

# **INCIDENCE OF TAPPING PANEL DRYNESS IN RUBBER IN THE SMALL HOLDINGS OF MEENACHIL TALUK**

**By**

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## **DISSERTATION**

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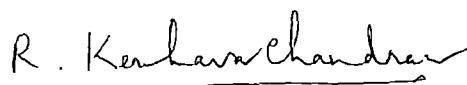
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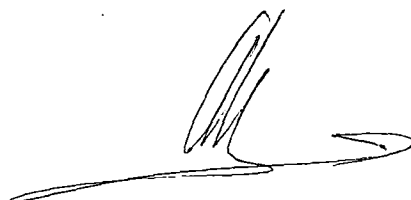
## CERTIFICATE

Certified that the dissertation 'Incidence of Tapping Panel Dryness in Rubber in the small holdings of Meenachil Taluk' is a record of research work done by Sri. Sebastian Michael under our guidance and supervision and that it has not previously formed the basis for the award of any degree or diploma to him.

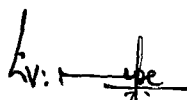
We, the undersigned members of the Committee of Sri. Sebastian Michael, a candidate for the Post Graduate Diploma in Natural Rubber Production, agree that the dissertation entitled 'Incidence of Tapping Panel Dryness in Rubber in the small holdings of Meenachil Taluk', may be submitted by Sri. Sebastian Michael, in partial fulfilment of the requirement of the Diploma.



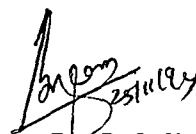
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SEBASTIAN MICHAEL

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## *Introduction*

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## INTRODUCTION

*Hevea brasiliensis*, known as the para rubber tree, is the most important commercial source of natural rubber. Latex, the economic product from the tree, is contained in an anastomosing type of latex vessel system situated in the bark. It is obtained by wounding the bark by a process termed tapping. When a cut is made on the trunk with a tapping knife, the latex flows out because of very high turgor pressure in the latex vessels. The initial flow of latex is due to elastic contraction of the walls after a sudden release of turgor as a result of tapping and subsequent flow is regulated by capillary forces. After tapping, the rate of flow can be expected to slow down with time because latex withdrawn over greater distance from the cut is subject to reduction in the pressure gradient and to greater resistance of an increasing length of partially collapsed vessels. The flow rate is markedly decreased and the flow ceases after a time, also due to the formation of internal and external plugs in the latex vessels.

A physiological phenomenon characterised by the absence of latex exudation, either over part of the cut or its entire length is commonly observed in plantations. This phenomenon, referred to as 'tapping panel dryness', is generally seen in two forms. It may be related to season or caused by intensive exploitation, in particular by over stimulation. This is the reversible form of tapping panel dryness (TPD). The other form, which is characterised by cell necro-

sis which spreads rapidly along the laticiferous mantles leads to total dryness and is irreversible. In most cases complete dryness is associated with a brownish discolouration in and below the tapping cut and hence the disorder is commonly referred to as brown bast.

The disorder was reported for the first time in Brazil in 1887 in *Hevea* in the Amazon forest and at the beginning of the century, in plantations in Asia (Rutgers and Dammerman, 1914).

Tapping panel dryness is a serious problem in the small holdings and the incidence of dry trees may be as high as 30 per cent (Paardekooper, 1989). But the data available on the actual extent of incidence in small holdings is scanty.

Meenachil taluk is a major rubber growing region in the state. A variety of high yielding clones are being grown in the area, the most popular being the clone RR11 105. A general complaint from the planters is that the clone RR11 105 is highly susceptible to Tapping Panel Dryness (TPD). The present study has been formulated to study the extent of incidence of TPD in the small holdings of this area, with the intention to evaluate whether the disorder is due to any defect in the nature of the exploitation system adopted.

## *Review of Literature*

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## REVIEW OF LITERATURE

Tapping panel dryness has been studied in India as well as in other major rubber growing countries of the world. The salient works on the same are reviewed hereunder.

### 2.1 General aspects of the disorder

The absence of any latex exudation, either over part of the cut or over its entire length, is generally referred to as dryness. Jacob and Prevot (1989) had classified dryness into two: one form, which may be related to season or caused by intensive exploitation, and in particular by over stimulation, is reversible, if this exploitation does not continue for too long. The other form is irreversible, it induces cell necrosis which spreads very rapidly along the laticiferous mantles and leads to total dryness. In most cases complete dryness is associated with a brownish discolouration in and below the tapping cut, so the disorder is commonly referred to as 'brown bast'.

Compagnon *et al.* (1953) had grouped the various forms of physiological disorders commonly considered as brown bast into the following five classes.

1. Abnormal colour of the cut, brown spots and cracks in the bark with eventual necrosis and stoppage of flow.
2. Partial dryness without brown colour or necrosis.
3. Woody burr formation resulting in deformation of the panel.

4. Coagulation of latex on the tapping cut with no flow of latex.
5. Total dryness without brown colour or necrosis.

The actual onset of brown bast is preceded by an excessive dilution of latex with late dripping. However, it had been noticed that certain trees go dry with no earlier late dripping (Compagnon *et al.*, 1953).

## 2.2 Symptoms of the disorder

### 2.2.1 Reversible bark dryness

The symptoms of the phenomenon have been studied and reported by many workers. Jacob and Prevot (1989) reported that examination of lengths of dry bark revealed a decrease in the length of the tapping cut affected, in the case of trees tapped normally where seasonal bark dryness was observed. It was sometimes found to occur in over-exploited trees which displayed varying degrees of affectation of the incidence. However, the bark dryness diminished when non-intensive tapping was resumed after sufficiently long resting period.

The bark of such trees which displayed partially dry zones was found not to differ histo-cytologically or histochemically from healthy trees (de Fay, 1981).

Histo-cytological examination of the bark of trees which had been affected by bark dryness by overstimulation with ethylene or 2,4-D revealed symptomatological differences in comparison with the typical brown bast phenomenon (de Fay, 1981, 1988). It was reported

that the bark thickened, became spongy and hyper hydrated near the zone of application. Small cracks were found to appear on the outside. The outer phloem displayed dilatation of the parenchyma, whose axial cells lying around the laticiferous mantles devided periclinally. As a result, the laticifers were crushed and rendered non-functional in that zone. There were no stone cells and there was no tertiary formation around the necrotic zones and no lignified gum. The phenomenon remained very local. In addition, only a few rare tylosoids were observed in the outer phloem (de Fay, 1988). However, most of the laticifers in the inner phloem were found to be cytologically normal and hence he suggested deep tapping to reach them.

These symptoms were found to appear a few months after intensive hormone treatment.

#### 2.2.2 Irreversible bark dryness

Eschbach *et al.*, (1983) found that the external symptoms varied with the type of clone and the seriousness of the disorder. In addition to bark dryness, browning of cortical cells appeared in certain zones which may or may not be concealed by the outer bark. Bark cracking, with a tendency to flaking, may occur to various extents as may greater or lesser trunk deformation caused by neoformed ligneous nodules.

Paranjothy *et al.* (1975) and de Fay (1981) described the various symptoms observed as follows.

*In situ* coagulation of latex and formation of tylosoids were

reported. Evagination of the neighbouring parenchyma cells were seen which invaded the laticifers. These tylosoids were found to proliferate, lignify their walls and accumulate tannins. These two phenomena, which occurred simultaneously were found to block the laticifers.

Tissue degeneration in the phloem is manifested due to various reasons:

i) Increased amount of tannins in the parenchyma cells surrounding the laticifers invaded by tylosoids which were responsible for the browning of the phloem.

ii) Secretion of lignified gums was observed. The rapid spread of the disease was related to the depositing of these gums on the wall of the laticifers.

iii) Growth of stone cells by the sclerification of neo-formed cells such as tylosoids.

iv) Formation of hyper plastic tissue derived from the proliferation of tylosoids, destroying the laticiferous network.

v) Appearance of cambial cells which may develop and isolate necrotic phloem zones. This may result in lignified nodules which are responsible for the deformation mentioned above.

### **2.3 Biochemical characteristics of latex**

Laticifers located in bark displaying early symptoms of bark dryness but which are still functional were found to display certain characteristic changes in their latex quality. Varying decreases in

pH, Pi and R-SH values have been reported which indicated a slowing of metabolic activity (Eschbach *et al.*, 1983; Van de Syde, 1984; Serres, 1985 and Jobbe-Duval, 1986).

#### 2.4 Biochemical and physiological studies

Various biochemical and biophysical changes have been reported to take place at the later stage, in trees showing the symptoms of the disorder. The most common symptoms included a phase of excessive late dripping of latex and a simultaneous fall in the rubber content. After a period of time, the volume per tapping was found to gradually decline. The colloidal stability of the latex was also found to be reduced resulting in particle damage, flocculation of rubber particles *in situ* and early plugging of latex vessels (Chrestin, 1985).

Studies of Chua (1967) showed that the reserves of starch and other soluble carbohydrates were not depleted. Investigations by de Fay (1981) revealed abundance of starch grains in the wood of affected trees and the vascular rays were found to function normally.

Changes in latex flow pattern (Sethuraj, 1968) and a reduction in turgor pressure (Sethuraj *et al.*, 1977), have also been reported. In intensively tapped trees, initial flow rate and turgor pressure were found to be reduced before the onset of dryness (Sethuraj *et al.*, 1976). A sharp increase in bursting index was reported by Eschbach (1983).



## 2.5 Probable causal factors

Early investigators have related the phenomenon to the reaction of the trees to wound healing (Rands, 1921; Rhodes, 1930). Fluctuation in the water relations as a consequence of excessive removal has been suggested to be the causative factor by Sharples *et al.* (1924). An abnormally strong dilution reaction during latex flow was considered to favour the development of brown bast (Frey-Wyssling, 1932).

Schweizer (1949) associated brown bast with lack of organic reserves. It was reported that by drastic tapping, the phospholipids and proteins increased with a simultaneous reduction in the proteins and calcium contents. In support of his view, Schweizer induced conditions similar to brown bast by ring barking above the tapping cut followed by intensive tapping.

A marked positive correlation between the stability of latex and potassium content had been obtained by Philpott (1951). A high content of potassium in the latex of brown bast affected trees was also reported.

Vollemma (1949) and Compagnon *et al.* (1953) observed that incidence of brown bast was greater during and after wintering.

Compagnon *et al.* (1953) had found that intensive exploitation resulted in Cu and K deficiency. But efforts to correlate mineral content with brown bast incidence have not so far yielded any convincing results. However, a significant correlation was obtained

between  $K_2O/CaO$  ratio in leaves and the percentage of brown bast (coagulation at the tapping cut) by the studies of Beaufils (1954). Incidence of such conditions could be reduced by potash fertilizers. A higher Mg/P ratio was also reported in latex in the susceptible clones (AVROS 308 and Gl 1) compared with resistant clones (PR 107). It was assumed that the above mentioned disorder (coagulation at the tapping cut) was an extreme case of latex instability and that Mg content of latex could be a determining factor. But an increase in K content and K/Ca, K/P ratio was observed by Pushpadas *et al.* (1975) in the latices of brown bast affected trees. So, theoretically it can be speculated that the reported brown bast condition with high Mg content and coagulation at the tapping cut may well be distinct from the conditions of brown bast reported to be associated with a high K content.

The results of later work showed that evidence of starch depletion or lowered sugar content in latex during the onset of dryness (Chua, 1965). The dry bark contained almost the same amount of total sugars as that in the normal bark.

It has been observed that conditions similar to brown bast, induced by surgical treatments, resulted in very low flow rate of dilute latex containing damaged bottom fraction particles and Chua (1965) suggested that such extreme rate of flocculation deep in the latex vessels may impede the flow, eventually inducing dryness. Role of divalent cation in promoting the destabilising effect of luteoids has also been reported (RRIM, 1985). In the majority of cases of brown bast, however a low dry rubber content (drc) of latex with late

dripping, was found to precede the onset of dryness. Dilution of latex could cause osmotic shock to the luteoid particles causing them to swell and burst. However, the mechanism by which a reduction in the rubber content caused is not clear.

The possible damage to all the membrane structures in latex cells and resulting impairment of nutrient supply and water exchange at plasmalemma was suggested by Chai Kim Chun *et al.* (1969) and Pushpadas *et al.* (1975).

A view has been expressed by Bealing and Chua (1972) that wound reaction might lead to a reduction in the permeability of the wall of the latex vessel resulting in a reduced availability of assimilates. In the same work, a progressive decline in the cation concentration of latices of the trees subjected to intensive tapping to induce brown bast have been reported. Conversely, a higher concentration of cations in latices of intensively tapped trees was reported in a later study by Paranjothy *et al.* (1975) and it has been suggested that changes in cation concentration might play a role in the observed deterioration of luteoids. With the aid of electron microscope, evidence was provided for the flocculation of rubber particles around luteoid particles in such latices and a hypothesis was proposed that coagulation of rubber particles inside latex vessels due to decreased luteoid stability might be the causative factor for the onset of brown bast syndrome. It was assumed that the histological characteristics of brown bast affected bark, such as tyloses and stone cells, follow the development of disorders caused by damaged luteoids while features such as tissue necrosis and hyperplasia of

the surrounding cells followed the death of the vessels. In these studies, phloem necrosis could not be detected and hence the earlier concept that phloem necrosis or senescence could be the primary cause of the disorder was ruled out.

Chrestin *et al.* (1984) postulated that intensive tapping or intensive use of stimulants increased NAD (P) H oxidase activity at the lutoid tonoplast. This would lead to damage to the lutoid membrane, causing flocculation through the release of B-Serum. The existence of an endogenous NAD (P) H oxidase in lutoids which generates toxic forms of oxygen ( $O_2^-$ ,  $H_2O_2$ , OH) responsible for the peroxidase degradation of organelle membrane in the latex from diseased tree was reported in further works of Chrestin (1985). This supplement the work done by Cretin and Bangratz (1983). Simultaneously, decrease in concentration of latex cystol scavengers (reduced thiols and ascorbates) as well as virtual disappearances of scavenging enzyme activities (SOD and catalase) was reported (Chrestin, 1984, 1985). The combination of increased peroxidative activities and considerably diminished quantities of scavengers in latex from affected trees result in destabilisation and lysis of lutoids leading to coagulation (Crestin, 1989).

Tupy (1973), Tupy and Primot (1976) found that high intensity tapping and/or stimulation reduced the sucrose content of latex and that bark dryness was associated with low latex sucrose levels. Tupy (1985) considered that inadequate sucrose availability for basic biological functions of latex vessels might result in their premature degeneration and in bark dryness.

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According to Eschbach *et al.* (1986), a reduction in sucrose, thiol and Mg contents and increase in redox potential (RP) were connected with a higher rate of bark dryness. The reduced availability of assimilates and the essential enzyme systems could be the principal cause of more frequent occurrence of the disorder. Guo (1990) found that thiols, ascorbic acid and A-serum protein contents in latex of GT 1 and RRIM 600 were lower in trees with brown bast than in healthy trees. GT 1, less susceptible to brown bast, showed greater reduction in proteins and thiols, but a smaller reduction in ascorbic acid.

Wickremasinghe *et al.* (1987), in studies with RRIC 101, found that free proline concentrations in the bark and latex of brown bast affected trees were considerably higher than those of healthy trees. Since proline accumulation in plants was often associated with water stress, the results pointed to the involvement of water stress in this disorder. Proline accumulation in latex could be used as an early warning signal for brown bast development.

Paardekooper (1989) examined the records of a number of clones and found a positive correlation between incidence of dryness and susceptibility to wind damage, suggesting that a certain form of dryness is induced by strain in the tissues associated with bending under wind stress. Trees which have actually been damaged by wind often develop dryness.

Numberous traumatism (mechanical such as tapping, chemical

or pathological infection) were reported to cause formation of ethylene (Yeang and Pratt, 1978) which was found to have an influence on biochemical, anatomical and histological factors (Liebermann, 1973).

Sivakumaran and Pakianathan (1983) induced dryness by puncturing the bark at four or five points along vertical strips on the panel and sealing the puncturing with drawing pins. By repeating the operation weekly or fortnightly, sharply reduced flow rates and a high incidence of dryness were induced in several clones.

Lukman (1989) reported that the type of climate indirectly influenced the TPD incidence. Wet regions gave a good chance for the growing of Secondary Leaf Fall disease. This disease caused the trees to suffer and easy to be affected by TPD.

The tapping panel dryness has been found to be non-random in distribution in the field. Affected trees tend to come in clusters, suggesting that brown bast would be spreading along the rows. Non-randomness of dryness was statistically proved in Thailand in a field of seedlings (Paardekooper, as reported in 'Rubber') and recently in Sri Lanka for five out of six clones on commercial estates (de Soyza *et al.*, 1983). The non-random occurrence of brown bast suggested the involvement of a particular environmental factor, since it seemed unlikely that the disorder would spread through the vessels via root grafts to neighbouring trees.

Cultivars differ in the level of their susceptibility to brown bast. Clones that are reported to be extremely vulnerable include PB 5/63, PB 28/59 and RRIM 628 (Paardekooper, 1989). Seedling

trees have been reported to be always more susceptible than bud grafts, as confirmed by breeding experiments where legitimate seedlings were compared with buddings derived from them. Among the different clones there appeared to be a negative correlation between incidence of dryness and plugging index: long flowing clones tend to develop more brown bast.

Observations of Commere *et al.* (1989) showed that the clones with high metabolic activity (PB 235, PB 260) were highly sensitive to dry cut; the clones with intermediary metabolism (GT 1, RRIM 600) had a medium reaction; the clones with low metabolism (PR 261) showed greater resistance to dry cut. Their experiments also showed that a connection existed between the height of the cut and illness severity. The latter became more serious nearer to the union on the panel bottom.

High yielding clones have been found to be more susceptible to tapping panel dryness compared to medium and low yielding clones (Sivakumar *et al.*, 1988).

Vijayakumar *et al.* (1990) quantified the relative susceptibilities of clones to TPD and reported that the susceptibility of clone RR11 105 is 1.9 times greater than that of clone GT 1.

In India, data available on the actual extent of incidence of TPD in the small holdings is scanty. An earlier survey conducted by the Rubber Research Institute of India in ten holdings each in Trivandrum, Kottayam and Calicut regions, showed 4.4 per cent incidence in clone RR11 105 (IRRDB Symp., 1990). The range of incidence

was from 0.1 to 16.7 per cent.

Sulochanamma *et al.* (1993) reported 17.9 per cent incidence in the clone RR11 105, from experimental plots under  $\frac{1}{2}$ S d/2 6d/7 intensity of tapping.

#### Measures of remedy

Trees which had developed complete dryness should be rested for six months, after which tapping can be resumed in healthy bark, often on a reduced cut length. However, the fact that in most trees brown bast will gradually spread throws doubt on the value of resting affected trees, and usually only a small percentage of trees actually were reported to recover (Paranjothy and Yeang, 1978).

Detailed recommendations, for small holdings, where brown bast is a particular problem because of the tendency to overtap, has been published by Anthony *et al.* (1981). As a precautionary measure it was recommended that three months before starting tapping, all trees should be provided with a single vertical isolation groove to the wood on the back guide line of the tapping panel, from the cut to the base of the tree. In the event of dryness developing, this groove should ensure that it does not spread to the second panel. In trees which develop partial or total dryness a further system of isolation groove is proposed. Tapping should be resumed on the full cut, but with periodic rest to minimise recurrence of the syndrome.



## *Materials and Methods*

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## **MATERIALS AND METHODS**

The study on the extent of incidence of Tapping Panel Dryness (TPD) and associated parameters in *Hevea brasiliensis* was carried out in the small holdings of Meenachil taluk, of Kottayam district. The aim of the study was to critically assess the incidence of TPD in the small holdings of Meenachil taluk and to evaluate whether the incidence is due to any defect in the exploitation system followed. The methodology adopted for the study is detailed below.

### **3.1 Jurisdiction of the study**

The survey was conducted in selected small holdings of Meenachil taluk, Kottayam district.

### **3.2 General information on the areas selected**

The major crop of the taluk is *Hevea*, the same being planted on the uplands which are characterised by hillocks with varying degrees of slope ranging from moderate to steep. The soil type in the uplands is oxisol. More than 90 per cent of the planted area come under small holdings. In majority of the cases, the size of holdings is less than one hectare. In nearly 80 per cent of the holdings, plantation have been raised availing of subsidy from the Rubber Board.

### **3.3 Selection of the holdings**

Fifty four small holders who sell their produce as latex and representing different parts of the taluk had been selected for the study. Only those holdings with less than two hectares of rubber area had been selected. The other criteria for selection of the holdings were that they should be planted with a single clone in the same year, tapping should be either on B0 1 or B0 2 panel, no stimulation practices adopted and the yield data should be available at least for the year 1993. The holdings selected for the study had been planted predominantly with the clone RR11 105, followed by clones RR11 600, GT 1 and RR11 208. The holdings with other clones were not selected for the study as they formed a part of the estate only, planted on experimental basis and hence separate production data of them were unavailable.

### **3.4 Collection of data**

Each of the selected holding was visited and data collected as per a pre-tested interview schedule, the details of which are given in Appendix-I.

#### **3.4.1 General informations**

The data collected included information on terrain of land, clones, year of planting, planting density and management practices. Data on cultural practices like manuring, disease control measures, weed control, cover crop establishment, etc. were also collected.

Spacing of the trees was randomly measured at five points. In addition, visual scorings were made for slope of the plantation, soil depth, rocky patches, etc.

#### 3.4.2 Details of tapping

From each of the selected units, details were collected regarding the standard adopted for tappability (girth and height of opening), system of tapping, tapping task, yearly bark consumption, depth of tapping, tapping rest provided, rainguarding practices, presence of outgrowths in the renewed bark, etc.

Five trees at random were closely examined for assessing quality of tapping. From such trees, bark depth of tapping, wounding of cambium (if any), opening height, bark consumption, etc. were recorded. Bark thickness, of ten trees in each holding, was measured using a bark guage.

Extent of injury on the renewed bark was scored as insignificant, moderate or heavy. Depth of tapping was categorised as normal, shallow or deep. Overall quality of tapping was assessed as good, satisfactory or bad.

#### 3.4.3 Incidence of TPD

Trees with completely dry tapping cut were physically counted. Each of the TPD affected tree was examined for opening of opposite panel or high panel. Observations were also made to see if

there was any abnormal incidence of TPD in locations such as surroundings of house and compound, cattle shed, low lying areas, canal/river banks, etc.

Informations on the rest period given to affected trees and other treatments were also collected.

The data collected from the holdings were subjected to statistical analysis, for drawing valid inferences.

## *Results*

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## RESULTS

The survey on examining<sup>in</sup> the incidence of tapping panel dryness in the small holdings of Meenachil taluk was taken up during the year 1994. The results obtained are presented below:

### 4.1 Area classes of holdings

The data on the size of the holdings surveyed is presented in Table 1. The mean size of the holdings studied was 0.76 hectares and the range was from 0.20 hectares to 1.90 hectares. Out of the 54 holdings surveyed, two holdings (4%) belonged to the area class of 0.20 ha and less, 21 holdings (39%) to the area class of 0.21 ha to 0.50 ha, 26 holdings (48%) to area class of 0.51 ha to 1.00 ha and five holdings to the class of more than one ha.

### 4.2 Frequency distribution of clones

The data on the clone-wise distribution of the holdings is given in Table 2. The clones planted in the area under study included RR11 105, RR11 600, GT 1 and RR11 208. Of the 54 holdings studied, 48 holdings (89%) were planted with the clone RR11 105, three (5%) with the clone RR11 600, two (4%) with GT 1 and one (2%) with RR11 208. This indicates a high preference for the clone RR11 105 among the small holders subjected to the survey. As clones RR11 600, GT 1 and RR11 208 together represented only around ten per cent of the holdings surveyed, the data from these holdings were not considered for

Table 1. Frequency distribution of area classes of holdings

Area class	Number of holdings	Percentage of holdings
0.20 ha and less	2	3.74
0.21 ha to 0.50 ha	21	38.88
0.51 to 1.00 ha	26	48.12
Above 1.00 ha	5	9.26
Total	54	

Table 2. Distribution of clones in small holdings undergoing exploitation in B0 1 and B0 2 panels

Clone	Number of holdings	Percentage of holdings
RRII 105	48	88.9
RRIM 600	3	5.6
GT 1	2	3.7
RRII 208	1	1.8
Total	54	



analysis. The holding under second year of tapping also was excluded from analysis, unless otherwise stated, as it was under a short period of exploitation only, to have any significant effect on TPD.

#### **4.3 Planting density and density of trees under tapping**

The data on planting density and density of trees under tapping are presented in Table 3 and 4 respectively. The planting density in the holdings surveyed ranged from 460 to 540 trees ha<sup>-1</sup>. In nine per cent of the holdings the planting density was 460 trees ha<sup>-1</sup> while in 26 per cent of the units it was between 461 to 500. The percentage of small holdings with planting density between 501 to 550 trees ha<sup>-1</sup> was 65. The density of trees under tapping ranged from 300 to 500 trees ha<sup>-1</sup> (Table 4). Among the holdings surveyed, 15 per cent holdings had below 400 tapping trees ha<sup>-1</sup>, 31 per cent had 401 to 450 trees ha<sup>-1</sup> and 54 per cent had 451 to 500 trees ha<sup>-1</sup>.

#### **4.4 Other basic information of the holdings**

##### **4.4.1 Slope**

The holdings surveyed were located on lands with varying degrees of slope and the data on the same are furnished in Table 5. Twenty five holdings were located in lands with flat to moderate slope (below 30% slope) whereas 29 holdings were on lands with steep slope (above 30% slope).

##### **4.4.2 Rain guarding**

Among the holdings surveyed, rainguarding was found to be

Table 3. Frequency distribution of planting density classes

Sl. No.	Planting density/ha	Number of units	Percentage of units
1	460	5	9.24
2	461 to 500	15	25.73
3	501 to 550	34	65.03

Table 4. Frequency distribution of density classes of tapping trees

Sl. No.	Tappable trees/ha	Number of units	Percentage of units
1	< 400	8	14.82
2	401 to 450	17	31.48
3	451 to 500	29	53.70

Table 5. Frequency distribution of holdings based on slope

Sl. No.	Slope of the area	Number of units	Percentage of units
1	Flat to moderate slope	25	46.3
2	Steep area	29	53.7

practised in 35 per cent of the holdings, while in the rest no rain-guarded tapping was undertaken. The pertinent data are furnished in Table 6.

#### 4.5 Tapping intensity

The tapping intensity followed in the holdings surveyed was  $\frac{1}{2}$  S d/2, without any rest on Sundays. In nine of the holdings surveyed, the tapping was found to be shallow while it was either optimum or deep in the others. Yield stimulants were used in none of the holdings.

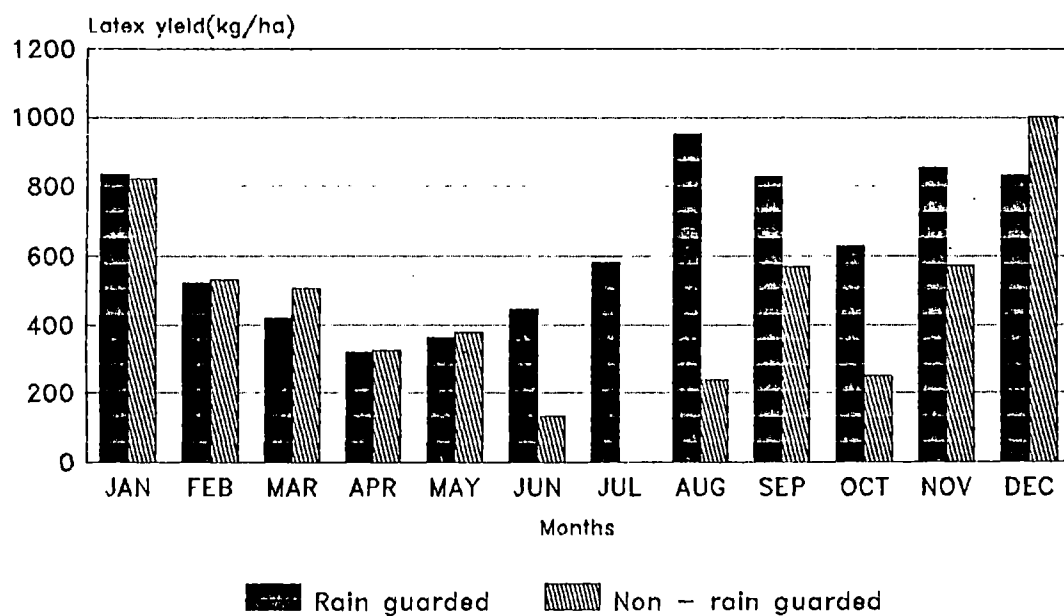
#### 4.6 Yield attributes

Monthly yield of latex, dry rubber content and mean dry rubber content in the rain-guarded and non-rain-guarded holdings for clone RRII 105 are presented in Figs. 1, 2 and 3. Figure 4 shows the cumulative yield of dry rubber (excluding scrap) in the rain-guarded and non-rain-guarded holdings in different months, for the year 1993. Data on total number of tapping days were not available. Cumulative yield from rain-guarded and non-rain-guarded holdings were comparable from January 1993 to May 1993. Cumulative yield of non-rain-guarded holdings registered a fall from June onwards, with widening of gap upto November. There was slightly narrowing of gap in December. The final difference in yield was  $597 \text{ kg ha}^{-1}$ . Mean drc was 1.22 per cent higher in the non-rain-guarded holdings. Mean yield of dry rubber from rain-guarded holdings was  $2433 \text{ kg ha}^{-1}$  and from non-rain-guarded holdings was  $1836 \text{ kg ha}^{-1}$ , for the year 1993 (Fig. 4).

Table 6. Frequency distribution of rainguarded and non-rainguarded holdings

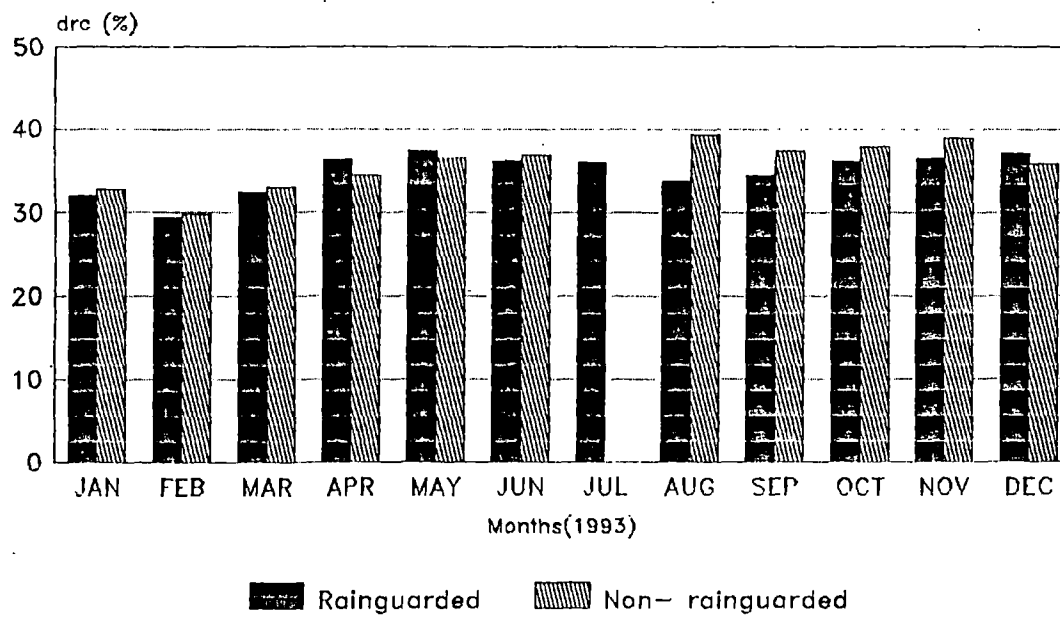
Sl. No.	Particulars	Number of units	Percentage of holdings
1	Rainguarded holdings	19	35.19
2	Non-rainguarded holdings	35	64.81

Fig.1. Monthly yield of latex in rainguarded and non-rainguarded holdings



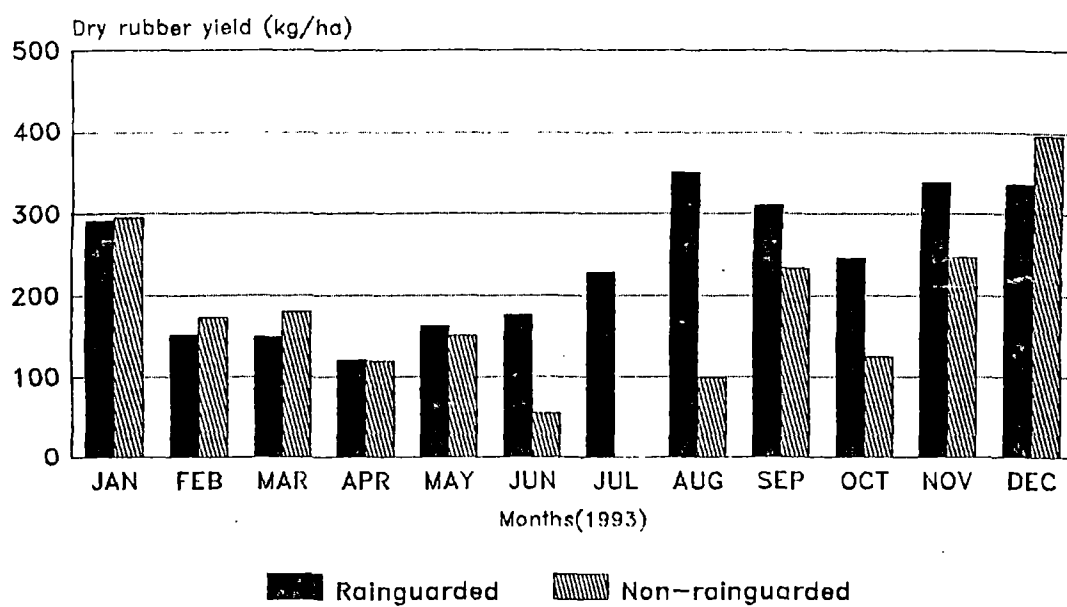
Meenachil Taluk—Clone RR11 105

Fig.2. Monthly variation in drc in rainguarded and non-rainguarded holdings



Meenachil Taluk - Clone RR11 105

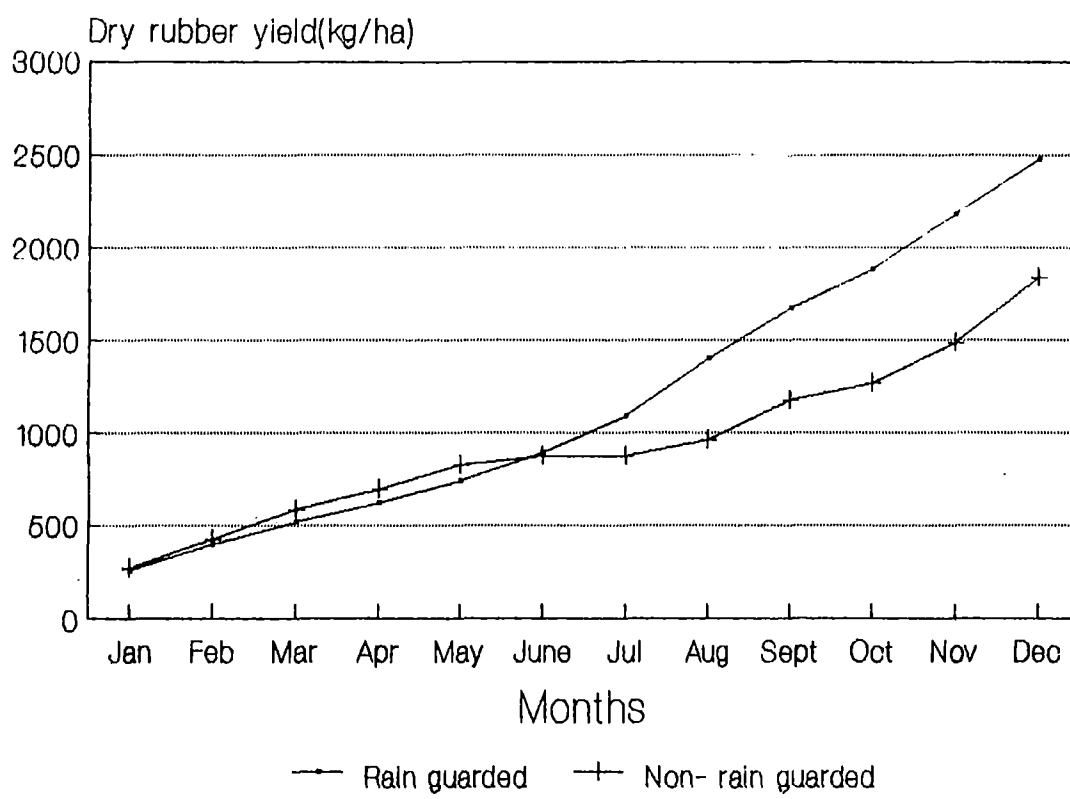
Fig.3. Monthly yield variation in dry rubber in rainguarded and non-rainguarded holdings



Meenachili Taluk - Clone RR11 105



Fig.4. Cumulative dry rubber yield (Rainguarded 17 holdings & Non-rainguarded 30 holdings)



#### **4.7 Incidence of TPD**

Mean percent incidence of TPD, variation in the incidence and the frequency distribution of different incidence classes are shown in Fig. 5. The mean incidence of TPD, in terms of completely dry tapping cuts, was eight per cent. In 23 per cent of the holding, the incidence was less than five per cent, while it was five to ten per cent in 55 per cent of the holdings. In 15 per cent of the holdings complete drying of the cut was between 10 to 15 per cent. It was 15 to 18 per cent only in six per cent of the holdings.

Effect of duration of tapping on the incidence of TPD, including the holdings under second year of tapping, is presented in Fig. 6. During the initial four years of tapping, the incidence was below five per cent. During subsequent years the incidence ranged from 3 per cent to 18 per cent.

#### **4.8 Correlation of incidence of TPD with yield attributes**

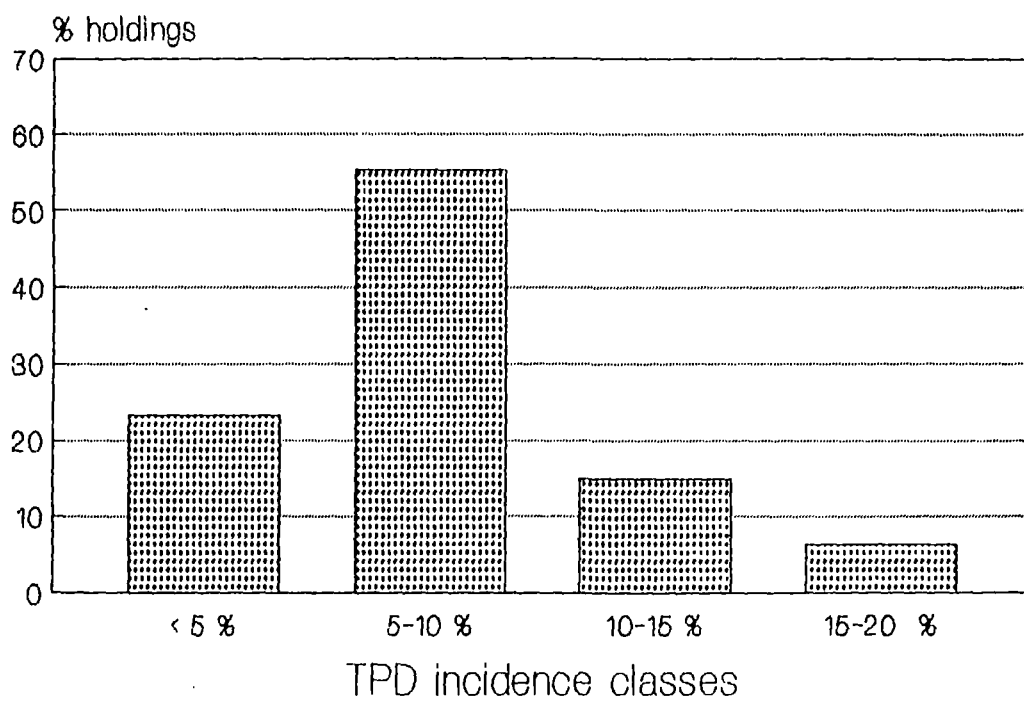
Coefficient of correlation ( $r$ ) between selected yield attributes and TPD are presented in Table 7. Mean data for dry rubber yield, incidence of TPD, annual bark consumption and mean annual drc in rainguarded and non-rainguarded holdings and the test of significance for these parameters are presented in Table 8. Data on annual yield of latex, dry rubber (excluding scrap), per cent of dry rubber content, number of trees affected by TPD in terms of completely dry tapping cut, data on mean bark thickness and mean bark consumption for the year 1993, in the individual holdings under study, are given

Table 7. Correlation coefficient (r) between selected yield attributes and TPD in *Hevea brasiliensis* (Clone RRII 105) in the small holdings of Meenachil taluk

	Non-rainguarded holdings (30 Nos)	Rainguarded holdings (17 Nos)	Combined (47 Nos)
Yield Vs incidence of TPD	+0.2567 NS	+0.33458 NS	+0.28978**
Bark consumption Vs per cent incidence of TPD	+0.5202**	+0.2350 NS	+0.4510**
Density Vs per cent incidence of TPD	+0.15637NS	-0.3132 NS	-0.0272 NS
Bark consumption Vs yield	-0.1651 NS	-0.1270 NS	+0.0333 NS
Bark thickness Vs per cent incidence of TPD	-0.2513 NS	-0.3713 NS	-0.3362**
Density Vs yield	-0.3317 NS	+0.3428 NS	-0.1849 NS
Density Vs Bark thickness	-	-	-0.07668NS
Bark thickness Vs yield	-0.2662 NS	-0.0584 NS	-0.04 NS
Bark thickness Vs Mean annual drc	+0.5696**	+0.5751*	+0.47869**
Mean annual drc Vs incidence of TPD	-0.08375 NS	-0.1954 NS	-0.14609NS

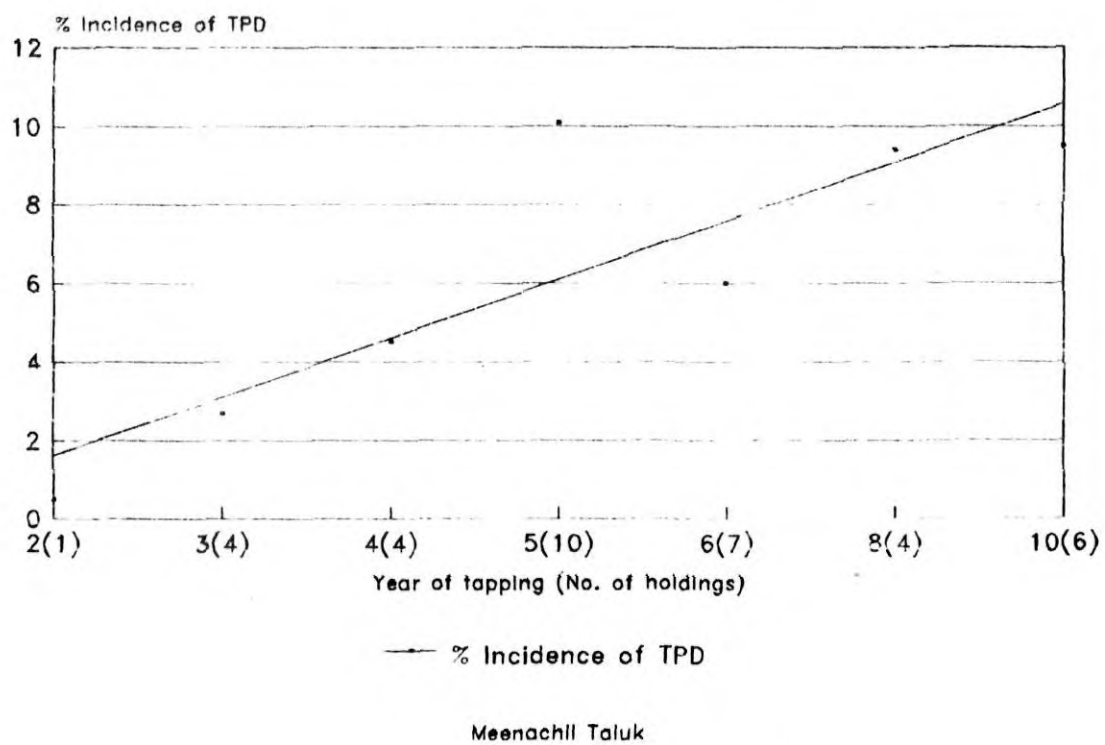
\*\* Significant at 1% level    \* Significant at 5% level  
NS - Non significant

Fig.5. TPD incidence classes



mean(+SD)=7.56+3.75,CV(%) =49.60  
Meenachil Taluk -Clones RR11 105,  
RR1M 600,GT 1 & RR11 208

Fig.6. Relationship of tapping duration and TPD in clone RR11 105



in Appendix-II, separately for rainguarded and non-rainguarded holdings.

#### 4.8.1 Correlation with planting density and bark thickness

Distribution of holdings of clone RR II 105 under different planting density classes is shown in Fig. 7. Mean bark thickness under different planting densities are also shown in the figure. The relationship between bark thickness and density of planting was found to be statistically non-significant (Table 7). Similarly, the relationship between the density and incidence of TPD was also non-significant (Table 7). However, bark thickness and incidence of TPD showed highly significant negative correlation (Fig. 8 and 9; Table 7).

#### 4.8.2 Correlation with bark consumption

Bark consumption showed significant (at 1% level) positive correlation with incidence of TPD (Table 7, Fig. 10). Further analysis showed the relationship to be significant only in non-rainguarded holdings, but not in rainguarded holdings (Table 7).

#### 4.8.3 Correlation with yield

Yield of dry rubber (excluding scrap) during 1993 showed significant positive correlation with TPD incidence (Table 7, Fig. 11). However, the incidence of TPD among rainguarded and non-rainguarded holdings were similar (Table 8). The mean annual dry rubber was 24.5 per cent less in the non-rainguarded holdings. Though mean

Table 8. Test of significance of yield attributes and per cent incidence of TPD between rainguarded and non-rainguarded holdings (Clone RR11 105) in Meenachil taluk

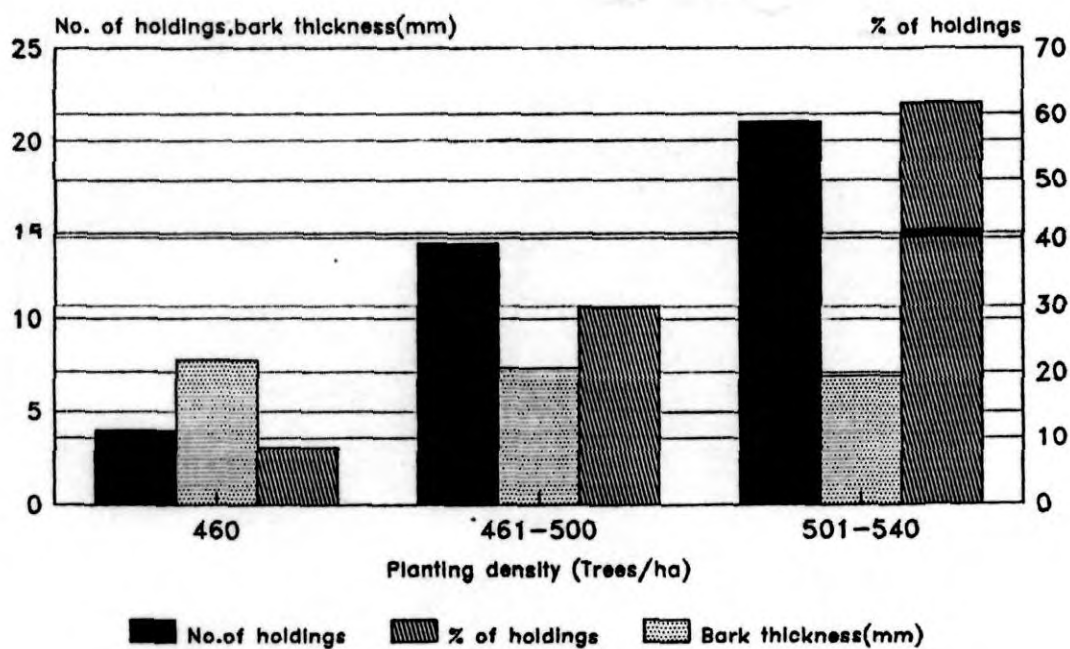
	Rainguarded holdings	Non-rainguarded holdings	't' test
Dry rubber yield (kg/ha)	2433.00	1836.00	4.99**
Incidence of TPD	8.14	7.22	0.2475 NS
Annual bark consumption	22.82	21.57	1.8545 NS
Annual mean drc	34.83	36.05	2.0228*

\*\* Significant at 1% level

\* Significant at 5% level

NS - Non significant

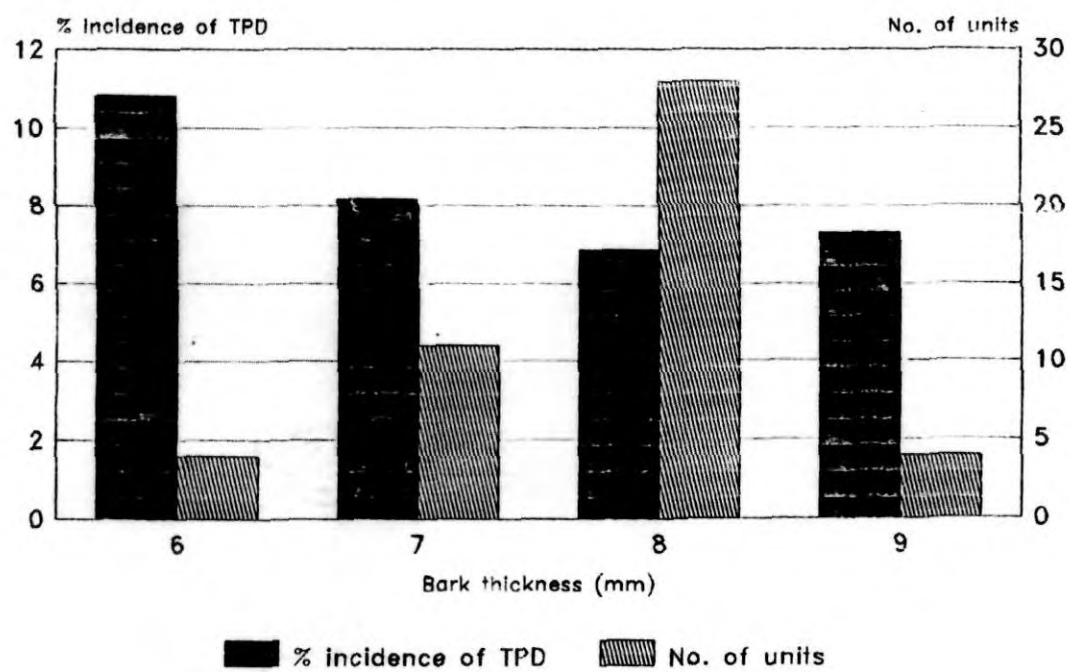
Fig.7. Effect of planting density on bark thickness



Meenachil Taluk - Clone RR11 105

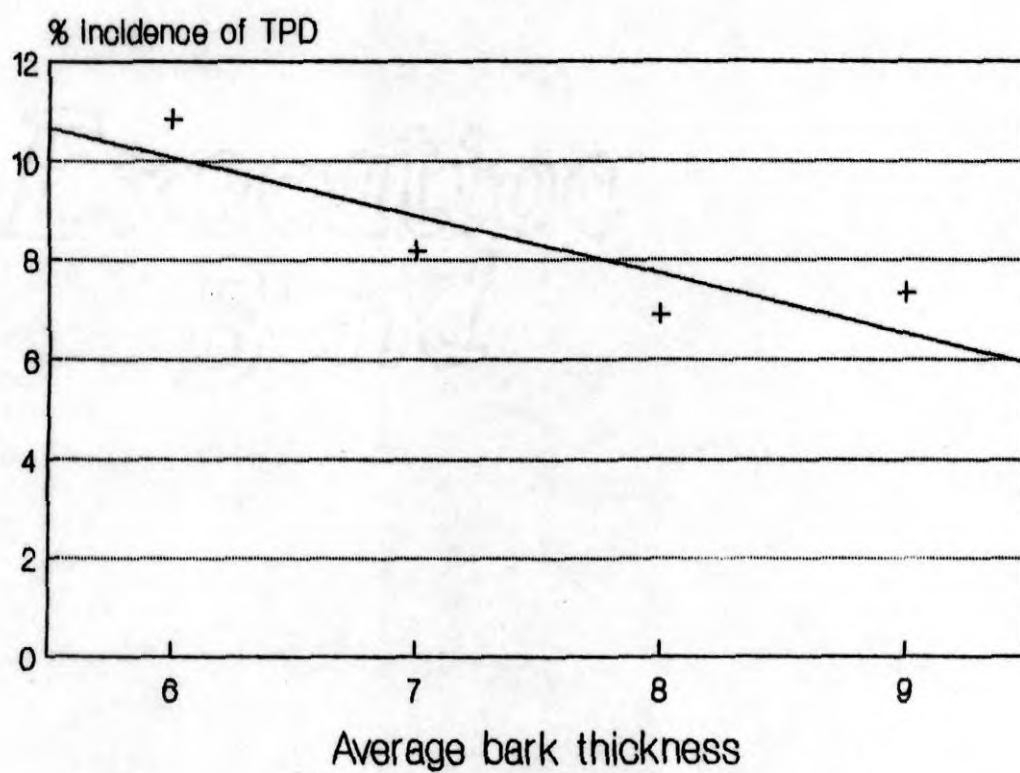


Fig.8. Relationship between bark thickness and TPD in clone RR11 105



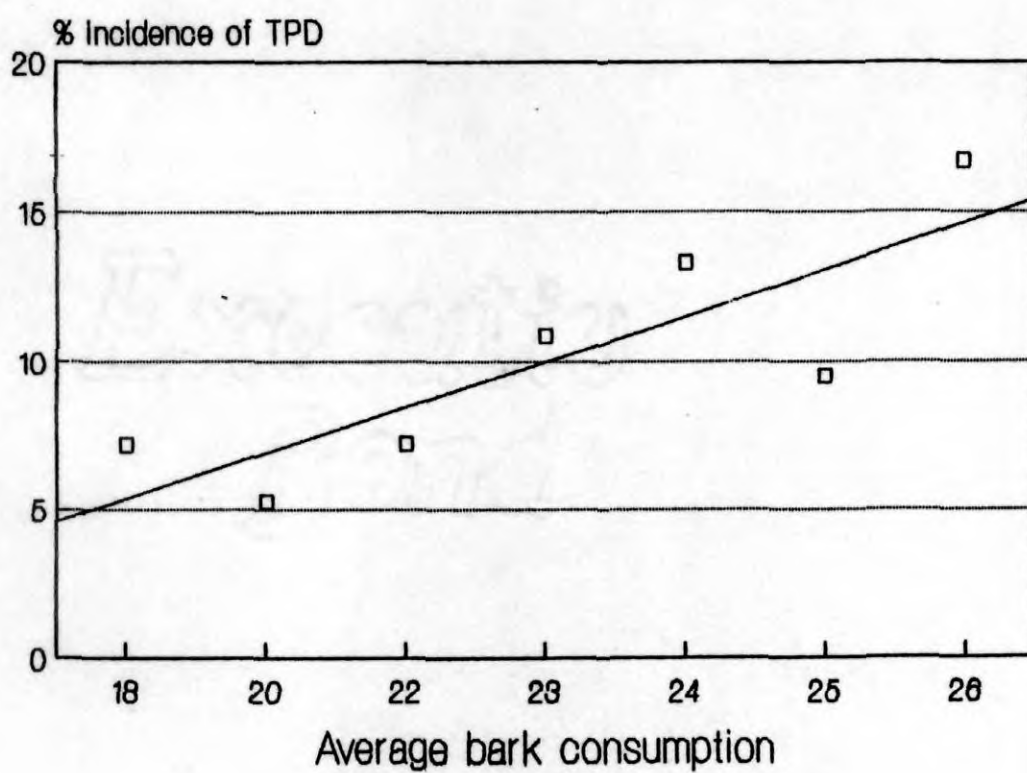
Meenachil Taluk

Fig.9. Influence of bark thickness on incidence of TPD



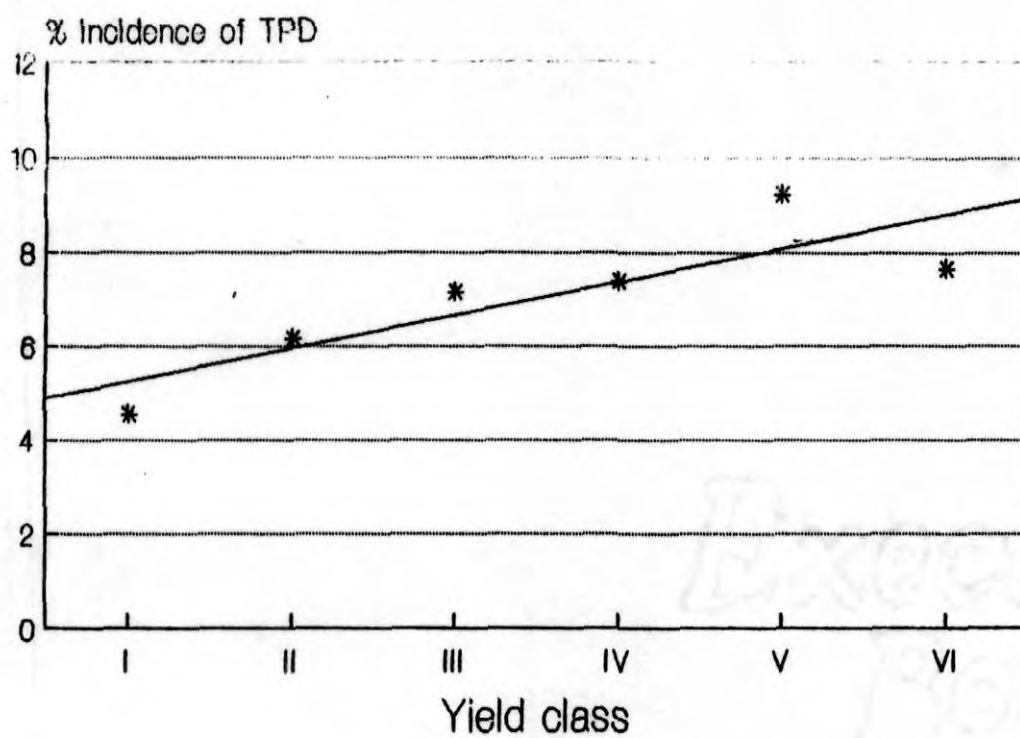
Meenachil Taluk - Clone RR11 105

Fig.10. Effect of bark consumption on incidence of TPD



Meenachil Taluk - Clone RR11 105

Fig.11. Effect of latex yield on incidence of TPD



Meenachil Taluk - clone RR11 105

annual drc was negatively correlated to TPD incidence, it was non-significant.

#### **4.9 Effect of bark thickness and yield on incidence of TPD**

Eventhough bark thickness and yield are related to TPD incidence (Table 7, Fig. 9 and 11), significant relationship was not observed between bark thickness and yield (Table 7). Simiarly, bark thickness and mean annual drc are positively and significantly correlated at one per cent level (Table 7, Fig.12). Though mean annual drc and TPD incidence are negatively correlated, the relationship is statistically non-significant (Table 7). Mean drc among the rain-guarded and non-guarded holdings were significantly different from each other at five per cent level (Table 8).

#### **4.10 Special features of the incidence**

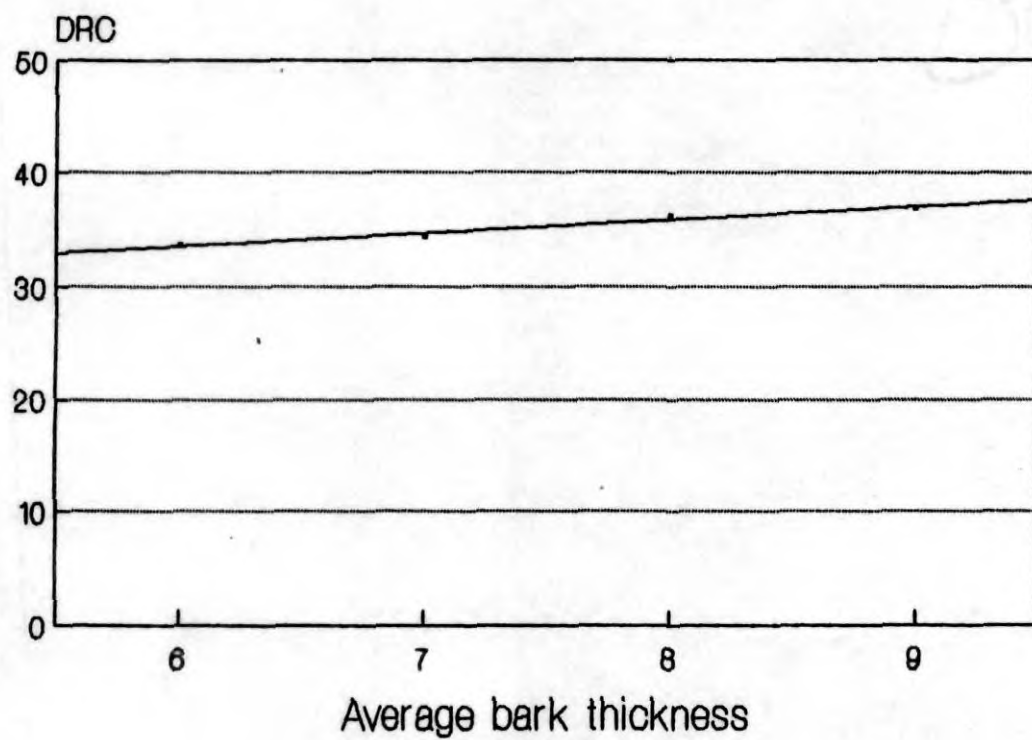
The present study showed that holdings which took more than normal time to attain tappability have lesser incidence of TPD (Fig. 13).

Generally, high incidence of TPD was observed near households and cattle sheds, in low lying areas, banks of river, canals, etc.

#### **4.11 General observations**

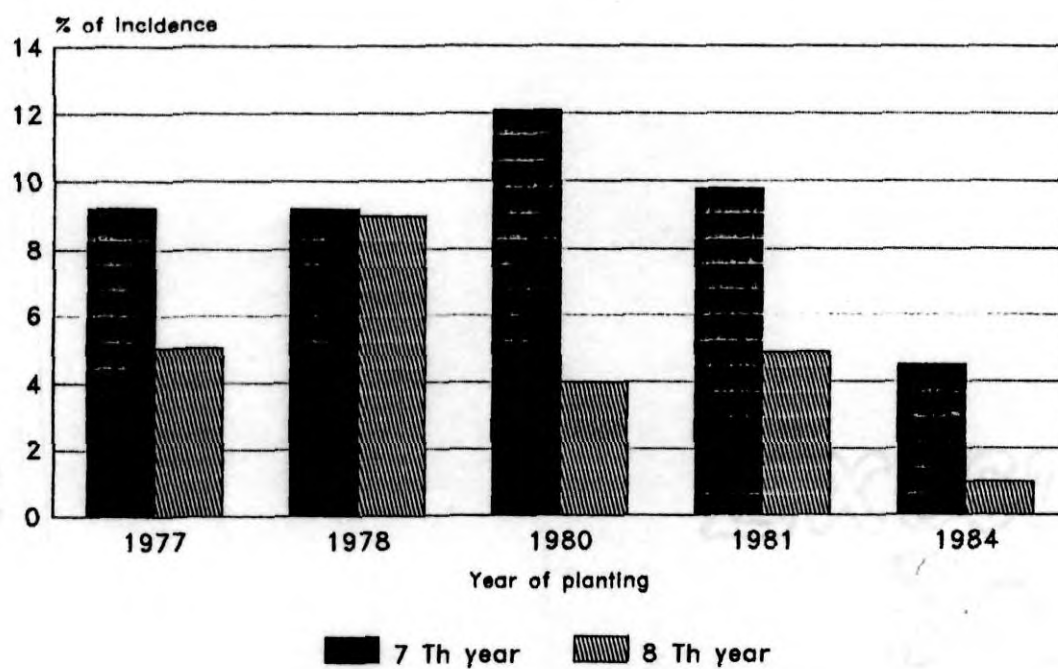
In the case of clone RR11 105, dryness was seen affected in

Fig.12. Influence of bark thickness on drc



Meenachil Taluk - Clone RR11 105

Fig.13. Effect of immaturity period on incidence of TPD



Meenachil Taluk

the B0 1 panel tapping itself, in the majority of cases. In the case of trees of the clones RRIM 600 and GT 1, the dryness started in the B0 2 panel tapping stage and they had only comparable girth conditions with other trees in the holding (Table 9).

In the trees which had been tapped in the opposite panel when the original cut got dried up, it was seen that the dryness had spread to that panel also, within a few weeks or few months of tapping (Table 10). In two trees of clone RRII 105, the B0 2 panel was also found to be dry without tapping of the panel.

#### **4.12 Treatment of affected bark**

In four holdings, the affected bark was seen treated with Bordeaux paste, which did not improve the condition of the affected bark, even though more than a year had elapsed after the treatment. In the other holdings no treatment was given to the affected bark (Table 11).

In all the cases, treated or untreated, the dried up bark was seen adpressed to the newly formed tissue inside. The dried bark cracked and or flaked and the newly formed tissue could be seen through the cracks. In the newly formed bark tissues, latex was seen close to the cambium only. The outer bark portion of these tissues was brownish in colour and the inner portion was yellowish grey.

In two trees, severe deformity and swelling was seen on the bark, up to about ten feet height. Bark dryness started in these trees on B0 1 panel tapping, but deformity and swelling was seen on



Table 9. Average girth conditions of trees of clone RRIM 600 and GT 1 (Affected by TPD and unaffected)

Sl. No.	Clone	Year of planting	Average girth of trees	
			Normal trees	TPD affected trees
1	RRIM 600 (two holdings)	1977	70 cm	72 cm
2	GT 1	1980	75 cm	75 cm
3	GT 1	1984	68 cm	69 cm

Table 10. TPD incidence in subsequent panel after drying up of first panel

Sl. No.	Number of trees observed	Panel tapped	Present condition of panel	Duration of tapping after which the incidence occurred in the panel
1	12	B0 2	Dry	2-3 months
2	7	B0 2	Dry	1-2 months
3	4	B0 2	Dry	2-3 weeks
4	2	B0 1	Dry	B0 2 also dry without tapping of the panel

Table 11. Treatment of TPD affected trees by the small holders of  
Meenachil taluk

Sl. No.	Details of treatment given	Number of holdings	Percentage of holdings
1	Recommended treatment	Nil	Nil
2	Bordeaux paste application	4	7.41
3	No treatment	50	92.59

both panels. Latex was seen deep inside the bark, but the panels were unsuitable for tapping due to uneven surface and burr formation. The swellings had woody tissue inside and the bark covering was thin. Latex was seen on the bark portion of these tissues.

#### **4.13 Details of rest given to affected trees**

Out of the 54 holdings surveyed, in 30 holdings (54 per cent) the TPD affected trees were rested for a year or more, before resuming normal tapping on them. In 15 holdings (27 per cent) the duration of rest given was 6-12 months. In six holdings (11 per cent) three to six months of rest were given. In three holdings (eight per cent) no resting of the trees was resorted to and the trees were tapped on the next panel or high panel, when the tapping panel got dried up due to TPD. The data on the rest period given to the affected trees is furnished in Table 12.

Table 12. Details of rest given to TPD affected trees

Sl. No.	Details of rest given	Number of holdings	Percentage of holdings
1	1 year and above	30	53.70
2	6-12 months	15	26.85
3	3-6 months	6	11.11
4	Not rested	3	8.34

## *Discussion*

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## DISCUSSION

The salient results obtained in the study are discussed hereunder.

### 5.1 Incidence of Tapping Panel Dryness

In clone RR11 105, high incidence of TPD in terms of completely dry tapping cut has been reported. Sulochanamma *et al.* (1993) reported 17.9 per cent of incidence in clone RR11 105 from experimental plots under  $\frac{1}{2}$ S d/2 6d/7 intensity of tapping. In another trial, 15.72 per cent of incidence was reported (RR11 Annual Report, 1993). The present study shows that the general incidence of TPD in RR11 105 in the small holdings of Meenachil taluk is not alarmingly high.

### 5.2 Latex yield and TPD incidence

Incidence of TPD is related to latex output and intensity of tapping (Sivakumar *et al.*, 1988; Kang and Hashim, 1989). In the present study also positive correlation was observed between dry rubber yield per unit area and incidence of TPD. Absence of such correlation within the rainguarded and non-rainguarded holdings might be due to small sample size.

Data shows that comparable incidence of TPD is encountered in rainguarded and non-rainguarded holdings without realising comparable yield. Mean annual yield in the non-rainguarded holdings was

24.5 per cent less when compared to the yield from rainguarded holdings.

The significant correlation with dry rubber yield (eventhough for only one year rather than with cumulative yield) indicate that incidence of TPD within reasonable limits need not result in lower yield in the holdings. Such reductions are likely only as a result of abnormally high incidence. Hence, in plantations where TPD incidence is very little, yield performance has to be critically examined to verify if there is any under exploitation.

Though bark thickness had highly significant positive correlation with mean annual drc, there was no correlation between annual mean drc and TPD incidence. This might be due to transient changes in drc due to the small percentage of affected trees.

### **5.3 Bark thickness and incidence of TPD**

Ng Ai Peng (1993) reported reduction in bark thickness with increasing density in planting. In the present survey such correlation could be not observed, since planting density of the holdings surveyed varied between 460 ha<sup>-1</sup> to 540 tree ha<sup>-1</sup>.

In the holdings under survey, the mean bark thickness showed variation from 6 mm to 9 mm and this parameter had highly significant correlation with TPD. Higher incidence in thin bark situations is mainly due to the physical difficulties to tap thin bark, which result in profuse wounding of cambium. The absence of correlation between bark thickness and yield suggests direct effect of bark thickness on TPD incidence.

#### 5.4 Bark consumption and incidence of TPD

Though bark consumption for the year 1993 only was considered, it showed highly significant correlation with TPD incidence. This relationship was pronounced in holdings where rainguarding was not practised and non-significant in the rainguarded holdings. This indicates practice of recovery tapping to a large extent by the farmers who do not resort to rainguarding. Bark consumption showed only non-significant correlation with yield.

The present study showed that incidence of tapping panel dryness was not alarmingly high in clone RR11 105, in the small holdings Meenachil taluk. It also indicated that low incidence of the syndrome might be often at the cost of yield. Other than tapping intensity, bark thickness and bark consumption were important factors which contributed to the incidence of TPD. Planting density upto 550 trees ha<sup>-1</sup> did not have any effect on bark thickness and consequently on the incidence of TPD.



## *Summary and Conclusion*

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## SUMMARY AND CONCLUSION

The study was conducted to find out the extent of incidence of TPD and related parameters in the rubber growing small holdings of Meenachil taluk. Fifty four small holders who sell their produce as latex and representing different parts of the taluk were selected for the study. Holdings with trees tapped either on B0 1 or B0 2 panel only were included in the study.

The study revealed that the small holders have high preference for the clone RR11 105 due to its inherent capacity for faster growth, higher yield and disease resistance. Rainguarded tapping is not being practised on a large scale, as only 35.19 per cent of the holdings resorted to this practice. Tapping intensity in the surveyed holdings was invariably  $\frac{1}{2}$  S d/2, without any rest on Sundays.

Planting density varied from 460 ha<sup>-1</sup> to 550 ha<sup>-1</sup> and density of trees under tapping varied from 300 ha<sup>-1</sup> to 500 ha<sup>-1</sup>. Planting density upto 550 ha<sup>-1</sup> was found not to have any effect on bark thickness or incidence of TPD.

The mean incidence of TPD, in terms of complete dry cuts, was 7.56 per cent for the clone RR11 105. During the initial four years of tapping, the incidence was below five per cent in the holdings surveyed.

In the present study, positive correlation was observed

between dry rubber yield per unit area and incidence of TPD. Mean bark thickness showed highly negative correlation with incidence of TPD. Also, bark thickness was found to have highly significant positive correlation with annual mean drc. But no correlation was observed between annual mean drc and TPD incidence. Bark consumption showed highly significant correlation with TPD incidence, and non significant correlation with yield. This indicates induction of TPD by recovery tapping without concomitant increase in yield. Thus comparable incidence of TPD was encountered in rainguarded and non-rainguarded holdings, without realising comparable yield.

Low incidence of TPD was observed in plantations with slower growth. High incidence of TPD was generally observed near house holds and cattle sheds, in low lying areas, banks of rivers and canals, etc.

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## Appendices

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APPENDIX-I  
CASE STUDY ON THE INCIDENCE OF TAPPING PANEL DRYNESS IN THE RUBBER  
SMALL HOLDINGS OF MEENACHIL TALUK

QUESTIONNAIRE

1. Name of the farmer :
2. Address :
3. Reg.No./Ref.No. of holding :
4. Year of planting :
5. Clone :
6. Area in hectares :
7. Spacing : Square/rectangular/contour ....ft
8. No. of trees under tapping :  
(including trees untapped  
due to TPD)
9. Year and month of opening :
10. Average girth at opening :
11. Height of opening :
12. Percentage of trees which :  
attained tappability at  
the time of opening
13. Task undertaken by the :  
tapper (with details, if  
he is undertaking tapping  
in other holdings)
14. Quality of tapping : Good/Satisfactory/Bad
15. Whether shallow or not :
16. Extent of injury : Nil/Insignificant/Moderate/  
Heavy
17. Bark consumption (CM/year) :

18. Bark thickness (MM) :  
(below tapping cut, 10  
trees at random)
19. Frequency of tapping :
20. Details of rest given :
21. Rainguarded or not :
22. Details of extra tapping :
23. Presence of out growth : Nil/Slight/Moderate/Heavy  
in renewed bark
24. Yield performance (whatever details available to be collected)  
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Latex (kg)

Mean drc

Scrap (kg)

No. of  
tapping  
days

25. No. of trees in which the :  
original tapping cut is  
completely dry  
(include data for all  
available)
26. No. of trees affected by TPD :  
in which opposite panel was  
opened  
a) No. of trees where :  
opposite panel is  
yielding  
b) No. of trees where :  
opposite panel is dry
27. No. of trees affected by TPD :  
in which high panel was opened  
for upword tapping

28. Present condition of affected trees :      B0 1      B0 2      H0  
    Yielding/   Yielding/   Yielding/  
    dry           dry           dry  
      No. of trees
29. Year in which the incidence occurred :  
      (1st year of tapping, 2nd year, etc.) (if available)
30. Relative position of the trees affected (near to cattle shed, house and compound etc.) :
31. Any other details requiring mention :
32. Treatment of affected bark :
33. Tapping rest given or not : yes/No
34. Duration of tapping rest :
35. General status of cultural operations
- a) Manuring
- |                |       |
|----------------|-------|
| Type of manure |       |
| Pre monsoon    | Kg/ha |
| Post monsoon   | Kg/ha |
- b) Disease control measures
- c) Pest management
- d) Weed status/control
- e) Cover crop established or not
36. General status of plantation
- a) Slope : Flat/Gentle slope/Moderate/Steep
- b) Soil depth : Poor/satisfactory/good
- c) Rocky patches % :
- d) Aspect : South/North/East/West

e) Interplanted or not :

37. Remarks, if any

Place:  
Date :

Signature  
Name of Investigator

APPENDIX-II  
DATA ON ANNUAL YIELD, BARK THICKNESS, BARK CONSUMPTION AND TPD  
INCIDENCE IN SELECTED SMALL HOLDINGS OF MEENACHIL TALUK

I. RAINGUARDED HOLDINGS

Code No. of estate *	Area (ha)	Latex weight (kg)	drc	Dry weight (kg)	Mean bark thick- ness (mm)	Bark consum- ption (cm)	No. of affect- ed trees
1	2	3	4	5	6	7	8
2	0.90	6320.300	35.94	2260.330	7	25	17
3	0.60	5022.000	33.35	1674.830	6	25	40
12	1.90	13866.600	36.28	5110.960	8	22	49
14	1.37	7794.300	33.26	2571.490	8	22	45
17	1.00	7672.700	31.90	2632.140	7	20	32
18	1.20	8503.300	38.20	2989.210	9	20	48
19	1.24	8936.200	34.90	3167.500	9	20	36
20	1.00	6610.400	38.90	2417.340	9	20	38
22	0.60	4413.200	34.95	1533.160	8	25	31
36	0.38	3310.100	32.80	902.780	7	25	20
37	0.80	4127.800	37.80	1624.560	8	25	21
42	0.90	5827.000	33.10	2147.050	8	25	46
43	0.80	5630.500	34.30	1887.340	8	23	30
44	0.95	6404.40	33.70	2176.500	8	22	22
46	0.50	2800.400	33.70	984.400	8	22	8
47	0.66	3942.300	34.30	1250.350	8	22	12
48	0.52	3583.200	34.80	1159.120	8	25	17

\* Addresses given in Appendix-111

Contd.



## Appendix-II. Continued

1	2	3	4	5	6	7	8
51	0.50	3277.80	33.56	1100.020	8	20	18
54	0.92	10060.300	34.05	3425.530	7	22	30
2. NON-RAINGUARDED HOLDINGS							
1	0.52	2666.900	40.08	1068.890	8	20	10
4	0.40	2372.400	34.82	812.280	8	22	14
5	0.85	3657.400	34.54	1200.880	7	20	4
6	0.58	3754.100	35.97	1259.730	7	20	16
7	0.40	1628.900	34.60	547.260	7	25	15
8	0.90	2868.100	36.20	998.810	8	20	18
9	0.80	3094.500	35.69	1083.680	9	22	22
10	0.67	3216.800	39.50	1162.090	8	25	26
11	0.60	2878.200	35.29	1024.620	8	22	19
13	0.32	2288.500	32.72	752.280	7	23	28
15	1.00	6722.800	37.54	2413.240	8	20	4
16	0.76	4584.000	36.60	1594.670	8	20	18
21	0.42	1657.800	34.36	547.470	8	18	7
23	0.80	3172.300	37.54	1165.420	8	22	30
24	0.40	584.900	36.40	212.900	6	18	1
25	0.50	3189.400	33.30	1038.310	6	26	40
26	1.37	4175.600	36.90	1467.290	8	20	40
27	0.76	2761.400	33.30	901.600	6	18	5
28	0.45	2361.000	38.70	806.260	8	18	20

Contd.

## Appendix-II. Continued

1	2	3	4	5	6	7	8
29	0.38	3161.900	38.80	1266.030	8	18	20
30	0.38	1868.500	38.30	641.480	7	22	18
31	0.40	2325.500	34.30	868.140	6	25	25
32	0.60	3323.000	38.10	1136.460	8	25	32
33	0.50	2589.500	38.30	818.760	8	23	16
34	0.45	2012.600	35.10	677.340	8	22	16
35	0.40	2243.900	35.80	807.180	8	22	12
38	0.80	3267.600	35.90	1065.290	8	25	25
39	0.50	2924.100	34.70	997.650	7	24	20
40	0.39	2343.700	32.30	766.390	7	20	8
41	0.26	1810.200	34.80	529.500	7	20	8
45	0.40	2190.900	37.60	648.570	8	20	4
49	1.00	4930.100	34.79	1715.180	8	22	40
50	0.40	1559.000	35.20	543.550	7	25	21
52	0.30	1406.900	33.57	439.860	6	30	6
53	0.85	3635.300	30.29	1101.130	7	22	18

APPENDIX-III  
Name and address of small holders surveyed

Code No. of estate	Name and address
1	2
1	Sri.Augustus M. Roy, Vaniappura, Ramapuram Bazar, P.O.
2	Sri.C.J.Jose, Cheemkallel, Ramapuram Bazar, P.O.
3	Smt.Thressiamma Joseph, Karakkattu, Ramapuram Bazar, P.O.
4	Smt.Thressiamma Scaria, Enthumplackal, Poonjar South, P.O.
5	Sri.Jose Scaria, Muthuthavalathil, Poonjar South, P.O.
6	Sri.P.C.Mathew, Padikara, Poonjar South, P.O.
7	Sri.C.A.Thomas, Srampickal, Poonjar South, P.O.
8	Sri.Baby Varkey, Vadakkal, Poonjar South, P.O.
9	Sri.Joseph Joseph, Vayalikkunneil, Poonjar South, P.O.
10	Sri.Varkey Abraham, Adattu, Njandukallu, Teekoy, P.O.
11	Smt.Ansamma Joseph, Panackakuzhiyil, Njandukallu, Teekoy, P.O.
12	Sri.T.T.Varkey, Thattamparambil, Njandukallu, Teekoy, P.O.
13	Sri.Jino Jacob, Panackakuzhiyil, Njandukallu, Teekoy, P.O.
14	Sri.Babu Joseph, Pallivathukkal, Ramapuram Bazar, P.O.
15	Sri.Joseph George, Cheemkallel, Vellilappally, Ramapuram Bazar, P.O.

Contd.

Appendix-III. Continued

1	2
16	Smt.Rosamma George, Cheemkallel, Vellilappally, Ramapuram Bazar, P.O.
17	Sri.Benny Mathew, Chockathu, Aimkombu, Kadanad, P.O.
18	Smt.Thressiamma Augustine, Mylackal, Aimkombu, Kadanad, P.O.
19	Sri.Jacob Mathew, Chockathu, Aimkombu, Kadanad, P.O.
20	Sri.Augusthy Augustin, Mailackal, Aimkombu, Kadanad, P.O.
21	Sri.T.M.Josekutty, Vallikunnel, Ezhacherry, P.O.
22	Smt.Annakkutty Mathew, Chockathu, Aimkombu, Kadanad, P.O.
23	Sri.Mathai Varkey, Thattamparambil, 6th Mile, Plasanal,P.O.
24	Prof.Joseph Meckathu, Panackapalam, Rubi Nagar, Changanacherry
25	Sri.C.M.Xavier, Challavayalil, Panackappalam, Plasanal, P.O.
26	Sri.V.C.Pothen, Vattakottayil, Thekkummuri, Puliyanloor, P.O.
27	Sri.Pius Thomas, Nellippuzha, Cherpumkal,P.O.
28	Sri.N.J.Stanislavos, Nellippuzha, Cherpumkal, P.O.
29	Smt.Thressiamma, Nellippuzha, Cherpumkal,P.O.
30	Sri.K.K.Joseph, Kakkattil, Thekkummuri, Puliyanloor, P.O.

Contd.

Appendix-III. Continued

1	2
31	Smt.Thankamma Philip, Karamayil, Cherpumkal,P.O.
32	Sri.V.T.Thomas, Moothasseril, Thekkummuri, Puliyanloor, P.O.
33	Smt.Aley Ulahannan, Puthuppallil, Melukavumattam, P.O.
34	Sri.Thommen Joseph, Nellamkuzhiyil, Melukavumattam, P.O.
35	Sri.A.M.Mathew, Ancheriyil, Melukavumattam, P.O.
36	Sri.Noble Ezhakiel, Vazhamattam, Melukavumattam, P.O.
37	Sri.A.T.Thomas, Edayanikkattu, Melukavumattam, P.O.
38	Sri.V.J.Joseph, Vettikuzhiyil, Melukavumattam, P.O.
39	Smt.Thressiama Joseph, Vettukallel, Melukavumattam, P.O.
40	Sri.Thomas Mathai, Kudilil, Neeloor, P.O.
41	Sri.Jacob, T.A., Thannickal, Kurumannu, P.O.
42	Sri. <sup>M</sup> .T.Michael, Mookenthottam, Alamattam, Kodumpidy, P.O.
43	Sri.Augustine, T.A., Thannickal, Maryland, P.O.
44	Sri.Sebastian Joseph, Kallidickal, Kadanad, P.O.
45	Sri.P.T.Thomas, Pampackal, Kollappally, P.O.

Contd.

Appendix-III. Continued

1	2
46	Sri.N.I.Augustine, Naduvilekoot, Kadanad, P.O.
47	Sri.Joy Joseph, Neduvilekoot, Kadanad, P.O.
48	Sri.K.J.Mathai, Kavalavazhiakel, Alamattam, Kodumpidy, P.O.
49	Sri.T.O.Mathew, Thattamparambil, Plasanal, P.O.
50	Sri.Varkey Abraham, Olayethil (Edattu), Njandukallu, Teekoy, P.O.
51	Sri.K.S.Sebastian, Kallidickal, Kadanad, P.O.
52	Sri.V.C.Joseph, Vellookunnel, Melukavumattam, P.O.
53	Sri.M.V.Thomas, Meckattu (Kochukarotte), Panackappalam, Plasanal, P.O.
54	Sri.Chacko Mathew, Chockattu, Aimkombu, Kadanad, P.O.

