after a tapping cycle of 10 tapping days in September 1978. Tapping was done by the V-cut method.

Yield of oleoresin at different times of the year showed marked variation (Table 2) but trees that give good oleoresin yields generally do so at all times of the year. A noteworthy feature was the relatively high yield of nearly all trees in the month of June 1979.

TABLE 2. Effect of Tapping time ("Season")

Code No. of Tree	Yield of Oleoresin (g)			
	Sept.	Dec.	March	June
101	24	93	68	138
102	18	68	31	113
103	14	00	11	18
104	03	148	93	188
105	01	00	09	28
106	12	13	28	133
107	05	00	08	48
108	37	28	28	218
109	34	28	48	113
110	64	43	53	193
111	14	38	38	68
112	32	38	43	118
113	29	8	53	168
114	38	58	48	210
115	21	53	31	118
116	—	00	03	08
117	7	00	08	68
118	15	33	58	158
119	10	00	12	38
120	14	03	41	33

Six Tapping days per tapping cycle; all V-cut incision.

Oleoresin yield also varies from day to day within any given tapping cycle. Generally, though not always, there is a steady decrease from day to day as depicted in Table 3. Similar data are available for all 4 tapping cycles for all trees and is fully described elsewhere.[5]

TABLE 3. Oleoresin Yield from Day to Day (Tree No. 5)

Tapping Day	Yield of Oleoresin		
	December 1978	March 1979	June 1979
1st	61	115	130
2nd	15	62	78
3rd	20	85	80
4th	21	65	85
5th	8	67	80

Method of tapping , V-cut

The variation in oleoresin yield at different times of the year is difficult to explain and appeared to be unrelated to rainfall and temperature. However, it was observed, that continued light rain, especially after a period of drought, resulted in a spurt of oleoresin flow.

4. Discussion

The terpenes of pine can be extracted in several ways. [6,8,9] (1) Tapping of oleoresin,[2,8] (2) solvent extraction of wood,[7] (3) steam distillation of chips and (4) dry distillation of wood. This study has been confined to the tapping of the tree for oleoresin. In addition, use of chemicals to stimulate oleoresin flow have not been considered in this study.[1]

As the Pinus plantations in this country have never been studied before at any level, a vast amount of preliminary work had to be done with a number of variables. The consideration of all these variables (in some detail) is a task of magnitiude which (we felt) could not come into the scope of this preliminary study. Therefore, essentially the study concerns (1) the development of a tapping technique that is not necessarily the very best, but one that could be maintained uniformly. (2) The use of this method of tapping to define some of the factors affecting oleoresin yield and (3) the determination of whether these plantations could be exploited commercially for turpentine and rosin manufacture.

During studies on the method of tapping, a number of methods were considered and discarded; only three of these showed any promise (1) V-cut, (2) Herring - bone cut and (3) Straight cut. There appeared to be little significance in the results of these trials due to marked variations between trees, and ultimately the V-cut was selected, mainly due to the ease of making this type of incision. It should be noted, however, that the recommended drain cut was a failure.

The next aspect studied was the position of the cut. Again, variation between trees masked the value of the results and no firm conclusion could be reached. However, in most experiments, tapping was done around a height of 100 cm, as field observations tended to favour this position.

It is considered that both the above types of experiment should be done on a very large number of trees if any useful conclusions are to be reached. We have not attempted this as our location and resources did not permit us to undertake a study of this magnitude on the field. Unfortunately, these limitations restricted us to the study of a total of 50 trees, selected mainly at random on most occasions.

However, these studies clearly showed that there is no relation between girth of tree and yield i.e. wide variation of yield observed between trees had no relation to vegetative growth. Our conclusion here is that the population of trees is a very mixed one and that oleoresin output is dominated by genetic factors.

While the dominating feature was the variation in flow of oleoresin from plant to plant, another interesting effect was the marked variation from tapping cycle to tapping cycle which is referred to here as "seasonal" variation. Our studies using a larger number of trees (100) showed that there are essentially 3 categories of trees:

(1) Those which produce a good yield at every tapping cycle (about 10% of the trees).

(2) Those which produce hardly any yield on all occasions (about 15%)

(3) The majority (75%) which produce a good yield only during 'favourable' circumstances.

The 'favourable' circumstances are difficult to define as we have not obtained a direct correlation of yield to either temperature or rainfall. Rainfall apparently has an effect but this is difficult to demonstrate. The following field observations were made :

(i) Heavy continuous rainfall resulted in low yields and also difficulties of collection.

(ii) Drought conditions also result in low yields.

(iii) Moderate rainfall especially after a period of drought gave a sudden spurt of yield.

Conclusions

1. The variation between trees with respect to oleoresin yield was a dominating factor.

2. There are trends of variation depending on 'season' which appear to be connected with rainfall.

3. As a result of the above, yields are very variable and it is unlikely that an industry could be set up for the systematic tapping of the plantations all the year round.

4. A mode of extraction based on the selective tapping of trees seasonally or slaughter tapping (removal of oleoresin in short time with extensive incisions) appears feasible.

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References

1. ANDERSON, A. B. (1955) *Forest Products Journal*, 417-420.
2. CEYLON FORESTER (1969) Vol IX pg. 3, 99.
3. CONSERVATOR OF FORESTS (1978) *Administrative Report*. Publ. by Forest Dept. of Sri Lanka.
4. DUTT, S. (1960) *The Ind. Oil and Soap J.*, 26 : 3–10.
5. GOONETLLEKE, L. A. (1979). M. Phil. Thesis, University of Colombo. "*Studies on the Pinus Plantations of Sri Lanka*" in preparation.
6. GUENTHER, E. (1952) "*The Essential Oils*" 6: 239-307 Van Nostrand Co. Ltd. (N.Y)
7. MEDNIKOV, F. A. & AKIMOVA, R. A. (1961) *Izest Vysshikn Ucheb Zaiedenii,, hesnai Zhur.* 4 160-4 in Chem. Abs. (1962) 56: 7558
8. WEALTH OF INDIA, *Raw Materials*, VIII: 64-71.
9. WEALTH OF INDIA, *Industrial Products*, Vol. III: 223-234.