Tapping Panel Dryness

An Annotated Bibliography

RUBBER RESEARCH INSTITUTE OF INDIA
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Rubber Research Institute of India

IRRDB
INTERNATIONAL WORKSHOP ON TPD

Tapping Panel Dryness
An Annotated Bibliography

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Tapping Panel Dryness:
An Annotated Bibliography

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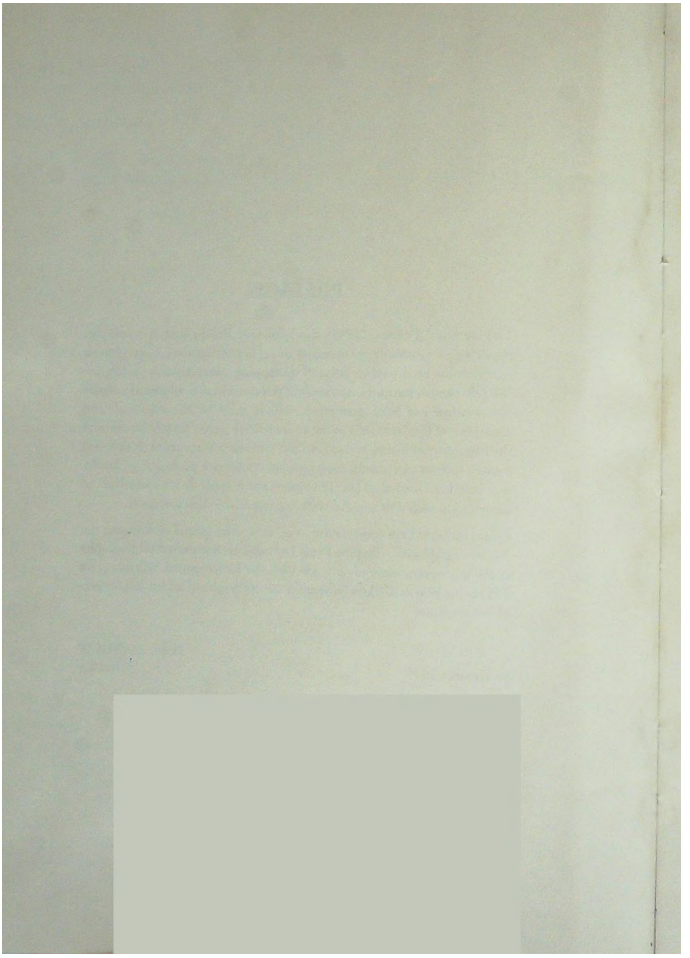
PREFACE

Tapping Panel Dryness (TPD) also known as Brown Bast is a complex physiological syndrome encountered in rubber plantations. Considerable attention has been paid to research on tapping panel dryness among the IRRDB member institutes. As a result of this considerable volume of valuable information has been generated, which need to be organized and disseminated for the benefit of the entire rubber sector. To familiarize with the latest developments in this field the information scattered in different sources such as periodicals, monographs, conference proceedings, books, etc., have been organized here in a systematic manner. It is hoped that this compilation would be a useful reference material in this direction.

I place on record my appreciation to all those who helped in bringing out this bibliography viz., **Tapping Panel Dryness: An Annotated Bibliography** at the appropriate time to coincide with the International Workshop on TPD being held at RRII on November 10, 2005 in the Golden Jubilee year of this institute.

31 October 2005

N.M. MATHEW
Director



ABOUT THE COMPILATION

This bibliography, *Tapping Panel Dryness: An Annotated Bibliography* is published in conjunction with the International Workshop on TPD 2005. It consists of literature on brown bast, bark dryness, stimulation methods, TPD control and related areas of tapping panel dryness. The compilation covers literature published from 1917 onwards. The objective of this compilation is to provide a reference list of TPD or brown bast research, which have been carried out and published in India and abroad. The materials were collected from journal articles, conference proceedings, workshop papers, monographs, books, theses, CD-ROMs and other relevant sources available in the library.

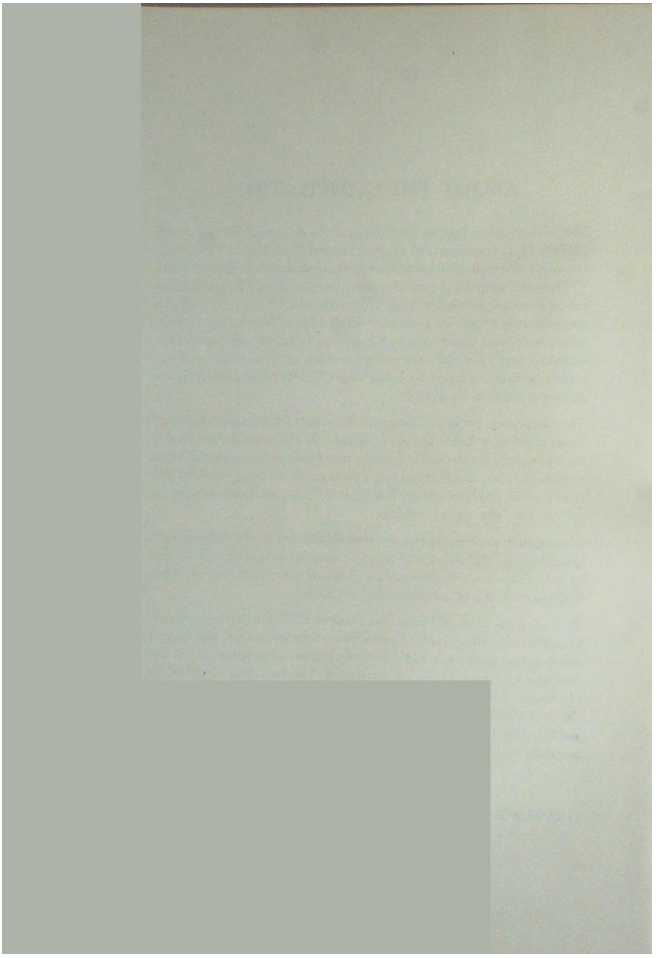
The compilation consists of three sections namely **Bibliography**, **Keyword Index** and **Author Index**. In the first section, the references are arranged in the chronological order under the surname of each author with individual contribution first and followed by publications of the same author as first author under joint authorship. The Keyword Index and Author Index are suffixed with their entry numbers.

The urgency in bringing out the compilation before the International Workshop on TPD and lack of sufficient time did not permit us to collect an exhaustive range of information. However, every endeavor had been made to make this as comprehensive as possible.

We are grateful to Dr. N.M.Mathew, Director, RRII, for giving permission to publish this bibliography. The immense help by Ms.V.R.Sujatha and active co-operation rendered by the staff of library at various stages in this compilation are gratefully acknowledged. The assistance rendered by Mr. Kurian K Thomas on all matters connected with the printing of this is also appreciated. Thanks are also due to M/s Creative Minds, Kottayam and M/s Alois Graphics, Kottayam for timely printing of this bibliography in a short notice. Any suggestion for improvement is highly welcome.

N. LATHA
MERCY JOSE

31 October 2005



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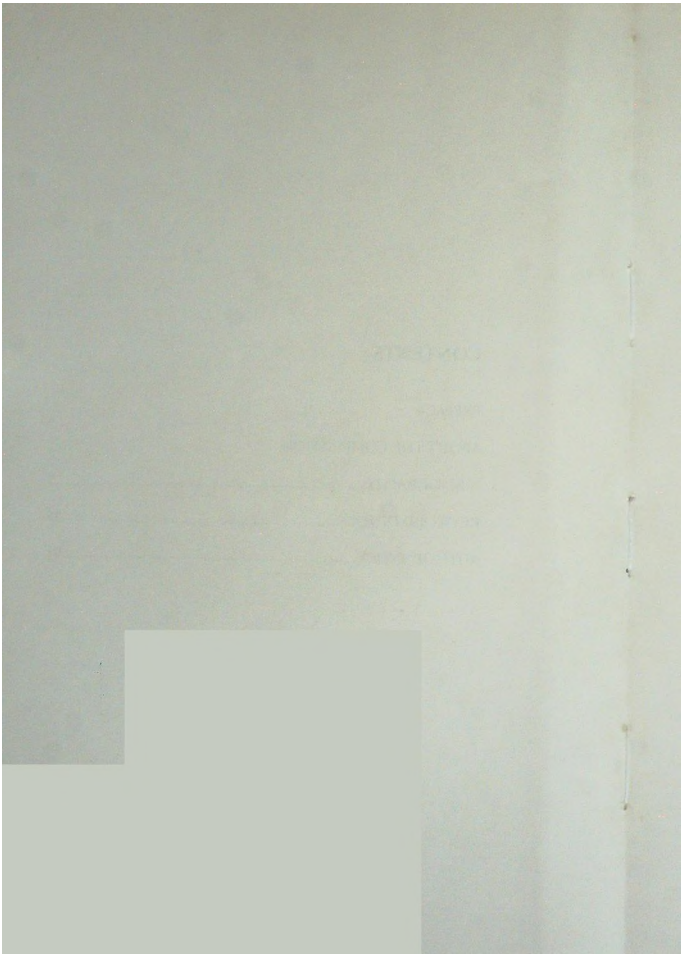

BIBLIOGRAPHY

1 **Anthony, J L; Paranjothy, K and Abraham, P D (1981)**

Method to control dryness in smallholdings

Planters' Bulletin, 167: 37-40.

Panel dryness of rubber trees is of economic importance as it renders the trees non-productive. Methods of controlling panel dryness of rubber trees are discussed, including isolation of the pre-tapping panel on virgin bark, and treatment of partially or totally dry cuts. Post dryness control is aimed to curtail the spread of dryness so that tapping can be continued on the unaffected bark. If necessary dry panels on virgin bark can be restored for future tapping by scraping away the diseased bark. Dry trees should be tapped with periodic rest to minimize recurrence of dryness. Tapping should be staggered so that the period of exploitation can be extended. A summary of exploitation practices for dry trees is also included.

Key words: Dryness control; Smallholdings

2 **Bealing, F J and Chua, S E (1972)**

Output, composition and metabolic activity of *Hevea* latex in relation to tapping intensity and the onset of brown bast

Journal of Rubber Research Institute of Malaysia, 23(3): 204-231.

The result of a tapping experiment on clone RRIM 623 is described. As expected, intensive tapping led to a pronounced increase in the number of dry trees showing the symptoms of brown bast. Dryness was not related to exhaustion of substrates in the tree, or to a decline in the metabolic capacity of the latex. Increase in tapping intensity was however accompanied by a very marked decrease in the N,P, Mg, Ca, sucrose, cyclitol and rubber contents of the latex, whereas the composition of the bark as a whole was only slightly affected. There is a strong implication that tapping results in diminished permeability of the latex vessels: the effect is directly proportional to tapping intensity and can be regarded as one aspect of a wound response. The onset of brown bast is attributed to *in situ* coagulation of the latex as the result of a critical reduction in the permeability of the vessel walls.

Key words; Brown bast; RRIM 623; Tapping intensity

3 **Belgrave, W N C (1917)**

Experiments on the prevention of brown bast

Agr. Bull.Fed. Malay States, 6: 187.

(RRIM Bibliography No.20, 1973.)

Key words: Brown bast; Disease control

4 **Belgrave, W N C (1917)**

A preliminary note on brown bast

Agr. Bull. Fed. Malay States, 6(1): 1-7, 9-10.

(RRIM Bibliography No.20, 1973.)

Key words: Brown bast

5 **Belgrave, W N C and South, F W (1918)**

Field notes and observations on brown bast

Tropical Agriculturist, 50: 286-290.

Key words: Brown bast

6 **Bertrand, H W R (1945)**

Treatment of brown bast

Quarterly Circ. Ceylon Rubber Research Scheme, 22: 21-22.

Key words: Brown bast; Treatment

7 **Bhatia, P K; Thomas, K U and Vaidyanathan, C S (1994)**

Cell wall proteins and tapping panel dryness syndrome in rubber (*Hevea brasiliensis*)

Indian Journal of Natural Rubber Research, 7(1): 59-62.

High-yielding *Hevea* trees often succumb to the physiological disorder tapping panel dryness (TPD), also known as brown bast. TPD, which occurs with extensive tapping, is characterized by excessive, late dripping coupled with a drop in rubber content; the bark also suffers from cracking, thickening and browning, and can become soft, hyper hydrated and/or have necrotic areas. This study investigated the characteristics of bark cell wall proteins in normal, partially affected and completely dry trees. The total soluble protein content of both scion and rootstock bark declined significantly with increasing TPD. The amino acid composition of bark protein from normal and completely dry trees was similar. The sugar content of glycoproteins in partially affected and completely dry tree bark was 4-5% higher than in normal trees. TPD was also characterized by a gradual reduction in the content of minor proteins in the bark.

Key words: Brown bast; Cell wall proteins; Rootstock; Scion; India

8 **Bobilioff, W (1919)**

The cause of brown bast disease of *Hevea brasiliensis*

Archief Voor De Rubbercultuur, 3:172-178.

RRIM Bibliography, No.20, 1973.)

From experiments it was shown that the cause of brown bast is physiological. Harmsen is the first who has positively declared brown bast to be non parasitical. As the disease develops anatomical changes can be observed in the bark (a) the formation of brown degenerate substances in inter-cellular spaces and middlelamels of the cortex cells. This degenerate substance gives the principal reactions for lignin b) the abnormal formation of store cells c) the formation of burrs. The slightest affection of the bark by brown bast can be shown by phloroglucin reaction; the intercellular and middle and middlelamels would be colored red.

The severity of the disease probably depends upon the general physiological conditions of the trees; therefore one tree can be more affected by brown bast than another.

Key words: Brown bast; Causative agent

9 **Bobilioff, W (1921)**

On the effect of tar on bast renewal in *Hevea brasiliensis*

Teysmannia, 32(10): 467.

(*Review of Applied Mycology,* 1: 1922, pp.267-268)

Key words: Bast renewal; Tar treatment

10 **Bobilioff, W (1921)**

Thinning-out and the occurrence of brown bast disease in *Hevea*

Teysmannia, 32(3): 141-142.

(*Review of Applied Mycology,* 1;1922, pp.85)

The factors consider for selecting trees for thinning are described. In selecting trees for thinning, other circumstances than mere yield must be taken into account, and especially liability to brown bast. The number of rows of latex vessels in the bast should be taken into consideration. The trees would then be removed in which the structure bears no relation to production i.e. those presumably susceptible to brown bast. Further investigations are necessary to confirm the reliability of this theory.

Key words: Brown bast; Thinning-out

11 **Brown bast of *Hevea* rubber**

Planters' Chronicle, 14;1919: 320-324.

Key words: Brown bast

12 **Bryce, G (1921)**

Brown bast and the rubber plant

Nature, 108: 81-82.

Key words: Brown bast

13 **Budiman, A (2000)**

The TPD's control with CPO based fungicide

Indonesian Rubber Conference & IRRDB Symposium 2000, Bogor, Indonesia, Program Book, pp.44.

Keywords: TPD control; Fungicide

14 Chan, W H (1996)

Survey of tree dryness on panels BO-1 and BO-2 of clone PB260.

The Planter, 72(839): 55-60.

In a survey of estates in Peninsular Malaysia, the incidence of dryness was higher in clone PB260 than in clones PB217 and GT1. On panel BO-1, mean dryness ranged from 2.1% in the first year to 8.5% in the sixth year of tapping in PB260 compared with 0.2 and 2.7% in the first and fourth years, respectively for PB217. On panel BO-2, the range was 16.0 to 18.6% from the third to sixth years, respectively for PB260, compared with only 8.1% in the third year for GT1. The maximum dryness in individual fields of PB260 reached 23.5% on panel BO-1 and 44.6% on panel BO-2 (very high). Rainfall pattern and soil depth strongly influenced the extent of dryness in clone PB260. Tree dryness was highest on shallow soils located in Kedah, Kelantan and Negeri Sembilan, where a regular dry season lasting 3-4 months exists and where moisture deficits are most likely to occur. On the other hand, low incidence of dryness was observed on deep soils located in Perak, Selangor, Pahang and Johor, where climatic conditions are more favourable and moisture deficits are more likely to be less severe or even absent. Tree dryness >10% on panel BO-1 and >15% on panel BO-2 is considered high. All areas except deep soils in the states of Perak, Selangor, Pahang and Johor exceeded these values. The remedial measures proposed to minimize tree dryness include reduction in tapping intensity and increasing the stand per hectare for locations with high propensity to tree dryness.

Key words: PB 260; Tapping intensity; Tree dryness; Malaysia

15 Chee, K H (1970)

Chemical control of panel diseases of *Hevea brasiliensis*

In: *Crop Protection in* Malaysia: *The Proceedings of the Conference*, 15-17 November 1970, Kuala Lumpur, Malaysia (Eds. Wastie, R L and Wood, B J). Incorporated Society of Planters, Kuala Lumpur, 1971, 213-220.

Key words: Chemical control; Panel diseases

16 Chee, K H (1971)

Some new disorders of the stem and panel of *Hevea*

Proceedings of the RRIM Planters' Conference, 1971, Kuala Lumpur, Malaysia, pp.79-188.

This paper describes some of the newly recorded maladies of the stem and panel, as well as a few minor ones that have become significant and suggests control measures where feasible. The disorders are divided and described according to stem disorders and panel disorders.

Key words: Bark bursts; Disease control; Panel necrosis; Malaysia

17 **Chen Murong; Huang Qingchun, Luo Daquan; Ye Shabin; Zheng Guanbiao; Chen Zuoyi and Shen Juying** (1994)

Causative agents of *Hevea* brown bast and witches' broom and their relationship

IRRDB TPD Workshop, 26-28 July 1994, SCATC, Hainan, China.

Key words: Brown bast; Serological test; Witches' broom

18 **Chen Murong; Luo Daquan; Xu Laiyu; Ye Shabin and Huang Qiangchun** (1999)

Transmission of brown bast of rubber trees by bark-grafting

Proceedings of IRRDB Symposium 1999, Hainan, China(Eds. Chen Quibo and Zhou Jiannan). Hainan Publishing House, China, pp.245-253.

Transmitting tests on brown bast of rubber trees by bark-grafting have conducted since 1993. Following results were observed. (1) Typical brown bast symptoms were displayed on the trunks of the originally healthy stocks three months after grafting. The incidence of the disease was 29% - 50%. The symptoms were water-soaked with brown lesions on the bark, dryness on the cut and less latex. (2) micro-precipitation and ELISA showed that trunks with brown bast accounted for 40-45% of the originally healthy stocks 13-14 months after grafting. (3) Under electronic microscope, phytoplasma were found in the cells of the phloem tissues from the trunks of the originally healthy stocks. The size of the phytoplasma was 300-850*μm*, with one layer of membrane being 9-12*μm* thickness. The phytoplasma were not found in the cells of the phloem tissues from the control trunks (healthy stocks, not grafting with diseased scions).

Key words: Bark grafting; Brown bast; ELISA; Serological test

19 **Chen Shoucai; Peng Shiqing; Huang Guixiu; Wu Kunxian; Fu Xianghui and Chen Zuoyi** (2002)

Association of decreased expression of a Myb transcription factor with the TPD (tapping panel dryness) syndrome in *Hevea brasiliensis*

Plant Molecular Biology, 51(1): 51-58.

TPD (tapping panel dryness) is a complex physiological syndrome widely found in rubber tree (*Hevea brasiliensis*) plantation, which causes sever yield and crop losses in natural rubber-producing countries. The molecular mechanism underlying TPD is not known and there is presently no effective prevention or treatment for this serious disease. To investigate the molecular mechanism of TPD, we isolated and characterized genes for which the change of expression is associated with TPD. We report here the identification and characterization of a Myb transcription factor *HbMyb1*. *HbMyb1* is expressed in leaves, barks, and latex of rubber trees, but its expression is significantly decreased in barks of TPD trees. Our results suggest that the expression of *HbMyb1* is likely associated with TPD and that the function of *HbMyb1* is associated with the integrity of bark tissue of rubber trees.

Key words: Gene expression; Myb transcription factor

20 Chrestin, H (1984)

Biochemical basis of bark dryness

Comple-Rendu du Colloque Exploitqtion-Physiologie etAmelioration de l'Hevea, 1984, IRCA-GERDAT, Montpeller, France, pp.273-293.

An enzymatic NAD(P)H oxidase activity that generates species of toxic oxygen was located at the level of the lutoidic tonoplast. The partial characterization of this enzyme shows that it is insensible towards classical inhibitors of respiratory chains, but activated by inhibitors of the alternate mitochondrial pathway (hydroxamic acids). It is also greatly activated by physiological concentrations of metallic cations (Fe^{3+} and Cu^{2+}), and quinone-like compounds, which may act as physiological activators or electron carriers. The diverse species of toxic oxygen emitted, lead to the peroxidatic degradation of the unsaturated lipids of the membranes and then to destabilization and lysis of the organelles, among which the lutoids themselves, in a way similar to that described for the NAD (P)H induced O_2 production and consecutive membrane alternation by mammalian microsomes or granulocytes. Intensive hormonal treatments of *Hevea* bark (over-stimulation with Ethrel) increase of the O_2 generating activity, and simultaneously decrease the level of cytosolic scavengers. This leads to the lysis of the latex organelles and especially of the lutoids, then to subsequent liberation into the latex of the "coagulating factors" which they normally compartmentalize. It results in latex coagulation within the bark and degeneration of the latex cells of the stressed trees: the dryness syndrome. Computer analysis allowed to draw a model describing the biochemical events leading this type of cell degeneration. Involvement of auto catalytic biosynthesis of endogenous ethylene under treatments with exogenous ethylene are evoked as a possible explanation for the induction of dryness by over-stimulation with Ethrel

Key words: Dryness Syndrome; Over stimulation; Ethrel

21 Chrestin, H (1989)

Biochemical aspects of bark dryness induced by over-stimulation of rubber trees with ethrel

In: *Physiology of Rubber Tree Latex* (Eds. d'Auzac, J, *et al*). CRC Press, Florida, USA, pp. 431-442.

Over exploitation of *Hevea* can lead to a stoppage of flow caused by the physiological disorder known as bark dryness or Brown Bast. Extensive studies of these "pathophysiological syndrome" have been carried out and a great number of hypotheses, such as impairment of phloem transport, depletion of latex nutrients, adverse water relations and wound reactions have been put forward to account for the different physiological or histological phenomena in the phloem, or more specifically in latex vessels. This chapter focuses on the existence of an endogenous NAD(P)H oxidase in lutoids which generates toxic forms of oxygen (O_2, H_2O_2, OH, etc) responsible for the peroxidative degradation of organelle membranes in the latex form diseased trees. It is shown that the induction of bark dryness through deliberate overstimulation with Ethrel® results in an imbalance in peroxidative activities; this has harmful effects on membranes and on protective scavenging activities in latex and results in the destabilization of organelles and in lysis.

Key words: Bark dryness; Ethrel; Over stimulation; Scavengers

22 **Chrestin, H; Jacob, J L and d'Auzac, J** (1985)

Biochemical basis for cessation of latex flow and occurrence of physiological bark dryness

Proceedings of the International Rubber Conference, 1985, Vol.3. Kuala Lumpur, Malaysia, pp.20-42.

Low yielding levels of *Hevea* and appearance of bark-dryness are often correlated to a limitation of latex flow which can be caused by high plugging index resulting from a high bursting index of the lutoids, in vitro as well as *in vivo*. Moreover, dry bark is often linked to latex coagulation *in situ*,. Associated with the destabilization of the lutoids in the latex from these diseased trees. The lutoids form the latex of *Hevea brasiliensis* consist of micro-vacuoles with typical lysosomal characteristics. It was recently confirmed that the lutoids contain an enzymatic NAD(P)H oxidase activity which generates species of toxic oxygen. This is detectable in the latex of very low yielding trees, and its particularly active in latex from trees with typical symptoms of bark dryness. Over exploitation of *Hevea*, and in particular overstimulation can lead to a definitive cessation f yield resulting from a physiological disorder known as bark dryness. In this paper it is suggested that the disorganization of all the membrane structure resulting form a disequilibrium between the toxic peroxidative activities and the scavenging activities within the latex vessels, is a key event leading to early plugging and under a more severe form, to the onset and development of at least a kind of bark dryness.

Key words: Bark dryness; Over exploitation; Oxidase activity

23 **Chrestin, H; Sookmark, U; Trouslot, P; Pellegrin, F and Nandris, D** (2004)

Rubber tree (*Hevea brasiliensis*) bark necrosis syndrome III: A physiological disease linked to impaired cyanide metabolism

Plant Disease, **88**(9): 1047.

First attempts to discriminate between tapping panel dryness (TPD) and bark necrosis (BN), two *Hevea* sp. bark diseases leading to the cessation of latex production, showed differences in latex biochemical characteristics (1). Further, contrary to TPD, BN is characterized by inner phloem necrosis starting at the rootstock/scion junction (RS/S) and spreading upward to the tapping cut. Recent etiological (3) and epidemiological studies did not provide evidence of a causative pathogen for BN, but showed that BN is favored by a combination of various stresses (2). Searching for molecular markers of BN using sodium dodecyl sulfate-polyacrylamide gel electrophoresis analyses highlighted differential expression of some proteins in the latex and bark, especially a 67-kDa protein, which accumulated in the inner phloem of the BN trees. This protein was identified by peptide micro sequencing as a linamarase. This led to the suspicion of the involvement of cyanogenesis in the spread of the syndrome inside the inner bark. The cDNAs of enzymes involved in cyanide (CN) metabolism were cloned form out *Hevea* sp. phloem specific cDNA library. In addition, the most BN- susceptible rubber clones were shown to exhibit higher cyanide potentions in the leaves, and bark, together with low cyanoalanine synthase (CAS) gene expression and activity. Furthermore, linamarine

was shown to accumulate in the phloem at the base of the trunk, especially above the rootstock/scion junction. The results of biochemical and gene expression studies associated with recent eco-physiological advances (2) strongly suggest a possible cell decompartmentalization near the RS/S junction, resulting in a local release of toxic concentration of highly diffusive CN. This, combined with a lethal imbalance between cyanogenic and CN-detoxifying activities (CAS) in the phloem of BN trees, could lead to poisoning of neighboring cells and to the spread of tissue necrosis toward the tapping cut. In conclusion, after providing evidence of exogenous factors favoring BN (2), this report highlights endogenous disorders that may be at the origin of this physiological disease leading to BN.

Key words: Bark necrosis; Cyanide metabolism; Latex biochemistry

24 Chua, S E (1966)

Physiological changes in *Hevea brasiliensis* tapping panels during the induction of dryness by interruption of phloem transport. I. Changes in latex

Journal of the Rubber Research Institute of Malaya, 19(5): 277-281.

Buddings of *Tjir* 1 were ring-barked above and below the tapping panel, rapidly inducing dryness at the tapping cut. Associated physiological changes included the production of a latex with low content of rubber hydrocarbon and total solids and a subnormal pH, the tapping cuts showed a grey discolouration near the phloem tissue. Ultracentrifuged samples of latex showed heavy flocculation of 'bottom fraction' particles, an indication of excessive dilution of the latex in the tissues isolated by ring barking. Paper chromatographic techniques revealed no evidence of apparent depletion of amino acids, organic acids or sugars n the tissues.

Key words: Latex centrifuging; Paper chromatography; Ring barking

25 Chua, S E (1966)

Physiological changes in *Hevea brasiliensis* tapping panels during the induction of dryness by interruption of phloem transport. II. Changes in bark

Journal of the Rubber Research Institute of Malaya, 19(5): 282-285.

The levels of sugars, amino acids, organic acids, starch and other metabolites in the bark of artificially induced dry trees were examined and compared with those of normal trees. It was found that from the paper chromatographic observations, the only consistent change observed was that the organic acid spots increased in size and intensity relative to those of normal trees, but at later stages, when the trees were almost dry, the organic acid spots decreased n size and intensity relative to control samples. The starch levels did show a slight change in amount but later stages the starch in dry bark decreased in amount relative to control trees. Catalase activity increased at the initial stages but decreased later when total dryness ensued. Rubber content of bark increased as dryness developed in the trees.

Key words: Catalase activity; Paper chromatography; Ring barking; Tree dryness

26 Chua, S E (1967)

Physiological changes in *Hevea* trees under intensive tapping

Journal of the Rubber Research Institute of Malaya, 20(2): 100-105.

The incidence of dryness becomes greater when the tapping intensity is increased. In these experiments employing intensive tapping systems, the frequency of tapping played a more important role than the length of cut inducing dryness, but the combination of both increased frequency and lengthening of the cut resulted in a very severe incidence of dryness. Heavy exploitation resulted in a decrease in the volume, rubber content and total solids of latex. Dry and normal bark tissues were compared, carbohydrates did not seem to be deleted. However, the levels of protein nitrogen and percent nitrogen were lower in dry than in normal bark tissues. The possible cause of dryness is discussed in relation to the senescence of phloem and laticiferous tissues.

Key words: Intensive tapping; Phloem senescence; Tapping frequency

27 Commere, J; Eschbach, J M and Serres, E (1989)

Tapping panel dryness in Cote d'Ivoire

Proceedings of the IRRDB Workshop on Tree dryness, 1989, Penang, Malaysia. pp.48-60.

From the beginning of rubber planting in Cote d'Ivoire, there have been about 2 million dry trees. Since then the cumulative loss due to dry cuts has been at about 45,000 tonnes, approximately the present annual production. For trees with no possible recovery, the sole recommendation would be to tap as fast as possible any part of the tree which has not yet been affected by the disease. The IRCA's research programme on tapping panel dryness includes three basic studies- histology and cytology, physiology and biochemistry and epidemiology to determine the causal agent of this phenomenon. It is evident that an international co-operation would be conducive to finding a control for this disease.

Key words: Status report; Cote d'Ivoire

28 Darussamin, A; Siswanto; Suharyanto and Chaidamsari, T(1995)

Changes in the chemical compositions and electrophoretic profile of latex and bark proteins related to tapping panel dryness incidence in *Hevea brasiliensis*

Menara Perkebunan, 63(02): 52-59.

Eight-year-old clone PR 261 trees at an experimental garden in west Java were subjected to one of the following tapping treatments: (A) 1/2s d/2 (control), (B) 1/2s d/1, (C) as B plus 5 Et [ethephon] application or (D) as B plus 10 Et application. Tapping panel dryness (TPD) severity was assessed visually on a scale of 0 (normal latex flow) to 6 (100 dry notch). After 2 months, half the trees in treatments A and B showed TPD with a severity rating of 1, but in treatments C and D all the trees had TPD with a severity rating of 2-6. Reduced latex flow, plugging index and sucrose concentration appeared to be early signs of TPD, occurring 3-4 weeks before visual symptoms, but latex Mg++ and thiol concentrations did not changes as noticeably. Using electrophoresis, proteins with molecular weights of 26 and 52kDa were

found in the bark of TPD-affected trees, but not in that of healthy trees. An ELISA based on polyclonal antibody raised against these proteins in a chicken could successfully distinguish between normal and TPD-affected trees.

Keywords: Bark proteins; ELISA; PB 261; West Java

29 **Das, G; Alam, B; Raj, S; Dey, S K; Sethuraj, M R and Sen-Mandi, S** (1998)

Effect of over-exploitation on physio-biochemical aspects of yield in rubber (*Hevea brasiliensis)*

National Symposium on Current Trends in Plant Physiology and Plant Biochemistry,1998, Hyderabad, India, pp.156.

Key words: Free radicals; Scavengers; Over-exploitation; India

30 **Das, G; Alam, B; Raj, S; Dey, S K; Sethuraj, M R and Sen-Mandi, S** (1999)

Tapping Panel Dryness syndrome in rubber (*Hevea brasiliensis*): A physio-biochemical approach

National Symposium on Plant Physiology and Biochemistry in Relation to Agriculture and Environment, 15-17 February 1999, Devi Ahilya University, Indore, India.

Key words: Free radicals; Scavengers; Superoxide dismutase; Physio chemical approach; India

31 **Das, G; Alam, B; Raj, S; Dey S K; Sethuraj, M R and Sen-Mandi, S** (2002)

Over-exploitation associated changes in free radicals and its scavengers in *Hevea brasiliensis.*

Journal of Rubber Research. 5(1): 28-40.

Tapping Panel dryness (TPD) syndrome, generally considered as a stress-induced physiological disorder, is a consequence of abnormal exploitation in rubber (*Hevea brasiliensis*). Numerous studies in other crops have revealed that stress induces/enhances the formation of fee radicals (FR) which gets moped up by its scavenging system. To study the status of free radicals (FR) and its scavenging system during occurrence of tapping panel syndrome (TPD), normal *Hevea brasiliensis* clone RRIM plants were subjected to frequent tapping and stimulation treatment (10% ethephon) to accelerate the occurrence of the syndrome in a field experiment in Agartala, Tripura, India from November 1996 to December 1997. A significant negative correlation was observed between FR in the bark and superoxide dismutase (SOD) in the lutoid with tapping. Latex thiol showed a very low linear correlation with progression of tapping. The study also revealed that the amount of FR in frequently tapped plants (where the wounding was excessive) was less than that of in the stimulated plants, though the damage to the scavenging system (SOD) was higher in the frequently tapped trees. It was also observed that with progression of time, the percentage of TPD was more in the frequently tapped trees than in the stimulated ones. Interestingly however, at the 115th actual tapping, the occurrence of TPD was found to be higher in the stimulated samples than that of in the frequently tapped plants. The control plants showed no TPD syndrome in both cases. This implies that excess generation of active oxygen with

defective defence mechanism (in terms of SOD) along with frequency of exploitation, source-sink imbalance etc. may determine the yielding potential and the TPD incidence in rubber.

Key words: Free radicals; Over exploitation; Scavengers; Stimulation; India

32 **Das, G; Raj, S; Alam, B; Dey, S K; Pothen, J; Sethuraj, M R; Sinha, T P and Sen-Mandi, S** (1997)

Free radical and its scavenging system in tapping panel dryness syndrome of rubber (*Hevea brasiliensis*)

National Seminar of Plant Physiology for Sustainable Agriculture, 19-21 March 1997, Indian Agricultural Research Institute, New Delhi, India, pp.111

Key words: Free radicals; Exploitation; Scavengers; Superoxide dismutase; India

33 **Das, G; Raj, S; Pothen, J; Dey, S K and Varghese, Y A** (1998)

Exploitation of *Hevea* under low temperature stress situations studies on exploitation systems giving tapping rests based on drop in minimum temperature

In: *Recent Advances in Plantation Crops Research*: Placrosym XIII, 16-18 December 1998, Coimbatore, Tamil Nadu, India. (Eds. N.Muraleedharan and R. Raj Kumar).Allied Publishers, New Delhi, India, pp.150-156.

Low temperature being the prime cause for late dripping in non-traditional belt of northeast India. An experiment was conducted incorporating three systems viz. $^1/_2$S d/1, $^1/_2$ S d/2 and $^1/_2$ S d/3 with three periods of tapping rests based on minimum temperatures of 20-10°C and compared with a control. Though the $^1/_2$ S d/1 system for all the combinations showed a high annual yield, the occurrence of tapping panel dryness (TPD) was found to be relatively high. The 15-15°C rest covers around 20 per cent of the peak yields in comparison with the continuous tapping systems. Analysis of yield showed a high significant relation between the sub-plot treatments of the temperature regimes. Mean yield was high (30.8 gm/tree/tap) for the continuous system of $^1/_2$ Sd/3 tapping system that also registered the same in the 20-20°C rest. With a low incidence of TPD (5%) the 15-15°C minimum temperature regime, for the $^1/_2$ Sd/2 system of tapping, in general, showed an optimum system for exploitation of latex yield during cold season under this non-traditional agroclimatic condition. Nevertheless, basic knowledge of the effects of rest periods during the cold season with an optimum system of tapping, coupled with a lack of long term deleterious effects, would necessarily render exploitation methods to tackle and overcome several prevailing limitations in the region.

Key words: Exploitation system; Low temperature stress; Tapping rest; Tapping system

34 **Das, G; Raj, S; Pothen, J; Sethuraj, M R; Sinha, T P and Sen-Mandi, S** (1998)

Status of free radical and its scavenging system with stimulation in *Hevea brasiliensis*

Plant Physiology and Biochemistry, 25(1): 47-50.

Tapping panel dryness (TPD) syndrome is expressed initially by prolonged (late) dripping of latex followed by pre-coagulation of latex in the tapping panel itself, which culminates, into

death of latex-bearing cells. The syndrome is found to be due to a cumulative effect of many factors like over-tapping, over dosage of stimulation and sub-optimal agro-climatic conditions. In an attempt to understand the role of free radical and its scavenging systems in occurrence of TPD, studies have been undertaken to estimate free radical (FR) by electron paramagnetic resonance spectrometer with simultaneous assessment of super oxide dismutase (SOD, EC), in the laticiferous cells/latex of five different clones of rubber. The bark of rubber trees when over-exploited with 5% ethephon, showed more free radical accumulation in comparison with the untreated trees; the level of SOD showed less amount in the treated plants. Apparently an increase of free radical and associated decrease of the scavenging system, thus leading to an imbalance in the two, may be one of the factors for TPD syndrome.

Keywords: Free radical; paramagnetic resonance; Scavenging system; Stimulation

35 de Fay, E (1982)

Drying induction kinetics of *Hevea brasiliensis*

Revue Generale Des Caoutchoucs & Plastiques, (IRCA), 621: 185-188.

The dry tapping cuts disease in *Hevea brasiliensis* can be induced by increasing the tapping rate. This enables a dynamic study of the appearance of dryness to be made. The overtapped *Heveas* first show a tendency towards exhaustion, the latex appearing in irregular pearl form on the tapping cut. Some of these trees then suddenly cease to produce latex. Their tapping cut becomes partially or entirely dry. On the material studied, the typical dryness started with the appearance of the following phenomena: internal coagulation of the latex and invasion of laticifers by thylosoides (bud bursts) from the associated parenchymatous cells. Other anomalies appear of which the most characteristic are accumulations of lignified gums on the sieve tubes and laticifer cells. Finally, the bark is disorganized by the development of abnormal tissues. The causes of the disorders resulting in typical dryness are discussed; a proposal is advanced concerning utilization diseased trees.

Key words: Bark dryness; Drying induction

36 de Fay, E (1988)

Ethylene stimulation of *Hevea*, bark dryness and brown bast

Journal of Natural Rubber Research, 3(4): 201-209.

The tapping cut at the moment of tapping, and the panel of control trees and trees treated with ethylene were observed with the naked eye and under optical microscopy. Dry zones were larger in the ethylene-stimulated trees. Drying was linked to bark thickness and other modifications (soft bark, hyperhydrated bark, white lines on the bark, necrotic areas and cracking at the surface). All these symptoms were the result of radial dilation of the outer phloem parenchyma caused by periclinal cell division, which was the reaction of the surface tissue to ethylene stimulation. Dryness is, therefore, accounted for by functional modifications of the bark rather than by the occasional presence of tyloses blocking a number of laticifers. Comparative histology of bark dryness following intensive ethylene treatment and bark affected by brown bast revealed different symptomatology. In addition, intensive stimulation by ethylene

did not enhance the development of brown bast. Apart from dryness of hormonal origin, a general tendency of *Hevea* to display temporary local dryness was observed. This was a seasonal, reversible phenomenon, which was not accompanied by any histological anomaly.

Key words: Bark dryness; Brown bast; Dry cut syndrome; Stimulation

37 de Fay, E and Hebant, C (1980)

Histological aspects of brown bast disease of unknown origin in *Hevea brasiliensis*

C-R-Hebd-Seances-Acad-Sci-Ser-D-Sci-Nat. Nov 17, 1980. Paris, Gauthier-Villars. 291 (10) pp. 865-868.

Key words: Brown bast; Histology

38 de Fay, E and Jacob, J L (1989)

Symptomatology, histological, and cytological aspects

In: *Physiology of Rubber Tree Latex* (Ed. d'Auzac, J *et al*). CRC Press, Florida, pp.407-430.

Bark dryness in *Hevea brasiliensis* is a complex phenomenon which involves a varied set of mechanisms and which probably has various causes. True Brown Bast is characterized by precise symptomatology, including in particular the appearance of tylosoids and the coagulation of latex *in situ*, abnormal behavior of the parenchyma cells adjoining the laticifers, and a general increase in synthesis of polyphenols. Although the disease can by induced artificially by excessive tapping, it is also observed in trees that are not overexploited and in areas far from the tapping panel. The histophysiological transformations in *Hevea* bark may have various causes or contributory factors, which may interfere with each other. Among them, traumatisms, physiological fatigue, soil/plant relationship and microscopic or submicroscopic causal agent as well should be taken into account. It should be noted that certain forms of bark dryness that are sometimes transitory and which may be caused for example by overstimulation with Ethrel or by repeated puncture of the tapping panel do not display certain characteristic symptoms of Brown Bast such as the formation of tylosoids or activation of the phenolic metabolism. These pathological features thus seem to be distinct for true brown bast; they have neither the same development nor probably not the same causes, and perhaps not even the same seriousness.

Key words: Bark dryness; Brown bast; Cytology; Histology; Over stimulation; Symptomatology

39 de Silva, C A (1961)

Brown bast disease of *Hevea*

Quarterly Journal of Rubber Research Institute of Ceylon. 37(4): 129-130.

A brief discussion of brown bast, a physiological disease of rubber, including symptoms, prevention and control. In Ceylon it is recommended that the tapping intensity be reduced if an incidence of more than 10% of brown bast occurs. The early symptoms should not be overlooked; control measures by resting the affected trees are to be taken in time. Since prevention is better than cure, every effort should be made to obtain high yields from the

modern high-yielding clonal material in the early years of tapping without unduly staining the trees.

Key words: Brown bast; Tapping intensity; Ceylon

40 **de Soya, A G A; Samaranayake, C; Abeywardene, V; Jayaratne, A H R and Wilbert, S (1983)**

A survey on the incidence and pattern of distribution of the brown bast disease of *Hevea*

Journal of the Rubber Research Institute of Sri Lanka, 61: 1-6

Key words: Brown bast; Distribution pattern; Sri Lanka

41 **Dian, K and Koffi, E K**

Modification of proteins expression in latex of tapping panel dryness (TPD) affected trees

Numerous studies have been undertaken for the understanding of tapping panel dryness disease, a syndrome affecting latex production in *Hevea brasiliensis*. However, the disease's origin is still unknown although many different hypothesis have been proposed to explain it. The molecular approach is used in this study to deepen the understanding of the phenomenon. Mono-dimensional SDS-PAGE was used to establish a relationship between the disease appearance and the modification in the expression of six polypeptides. One of these polymorphic polypeptides was shown to be involved in lutoids destabilization process and is believed to be one of the major factors affecting latex coagulation *in situ*. Two dimensional (E2D) gel electrophoresis has been used to show an overall deviation in the genomic expression, no matter clone susceptibility, associated with the disease development. However, the magnitude of such deviation is linked to clone susceptibility to the disease.

Key words: Proteins expression; Gel electrophoresis

42 **Dian, K; Sangare, A and Diopoh, J K (1995)**

Evidence for specific variation of protein pattern during tapping panel dryness condition development in *Hevea brasiliensis*

Plant Science, 105(2): 207-216

Tapping panel dryness (TPD) condition affects the production of latex in *Hevea brasiliensis* plantations. Latex production is severely decreased in diseased plants and can be completely shut down in the ultimate stage of the phenomenon. In search of the molecular basis of the disease, we have analysed the changes in latex protein pattern during the development of this condition. Five proteins specific to the cytosolic compartment of latex were found to be related to the disease. Major changes consisted of a dramatic increase of a 26-kDa and a 14.5-kDa protein in diseased plants and minor changes affected a 55-kDa, a34-kDa and a 21-kDa protein. The 26-kDa protein was found to be linked to the coagulation process. Its accumulation is specifically correlated to the disease development and is inhibited by

ethylene. The 14.5-kDa protein accumulates preferentially in the severe stages of the condition. A disfunctioning of the coagulation process is proposed to be the major cause of the syndrome.

Keywords: Protein accumulation; TPD proteins

43 **Do Kim Thanh** (1997)

Review of dryness incidence in exploitation trials

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 1997, Hainan, China, pp. 78-81.

Data on dryness incidence in Class I clones in various exploitation trials are presented. The effects on the incidence of dryness of tapping frequency, stimulation, soil type and the altitude of the various rubber planting areas also discussed.

Key words: Exploitation; Tapping frequency; Soil; Stimulation

44 **Edgar, A T** (1958)

Pests and diseases

In: *Manual of Rubber Planting (Malaya)*. The incorporated Society of Planters, Kuala Lumpur, Malaysia, pp.248-249.

Key words: Brown bast; Malaysia

45 **Eschbach, J M; Hasibuan, S E and James, A Q** (1994)

Clonal influence of panel management on bark necrosis

IRRDB TPD Workshop, 26-28 July 1994, SCATC, Hainan, China.

An experiment started two years ago in North Sumatra, on clone PB 260 and PB 330, showed that panel changing of the tapping cut increases the intensity of Bark Necrosis (BN) disease. For clone PB 260 the level of BN increases from 3 to 37% and for clone PB 330, from 1 to 10% when compared to the control without panel changing. The trees of both clones show good physiological conditions and the disease cannot be attributed to over exploitation or over stimulation. The policy of panel management for new precocious high yielding clones must therefore be carefully considered.

Key words: Bark necrosis; Over exploitation; Panel change; Panel management; Stimulation

46 **Eschbach, J M; Lacrotte, R and Serres, E** (1989)

Conditions which favour the onset of brown bast

In: *Physiology of Rubber Tree Latex* (Ed. d'Auzac, J *et al*). CRC Press, Florida, pp.443-458.

The occurrence of bark dryness, which results from physiological disorders caused by tapping, has several primary or secondary causes. The influence of environmental conditions, soil and

climate, exploitation intensity and genotype, linked with assimilate contents, suggest that the stopping of flow may be induced by premature senescence of the laticifers aggravated by inadequate availability of the assimilates required for maintaining of metabolic activity of cells. Mineral imbalance, a fall in photosynthetic activity, an impediment to the movement of assimilates, too great an exhaustion of the reserves required for the reforming of latex, and inadequate availability of water are all factors which contribute to the stopping of latex flow in order to conserve the vital functions of the *Hevea* in which it is reminded that rubber is a secondary metabolite. Nevertheless, the possibility that certain types of cortical necrosis, which lead to the stopping of flow, may have pathogenic causes cannot be excluded

Key words: Brown bast; Physiological parameters

47 **Farmer, J B and Horne, A S** (1921)

On brown bast and its immediate cause

India Rubber Journal, 61:1225-1226.

Key words: Brown bast

48 **Gehlsen, C A** (1939)

Brown bast of rubber

Tropenpflanzer, 42: 323-329.

(RRIM Bibliography, No.20, 1973)

Key words: Brown bast

49 **Gandimathi, H; Hamzah, Z; Sivakumaran, S; and Daud, Mohamed Napi** (1999)

Latex physiological parameters in relation to tapping panel dryness and yield prediction in PB 260: A case study

Proceedings of IRRDB Symposium , 1999, Hainan, China. pp.221-227.

Latex physiological parameters were measured monthly in thirty trees of the dryness-susceptible clone PB260 over four years. Statistical analysis showed that the significant parameters for determining variable dryness and yield included the percentage dry rubber content (% DRC), magnesium (Mg) and potassium (K) levels for dryness; and half hour volume yield (HV), thiols and pH, or, HV, percentage bottom fraction (%BF) and dryness (when thiols were omitted from the analysis) for yield. The findings point to a possibility of further study, control and prevention of dryness through fertilizer application of macro-element minerals found to be Mg and K. Since many earlier studies have also indicated the importance of minerals like P, N and Ca as well as Mg, this cannot be said to be a new finding. The value of mere "studies" of dryness and yield is questioned, and it is suggested that practical experimental approaches for reducing or preventing dryness and increasing yield based on using already available information are preferable.

Key words: Clonal susceptibility; Macro element treatment; Physiological parameters; PB 260; Yield

50 **Gohet, E; Kouadio, D; Prevot, J C; Obouayeba, S; Clement, A; d'Auzac, J; Keli, J Z and Jacob , J L (1997)**

Relation between clone type, latex sucrose content and the occurrence of tapping panel dryness in *Hevea brasiliensis*

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis,1997, Hainan, China, pp.21-27.

There is a hypothesis by the French Scientists that a distinction can be made between at least two types of TPD that differ considerably in severity, type and development, i.e. reversible (fatigue-related) and irreversible TPD. A very clear link between resistance to fatigue-related TPD and the sucrose content of the laticifers system is demonstrated by the work reported.

Keywords: Latex sucrose content; Reversible TPD; Irreversible TPD

51 **Gomez, J B and Ghandimathi, H (1990)**

The brown bast syndrome of *Hevea*: I. Morphological observations.

Journal of Natural Rubber Research, 5(2): 81-89.

A study of several cases of trees suffering from brown bast involving visual examination, scoring using a sharp instrument, looking at sectional views and histological examination of the tissues indicated that excessive meristematic activity is a predominant feature which leads to the formation of tumorous tissues. The eventual manifestation of tumors is caused by the activities of vascular cambium and adventitious meristems surrounding the previous centers of necrotic activity, which result in the formation of nodules, which finally form the so-called occluded xylem. In some cases, however, the formation of the nodule is not evident and the affected bark dries, cracks up and sloughs off. In such cases, smooth renewal of bark results from the activity of the vascular cambium alone. The implications of these findings are discussed.

Key words: Bark renewal; Brown bast; Vascular cambium, Malaysia

52 **Gomez, J B; Hamzah, S; Ghandimathi, H and Ho,L H (1990)**

The brown bast syndrome of *Hevea*: II. Histological observations

Journal of Natural Rubber Research, 5(2): 90-101.

Histological observations on trees suffering from brown bast were made on bark samples from partially dry trees and dry trees which showed external symptoms of dryness or malformations typical of brown bast. The formation of tyloses in laticifers, the ultimate lignification of the tyloses and the significance of these are considered. Histological changes were also evident in tissues associated with the laticiferous system but the earliest symptoms were evident in the laticifer.

Key words: Brown bast; Histology; Laticifers; Malaysia

53 **Gomez, J B; Hamzah, S; Ghandimathi, H and Ho, L H** (1990)

Studies on the brown bast syndrome of *Hevea*: Histological observations

Journal of Natural Rubber Research, 5(2): 90.

Key words: Brown bast; Histology

54 **Guo,Y G** (1990)

The thiol, ascorbic acid and A-serum protein contents in latex of brown bast tree

The Planter, 66(771): 278-280.

The contents of these latex components in the rubber clones GTI and RRIM600 were lower in trees with brown bast than in healthy trees. GTI, less susceptible to brown bast, showed greater reductions in protein and thiol but a smaller reduction in ascorbic acid.

Key words: Brown bast; Latex protein

55 **Hamzah, S; Xiao, X; Luo, S; Chan, J L and Yeang, H Y**(1999)

Protein marker for tapping panel dryness identified as the small rubber particle protein (Hev b 3)

Proceedings of IRRDB Symposium, 1999, Hainan, China (Eds. Chen Quibo and Zhou Jiannan). Hainan Publishing House, China, pp.325-330.

Previous studies using electrophoretic techniques have identified several putative protein markers in *Hevea* latex that are linked to tapping panel dryness (TPD). A major marker that was frequently encountered was a latex protein of 22-26 *kd*. In the present study, analysis by Western blot and two-site ELISA showed this marker to be the 22.4 *kd* small rubber particle protein (SRPP) which is an allergenic peptide also known as Hev b3. The SRPP level in C-serum of partially dry trees was elevated, but no similar increase was found in the SRPP levels when assayed in the whole latex. These results suggested that there was no de novo synthesis of SRPP induced by the onset of partial dryness and the protein is not therefore a direct marker for incipient tree dryness. SRPP may nevertheless be indirectly associated with TPD by its being an indicator of latex instability.

Keywords: Electrophoretic techniques; Protein markers; Rubber particles

56 **Hao Bing Zhong and Wu JiLin** (1993)

Ultrastructure of laticifers in drying bark induced by over-exploitation of *Hevea brasiliensis* with ethephon

Journal of Natural Rubber Research. 8(4): 286-292.

Bark dryness [brown bast] was induced in *Hevea* clone PB 86 by stimulation at monthly intervals with 10% ethephon and tapping on 1S d/1 for 4 months. Laticifers near the dry tapping cut, observed under TEM, showed no obvious latex coagulation *in situ*. The laticifers were partially empty, with rubber particles and other organelles greatly reduced in number.

The nuclei appeared electron-lucent with partially disorganized nuclear membranes. The lutoids were often filled with electron-dense materials in which some small rubber particles were embedded. With many lutoids broken, some large vacuoles appeared in the laticifers. A considerable amount of the myelin-like structures formed in the laticifers.

Key words: Brown-bast; Ethephon; Laticifers; Over exploitation; Rubber particles

57 **Hao Bing Zhong and Wu JiLin** (1993)

Ultrastructure of radial extension of brown bast in diseased *Hevea* in resting

Chinese Journal of Tropical Crops, 14(2): 42- 52.

Key words: Brown bast; Laticifers

58 **Hao Bing Zhong and Wu JiLin** (1994)

Ultrastructural observations of radial extension of brown bast in diseased *Hevea* in resting

IRRDB TPD Workshop, 26-28 July 1994, SCATC, Hainan, China.

The observations using light microscopy and transmission electron microscopy demonstrate that brown bast could spread from the diseased tissues to the new tissues produced by cambium in the diseased *Hevea brasiliensis* in resting period. In the course of spreading, the disease symptoms appeared first in the laticifers of the newly produced tissues. The first visible symptoms on the ultrastructure of the affected laticifers were the occurrence of a considerable amount of myelin-like structures and the appearance of the fine fibrils in the nuclei in addition to the coagulation *in situ* of some rubber particles. We believe that the radial extension of brown bast in resting trees is hard to be explained by the current views on the causes and extension mechanisms of the disease.

Key words: Brown bast; Laticifers, Radial extension; Rubber particles

59 **Harmsen, J R** (1919)

Brown bast disease: Detailed results of treatment with tar

Malayan Tin and Rubber Journal, 8: 679-684.

(Review of Applied Mycology, 1:1922)

Key words: Brown bast; Disease control; Tar treatment

60 **Horne, A S** (1921)

Phloem necrosis (brown bast disease) in *Hevea brasiliensis*

Annals of Botany, 35(139): 457-459.

This paper describes about the anatomical details of the bark taken both from diseased and suspected trees.

Key words: Bark anatomy; Brown bast; Phloem necrosis

61 **Horne, A S(1925)**

Further observations on phloem necrosis (brown bast disease) in *Hevea brasiliensis*

Tropical Agriculturist, 64: 328-333.

Key words: Brown bast; Phloem necrosis

62 **Huang Guixiu; Chen Shoucai; Wu Kunxin; Peng Shiqing and Fu Xianghui (1999)**

mRNA differential display between healthy and TPD trees of *Hevea brasiliensis*

Proceedings of IRRDB Symposium, 1999. Hainan, China, pp.337-344.

Numerous studies have been carried out for the understanding of tapping panel dryness (TPD) disease, an extremely complex physiological syndrome affecting latex production in *Hevea brasiliensis*, which creating a serious economic handicap for rubber plantations. The cause of the disease, however, is still unknown although many different hypothesis have been proposed to explain it. In this study, the DDRT-PCR is used to search for differentially expressed genes between the healthy and TPD trees to understand the nature of the TPD phenomenon. Total RNAs of latexes and barks from both healthy and TPD trees, which belong to the clones RRIM 600, 13-28, 1-20, PB5/51 X PR 107, RRIM600 X PR107, were purified respectively and then subjected to DDRT-PCR. The result of displayed on sequencing gel showed that one marked common band appeared both latex and bark in all detected clones of healthy trees, but the band was very weak or not appeared in all tested TPD trees. The fragment proved to be positive by Northern Blot was cloned. Sequencing result showed that it is 725 bp long and no homologies are found. Further study may reveal the mechanism of the TPD disease occurring on *Hevea brasiliensis* when the expression of this gene is inhibited.

Key words: DDRT-PCR; Gene expression; Rubber clones

63 **Jacob, J L and Prevot, J C (1989)**

Bark dryness: Histological, cytological and biochemical aspects

Proceedings of the IRRDB Workshop on Tree Dryness, 26-27 June 1989, Penang, Malaysia, pp.20-32.

Bark dryness has been observed for a very long time, at the beginning of the century in Asia and even at the end of the 19th century in Brazil. The purpose of the present work was to use existing histo-cytological and biochemical knowledge to review the situation in a field, which today appears to be acquiring crucial importance. It should first be stressed that there are two forms of bark dryness. One form, which may be related to the season or caused by too 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 (brown bast) of the tapped bark in a short period or time. Although this phenomenon can be caused artificially(by over- tapping, compression, etc.), it can appear in normally exploited trees and can even occur from first opening onwards. This type of bark dryness

also displays cyto-histological symptoms in the phloem and different biochemical characteristic of the latex.

Key words: Bark dryness; Histology; Irreversible dryness; Over exploitation; Reversible dryness

64 **Jacob, J L; Prevot, J C and Lacrotte, R** (1994)

Tapping panel dryness in *Hevea brasiliensis.*

Plantations, Recherche, Developpement, 1(3): 22-24.

The total or partial absence of latex flow, or tapping panel dryness, in *Hevea brasiliensis,* may or may not be combined with necrosis. If there is none, it is usually a case of laticifers fatigue and tapping can be resumed after a rest period. Necrotic tapping panel dryness is a serious histological, cytological and metabolic disruption, which causes considerable disorganization of the entire secondary phloem and spreads in all directions. This is caused by disease types of stresses and is usually irreversible.

Key words: Latex flow; Phloem necrosis; France

65 **Jones, K J and Nezryetti** (1986)

Brown panel canker of rubber in Jambi province Indonesia

Phytopathology, 76(10): 1124.

A large proportion of rubber trees (*Hevea brasiliensis*) in Jambi province, Indonesia, are affected by a brown panel canker. The renewing bark on the tapping panel becomes dry and lumpy, with disorganization of lactiferous tissues and phloem. This results in the inability to retap the panel which reduces the yield and shortens the productive life of the affected trees considerably. A *Fusarium sp.* was consistently isolated from affected trees at three location. The *Fusarium* was shown to produce cankers and localized growth abnormalities when inoculated onto one-year-old rubber trees in pots in the greenhouse.

Key word: Brown bast; Brown panel canker; Indonesia

66 **Keuchenius, P E** (1920)

Investigations on brown bast

Archief Voor De Rubbercultuur, 4: 1-4.

(RRIM Bibliography, No.20, 1973.)

Key words: Brown bast

67 **Keuchenius, P E** (1921)

Brown bast of *Hevea brasiliensis*

Review of Applied Mycology, 1: 263-267.

Key words: Brown bast

68 **Keuchenius, P E (1922)**

Experiments in the practice of brown bast control

Review of Applied Mycology, 1: 263-267.

Key words: Brown bast; Disease control

69 **Keuchenius, P E (1924)**

Consideration on brown bast disease

Archief Voor De Rubbercultuur, 8: 803-816.

(RRIM Bibliography, No.20, 1973)

Key words: Brown bast

70 **Kongsawadworakul, P; Pujade-Renaud, V; Chrestin, H; Montoro, P; Lacrotte, R and Narangajavana, J**

Cloning and expression of genes involved in oxidative stress in the latex from TPD trees

Proceedings of the Seminar on The Biochemical and Molecular Tools for Exploitation Diagnostic and Rubber Tree Improvement. (Eds. Narangajavana, J. and Chrestin, H). Mahidol University, Bangkok, Thailand, pp. XII - 1-9.

Key words: Gene expression: Oxidative stress

71 **Krishnakumar, R; Annamalainathan, K; Simon, S P and Jacob, J (1998)**

TPD Syndrome increases bark respiration in *Hevea*

In: *Recent Advances in Plantation Crops Research*: Placrosym XIII, 16-18 December 1998, Coimbatore, Tamil Nadu, India. (Eds. N.Muraleedharan and R. Raj Kumar). Allied Publishers, New Delhi, India, pp. 241-245.

A study was conducted in *Hevea* clones (GT-1 and RRII 105) to examine the respiratory rates of the bark tissues from tapping panel dryness (TPD) affected and normal trees and relate to the carbohydrate status of the tissues. Concomitant with an increase in total sugars, sucrose and starch contents in the bark, respiration rate also increased in TPD affected once when compared to healthy bark from normal trees. Bark tissues from the opposite side of the tapping panel of the two clones showed a decrease in the respiration; however, they did not show much variation in their carbohydrate contents in healthy trees. In partially affected GT-1, sucrose and total sugar contents of the bark tissues from the latex yielding (wet) portion of the tapping panel showed a significant decrease compared to the dry portion of the same bark. Carbohydrate content and respiration of wet and dry portions of the panel from TPD trees did not vary in RRII 105 as well. It would appear that increased availability of carbohydrates and increased respiration in the bark must have led to increased biomass production at the cost of rubber biosynthesis in TPD affected *Hevea* trees.

Key words: Bark respiration; GT 1; RRII 105; India

72 **Krishnakumar, R; Annamalainathan, K; Simon, S P and Jacob, J (2001)**

Tapping panel dryness syndrome in *Hevea* increases dark respiration but not ATP status

Indian Journal of Natural Rubber Research, 14(1): 14-19.

Tapping panel dryness(TPD) affects the ability of *Hevea* trees to synthesize rubber (cis-poly isoprene) and thus decreases the yield The present study conducted in *Hevea* clones RRIM 600 and RRII 105 showed that concomitant with an increase in the total sugars and starch contents in the bark, respiration rate also increased but the ATP concentration in the cytosol markedly decreased in TPD affected bark compared to healthy bark from normal trees. This appears to be due to an increase in the non-phosphorylating cyanide resistant alternative respiration in the affected trees.

Keywords: Respiratory pathways; Rubber biosynthesis; India

73 **Krishnakumar, R; Cornish, K and Jacob, J (2001)**

Rubber biosynthesis in tapping panel dryness affected *Hevea* trees

Journal of Rubber Research 4(2): 131-139.

The activity of rubber transferase (RuT) determined in washed rubber particle (WRP) and while latex showed a marked increase in the advanced stages of tapping panel dryness (TPD) compared to healthy and early stages of TPD. Prenyl transferase activity measured in the C-serum of latex showed a slight decrease in the early stages of TPD, but was substantially large in the advanced stages of TPD. There was a positive correlation between RuT and prenyl transferase activities. The increased activities of RuT and prenyl transferase under *in vitro* conditions in presence of adequate conversion of their substrates suggest the presence of a large number of small rubber particles in a given unit weight of WRP. The mean rubber particle size slightly increased in the early stages of TPD, but was smaller in the advanced stages of TPD. The mean rubber particle size was negatively correlated with RuT activity. It is suspected that both RuT and prenyl transferase remained inactive under *in vivo* conditions possibly due to inadequate supply of their immediate substrates. These findings are discussed in the light of their earlier results that showed enhanced respiration in the TPD affected bark tissues.

Keywords: Prenyl transferase; Rubber biosynthesis; Rubber particles

74 **Krishnakumar, R and Jacob, J (2002)**

Effect of panel changing on tapping panel dryness in *Hevea*

Indian Journal of Natural Rubber Research, 15(1): 96-99.

Providing a period of tapping rest and changing the tapping panel are the plantation practices generally followed to manage tapping panel dryness (TPD) in *Hevea brasiliensis*. Experimental data on the recurrence of TPD when a new panel is opened is not available. This study examines whether panel changing can ensure recovery from TPD. A twenty one year old *Hevea* plantation (clone GT1) was taken up for this study. It is hypothesized that TPD is related to some intrinsic factors possibly associates with endogenous ethylene production and action in the

trees rather than an external biotic agent. The likely intrinsic differences in the ethylene production capacity or tissue sensitivity to ethylene between different trees within a clone may explain the random nature of TPD occurrence and its apparent spread from one panel to another in a given tree upon tapping.

Keywords: Endogenous ethylene; Panel change; Tapping rest; India

75 **Krishnakumar, R and Jacob, J** (2003)

Overproduction of endogenous ethylene inhibits rubber biosynthesis in *Hevea brasiliensis*

Bioprospecting of Commercially Important Plants: Proceedings of the National Symposium on "Biochemical Approaches for Utilization and Exploitation of Commercially Important Plants", 12-14 Nov. 2003, Jorhat, India.

A study was conducted to understand the role of endogenous ethylene in latex yield and tapping panel dryness (TPD) occurrence in *Hevea brasiliensis*. Twenty normal yielding trees and 20 TPD affected trees from a 14-year-old rubber plantation of clone RRII 105 were selected. The trees were under regular tapping (a process of controlled wounding of the bark tissue) in alternate days for latex collection. Wound-induced ethylene produced in the bark tissue of TPD affected trees was significantly higher than that of healthy trees. There was a reduction in the extent of TPD and an increase in latex production in TPD affected trees when they were treated with cobalt chloride, an inhibitor of ethylene biosynthesis, which was applied prophylactically on the bark. These results suggest the involvement of high endogenous ethylene levels in the bark causing the oxidative stress and thereby inhibiting rubber biosynthesis in TPD affected *H. brasiliensis* trees.

Key words: Endogenous ethylene; Oxidative stress; Rubber biosynthesis; Yield; India

76 **Krishnakumar, R; Sasidhar, V R and Sethuraj, M R** (1997)

Influence of TPD on cytokinin level in *Hevea* bark

Indian Journal of Natural Rubber Research, 10(1&2): 107-109.

The trans-zeatin content in the bark was significantly lower in scion tissues collected from trees affected by panel tapping dryness than in that from healthy trees, but there were no significant differences in trans-zeatin content in the bark from rootstocks of healthy and affected trees.

Key words: Cytokinin; India

77 **Krishnakumar, R; Sreelatha, S; Gopalakrishnan, J; Jacob, J and Sethuraj, M R** (1996)

Relationship of increased peroxidase activity and decreased cytokinin content in TPD affected *Hevea* trees.

Developments in plantation crops research. Proceedings of the PLACROSYM XII, 27-29 November 1996, Kottayam, India, pp.142-146.

Trans-zeatin riboside (t-ZR) levels, peroxidase activity and phenol content in the bark tissues of normal and trees affected by tapping panel dryness (TPD) were analysed. The cytokinin

from each bark tissue samples was extracted. The partially purified extracts were used to determine the t-ZR content in the bark tissue through direct ELISA using polyclonal antibodies raised against t-ZR-BSA conjugate. The normal plants showed significantly higher t-ZR content than the TPD affected plants. The higher t-ZR content in normal plants was negatively correlated with their peroxidase activity and phenol content. The biological significance of these negative correlation is discussed *vis-a-vis* biotic stress and free radical scavenging.

Key words: Cytokinin;ELISA; Peroxidase activity; Trans-zeatin riboside; India

78 **Krishnakumar, R; Sreelatha, S; Thomas, M; Gopalakrishnan, J; Jacob, J and Sethuraj, M R** (1996)

Biochemical investigations on tapping panel dryness in *Hevea brasiliensis*

National Symposium on Current Trends in Plant Physiology and Plant Biochemistry, 23-25 February 1996, CCS Haryana Agricultural University, India.

Key words: Biochemical composition; Oxidative stress; India

79 **Krishnakumar, R; Sreelatha, S; Thomas, M; Gopalakrishnan, J; Jacob, J and Sethuraj, M R** (1999)

Biochemical composition of soft bark tissues in *Hevea* affected by tapping panel dryness

Indian Journal of Natural Rubber Research, 12(1&2): 92-99.

The biochemical composition of the live laticiferous tissues of TPD affected and healthy *Hevea* trees was compared in the present study. The TPD affected laticiferous tissues contained comparatively higher levels of sugars, phenols and soluble proteins than healthy tissues. Also there was significantly higher activity of peroxidase and lower activity of polyphenol oxidase in the affected than in the healthy tissues. The results showed that lack of availability of sucrose was not the cause for TPD. The high peroxidase activity and the accumulation of phenols in the laticiferous tissue indicate possible oxidative stress in the TPD affected bark tissues. It appears that oxidative damage of laticiferous vessels may be responsible for the complete shut down of the rubber biosynthetic machinery, possibly by altering the energy metabolism in fully dry trees.

Keywords: Biochemical composition; Oxidative stress; India

80 **Krishnakumar, R; Thomas, M; Sobhana, P and Jacob, J** (2003)

Tapping panel dryness syndrome: A review

International Workshop on Exploitation Technology, 15-18 December 2003, Rubber Research Institute of India, Kottayam, India.

TPD is a serious problem in modern high yielding *Hevea* clones. Although this is a major yield limiting factor, TPD offers a uniquely interesting and intellectually challenging problem for inter disciplinary research. The often abrupt and complete shut down of the latex biosynthesis machinery in TPD affected trees is a spectacular physiological event that has few parallels in plant biology. Although TPD has been a persistent problem since the beginning of

commercial rubber cultivation and it has assumed serious proportions in the recent decades with the advent of high yielding clones, the exact cause of this malady or its solution is unknown even today. However, our understanding of the problem has been considerably enhanced in the recent couple of years. Although there have been some inconclusive reports about the possible involvement of a biotic agent associated with TPD, the overwhelming evidence in the literature points to a physiological malfunctioning in the laticiferous tissues. Over-exploitation leads to TPD, but supply of carbohydrates have never been a limiting factor for rubber biosynthesis. Over-exploitation results in biotic stress leading to oxidative damage and poor energy supply for the metabolic conversion of carbohydrates into rubber resulting in the accumulation of sugars in the drainage area of TPD affected trees. There is also evidence that hyper-activation of the bark to wound induced ethylene production may predispose a tree to TPD. Investigating the impact of root-stock-scion interactions on the dynamics of ethylene production in the bark tissues of the scion may give possible clues for the cause of TPD and its eventual control or management. In this context it is important to note that a larger genetic distance existed between the rootstock and scion of TPD affected trees than normal healthy trees.

Key words: Over exploitation; Rootstock; Rubber biosynthesis; Scion; India

81 **Lacrotte, R; Gidrol, X; Vichitcholchai, N; Pujade-Renaud, V; Narangajavana, J and Chrestin, H (1995)**

Hevea: protein markers of tapping panel dryness

Plantations, Recherche, Developpement, 2(4): 40-45.

A study was made of tapping panel dryness (previously known as brown bast), which occurred spontaneously in a plot of RRIM 600 trees under standard tapping conditions in Thailand. The trees were grouped into categories according to the severity of the disorder: healthy or with 10, 50 or 80-100% of the cut dry. Latex was collected and its protein composition analysed electrophoretically. The banding patterns obtained from healthy trees were clearly different from those of each of the other categories, with certain protein bands appearing and increasing in intensity as the extent of the disorder increased. It was concluded that it is possible to diagnose tapping panel dryness and its severity using protein markers.

Keywords: Protein markers; Thailand

82 **Lacrotte, R; Vichitcholchai, N; Chrestin, H; Kosaisawe, J; Taingtae, K and Pujade-Renaud, V (1997)**

Protein markers linked to the tapping panel dryness (TPD) of *Hevea brasiliensis*

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 1997, Hainan, China, pp. 40-54.

The Tapping Panel Dryness(TPD) disease results in a transient or a definitive cessation of latex production. Two types of TPD have been defined: necrotic TPD and over-exploitation-induced TPD. The former occurring randomly in a plantation and then spreading, often along the lanes of trees, and the latter being a physiological fatigue feature. Using 1-and 2-D-

SDS-PAG Electrophoresis of the latex proteins, it has been shown that the latex from TPD trees exhibited systematically different patterns of cytosolic proteins, compared with control trees of clone RRIM 600, namely over-expression of a 22+_3kDa acidic protein and other low molecular weight (14-17kDa) acidic proteins, a de novo expression of a 29kDa protein and a decreased expression of two 33+_3kDa proteins. It was found that both types of (necrotic and induced) TPD generally exhibited the same differences. Therefore, it is highly probable that at least the over-expressed or *de novo*-expressed cytosolic proteins may be stress proteins which give warning of a stress leading to TPD. Such markers will be very useful to predict the risk of any kind of TPD but would not allow differentiation between spontaneous and induced TPD, if they really are different. Latex Diagnosis(LD: measurement of latex inorganic phosphate, reduced thiol, sucrose and dry rubber content) could provide a warning of over-exploitation, especially through over-stimulation, which leads quickly to the onset of transient TPD and progressively to the inception of definitive TPD. After 70 months of the experiment, the concentrations of sucrose and reduced thiols in the latex from over-stimulated trees decreased to a low level, while the high concentration of inorganic phosphorus in the latex of over-stimulated trees revealed a very high metabolic activity, consuming too much energy with only a small extra gain in production. There was no warning of real over-exploitation in the case of daily tapping: the concentrations of sucrose and reduced thiols in the latex remained in the same range as those of the control, while inorganic phosphorus concentration remained significantly higher than the control thus revealing a high metabolic activity because of the high latex regeneration rate for such a short harvesting time.

Keywords: Inorganic Phosphorous; Physiological fatigue; Protein markers; Thailand

83 **Lacrotte, R; Vichitcholchai, N; Chrestin, H; Pujade-Renaud, V; Kosaisawe, J; Srisarn, P; Narangajavana, J; Montoro, P and Gidrol, X** (1997)

Latex diagnostic and molecular markers of the tapping panel dryness (TPD)

In: *Proceedings of the Deminar on the Biochemical and Molecular Tools for Exploitation diagnostic And Rubber Tree Improvement*, 1997. (Eds. Narangajavan, J and Chrestin, H). Bangkok, Thailand, pp.IX-1-27.

Key words: Latex diagnosis; Molecular markers; Thailand

84 **Latha, N and Jose, M** (2003)

Exploitation Technology of Hevea: An Annotated Bibliography. Rubber Research Institute of India, Kottayam, India, 107p.

Key words: Exploitation technology literature; Bibliography; India

85 **Lee C K and Hashim, Ismail** (1989)

Effect of exploitation systems on panel dryness

Proceedings of RRIM, Rubber Growers' Conference, 1989, Malacca. Malaysia, pp.334-347.

There were clonal differences in susceptibility to panel dryness. Clones PB 260 and PB 255 had higher incidence of panel dryness compared with clones RRIM 600, RRIM 623, RRIM

712, PB 235, PB 261 and PBIG seedlings. In some cultivars, the 1/2S d/2 tapping system resulted in a slightly higher percentage of pane dryness compared with the low intensity systems. However, in most of the cultivars, there was no consistent difference in the percentage of panel dryness in trees tapped on these systems. Nevertheless, intensive full-spiral and reduced-spiral systems were strongly associated with a high incidence of panel dryness. Stimulation together with intensive tapping tended to increase the incidence of panel dryness in most cultivars. In these cultivars the percentage of panel dryness usually increased with time. Hence, prolonged exploitation particularly with intensive tapping systems together with high dosages of stimulation could result in a high incidence of panel dryness and subsequently yield decline. Excessive drainage of latex from the trees could also be a major contributory cause of panel dryness. In general, panel change could result in a temporary decrease in the incidence of panel dryness.

Key words: Exploitation; *Hevea* clones; Panel change

86 **Li, A; Lin Zhamou; Zbrong, X and Lin, J** (1984)

Treatment of Brown bast in *Hevea brasiliensis*

Journal of Tropical crops, 40: 10-18.

Key words: Brown bast; Disease Control

87 **Li Shizong; Lin Zhaomu; Zuo Qizing and Lin Giqiang** (1984)

Prevention and cure of brown bast

Research on Tropical Crops, 2: 10-18.

Key words: Brown bast; Disease control

88 **Li Shicong and Lin Zhaomu** (1994)

Microelement treatment of resting bark dryness *Hevea* trees and their re-exploitation

IRRDB TPD Workshop, 26-28 July 1994, SCATC, Hainan, China.

In 1970s, an approach of remedying and retapping of resting bark dryness trees, including application of compound micro-elements on the shallowly scraped bark of the resting affected trees and tapping of healthy bark at the upper part of the trees was tested. This approach, integrating bark scraping and chemical treatment with adequate tapping, had come out with better results. In a view of verifying its application efficiency on a commercial scale a study on chemical treatment and re-exploitation of resting bark dryness trees was carried out in 1982 in the whole Wei-xing state farm in Hainan province. The results of 12 years experiments were presented. A commercial scale pairing method design was arranged in this study with one treatment and the control. For the control, bark dryness trees at resting were not treated but tapped upward on the high panel on the S/2 d/3 system, and the yield and the incidence of bark dryness were observed. For the treatment trees, the hard cortex of the diseased zones was shallowly scraped and shaved to turn up brown spots from the tapping cut to the base of its panel; compound micro-elements solutions

were painted on the scraped bark, and on each side of the trunk one hole was drilled and inserted respectively with small tubes A and B containing microelements. The resting infected trees were puncture tapped on the high panel one week after the treatment. A vertical exploitation strip of 25X2 cm was created on the upper bark with the cork cortex removed, smeared with 5% ET and tapped on d/3 (3 punctures/tapping). The treated trees were tapped 6 times for one tapping cycle and then rested for one week, in other words 48 tappings per year in 8 tapping cycles.

Key words: Bark dryness; Microelement treatment; Tapping cycle; Yield; China

89 **Lukman** (1989)

Tapping panel dryness in Indonesia

Proceedings of the IRRDB workshop on Tree dryness, 26-27 June, 1989, Penang, Malaysia. pp.73-81.

Tapping panel dryness is caused by brown bast and bark necrosis. Brown bast is a physiological disease while bark necrosis is caused by fungus. Tapping panel dryness in Indonesia is reported in commercial plantations as well as in trials. Some curative efforts for the disease are explained.

Key words: Bark necrosis; Brown Bast; Disease control; Indonesia

90 **Lukman** (1992)

Tapping panel dryness on upward tapping

Proceedings of the IRRDB Joint Meeting Breeders, Pathology, Physiology and Exploitation Groups, 27-28 October1992, Jakarta, Indonesia, pp.68-71.

Rubber planters tend to apply high intensity exploitation systems to achieve high production targets and, as a result, occurrences of bark dryness increase. Observations on nine estates which used upward tapping combined with change – over – panel indicated a high percentage of Tapping Panel Dryness (TPD). The reasons for incidences of TPD are discussed.

Keywords: Bark dryness; Panel change; Tapping intensity; Upward tapping; Indonesia

91 **Lulu, A A and Dar, W D** (1989)

Status of tapping panel dryness of matured rubber in the Philippines

Proceedings of the IRRDB workshop on Tree dryness, 26-27 June, 1989, Penang, Malaysia, pp.42-47.

In Philippines rubber production is concentrated in Mindanao which is relatively free from strong winds and typhoons. Rubber clones are directly imported from other countries where rubber production is at an advanced stage. This paper covers the details of a survey carried out to study the status of tapping panel dryness in Philippines.

Key words: Status report; Philippines

92 **Michael, S** (1994)

Incidence of tapping panel dryness in rubber in the small holdings of Meenachil Taluk

Dissertation, Post Graduate Diploma in Natural Rubber Production, College of Horticulture, Kerala Agricultural University, Thrissur, India, 1994, 47p.

Key words: Smallholdings; India

93 **Moraes, L A C; Moraes, V H-de-F and Moreira, A** (2002)

Effect of the cyanogenesis on the incompatibility of crown clones of *Hevea* spp. budded onto IPA 1.

Pesquisa Agropecuaria Brasileira, 37(7): 925-932.

The role of cyanogenic glycosides in the incompatibility of *H. brasiliensis* clone IPA 1 with the budded clones of other *Hevea* species was investigated. The activities of beta-glycosidase, beta-diglycosidase and beta-cyano alanine synthase (beta-CAS), involved in cyanide metabolism, were investigated in the stem bark of clones IPA 1, Fx 3864 and Fx 4098. Clones of high and low cyanogenic potential (HCN-p) were crown budded on IPA 1, and the development of the budded plants was recorded. The HCN-p of young and mature leaves of other crown clones known to be compatible or incompatible was determined. The beta-CAS activity of IPA 1 was as low as in non-cyanogenic plants, and very high in clone Fx 4098. IPA 1 had high beta-glycosidase and beta-diglycosidase activities, which, together with very low beta-CAS activity, showed the susceptibility of this clone to cyanide. Crown clones with low and high HCN-p in young leaves, and high HCN-p in mature leaves, were compatible. In incompatible clones, HCN-p was reduced in mature leaves. Results support the hypothesis that the incompatibility is caused by the translocation of linustatin from leaves to the stem of IPA 1. The incompatibility symptoms resemble some aspects of the Tapping Panel Dryness (TPD), suggesting a relationship of TPD with cyanogenesis.

Key words: Cyanogenesis ; *Hevea* clones

94 **Murray, R K S** (1930)

Brown Bast

In: *Diseases of Rubber in Ceylon Rubber Research Scheme*, Ceylon, pp.16-20.

Key words: Brown bast; Ceylon

95 **Mydin, K K; John, A; Marattukulam, J G; Saraswathyamma, C K and Saraswathy, P** (1999)

Variability and distribution of tapping panel dryness in *Hevea brasiliensis*

Proceedings of IRRDB symposium 1999, Hainan, China (Eds. Chen Quibo and Zhou Jiannan). Hainan Publishing House, China, pp.83-90.

A large-scale evaluation trial of 21 clones of *Hevea brasiliensis* was studied with respect to yield, girth and the incidence of tapping panel dryness (TPD) over nine years of exploitation. Tapping panel dryness was confirmed to be a distinct clonal characteristic with high heritability

and low genetic advance. A significantly positive correlation of TPD with girth and girth increment over nine years of tapping was observed. The distribution of TPD affected trees in the field was not random in most of the clones studied. Non-additive gene action in the inheritance of TPD as indicated by the genetic parameters and its implications on *Hevea* breeding are discussed.

Key words: *Hevea* clones; Genetic advance; Heritability; Large scale trial; India

96 Nair, N U (2004)

Tapping panel dryness survey in small holdings in India-A report

IRRDB Conference on NR Industry: Responding to Globalization, 7-8 September 2004, Kunming, China, pp. 1-5.

Tapping Panel Dryness (TPD) also known as Brown Bast is a syndrome encountered in rubber plantations. TPD was reported first in wild *Hevea* trees in the Amazon forest as early as 1887. The symptoms range from partial dryness of the tapping cut, browning and thickening of the bark to cracking and deformation of the bark in some instances. The most common symptoms include a phase of excessive dripping of latex with simultaneous fall in the dry rubber content and a gradual decline in the volume per tapping. Many four high yielding clones are highly susceptible to TPD, leading to serious ,loss in production. Fifteen to twenty percent of trees getting dry in about five years of tapping has become a common feature in many plantations. The global loss in production of natural rubber due to TPD with an average 10% incidence has been projected to be as high as 500,000 tonnes in the IRRDB technical discussions. Most of the researchers' view regarding the causes of TPD is mainly due to over exploitation or over-stimulation particularly the higher tapping frequency. Intensive exploitation causes excessive over flow of latex and consequently nutritional stress. Stress of any kind such as typhoons, root disease and other mechanical shock may also induce TPD. Incidence of TPD can be reduced by reducing the exploitation intensity. Tapping rest imposed for varying periods may revive some of the trees, but in the majority of cases, re-occurrence of the syndrome is encounters. In spite of the extensive studies on the relationship between TPD and clone, nutrient levels, topography, exploitation systems, etc., no definite pattern has emerged except that there is clonal variation with regard to susceptibility and incidence of is TPD always higher with intensive exploitation. Documentation of the crop loss due to TPD in small holdings is essential since it contributes more than 85% of the natural rubber production. India's lead in productivity among the rubber producing countries is due to the wide spread cultivation of RRII 105 by the smallholders. In the traditional tract, this clone occupies 65% of the cultivated area. Its yield potential is not yet achieved even in the traditional tract mainly due to crop n loss from TPD as a result of intensive exploitation practiced by the small holders. Therefore, a less intensive tapping frequency (1/2 S d/3) is recommended for this clone. Comparative studies of 1/2S/d3 tapping system with traditional 1/2Sd/2 in a RRIC 100 rubber plantation in Sri Lanka revealed that the incidence of TPD was similar in both systems. The lesser cost of production and 20% less bark consumption the advantages of d/3 system over d/2 (Nugawela *et al.* 1998). A Tapping Panel Dryness Survey was initiated in smallholdings covering the three agro climatic regions comprising South (Kanyakumari region experiencing

a tropical humid climate with plenty of seasonal rainfall,) Central (with well pronounced wet and dry season) and North region (with a prolonged dry spell of four months) of the traditional rubber growing tract.

Keywords: Productivity; Smallholdings; Status report; India

97 **Nair, N U; Sreelatha, S; Thomas, M; Simon S P and Vijayakumar K R** (2001)

Latex diagnosis for assessment of clonal performance in *Hevea*

Indian Journal of Natural Rubber Research, 14 (1): 63-65.

The performance of *Hevea* clones grown in Kerala, India, which belong to high (RRII105, PB235, PB215 and PB217), medium (GT1) and low (Ch 4, Pil B84, Tjir 16 and Ch 29) yielding groups, was evaluated based on the biochemical parameters of the latex. Low-yielders, which were characterized by low dry rubber, sugar and Pi contents, showed slow metabolism. On the other hand, the high-yielding clones PB235 and RRII105, with low sugar and thiol contents coupled with high Pi, exhibited an active metabolism in latex vessels. This characteristic, combined with long flow duration, make these clones more sensitive to tapping panel dryness (TPD). PB217, which had higher sugar and thiol contents attributed to less active metabolism, is more suitable to higher intensity of exploitation, combined with the possibility of lower TPD incidence. GT1, with lower Pi and dry rubber contents but higher thiol level, exhibited intermediate metabolism and characteristics, suggesting that stimulation may favour optimum yield in this clone.

Key words: Biochemical parameters; *Hevea* clones; Latex diagnosis

98 **Nandris, D; Moreau, R; Pellegrin, F; Chrestin, H; Abina, J and Angui, P** (2004)

Rubber tree (*Hevea brasiliensis*) bark necrosis syndrome II First comprehensive report on causal stresses

Plant Disease, 88(9): 1047.

Key words: Bark necrosis; Causative agents;

99 **Nandris, D; Pellegrin, F and Chrestin, H** (2004)

No evidence of polymorphism for rubber tree bark necrosis and early symptoms for its discrimination from TPD

IRRDB Conference on NR Industry: Responding to Globalization, 7-8 September 2004, Kunming, China.

The main constraint in rubber plantations worldwide is the cessation of latex production caused by two different syndromes: 1. Tapping Panel Dryness (TPD) which is considered to be a reversible physiological response to overexploitation and 2. Bark Necrosis (BN), an irreversible syndrome of the phloem that spreads from the collar towards the tapping cut. The

controversial question of the polymorphism of these bark syndromes was recently settled thanks to the conclusions of a survey made in a large number of rubber plantations throughout the world rubber growing zone. The symptoms and chronology of "dry" trees and/or potential TPD trees observed in every plantation visited were similar to the initial description of BN reported in cote d' Ivoire from 1984 on. The range of severity of BN and the proportion of BN to TPD varied significantly depending on the clone, the age of the trees, the site and the country. Te fact that most of the dry trees surveyed in recently opened blocks revealed inner symptoms typical of BN may provide useful clues for early discrimination between the two syndromes.

Key words: Bark necrosis; Epidemiology

100 **Nandris, D; Pellegrin, F; Moreau, R; Abina, J; Angui, P and Chrestin, H**(2004)

Etiology, Epidemiology and environmental investigations on the causal factors of rubber tree (*Hevea brasiliensis*) bark necrosis: A physiological trunk disease caused by an accumulation of stresses

IRRDB Conference on NR Industry: Responding to Globalization, 7-8 September 2004, Kunming, China.

Bark Necrosis (BN), first studied and described in Cote d'Ivoire, in the 1980s, now affects most modern rubber plantations worldwide, with a wide range of severity across sites. While previous and recent etiological analyses remain non-conclusive, environmental factors were shown to be associated with BN. Indeed, numerous epidemiological surveys conducted in various African and Asian plantations on recently tapped blocks revealed the non-random location of the earliest single diseased trees. These risk areas are mainly characterized by the proximity of a swamp, plantation road, windrow, old bulldozer track, residual forest stump or slope break. In BN emergence areas, while no significant correlation was found with chemical soil parameters, physical soil analyses (e.g. penetrometry) revealed higher soil compaction, often associated with poorer rhizogenesis in BN trees. Furthermore, initial BN symptoms were preferentially observed near the grafted bud at the rootstock/scion junction (RS/S). Numerous comparative ecophysiological measurements of leaf water potential, stem water potential, and predawn base potential, using a PMS (plant moisture stress) pressure chamber, indicated water stress in BN trees. These results and preliminary dye transfer studies at the RS/S junction suggested a non-optimal vascular relation between the root system and the trunk of BN trees. Thus, compaction-associated reduced water availability of the soil, poor root capacity to meet the water demand during drier dry seasons, combined with disturbed sap flows and recurrent local water drainage (latex flows) are now suspected to jointly act as the main exogenous causal stresses that induce the BN process at the RS/S bud zone, before spreading upward to the tapping cut. This multidisciplinary approach provides a new comprehensive scenario for the emergence of this multi-factorial physiological disease.

Key words: Bark dryness; Bark necrosis; Etiology; Epidemiology; Ecophysiology; Physiopathology; Physical constraints; Rootstock; Scion; Stress

01 **Nataraja, K N; Krishnakumar, R; Jacob, J and Sethuraj, M R (1997)**

Analysis of the protein profiles of healthy and TPD-affected *Hevea brasiliensis* bark tissues

*IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis,*1997, Hainan, China, pp.17-20.

The study was conducted with the objective to understand the bark protein profiles of healthy and TPD-affected *Hevea.* Soft bark tissues were collected (2- 3mm thick laticiferous tissue adjacent to the cambium) from both fully dry and healthy tees of clone RRII 105. The tissue was homogenized in borate buffer (pH 9.0) and the total buffer soluble protein was extracted and estimated. The extract was then subjected firstly to 85°C and subsequently 95°C heat treatment for 20 minutes. The heat stable proteins were collected and estimated. The crude extract and heat stable fractions (HSFs) were further analyzed by electrophoretic separation (SDS-PAGE). In addition, the C-serum proteins in healthy and late dripping trees were tested for the presence of stress induced LEA group of proteins. The buffer soluble protein content did not differ significantly in either the crude extract or HSF at 85°C between TPD-affected and healthy trees. However, in the HSF at 95°C proteins were significantly higher in the healthy trees versus the TPD-affected trees. When shocked at 85°C there was a 25% reduction in the protein content of the crude extract as against 31% in case of TPD-affected bark. These reductions were 51% and 58% at 95°C in the healthy and TPD-affected bark, respectively. These results suggest that the bark proteins of *Hevea* are remarkably tolerant to heat shock. The protein profile analysis by SDS-PAGE revealed the presence of a protein (approx. 70kDa) in TPD-affected bark in relatively higher quantities which seemed to be relatively heat stable. In addition to this, some new sets of heat stable proteins in the lower molecular weight range (<30kDA) were also noticed in TPD-affected bark. Further investigations on the significance of these proteins are in progress. A dot-blot analysis using LEA-2 and LEA-3 group polyclonal antibodies revealed the presence of LEA proteins in the C-serum in both healthy and late dripping trees. The LEA and heat stable proteins are known to impart stress tolerance in plants. Hence, their role in TPD is being investigated.

Key words; Bark protein profiles; Clonal susceptibility; Heat stable protein; RRII105; Stress tolerance; India

2 **Nataraja, K N; Krishnakumar, R; Jacob, J and Sethuraj, M R (1998)**

Comparison of heat stable protein contents in bark tissues of healthy and tapping panel dryness affected *Hevea brasiliensis*

Indian Journal of Natural Rubber Research, 11(1&2): 98-100.

This experiments were conducted with the objective to examine if the concentrations of stress-related, thermostable proteins were different in the soft bark tissues of healthy and TPD affected *Hevea* trees. Stress-related proteins have been shown to be stable even at a high temperature as high as 95°C. It is likely that some of these proteins may be dehydrins, a group of LEA proteins, which have been shown to be present in the bark tissues of many woody species, and they are extremely thermo-stable. Further analysis using immunological approaches are needed to identify and quantify the thermo-stable bark proteins *vis-à-vis* TPD syndrome.

It is however likely that clones which can accumulate relatively more amount of stress-related thermo-stable proteins may be less susceptible to TPD.

Key words: Brown bast; Heat stable protein; India

103 **Nugawela, A and Aluthhewage, R K (1990)**

The effect of tapping on the CO_2 assimilation rates of *Hevea brasiliensis* Muell. Arg. leaves

Journal of the Rubber Research Institute of Sri Lanka, 70: 45-51.

Gas exchange measurements were made using detached leaves from the upper, middle and lower strata of the canopy of tapped and untapped mature *Hevea brasiliensis* plants (genotypes PB86 and RRIC 100). Gas exchange measurements were also made at 08.00-11.00 h, 11.00-14.00 h and 14.00-17.00 h on attached leaves of micro-tapped and untapped potted young plants of the same genotypes. In both genotypes, the CO_2 assimilation rates of leaves from the upper stratum of tapped trees and of micro-tapped plants were lower than those of untapped plants. The increase in assimilate sink demand caused by tapping and its consequences (including tapping panel dryness [brown bast] disorder) are discussed.

Key words: Brown bast; Gas exchange; CO_2 assimilation

104 Olapade E U and Ueleke, C L(1989)

Situation report on tapping panel dryness of *Hevea brasiliensis* in Nigeria

Proceedings of the IRRDB workshop on Tree dryness, 26-27 June 1989, Penang, Malaysia, pp.70-72.

In Nigeria, bark dryness on *Hevea* trees has been observed in the plantations. This report indicates the incidence of the phenomenon at the Rubber Research Institute of Nigeria (RRIN) and some rubber estates in Southern Nigeria. All the ten clones investigated in this study at the RRIN showed the tree panel dryness syndrome but with varying degrees ranging from partial dryness to complete dryness and with severity ranging from 25-82%.

Key words: Status report; Nigeria

105 Omokhafe, K O (2001)

Preliminary investigation into tree dryness in *Hevea brasiliensis* (Wild.Ex Adr. De Juss) Muell. Arg. by path analysis of tree dryness and latex parameters

Tropicultura. 19(1): 1-4.

(CAB Abstracts 2000/08- 20002/07)

The correlation between tree dryness and four latex parameters was studied in eleven clones of *Hevea brasiliensis* at Etche, Rivers State, Nigeria. The latex parameters used for evaluation were initial volume, initial flow rate, final volume and plugging index, with the latex parameters on trees dryness as the dependent factor. Estimates of direct and indirect effects of each of the latex parameters on tree dryness were calculated through linear correlation and path analysis.

The correlation coefficient between initial volume and initial flow rate was 1.00, and both characters had the same correlation coefficients with other latex parameters and tree dryness. This implies that initial volume and initial flow rate are alternative for evaluation of correlation between initial volume, initial flow rate and tree dryness at square root= 0.52, and high indirect effect of initial volume and initial flow rate through final volume. In addition, despite the low correlation coefficient of square root = -0.20 between final volume and tree dryness, the direct effect of final volume on tree dryness was high at 0.812. Final volume is, therefore, an important factor in the incidence of tree dryness.

Key words: Latex flow; Latex parameters; Path analysis; Tree dryness; Nigeria

106 **Omokhafe, K O (2004)**

Clonal stability of tree dryness in *Hevea brasiliensis* Muell. Arg.

Genetics and Molecular Biology, 27(2):1-5

Clonal stability of tree dryness was evaluated in eleven clones of *Hevea brasiliensis* at the Rubber Research Institute of Nigeria. The experimental design was the randomized complete block with three replicates and ten trees per replicate. The clones were evaluated in three locations. Four stability parameters were applied. The stability parameters were: environmental variance, regression index, variance due to regression, and Shukla's stability variance. Clone C 202 was outstanding for clonal stability and could be useful for further studies and genetic improvement of tree dryness. Other four clones (C 76, C 150, C 159 and RRIM 600) were also stable.

Key words: Clonal stability; Tree dryness; Nigeria

107 **Omokhafe, K O and Aniamaka, E E (2000)**

Heritability estimates of tree dryness and correlation with latex parameters in *Hevea brasiliensis*

Journal of the Rubber Research Institute of Sri Lanka, 83: 17-22.

Key words: Heritability; Latex parameters; Tree dryness

108 **Pakianathan, S W; Tata, S J; Chon, L F and Sethuraj, M R (1992)**

Certain aspects of physiology and biochemistry of latex production

In: *Natural Rubber: Biology, Cultivation and Technology*, (Eds. M R Sethuraj and N M Mathew). Elsevier, Amsterdam, The Netherlands, pp.308-311.

Key words: Brown bast; Latex physiology; Latex biochemistry

109 **PanYanqing (1997)**

Some notes on a future study of TPD in China

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 1997, Hainan, China, pp.1-2.

Key words: Status report; China

110 **Paranjothy, K** (1976)

Brown bast

Lecture notes, RRIM Short Course on Tapping, Tapping Systems and Yield Stimulation, pp.31-38.

Key words: Brown bast; Malaysia

111 **Paranjothy, K** (1979)

Brown bast and exploitation of dry trees

RRIM Training Manual on Tapping, Tapping systems and yield stimulation of Hevea, June1979, pp. 52-60.

Key words: Brown bast; Malaysia

112 **Paranjothy, K; Gomez, J B and Yeang, H Y** (1975)

Physiological aspects of brown bast development

Proceedings of International Rubber Conference, 1975, Kuala Lumpur, Malaysia, pp.181-202.

Brown bast is essentially a disorder of the latex vessels, originating in and spreading along the vessels. This is deduced from the general failure of spread of brown bast from one regenerated panel to another and from virgin bark to regenerated bark. The disorder is brought about by instability of lutoids within the vessels, this leading finally to coagulation of the vessel contents. Evidence in support of this includes the flocculation of rubber particles around lutoids within vessels, bottom fraction damage in lattices of intensively tapped and partially dry trees, reduced uptake of dyes by the bottom fraction in intensively tapped lattices and the appearance of flocs of lutoids and rubber particles in the latex streams of intensively tapped trees.

Key words: Brown Bast; Intensive tapping; Lutoid instability; Rubber particles

113 **Paranjothy, K and Yeang, H Y** (1977)

A consideration of the nature and control of brown bast

Proceedings of the RRIM Planters' Conference, 1977, Kuala Lumpur, Malaysia, pp.74-90.

Brown bast is a well known but poorly understood disorder of tapped trees. Although the disorder does not lead to tree death, there is an absence of latex flow in diseased bark and tapping is often impossible in the uneven and burred bark that eventually replaces the affected tissues. Besides this, brown bast remains an important factor in determining tapping intensities and therefore yield. Brown bast is recognized as a physiological disorder of exploitation. The literature is selectively reviewed to point out in particular the relationship between tapping intensity and brown bast. Data from records of *Hevea* breeding trials shown that there are differences between clones in their susceptibility to brown bast. It is also shown that differences exist between seedlings and buddings of comparable genetic material in their susceptibility to brown bast. It is inferred that susceptibility to brown bast, besides

being genetically influenced, may also be dependent on some aspect of the physiology of seedling trees. Some characteristic features of the mode of brown bast development are described. The general failure of brown bast to spread from one regenerated panel to another or from virgin bark to regenerated bark above the tapping cut at its initial stages is examined in detail. It is deducted that brown bast is essentially a disorder of latex vessels, originating in and spreading along vessels. Evidence suggesting that the disorder is brought about by instability of lutoids and other cellular organelles leading to coagulation of the vessel contents is briefly examined. The practical implications of the newly developed views are examined. The current practice where brown bast trees are rested and periodically re-opened is not considered beneficial and it is shown that any latex obtained from trees which 'recover' after tapping rest is derived largely from regenerated bark beneath diseased tissues. It is recommended, on the other hand, that brown bast trees be exploited on yielding bark without a tapping rest. In this connection the surgical isolation of affected bark before renewed tapping is shown to be beneficial. The value and prospects of curtailing brown bast, when it does occur, to pre-isolated panels are evaluated.

Key words: Brown bast; Lutoid instability; Tapping intensity

114 **Pellegrin, F; Nandris, D; Chrestin, H and Duran Vila, N** (2004)

Rubber tree (*Hevea brasiliensis*) bark necrosis syndrome I: Still no evidence of a biotic causal agent.

Plant Disease. 88(9): 1046.

The main constraint in rubber plantations worldwide is the cessation of latex production because of two syndromes: (i) tapping panel dryness, a reversible physiological response to overexploitation; and (ii) bark necrosis (BN), an irreversible syndrome spreading from the collar toward the tapping cut. Early BN symptoms develop in the inner phloem tissues but never affect the cambium. Necrotic patches appear in the outer phloem, including bark cracking and peeling, plantations never lead to tree death. BN spreads gradually to neighbouring rubber trees, and evidence of linear disease centers suggest that a pathogen may be involved, possibly transmitted by the tapping knife. Several etiological investigations performed on leaves, bark and latex using different methods were inconclusive. Thus, a physiological disease is now suspected to cause BN that involves exogenous stresses, non optimal vascular relations at the rootstock/scion junction and impaired cyanide metabolism.

Key words: Bark Necrosis

115 **Peries, O S** (1975)

Incidence and control of bark rot in *Hevea*

The planter, 51(596): 491-498.

Bark rot, Black thread of stripe canker is an endemic bark disease of the rubber tree in Sri Lanka. Studies showed that a spore suspension containing 10 zoospores per ml, equivalent to 1 zoospore per drop, can cause infection of injured bark. Tapping of wet trees is therefore dissuaded when the inocculum is present. i.e. during the occurrence of infected pods or leaves.

The recommended curative treatment of the disease consists of removing all infected bark. There is no necessity to chisel out discolored wood as the studies also have shown that the fungus does not penetrate deeply into the wood.

Key words: Bark rot; Disease control; Sri Lanka

116 **Petch, T (1919)**

Brown bast

Tropical Agriculturist, 53: 133-38.

(RRIM Bibliography, No.20, 1973)

Key words: Brown bast

117 **Petch, T (1921)**

Brown bast

In: *The Diseases and Pests of the Rubber Tree*. Macmillan and Co., London, pp.169-180.

Key words: Brown bast; Causative agents

118 **Pillay, P N R and George, M K (1980)**

Stem Diseases

In: *Handbook of Natural Rubber Production in India*. (Eds. Pillay, P N R and George, M K). Rubber Research Institute of India, Kottayam, Kerala, India, 1980, pp. 281-292.

Key words: Bark necrosis; Clonal susceptibility; Disease control

119 **Pratt, H G (1917)**

Brown bast on rubber trees, its cause and spread

Malayan Tin and rubber Journal, 6: 9-15.

(RRIM Bibliography No.20, 1973)

Key words: Brown bast; Causative agent

120 **Premakumari, D; Panikkar, A O N; Sethuraj, M R and Marattukalam, J G (1991)**

Growth, yield and flow characters and their correlations with brown bast incidence in ten *Hevea* clones

Indian Journal of Natural Rubber Research, 4(2): 107-113.

Ten *Hevea* clones were evaluated for growth, latex flow characters, yield and incidence of the plant disorder brown bast. Clones differed for initial rate of flow, duration of flow, plugging index, dry rubber content, girth, total volume of latex and dry rubber yield. Girth increment

being genetically influenced, may also be dependent on some aspect of the physiology of seedling trees. Some characteristic features of the mode of brown bast development are described. The general failure of brown bast to spread from one regenerated panel to another or from virgin bark to regenerated bark above the tapping cut at its initial stages is examined in detail. It is deducted that brown bast is essentially a disorder of latex vessels, originating in and spreading along vessels. Evidence suggesting that the disorder is brought about by instability of lutoids and other cellular organelles leading to coagulation of the vessel contents is briefly examined. The practical implications of the newly developed views are examined. The current practice where brown bast trees are rested and periodically re-opened is not considered beneficial and it is shown that any latex obtained from trees which 'recover' after tapping rest is derived largely from regenerated bark beneath diseased tissues. It is recommended, on the other hand, that brown bast trees be exploited on yielding bark without a tapping rest. In this connection the surgical isolation of affected bark before renewed tapping is shown to be beneficial. The value and prospects of curtailing brown bast, when it does occur, to pre-isolated panels are evaluated.

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The recommended curative treatment of the disease consists of removing all infected bark. There is no necessity to chisel out discolored wood as the studies also have shown that the fungus does not penetrate deeply into the wood.

Key words: Bark rot; Disease control; Sri Lanka

116 Petch, T (1919)

Brown bast

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(RRIM Bibliography, No.20, 1973)

Key words: Brown bast

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Indian Journal of Natural Rubber Research, 4(2): 107-113.

Ten *Hevea* clones were evaluated for growth, latex flow characters, yield and incidence of the plant disorder brown bast. Clones differed for initial rate of flow, duration of flow, plugging index, dry rubber content, girth, total volume of latex and dry rubber yield. Girth increment

126 **Ramachandran, P; Mathur, S; Francis, L; Varma, A ; Mathew, J; Mathew, N M and Sethuraj, M R (2000)**

Evidence for association of a viroid with tapping panel dryness syndrome of rubber (*Hevea brasiliensis*)

Plant Disease, 84(10): 1155

Tapping panel dryness (TPD) is one of the most destructive maladies affecting rubber plantations and is becoming a matter of serious concern. Reduced latex yield leading to total drying of the tapping panel is the obvious symptom. The cause of TPD syndrome is unknown but has been mostly attributed to abiotic causes. In India, the high yielding commercial clone RRII 105 is affected by TPD-affected trees show symptoms of bark scaling, cracking, drying, necrotic streaking, and browning of internal bark leading to the decay of internal tissues. Often prominent abnormal bulges on the lower part of tree trunks occur where the first panel begins to dry. Investigations on TPD-affected rubber samples did not reveal the association of fungus, bacterium, virus, or a protozoan. Total nucleic acid extracts purified from leaf and bark tissues of affected samples and analysed by polyacrylamide gel electrophoresis under denaturing conditions of low salt and high temperature showed the presence of nucleic acids similar in electrophoretic mobility to low molecular weight (LMW) RNA, of 359 nucleotides such as potato spindle tuber viroid (PSTVd). The LMW nucleic acid detected from TPD-affected samples was found to be RNA based on its sensitivity to RNAase and insensitivity to DNAase, phenol, and heat treatments. The LMW RNA was purified and cloned in a PUC 19-derived vector by using primers specific to PSTVd (1). The cloned DNA, when random labeled and used as probe reacted specifically to nucleic acid extracts from TPD-affected rubber trees but not from healthy tissue in dot-blot hybridization assays. Based on the above findings, a viroid etiology for TPD syndrome is proposed.

Keywords: Etiology; Gel electrophoresis; Viroid etiology; India

127 **Ramakrishnan, T S and Pillay, P N R (1963)**

Brown Bast

Rubber Board Bulletin, 7(2&3): 60-63.

The symptoms are described of a physiological disorder affecting the tapping cut and bark. Clones G1 1, BD 5, 10, CH30, CH31, AVROS255 and RRIM628 are particularly susceptible to the disorder, and high-yielding clones are more prone than low-yielding ones. When more than 10% of the plantation is affected the length of the cut and the frequency of tapping should be reduced. Affected trees should be rested for 3-6 months according to the severity of the disorder, and the damaged bark removed. Injection of copper sulphate at 6-monthly intervals into the affected trees is reported as giving some control but the response varied from tree to tree.

Key words: Brown bast; Fungicide; Rubber clones; India

on tapping and incidence of brown bast were not statistically significant. Brown bast incidence was positively correlated with total volume of latex and dry rubber yield. Positive relationships of this trait with initial rate of flow, duration of flow and dry rubber content and its negative relationships with girth increment on tapping and plugging index were not significant. It was indicated that high latex volume at the initial years of tapping contributed to occurrence of brown bast during subsequent years. Among medium to low yielding clones more interference of other factors was apparent.

Key words: Brown bast; Dry rubber content; Latex flow; Yield; India

121 **Premakumari, D; Panikkar, A O N; Sethuraj, M R and Marattukalam, J G (1997)**

Associations of structural traits: Yield, girth and occurrence of tapping panel dryness in *Hevea brasiliensis*

Indian Journal of Natural Rubber Research, 10(1&2): 27-33.

A correlation study on ten *Hevea brasiliensis* clones showed that the factors detrimental to girth increment on tapping favours the occurrence of tapping panel dryness. Laticifer area index was an exception, which has positive association with both. The number of latex vessel rows, the number of intraxylary phloem groups and total volume of latex produced together contributed to 49 per cent variation in the occurrence of tapping panel dryness of which the two structural traits alone governed 39 per cent variation. The associations of characters indicated that a very high number of latex vessel rows in high yielding clones leads to high incidence of tapping panel dryness. Hence selection based on high girth, good quantity of intraxylary phloem and balanced number of latex vessel rows is suggested for sustainable yield by reducing TPD. The two structural traits mentioned above are useful parameters for early prediction of clonal susceptibility to TPD at least to some extent. The importance of laticifer area index and number of intraxylary phloem groups as selection parameters is discussed.

Keywords: Anatomy; Clonal susceptibility; *Hevea* clones; Yield; India

122 **Premakumari, D; Sethuraj, M R; Thomas, V and Saraswathyamma, C K (1996)**

Grafting for replacement of TPD affected bark of *Hevea brasiliensis*

Indian Journal of Natural Rubber Research, 9(2): 130-136.

Tapping panel dryness is a serious problem in rubber plantations especially where high yielding clones are planted. It is considered as a physiological disorder affecting the laticiferous system, extending to the other bark tissues of the affected side and is related to the intensity of tapping. Once occurred, no remedy is suggested other than leaving the tree to rest. A novel approach, to replace the affected bark with healthy one by grafting, was tried and the observations are reported in this paper. On final observation the grafted portions in all the six trees were viable with active growth. Its surface had grown in level with that of the resting bark around. On tapping it was observed that the bark is fresh, turgid and normal for colour and latex flow while the bark in control panels were partially of totally dry. This

technique needs further refinements especially in the selection of area of the donor bark and the duration of rest after grafting before tapping the newly grafted bark.

Key words: Grafting; Tapping; India

123 **Pretillaka, S P; Yapa, P A J and Bamunuarachchi, A (1985)**

Serum protein patterns in healthy and brown bast affected trees of *Hevea*

Journal of Rubber Research Institute of Sri Lanka, 64: 7-12.

Serum protein patterns of healthy and brown bast affected *Hevea* trees of six clones viz., RRIC 7, RRIC 45, RRIC 100, RRIC 101, RRIM 600 and PB 86, were investigated. Total protein content in serum decreased noticeably in all six clones when affected by brown bast, the highest reduction being 50% in PB 86. Gel electrophoretic separation of serum proteins complemented these findings, with the disappearance of a number of bands and reduced intensity of the remaining bands. Protein content at different heights showed a high degree of reduction extending upwards from the tapping panel in clone RRIC 101 whilst in RRIM 600 it extended downward from the tapping panel. Proteins are indicative of the spread of brown bast to neighbouring tissues at varying degrees although they may not result in a noticeable change in external appearance or in latex yields.

Key words: Brown bast; RRIC clones; Serum protein; Sri Lanka

124 **Pushpadas, M V (1995)**

Brown bast disease of rubber trees

Rubber Board Bulletin, 27(2): 32-34.

Key words: Brown bast; Disease control; India

125 **Pushpadas, M V; Nair, K K; Krishnakuamari, M and Karthikakuttyamma, M (1974)**

Brown bast and nutrition: A case study

Rubber Planters' Conference India 1974, Rubber Board, Kottayam, India.

GG1 seedlings planted in 1966 in an estate in Kerala, were fertilized during its immature phase using NPK mixture having a high proportion of potassium and on a S/2. d/3 system in September, 1971, an unusually high yield, two to three times the normal, was obtained and late-dripping was also noticed. Within a few months, incidence of brown bast became evident. It would appear from the manurial history and the results of analysis of soil, leaf and latex samples that unbalanced nutrition of the tree may be responsible for the unhealthy symptoms. The study shows that high intensity of tapping or frequency of the wounding process per se is not the cause of the type of brown bast observed in the estate. The process of long duration of flow or withdrawal of a large quantity of latex resulting in the loss of a critical quantity of materials from the trees in a relatively short period appears to be a pre-condition for the development of this type of brown bast.

Key words: Brown bast; Nutrition; India

128 **Rands, R D(1919)**

Brown bast disease of *Hevea brasiliensis*: Preliminary account

Archief Voor De Rubbercultuur, 3:156-157.

(RRIM Bibliography, No. 20, 1973.)

Key words: Brown bast

129 **Rands, R D (1921)**

Brown bast disease of plantation rubber: Its cause and prevention

Review of Applied Mycology, 1:137-140

Brown bast diseased trees are often being characterized by irregular overgrowths known as 'burrs'.The severity of the disease in the East Indies and Federated Malay States has led to much investigation. Brown bast disease is generally easily recognized by a partial or complete dryness of the tapping cut accompanied by a grayish to greenish-brown discoloration in the middle and inner bark.

Key words: Brown bast; East Indies

130 **Rands, R D (1921)**

Histological studies on the brown bast disease of plantation rubber

Meded Inst. Voor Plantenziekten, 49:27.

(*Review of Applied Mycology*, 1:1922. 140-142.)

The results of studies conducted on the disease shows that this is a non-parasitic trouble caused by certain methods of tappings . It is concluded that the disease known as brown bast is very probably only an abnormal and extreme type of wound response, and that this abnormality occurs apparently because of the nature of the wounding to which *Hevea* is subjected in the process of tapping.

Key words: Brown bast; East Indies

131 **Rao, B S (1975)**

Brown bast

In: *Maladies of Hevea in Malaysia*,. Rubber Research Institute of Malaysia, Kuala Lumpur, Malaysia, pp.73-74.

Key words: Brown bast; Malaysia

132 **Ratnayake, C M B (1973)**

An assay of growth inhibitors in seed oil and normal and diseased (brown bast) bark of *Hevea*.

Quarterly Journal Rubber Research Institute of Sri Lanka, 50: 1-2, 19-27.

Mikania stem apices and coreopsis flower stalks were shown to be acceptable substitutes for

oats in the coleoptile test; both these materials were used to test the growth substances present in rubber seed oil, normal bark and brown bast-diseased bark. The concentrations of growth-promoting substances in normal and diseased bark were similar, but those of inhibitors were greater in diseased bark. The concentrations of inhibitors in the seed oil were higher than those in bark. Content of growth inhibitors was significantly higher in diseased than in healthy rubber bark but it is not yet established that the increase causes the disease. High yielding clones are generally more susceptible to brown bast and may have susceptibility bred into them.

Key words: Brown bast; Growth inhibitors; Sri Lanka

133 **Rejithkumar, S L** (2003)

Studies on the occurrence of tapping panel dryness (TPD) in clone RRII 105 in rubber smallholdings

Dissertation, M.Sc. Plantation Development, University of Calicut, Kerala, India, 53p.

Key words: RRII 105; Smallholdings; India

134 **Rhodes, E** (1930)

Brown bast: Some consideration as to its nature

Quarterly Journal of Rubber Research Institute of Malaya, 2(1): 1-11.

Key words: Brown bast

135 **Ribaillier, D** (1967)

Some comments on an experience with experimental brown bast. (French)

IRCA Report, 2.

(IRRDB Bibliography on Physiology, Biochemistry and Exploitation of *Hevea brasiliensis,* 1985, No.416)

Key words: Brown bast

136 **Ribaillier, D** (1967)

Preliminary study of experimental brown bast (French)

IRCA Report, 3.

(IRRDB Bibliography on Physiology, Biochemistry and Exploitation of *Hevea brasiliensis,* 1985, No.417)

Key words: Brown bast

137 **Richards, R M** (1919)

Brown bast: The treatment of affected *Hevea* trees

Tropical Agriculturist, 53:192-196.

Key words: Brown bast; Treatment

138 **Samaranayake, C and Yapa, P A J** (1989)

Studies on brown bast in Sri Lanka

Proceedings of the IRRDB Workshop on Tree dryness, 26-27 June1989, Penang, Malaysia, pp.33-36.

This report reviews briefly the studies done in Sri Lanka on various aspects of brown bast. Early studies were aimed at ascertaining whether the spread of the disease could be curtailed and the trees could be exploited on unaffected bark. Investigations have also been carried out at the RRISL laboratories on the possible involvement of a water stress situation in brown bast. After decades of investigation the problem of panel dryness still remains unsolved.

Key words: Brown Bast; Status report; Sri Lanka

139 **Sanderson, A R** (1923)

Brown bast

Review of Applied Mycology, 2:178-179.

Key words: Brown bast

140 **Sanderson, A R and Sutcliffe, H** (1921)

Brown bast: An investigation into its causes and methods of treatment. The Rubber Growers' Association, London. 71p

The book gives a full description of the characters of the bark in *Hevea* when affected with the brown bast disease.

Key words: Bark characters; Brown bast

141 **Sankariammal, L and Saraswathyamma, C K** (2004)

Cytopalynological investigations in tapping panel dryness affected trees of *Hevea brasiliensis* (Muell. Arg)

Indian Journal of Genetics and Plant Breeding, 64 (2): 171-172.

Keywords: Cytopalynology; India

142 **Schreurs, J** (1969)

Difolatan, a promising fungicide for control of the tapping panel disease black thread in *Hevea brasiliensis*

Neth. Journal of Plant Pathology. 75(1/2): 113-118.

(Agricola 1970-1978)

Key words: Black thread; Fungicide; Panel diseases

143 **Schweizer, J** (1949)

Brown bast disease

Archief Voor De rubbercultuur, 26(5): 385-397.

Key words: Brown bast

144 **Sethuraj, M R** (1974)

Brown bast incidence and tapping

In: *Lecture notes for short-term training course on Rubber cultivation, Processing and Estate Management. Rubber Research Institute of India*, Kottayam, India.

Key words: Brown bast; Tapping; India

145 **Sethuraj, M R** (1988)

A conceptual analysis of the brown bast syndrome

Colloque Hevea 2-7 November 1988, Montpellier Cedex, Paris.

Key words: Brown bast; India

146 **Sethuraj, M R** (1989)

Present status of investigations in the Rubber Research Institute of India on panel dryness syndrome

Proceeding of the IRRDB Workshop on Tree Dryness, 26-27 June 1989, Penang, Malaysia, pp.37-40.

The conceptual development in the physiology of panel dryness incidence has been slow in spite of decades of research in this field by different research institutes. No causative organism could so far be identified and the pattern of distribution of dry trees in a field perhaps discounts such a possibility. The sequence of events that leads to panel dryness also seems to vary under different situations. The usually observed late dripping phenomenon prior to the onset of dryness is also not universally observed. There are reports that sometimes trees go dry abruptly without any such late dripping phase. The situation is more confusing by reports, though

rare, of the occurrence of similar dry syndrome in trees which are not even opened for tapping. Many biochemical theories propounded are related to destruction of membrane stability of lutoid particles. There are two common notions originated from the long experience of planters: (a) the higher the tapping intensity the higher will be the incidence of brown bast, and (b) there is variation in clonal susceptibility. These two aspects have been experimentally validated by the cause for the incidence of this syndrome within a population of the same clone under the same system of tapping is still an enigma. Recognizing the problems encountered in this area of research, the Rubber Research Institute of India (RRII) has resorted to a multi-disciplinary approach.

Key words: Clonal susceptibility; Panel dryness; Status report; Tapping intensity; India

147 Sethuraj, M R (1992)

Proposals for the International network research programme on tapping panel dryness

Proceedings of the IRRDB Joint Meeting: Breeders, Pathology, Physiology and Exploitation Groups, 27-28 October 1992, Jakarta, pp.77-98.

Tapping panel dryness (TPD) is often known as brown bast. TPD symptoms range from partial dryness with no browning of the tapping cut, browning and thickening of the bark to cracking and deformation of the bark in some instances.. The syndrome is characterized by the appearance of tylosoids and the coagulation of latex *in situ*, abnormal behaviour of parenchyma cells adjoining the laticifers and a general increase in synthesis of polyphenols. The syndrome has become more serious with the development of modern higher yielding clones such that significant numbers of trees (15-20%) are affected leading to serious losses of production. A co-ordinated international research programme has been proposed to ascertain the cause of the syndrome. The paper discusses the current available information on the potential causes such as an organism and soil, climatic and clonal effects. It goes on to describe the various biological and physiological changes that occur during the different stages of the syndrome.

Keywords: International network research; Soil climate

148 Sethuraj, M R; Nair, N U; George, M J and Mani, K T (1977)

Physiology of latex flow in *Hevea brasiliensis* as influenced by intensive tapping

Journal of the Rubber Research Institute of Sri Lanka, 54: 221-226.

The study was conducted to analyse the effect of intensive tapping on latex flow. The results indicate that intensive tapping reduces initial rate of flow, turgor pressure and dilution reaction. No influence of intensive tapping on lutoid stability during the initial period of intensive tapping was observed. The fall in yield following intensive tapping could be accounted to a large extent to a fall in the initial flow rate.

Key words: Intensive tapping; Latex flow; India

149 **Sethuraj, M R and Raghavendra, A S** (1987)

Rubber

In: *Tree Crop Physiology* (Eds. Sethuraj M R and Raghavendra, A S). Elsevier, Amsterdam, The Netherlands, pp. 216-218.

Key words: Brown bast

150 **Sharples, A** (1922)

Consideration of recent work on the Brown bast problem

Malayan Agricultural Journal, 10(6):155-170.

The author gives a comparative resume of the work done contemporaneously; by the committee in Malaya and Rands in Java. A large number of different organisms were isolated form tissues of *Hevea* affected with brown bast and are listed . The paper also includes a short review of the methods of prevention and treatment of brown bast advocated in Malaya and elsewhere, and a consideration of the histological features of diseased tissues in which the opinion is expressed that too much importance has been assigned to the phloem changes.

Key words: Brown bast; Histology; Phloem change; Treatment; Malaya

151 **Sharples, A** (1925)

Brown bast disease of rubber trees

Tropical Agriculturist, 64: 323-328.

(RRIM Bibliography, No.20, 1973.)

The observations of four years experiments on brown bast disease of *Hevea brasiliensis* was summarized. The results have led him to maintain the position that the disease is purely physiological in origin, depending mainly on the water relations of the tissues of the host.

Key words: Brown bast; Water relations

152 **Sharples, A** (1936)

Brown bast

In: *Diseases and Pests of the Rubber Tree*, MacMillan and Co., Limited, London. pp.229-265.

Key words: Brown bast; Causative agent; Disease control

153 **Sharples, A and Lambourne, L** (1923)

A preliminary report on brown bast experiments in Malaya

Malayan Agricultural Journal, 11(2): 30-35.

The results of the first series of field experiments on the production of brown bast in Malaya indicated that the systems of tapping rubber trees in common use were not sufficiently drastic

for the purpose of comparative tests, a single daily cut on a quarter or half the tree not producing enough brown bast to lead to any definite conclusions.

Key words: Brown bast; Malaya

154 **Sharples, A and Lambourne, J** (1924)

Field experiments relating to brown bast disease of *Hevea brasisliensis*

Malayan Agricultural Jounal, 12(9&10): 290-343.

The results of investigations on the brown bast disease of rubber from 1920 to 1922 are described. The salient features of the experiments have already been published, but the present paper contains numerous additional details on the various tapping methods and their effect on the incidence of brown bast and the yield of the trees, together with much statistical information and a general survey of the present status of the problem. The results of the author's work are regarded as giving little support to the theory of Keuchenius as to the bacterial origin of the disease, or for Horne's phloem necrosis explanation. The withdrawal of excessive amounts of latex appears to be of primary importance in the causation of brown bast, while wounding during tapping operations platys a negligible part.

Key words: Brown bast; Malaysia

155 **Shyma, E B** (2004)

Rhizosphere microflora and soil properties of *Hevea* in relation to tapping panel dryness (TPD)

A project report for M.Sc Microbiology, School of Life Sciences, Kannur University of Kerala, India, 27p.

Key words: Rhizoshere microflora; Soil properties; India

156 **Siswanto** (1994)

Physiological mechanism related to latex production of *Hevea brasiliensis*

Buletin-Bioteknologi-Perkebunan., 1(1): 23-29.

The two factors which limit latex production, i.e. latex flow and in situ regeneration are discussed. Lutoids play an important role in stopping latex flow after tapping. The regeneration of latex between tappings is controlled by the pH, ion composition and biochemical energy in the laticifers. Latex diagnosis using physiological parameters such as pH, bursting index, sucrose, total solids, plugging index, thiol and Mg2+ content is important for the determination of potential production. The imbalance between latex regeneration and production may cause the important physiological disorder tapping panel dryness (TPD). The degradation of membrane lutoids by toxic forms of oxygen may be the major cause of TPD.

Key words: Latex diagnosis; Latex flow; Physiological parameters; Indonesia

157 **Siswanto** (1997)

Dryness syndrome, spreading and control of tapping panel dryness in suggested clone of rubber trees

Warta Pusat Penelitian Bioteknolog Perkebunan, 3(1): 2-15.

(HORTCD 1989-2001/09)

Tapping panel dryness (TPD) syndrome occurs when latex coagulates in a tapping panel a few min after tapping. Sometimes this syndrome is indicated by brown-coloured bark. A method to control TPD using bark scraping and application of NoBB (a mixture of plant growth regulators), in *Hevea* clones PR 261 (9-years-old) and WR 101 (17 years old) was investigated in Bogor, Indonesia, in 1994. Bark scraping was done by removing bark from infected panels using a tap knife to 1.5 mm from the cambium. NoBB (50 ml/application or 150 ml/tree in 3 applications to a 100-cm-long tapping panel 0, 30 and 60 days after bark scrapping) was applied to the panel for bark recovery. One year after treatment, PR 261 exhibited 94% recovery, with thickness of recovered bark of 4.4 mm and latex production/tapping of 31.1 g/tree. Respective values for WR 101 were 86% recovery, bark thickness of 5.3 mm and latex production/tapping of 47.2 g/tree. A second experiment was carried out in Cikasungka and Cimulang, West Java, Indonesia, using clones PR 300, PR 303, RRIM 600, GT1 and GYT 577. Results showed that 80-85% of TPD-infected trees recovered after treatment with bark scraping + NoBB, with an average latex production/tapping of 24-44 g/tree. It was concluded that *Hevea* trees infected with TPD did not necessarily have to be rested.

Key words: Dryness syndrome; *Hevea* clones; Tapping panel dryness control; Indonesia

158 **Siswanto** (1998)

Hen egg-yolk antibody for detection of protein markers of tapping panel dryness in rubber trees

Menara Perkebunan(Indonesia), 66(1): 20-28.

(AGRIS 1999-2002/12)

Yield loss due to tapping panel dryness (TPD) in rubber plantations is economically important because there is no latex flow when the trees are tapped. The development of tools for early detection of TPD incidence is necessary for preventing his physiological disorder. The purpose of the present work was to identify and characterize the changes of protein expression in latex C-serum associated with TPD incidence and to produce the IgY antibodies which could be applied for early detection of TPD in rubber trees. The protein banding patterns of latex C-serum of four clone from healthy trees were compared with those of TPD trees either by two-dimensional (2-D) or SDS-PAGE electrophoresis on polyacrylamide gel. Polyclonal antibodies (IgY) produced in egg yolk of laying hen were prepared against C-serum protein of noraml trees and used for ELISA and immunobloting detection. Native-IEF and 2-D electrophoresis analysis of latex C-serum revealed the existence of several differential protein expression between normal and TPD trees. Three specific proteins observed only in the C-serum of normal trees

were 40 kDa (pI 5.1), 20 kDa (pT 4.2), and 29 kDa (pI 4.6). An indirect-ELISA showed that IgY antibody produced in egg-yolk of laying hens was more reactive against C-serum of normal trees that TPD trees, suggesting that this IgY could be used for early detection of TPD incidence. As observed in SDS-PAGE protein blots, IgY reacted specifically with single protein at 66 kDa and interestingly in native IEF reacted with two protein bands at pI 5.1 and 5.3 of latex C-serum of normal trees but did not react with proteins of TPD trees.

Keywords: Egg-yolk antibody; Protein markers; SDS-PAGE; 2-D electrophoresis; ELISA; Immunoblotting

159 **Siswanto and Darussamin, A** (1995)

Detection and treatment of tapping panel dryness (TPD) in rubber plantation

Warta Pusat Penelitian Bioteknologi Perkebunan, 1(1): 10-14.

Tapping panel dryness (TPD) causes losses of about $68 million per year to the rubber industry in Indonesia. In this study, TPD was detected (during the harvest period) by pre coagulation on the harvest line. Resting the affected plants for a while did not have any great beneficial effect. The most effective treatment was to scrub the trunk and remove the affected skin. To avoid fungal infection, a mixture of palm oil and fungicide (95:5) was spread over the wound then harvesting was suspended for 2 weeks. This method was found to be effective for clone WR101. The highest percentage of cured plants was obtained with the addition of KCl fertilizer at 1.5 times the recommended dose or 250g/plant, twice a year. TPD diagnosis can be advanced by 3-4 weeks by detecting a reduction in the sucrose concentration and an increase in the phosphate ion concentration in the latex. Blocking index and flow rate also increased during the 4 weeks before TPD was noticed.

Keywords: Fungicide; TPDcontrol

160 **Siswanto and Firmansyah** (1989)

Attempts to control bark dryness in rubber plants

Proceedings of the IRRDB workshop on Tree dryness, 26-27 June 1989, Penang, Malaysia. pp 90-100.

Bark dryness is a common disease in small holder rubber plantations in Indonesia. Yield loss due to this disease is very important since the panel bark of the rubber plants produces no latex. An experiment on how to overcome brown bast disease has been conducted on WR 101 in Sembawa experimental garden since November 1985. In this experiment the following treatments were compared: isolation; scraping and application of mixtures of oil palm and fungicide; isolation, scraping and application of ethephon; isolation and scraping only; isolation, scraping and addition of KCl; and resting. Results show that resting the rubber plants suffering from bark dryness is not effective, as the recovery is only about 15% with relative recovery intensity of 30% and latex yield of 31.1 ml/tree/tapping after twenty-one months of rest. Isolation and scraping are effective for overcoming the spread of bark dryness, and 65%-85% of the plants recovered from the disease. The renewal bark became normal with relative recovery

intensity of 65.5%-79.5% and latex yield of 73.9-111.6 ml/tree/tapping. Besides, by making a new groove the rubber plants did not need a resting time and could be tapped as usual, producing 64.5 kg/tree/year/farmer. Palm oil, ethephon and potassium fertilizer did not increase renewal bark thickness. Latex volume and velocity of latex flow could be used as parameters to estimate bark dryness intensity with a coefficient of determination of about 93%. Loss of smallholder rubber yields in Indonesia as a result of resting plants suffering form bark dryness is estimated to cost 140.4 billion rupiahs per year.

Key words: Bark dryness; Smallholdings; Yield; Indonesia

161 **Siswanto; Suharyanto and Darussamin, A** (1997)

Immunological detection of specific protein from latex C-serum in relation to tapping panel dryness disorder in *Hevea brasiliensis*

Proceedings of the Indonesian Biotechnology Conference, 1997, vol.2. Bogor, Indonesia, pp.689-698.

(Agris 1999-2002/12)

In rubber plantations, the incidence of Tapping Panel Dryness (TPD), which is normally caused by over exploitation or over stimulation can attain to 30 percent. In Indonesia, latex production losses due to TPD attack has attributed to 140 billions/year. To develop a diagnostics tool for early detection of TPD, a research has been conducted to produce a specific egg yolk antibody (IgY). An antibody for TPD detection was developed by immunizing chickens using protein extracts of normal bark trees. Using I-ELISA test, the anti normal bark tree (Ab-N5) antibody was strongly reacted against latex C-serum of normal trees but reacted weakly against TPD infected trees. However, this antibody was not so specific if tested using samples from lutoid and bark protein of normal and TPD trees. The binding sites of Ab-N5 was against protein of C-serum with MW 66 kDa. This protein was disappeared when the trees was infected with TPD. The purification of this protein using sephacryl S-200 HR gel for further characterization and the development of monoclonal antibody has being investigated. The successful treatment of TPD using bark scraping and added with growth regulators were also discussed.

Key words: Bark scraping; ELISA; Growth regulators; Indonesia

162 **Sivakumaran, S; Chew, O K and Gan, L T** (1986)

Incidence and development of dryness in some modern *Hevea* cultivars

Proceedings of RRIM Growers' Conference, 1986, Ipoh, Malaysia,. 104-128.

The susceptibility of clones PB 260 and PB 235 to dryness is greater than other popular clones particularly when planted in certain environments. High levels of dryness have been recorded during the initial years of tapping on Panel BO-1. The development of dryness and its spread on base panels of trees of these two clones are very rapid, extensive and deep seated with latex vessels close to the cambium being affected soon after inception of partial dryness on the tapping cut. The tapping cuts opened at 152.4 cm on Panel BO-2 may be yielding

though the base of the panel is affected but the entire panel becomes dry within twelve months of opening these panels for tapping. The high panels are initially free from dryness and can be exploited although in some trees, dryness developed on upward cuts after six months of tapping. The two types of bark discoloration observed in dry trees of these two clones are described and explained. The mode, pattern and spread of dryness and inherent latex instability suggest, as described for other clones, that dryness is a physiological disorder associated with latex vessels. The failure to isolate pathogens or mycoplasma confirms that the disorder is non-pathological. The pre-isolation technique has not been fully effective in preventing spread of dryness from Panel BO-1 to Panel BO-2. The causal factors for its failure have been investigated and possible modification discussed. This technique could be considered as a precautionary method if implemented effectively. It is necessary to adopt low intensity exploitation methods for these clones and to carry out post-tapping isolation in dry trees to enable continued exploitation of non-dry areas on the panel.

Key words: Bark dryness; *Hevea* clones; Low intensity exploitation; Post-tapping isolation

163 **Sivakumaran, S; Ghandimathi,H; Hamzah, Z; Yeang, H Y and Hamzah, S**(1997)

Studies on physiological and nutritional aspects in relation to TPD development in clone PB 260

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 1997 Hainan, China. pp.63-76.

The changes in several physiological and nutritional parameters have been investigated in relation to the natural development of tapping panel dryness in trees of clone PB 260. These various parameters have been routinely monitored on sixty core trees ate specified frequencies over a period of twenty-three months. Dryness developed in several trees irrespective of differences in initial inherent yields. As expected, yields declined significantly in all dry trees. Plugging index measurements did not show differences between normal and dry trees. Among the several physiological parameters studied, it has been established that significant differences between dry trees and normal trees were only recorded for four parameters, viz. percentage bottom fraction, inorganic phosphorus, proline and magnesium. However, detailed examination of data did not show any consistent patterns or trends when attempting to establish possible abnormal changes in these parameters during periods preceding the onset of partial dryness on the cut in affected trees. The changes in concentration of macro- and micro-nutrients in both latex and bark tissues did not show marked differences between normal and dry trees apart from the possible exception of latex copper which recorded higher concentrations prior to the onset of dryness in affected trees. Significant increases in the amount of tylosis in latex vessels of dry trees were also recorded relative to that in normal trees. These studies have identified four latex physiological parameters, namely, percentage bottom fraction, inorganic phosphorus, proline and magnesium, which may be implicated in dryness development in trees of clone PB 260. These, together with some micronutrients such as latex copper, merit further detailed and intensive investigations, possibly including measurements of these parameters carried out at each tapping. It is likely that the date generated from such studies with a higher degree of sensitivity might enable detection of critical changes in these parameters, well before the onset of dryness on the tapping cut of affected trees. If this could be achieved,

then it is likely that these parameters could be used as early warning indicators of impending dryness in *Hevea* trees.

Key words: Bottom fraction; Inorganic phosphorous; Physiological parameters

164 **Sivakumaran, S; Ghandimathi, H; Hamzah, Z; Yusof, F; Hamzah, S and Yeang, H Y** (2002)

Physiological and nutritional aspects in relation to the spontaneous development of tapping panel dryness in clone PB 260

Journal of Rubber Research, 5 (3): 135-156.

The changes in several physiological and nutritional parameters were investigated in relation to the spontaneous development of tapping panel dryness in clone PB 260. These parameters were monitored at regular intervals on sixty core trees over a period of twenty-three months. Dryness developed in several trees irrespective of their initial latex yield. Among the latex physiological parameters studied, significant differences between dry and normal trees were recorded for the four parameters studied, significant differences between dry and normal trees were recorded for four parameters viz, bottom fraction volume, inorganic phosphorus, proline and free magnesium. However, detailed examination of these parameters preceding onset of partial dryness on the cut in affected trees did not show any distinct pattern or trend that could serve as a consistent and reliable early warning of the impending onset of dryness. Changes in the concentration of macro-and micro-nutrients in both latex and bark tissue did not show marked differences between normal and dry trees, but a significant increase in tylosis was recorded in latex vessels of dry trees.

Key words: Bottom fraction; Inorganic phosphorus; Latex; Macro-nutrients; Micro-nutrients; Physiological parameters

165 **Sivakumaran, S and Haridas, G** (1989)

Incidence of tree dryness in precocious high-yielding clones

Proceedings of the IRRDB workshop on Tree dryness, 26-27 June 1989, Penang, Malaysia.1-19.

Additional studies have confirmed previous reports that the incidence of dryness on *Panel BO-1* in susceptible clones is both severe and extensive. It is now increasingly evident that dryness development in both PB clones (PB 260 and PB 235) is enhanced when they are planted in agroclimatically dry regions of the country and that incidence of dryness is higher on poorer or Class IV soils. Data available seem to suggest that there is no relationship between levels of dryness recorded in both the PB clones and the amount of crop extracted or frequency of tapping. It is also apparent from case studies of selected estates in various agroclimatic regions, with low and high incidences of dryness, that variations in most other factors such as topography of field, type of planting materials used, mode of planting, etc. cannot account for the marked differences in dryness. The propensity for fresh dryness development on the second panel of tapping is evident in trees, which have survived without dryness on *Panel BO-1* in older planting in several areas. This would imply that dryness could continue to be a problem in susceptible clones throughout their economic life. The rapid development of dryness on *Panel BO-2* in the majority of trees which were previously dry on *Panel BO-1* within the

first twelve months of tapping suggests that unless there are effective methods to check spread of dryness, most trees will be unsuitable for further exploitation once dryness develops on *Panel BO-1*. This paper reviews the pre- and post-tapping control methods currently recommended and discusses the need for their modifications. It is now known that a single pre-isolation at the commencement of tapping is not fully effective and that there is a need to consider repeat isolation annually. Data are presented to show that the post-tapping control methods by isolation cuts may not be suitable for both the PB clones, in view of the rapidity of development and spread of dryness in these clones. The paper also discusses the likely mode of dryness development in both the susceptible clones in the light of known research findings. Further areas of research that need to be carried out to provide solutions and clarifications to several unsolved aspects of tree dryness are also identified.

Key words: High yielding clones; Pre-tapping control; Post-tapping control; Tree dryness control

166 **Sivakumaran, S; Haridas, G and Abraham, P D(1988)**

Problem of tree dryness with high yielding precocious clones and methods to exploit such clones

Colloque Hevea 2-7 November 1988, Montpellier Cedex, Paris, pp.253-267.

Key words: Tree dryness; High yielding clones

167 **Sivakumaran, S; Leong, S K; Ghouse, M; Ng, A P and Sivanadyan, K** (1994)

Influence of some agronomic practices on tapping panel dryness in *Hevea* trees

IRRDB TPD Workshop, 26-28 July 1994, Hainan, China.

The effects of some selected agronomic practices on incidence of tapping panel dryness have been investigated in several field trials. In particular, the effect of high density planting, influence of rootstock on dryness development in the scion and effects of application of increased levels of potassium on tapping panel dryness have been examined, primarily to identify practices which could help curtail or reduce effects of occurrence of tree dryness. Data presented will show that there was no significant increase in incidence of dryness with higher densities of planting both in susceptible and non-susceptible clones. The absence of an increase in incidence for precocious yielding clones (PB 260, PB 235), while ensuring higher yield productivity with higher density of planting, would imply that this could be a practical approach to tackle certain levels of dryness normally associated with these clones in the early years of tapping. Similarly it is apparent that rootstocks have had minimal effect on dryness incidence in the scion irrespective of the latter's variation in susceptibility to dryness. This was true of both good and poor rootstocks. However, irrespective of rootstock, scions with known propensity to dryness had significantly higher levels of dryness than that of non-susceptible scions. The effects of rootstocks on yields of scions were not very consistent. The application of higher levels of potassium had enabled significant reduction in dryness incidence when compared with application of reduced rates.. However, the positive effects were only noted in locations that are agroclimatically dry and on poor latiritic soils. There were no effects of dryness

incidence in a similar trial located in an agroclimatically wet region with better soils. The significance of the above findings are discussed in relation to tapping panel dryness and the need for additional investigations prior to firm conclusions are indicated for certain aspects highlighted in this paper. It is apparent that adoption of appropriated combinations of various agronomic practices could help reduce dryness incidence and maintain normal levels of yield productivity.

Key words: Rootstock; Scion; Tree dryness control

168 **Sivakumaran, S and Pakianathan, S W** (1983)

Studies on tree dryness: I. A simple and rapid method of inducing dryness in *Hevea* trees

Journal of Rubber Research Institute of Malaysia, 31(2): 88-101.

This method of inducing dryness in *Hevea* trees involves puncture of the bark at four or five points along vertical strips on the panel before and after conventional tapping and sealing the punctures with drawing pins. This procedure is repeated at weekly or fortnightly intervals with fresh punctures made below the preceding ones. This technique has been shown to be effective for inducing dryness in a wide range of *Hevea* cultivars. However there are differences in the rate at which dryness is induced on virgin and renewed bark of a given cultivar. This technique of inducing dryness in trees under normal intensities of tapping may be a more promising method of studying changes in physiological parameters that may be associated with onset and development of dryness in *Hevea* trees than that based on very intensive methods of tapping. This paper also discusses changes in other related parameters such as yield, initial flow rate and dry rubber content in trees subjected to this technique. Further studies are in progress to establish if any of these could be developed as an early warning signal of impending dryness in *Hevea* trees.

Key words: Bark puncture; Dry rubber content; Latex flow; Tree dryness

169 **Siwei Fan, and Yang Shaoqiong** (1984)

Cause of brown bast and its hypothesis of *Hevea*

Chinese Journal of Tropical Crops Research, 4: 43-48.

(The planter, 66;1990:280)

Key words: Brown bast; Causal agent; China

170 **Siwei Fan and Yang Shaoqiong** (1991)

Concept, hypothesis and causative mechanisms of *Hevea* bark dryness

Chinese Journal of Tropical Crops Research, 2: 73-80

(IRRDB TPD workshop, 1994.)

Key words: Bark dryness; Causative agent; China

171 **Siwei Fan and Yang Shaoqiong** (1994)

Special and localized senescence disease bark dryness due to over-exploitation and over-drainage

IRRDB Tapping Panel Dryness Workshop, 26-28 July 1994 , Hainan, China.

This paper compares in a static way the contents of antioxidants and total phenols, activity of peroxidase, cathepsin and acid phosphatase as well as lutoid bursting index of latex or bark tissues from *Hevea* rubber trees with dryness of different severity. Based on the findings on these physiological and biochemical changes, the authors suggest that the physiological dryness of *Hevea* due to over-exploitation and over-extraction of latex, is a special and localized senescence malady in nature.

Key words: Over exploitation; Physiological changes; China

172 **Siwei Fan and Yang Shaoqiong** (1995)

Tapping panel dryness induced by excessive tapping is a local senescence phenomena

Chinese Journal of Tropical Crop Research, 19:15-22.

Key words: Over exploitation; China

173 **Sobhana, P; Thomas, M; Krishnakumar, R; Saha, T; Sreena, A S and Jacob, J** (1999)

Can differences in the genetics between the root stock and scion lead to tapping panel dryness syndrome ?

Proceedings of IRRDB Symposium 1999, Hainan, Peoples' Republic of China(Eds. Chen Quibo and Zhou Jiannan). Hainan Publishing House, China, pp.331-336.

In this study, the authors tested a novel hypothesis that a greater genetic distance between rootstock and scion may interfere with the physiology of the scion, eventually leading to symptoms of delayed incompatibility between them culminating in a physiological disorder like tapping panel dryness syndrome(TPD) in *Hevea brasiliensis*. This was addressed by subjecting the bark tissues from rootstock and scion portions of healthy and fully TPD affected trees to isozyme and RAPD analyses. As expected the RAPD profiles indicated perfect genetic homogeneity between the scion tissues(genetic distance=0) because all the scion samples came from the same clone, GT1. The genetic distance among the rootstock tissues (which were grown from heterozygous seeds) ranged from 7-39%. The isozyme profile of the enzyme peroxidase showed variability among the genetically homozygous scion tissues as well as the heterozygous rootstock tissues, indicating an influence of rootstock on the scion. While the changes in the RAPD profiles between two trees could be attributed to true genetic differences, the same cannot be said with reference to enzyme polymorphism which is more related to gene expression that could be influenced as much by the environment as the plant's genetics. The RAPD profiles indicated that the genetic distance between rootstock and scion tissues was higher in the TPD affected than healthy trees. The implications of this observation in various aspects of Plant Biology are discussed.

Keywords: Bud grafting; Genetic distance; Rootstock; Scion; India

174 **Soepena, H (1992)**

Bark necrosis relating to tapping panel dryness

Proceedings of the IRRDB joint meeting Breeders, Pathology and Physiology and Exploitation Groups, 27-28 October 1992, Jakarta,. pp.72-76.

Tapping panel dryness is caused by Brown Bast (BB) and Bark Necrosis(BN) diseases. BB is described as a physiological disease whilst BN is caused by fungi. BN is claimed to be the cause of 60% of TPD. BN has recently become a serious disease on rubber. The disease which causes bark decay may destroy the whole bark of the trunk. The decaying bark produces a specific smell which attracts some species of bark borer insects especially *Xyleborns mascarensis* and *Platypus capulatus* which normally live in decaying trunks or logs. The insects transmit wood decaying fungi such as *Ustulina deusta* (Hoffm.) Lind or *Phelimus noxius* Corner as secondary pathogens which cause the death of trees. The primary cause of BN is still unclear but *Fusarium culmorum* (Smith) Sace and *Fusarium sp.* associated with *Botryodeploida sp.* is usually found on infected bark. The proportion of infected trees can reach 70% or more of the stands and reduce latex production by up to 58%. The disease can be cured with fungicide treatments especially with catafol or tidemorf. A single treatment of Calixin RM has healed 90% of infected plants.

Keywords: Bark Necrosis; Bark borer insects; Brown Bast; Fungicide

175 **Sookmark, U; Pujade-Renaud, V; Chrestin, H; Lacrotte, R; Natyanetr, C; Seguin, M; Romruensukharom, P and Narangajavana, J (2002)**

Characterization of Polypeptides accumulated in the latex cytosol of rubber trees affected by the tapping panel dryness syndrome

Plant Cell & Physiology, 43(11): 1323-1333.

The tapping panel dryness (TPD) syndrome of rubber is characterized by the reduction or ultimately total cessation of latex flow upon tapping, due to physiological disorders in the bark tissue. The protein pattern in the cytoplasm from healthy and TPD tree latex cells was compared by electrophoresis. Two polypeptides (P15 and P22) of 15 and 22kDa, respectively, were found to accumulate in the cytosol of the TPD-affected trees, whereas a 29 kDa polypeptide (P29) appeared de novo, P15 and P22 were identified as REF (Hev bl) and SRPP (Hev b3), respectively, two proteins proposed to be involved in rubber biosynthesis. P29 appeared to be a new member of the patatin-like protein family. Specific molecular probes were designed for a detailed characterization of REF and SRPP gene expression and RFLP mapping. This allowed the demonstration that REF and SRPP display very similar expression profiles. They are highly over-expressed by the tapping-induced metabolic activation, although not by wounding perse, or ethylene or ABA. In addition to this similarity in gene expression, they were found to share one common locus in the genome. No significant difference in REF and SRPP gene expression was observed between healthy and TPD trees, indicating that their TPD- related accumulation in the cytosol was not transcriptionally regulated. Western blot analysis demonstrated that osmotic lysis of the sedimentable organelles (lutoids) *in vitro* caused the release of REF and SRPP from the rubber particle

membrane into the cytosol. A mechanism of cellular delocalization as a consequence of the lutoids instability is proposed to explain REF and SRPP accumulation in the cytosol of TPD trees.

Key words: Cellular decompartmentalization; Ethylene; Latex

176 **Sukonrot, W** (1989)

Status report on panel dryness in Thailand

Proceedings of the IRRDB Workshop on Tree dryness, 26-27 June, 1989, Penang, Malaysia, pp.41.

Research on tapping panel dryness has never been carried out in Thailand. Many of the reports on tapping experiments showed a very high dryness incidence of up to 33% in the 1/3S d/2 system used by most smallholders in Thailand. Rubber trees are introduced to the new planting area in the north-east. Observations on about eighty tapping trees per clone on $^1/_2$ S d/2 after five tapping years at Nong Khai Province showed that the incidence of dryness in GT1 and RRIM 600 was 24% and 8% respectively. Tapping panel dryness in Thailand is not less than any in other countries. Research in this area will be undertaken and hopefully there will be some reports in the next meeting.

Key words: Status report; Thailand

177 **Sulochanamma, S; Thomas, K U and Vijayakumar, K R** (1988)

Effects of different exploitation systems on yield and brown bast incidence in RRII 105, a high yielding clone during BO-1 Panel stage

Placrosym VIII, 1988, Cochin, India. *Journal of Plantation Crops*, 18 (Supplement), pp. 342-345.

Key words: Brown bast; Exploitation; RRII 105; Yield; India

178 **Sulochanamma, S; Vijayakumar, K R; Rajasekharan, P; Thomas, K U and Sethuraj, M R** (1992)

Yield performance and tapping panel dryness (TPD) in RRII 105 under different intensities of exploitation

Placrosym X, 1992, Kasaragod, India. *Journal of Plantation Crops*, 21 (Supplement): pp.342-345.

The yield of rubber (*Hevea brasiliensis*) depends on the duration of flow at tapping and on the regeneration of latex between two tappings. Tapping panel dryness (TPD), a physiological disorder increases with tapping intensity and frequency. However, this incidence might be reduced by changing tapping system without much reduction in net profit. The common tapping system used for budded rubber tree is half spiral alternate daily tapping (1/2S d/2 6d/7). In this study half spiral third daily tapping and quarter spiral change over system was evaluated in comparison to conventional 1/2Sd/2 system for a period of six years. The yield was maximum under 1/2Sd/2 followed by 1/2Sd/3 and 2x 1/4d/2 change over system. The yield difference between 1/2Sd/2 and 1/2S d/3 systems narrowed down in fifth year and by

sixth year 1/2Sd/3 out yielded 1/2S d/2. The incidence of TPD was much low under d/3 tapping system. The discounted farm business income is more for 1/2S d/2 6d/7 over a period of six years, even though the return is more for d/3 in the fifth and sixth year. Thus, half spiral third daily tapping system with weekly one day rest can be employed for RRII 105 with a view to reduce tapping panel dryness.

Key words: Exploitation; Tapping intensity; Yield; RRIIM105; India

179 **Tan Ah Moy** (1974)

Diseases of the stem and tapping panel

RRIM Refresher Course on Rubber Planting, 3-8 December 1974., Kuala Lumpur, Malaysia.

Key words: Panel diseases; Stem diseases

180 **Taylor, R A** (1926)

A note on brown bast

Tropical Agriculturist, 72: 323.

(In: Natural Rubber: Biology, Cultivation and Technology, (Sethuraj, M R and Mathew, N M, Eds.) Elsevier, London, pp.322)

Key words: Brown bast

181 **Thankamma, L** (1996)

New tapping system to prevent brown bast, boost yield

Rubber Asia, 10(5):69-75.

Key words: Brown bast; Tapping system

182 **Thomas, M; Sreelatha, S; Simon, S P; Nair, N U; Thomas, K U; Jacob, J and Sethuraj, M R** (1996)

Availability of photosynthates and occurrence of tapping panel dryness syndrome in *Hevea brasiliensis*

In: *Developments in Plantation Crops Research: Placrosym* XII, 27-29 November 1996, Kottayam, India. (Eds. N.M.Mathew and C. Kuruvilla Jacob). Allied Publishers, New Delhi, India, pp.139-141.

Healthy trees of the *Hevea* clone RRII 105 were continuously monitored at biweekly intervals for sucrose, inorganic phosphorus (Pi) and thiols contents in their latex and weekly for the occurrence of tapping panel dryness (TPD) with the objective of relating any changes in these parameters with the onset of TPD. Six trees out of fifty showed symptoms of TPD during the 20 months period of the present investigation. The concentrations of sucrose and Pi in the latex were higher in the affected trees than in the normal trees 15 to 45 days before

the onset of TPD. Before this period there was no significant difference in sucrose and Pi content. No clear pattern was observed for thiols. The occurrence of high concentrations of sucrose suggests that the supply of photosynthates for rubber synthesis was not the primary cause for TPD. The simultaneous occurrence of high concentrations of sucrose and Pi in the latex indicates a possible inhibition in the metabolic conversion of sucrose into rubber due to poor energy status of the laticiferous tissues of the trees that are being affected by TPD.

Key words: *Hevea* clones; Inorganic phosphorous; Sucrose; RRII 105; India

183 **Thomas M; Saha, T; Sobhana, P and Jacob, J** (2000)

Dissimilarities in the genetics between the rootstock and scion and their relationship with the occurrence of tapping panel dryness syndrome in *Hevea*

Proceedings of the National Seminar on Recent Advances in Plant Biology, 3-5 February 2000, Central Plantation Crop Research Institute, Kasaragod, India, pp.61.

Key words: Genetic variability; Panel dryness; Rootstock; Scion; India

184 **Thomas, V; Saraswathyamma, C K and Sethuraj M R** (1998)

Effect of debarking on rubber trees (*Hevea brasiliensis* Muell. Arg.) affected by bark dryness

The Planter, 74(867): 335-337.

An attempt was made to manage tapping panel dryness (TPD) in plantations of *H. brasiliensis* clones RRII 105 and RRII 203 on a smallholding at Iymkombu in Kottayam district, Kerala, in 1988. Dry, unproductive bark was removed by successive tapping, leaving the residual bark undisturbed. The debarked area of the tree was coated with a wound dressing of animal fat, tar and soil (1:1:1) at 3-month intervals for 1 year. The combined activity of vascular cambium and residual bark resulted in bark regeneration. Renewed bark was tapped after 2 years, when the continuous latex flow indicated that the bark was productive. Debarked trees were still alive and productive after a further 7 years. The technique needs further refinement before recommendation for wide adoption.

Key words: Bark dryness; Debarking; Smallholdings; India

185 **Van De Sype, H** (1984)

The dry cut syndrome of *Hevea brasiliensis*: Evolution, agronomical and physiological aspects.

In: *Colloque Exploitation Physiologie de l'Hevea,* Montpellier, 9-12 July 1984, IRCA-GERDAT (Paris). pp. 249-272.

Key words: Dry cut syndrome; Physiological parameters

186 **Varma, A; Ramachandran, P; Sethuraj, M R and Jacob, M**

Etiological investigations on brown bast disease

Brown bast (BB) or tapping panel dryness syndrome of rubber is a serious concern of rubber

plantations. The disease has assumed serious proportions in all rubber growing countries like Malaysia, Indonesia, China, India and Sri Lanka. The most important symptom of the disease is gradual drying up of the tapping panel. In an extensive survey of the rubber plantations of Kerala the disease was found to affect plants even within two years of the start of tapping. The severity of the disease increases gradually resulting in complete drying of panel. The most popular clone RRII 105 is among one of the highly susceptible clones. The drying up of panel is also very fast in clone RRII 105; at the Vaniampara Estate a few plants of this clone dried up within three months of the start of tapping in April 1995. There is a brownish (necrotic) discoloration in the bark of the affected trees whereas those of healthy trees do not have similar browning. Some trees develop distinct distortion of the stem below the panel accompanied by severe bark cracking. The leaves of such plants, however, do not have any obvious stress symptom. A large number of samples of leaves and bark from BB affected plants were collected from two different locations in Kerala. None of these samples were found to contain any fungal, bacterial or viral pathogens as were determined by isolation, light microscopy and electron microscopy. Total nucleic acid from the leaves collected from diseased and healthy plants were isolated using phenol extraction procedures, purifies by cellulose column chromatography, analyzed by polyacrylamide gel electrophoresis under native and denaturating conditions. Extracts from the barks of clone RRII 105 were found to contain a distinct nucleic acid band with a mobility similar to that of potato spindle tuber viroid. This observation indicated the possibility of the association of a low molecular weight RNA with BB affected trees.

Key words: Brown bast; Etiological investigation; RRII 105; India

187 **Vichitcholchai, N; Kosaisawe,J and Lacrotte, R** (1997)

Latex diagnostic: warming of over-exploitation of *Hevea brasiliensis* in Thailand's non-traditional area.

In: *Symposium on Natural Rubber (Hevea brasiliensis):* Vol. II *physiology & exploitation and crop protection & planting methods sessions,* 14-15 October 1997, Ho Chi Minh City, Vietnam, pp.61-65.

The Latex Diagnostic test (measurement of latex inorganic phosphate, reduced thiol, sucrose and dry rubber content) could allow warning of over-exploitation, especially through over-stimulation, which leads quickly to the onset of transient tapping panel dryness disease (TPD) and progressively to the onset of definitive TPD. In experiments at Chachoengsao, Thailand [year not given], 400 six-year-old untapped trees of *Hevea brasiliensis* clone RRIM 600 were tapped half spiral every 2 days and subjected to various ethylene over-stimulation or over-tapping treatments. Sucrose content was significantly lower in the latex of stimulated trees, especially in treatments with the highest intensity and frequency of stimulation. Inorganic phosphorus was markedly higher in the latex of over-stimulated and over-tapped (daily tapping) trees than in that of control trees, which suggested that over-exploitation led to increased metabolic activity and energy use. In the case of daily tapping, there was no warning of over-exploitation. The concentrations of sucrose and reduced thiols in the latex remained within the same range as those of the control, whilst inorganic phosphorus concentration remained significantly higher than the control.

Key words: Latex diagnosis; RRIM 600; Over-exploitation

188 **Vijayakumar, K R; Thomas, K U and Rajagopal, R** (2000)

Tapping

Natural Rubber: Agromanagement and Crop Processing. (Eds.George, P J and Jacob, C K). Rubber Research Institute of India, Kottayam, Kerala, India, 2000, pp.215-238.

Key words: Dry rubber content; Exploitation

189 **Vijayakumar, K R; Sulochanamma, S; Thomas, M; Sreelatha, S; Simon, S P and Sethuraj, M R** (1990)

The effect of intensive tapping on induction of tapping panel dryness and associated biochemical changes in two clones of *Hevea*

Physiology and Exploitation of Hevea brasiliensis: Proceedings of IRRDB symposium, 1990, Kunming, China. pp.103-110.

Randomness in the incidence of Tapping Panel Dryness (TPD) in any field makes it difficult to quantify clonal susceptibility to this syndrome. In a preliminary study, using GT1 as a reference clone, the susceptibility of RRII 105 to the syndrome was quantified by an index based on the period required to induce total dryness of the tapping cut under a high intensity tapping system. The incidence of TPD was more rapid in RRII 105; the rate of incidence of the TPD for clone RRII 105 was 1.92 times greater than that found for clone GT1. The possibility of using this an index to classify clones according to susceptibility to TPD is discussed. Biochemical parameters such as bursting index, total and free acid phosphatase activity, proteins, sugars and lipids were monitored in the experimental trees. The pattern of changes markedly varied between the two clones studied. A lower bursting index and higher levels of sugars and proteins were observed in the initial months in the latex of the intensively tapped trees of the susceptible clone. The possibility of using these parameters also, for early prediction of susceptibility to TPD, is discussed.

Key words: Biochemical parameters; *Hevea* clones Tapping intensity; India

190 **Vincent, E** (1919)

Brown bast mystery

Planters' Chronicle, 14&15: 483-91, 761-63, 291-93.

(RRIM Bibliography No.20, 1973.)

Key words: Brown bast

191 **Vollema, J S** (1949)

Some observations on the occurrence of brown bast disease [of *Hevea*]

Bergcultures, 18: 243-245.

(HOA, 20, No.425:1950.)

It has been suggested that less severe tapping might reduce the incidence of brown bast in

Hevea. An experiment at the Tjiomas Trial gardens, however, started in 1939, showed that the system s/3, d/2, 67% (one-third of the circumference tapped every other day) did not reduce the incidence compared with the system s/2, d/3, 67% (one half of the circumference tapped every third day). In fact there was a 10% increase. A further experiment in which the development of brown bast was periodically recorded showed that incidence increased after the rest period of the trees, being at a maximum from December to April. The suggestion is made that this is due to the fact that food reserves are utilized by the newly-developing leaves and are not available for regeneration of latex. In order to test this hypothesis a trial is being made to compare the effect of the tapping system s/3, d/2, 67% continued throughout the year with a similar system applied for only 8 months of the year, the trees being left untapped for a period of 4 months during and directly following the rest period.

Key words: Brown bast; Tapping system

192 **Tian Wei Min and Hao Bing Zhong** (1999)

Protein-storing cells with 67 kDa protein in regularly tapped *Hevea* trees and in trees affected by tapping panel dryness

Journal of Rubber Research 2(03): 183-191.

Protein-storing cells (PSCs) are found in secondary phloem of *Hevea* trees. In this study it was found that a 67 kDa protein based on SDS-PAGE might be the main component of the vacuole proteins in PSCs. SDS-PAGE analysis indicated that the 67 kDa protein varied in abundance at different levels of tree trunk in untapped and tapped trees, and that the protein also changed when tapped trees were affected by tapping panel disease (TPD). These changes were consistent with that of the amount of PSC vacuole proteins detectable by microscopy. The indirect immunocytochemistry in light microscopical level gave a more reliable evidence that the 67 kDa protein is quantitatively the more important component of the PSC vacuole inclusion. Latex exploitation caused a marked decrease in relative abundance of 67 kDa protein in the area under the tapping cut of the tree trunk. In comparison with healthy tapped trees, the trees which were affected by TPD and rested from tapping had much more 67 kDa protein in the bark tissues near the tapping cut. These facts indicate that the 67 kDa protein may be utilized as storage material for latex regeneration in the tapped trees and that the relatively abundant 67 kDa protein in TPD trees may be caused by resting the trees from latex exploitation.

Key words: Protein storing cells; 67 kDa Protein

193 **Wickramasinghe, S P; Yapa, P A J and de Zoyza, T V W** (1987)

Accumulation of free proline in bark and latex of *Hevea brasiliensis* affected by Brown bast

Journal of Rubber Research Institute of Sri Lanka, 67: 9-17.

Brown bast (bark dryness) is a physiological disorder, which results in loss of yield. In studies with clone RRIC 101, 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 is often associated with water stress, the results point to the involvement of water stress in this disorder. Proline accumulation in the latex could be used as an early warning signal for brown bast development.

Key words: Brown-bast; Proline accumulation; Water stress

194 **Wickremasinghe, Seetha I** (1986)

Brown bast incidence of *Hevea brasiliensis*

Bulletin of Rubber Research Institute of Sri Lanka, 22: 5-8.

This disease has become serious in most rubber-growing countries. Patches of dry bark appear on the tapping cut; later, bark below the tapping cut swells and cracks, with serious loss of yield of latex. No pathogen was found in association with brown bast, and it is generally recognized as a physiological disorder. Rubber clones vary in susceptibility. Causal mechanisms and factors affecting incidence are discussed. It is concluded that, due to its considerable economic importance, early symptoms should be a warning signal for immediate control measures by varying tapping practices.

Key words: Brown-Bast; Causative agents

195 **Wu JiLin and Hao Bing Zhong** (1994)

Ultrastructural observations of brown bast in *Hevea brasiliensis*

Indian Journal of Natural Rubber Research, 7(2): 95-102.

The diseased laticifers in which the rubber particles did not coagulated and the cells near the laticifers in brown bast trees of *Hevea brasiliensis* were observed using transmission electron microscopy. The various organelles in the laticifers showed many abnormal changes. One of the important changes was membrane turnover disorder. On one hand, the membranes especially the boundary membranes of some lutoids, Frey-Wyssling complexes, nuclei etc. were disorganized, and on the other hand, the membrane materials appearing as myelin like structures abnormally accumulated in diseased laticifers. The other important changes occurred in nuclei of diseased laticifers. One of the significant characteristics of the nucleus in diseased laticifers was the frequent presence of bundles of straight microfibrils about 5 nm in diameter. The microfibrils might be microfilaments. Besides, the nuclei were often found with decreased contents and partly disorganized nuclear membrane.

Key words: Abnormal ultrastucture; Brown bast; Latex coagulation

196 **Wu Jilin; Hao Bingzhong and Tan Haiyan** (2004)

Histological and cytological studies of rapid whole cut dryness process in *Hevea brasiliensis*

IRRDB Conference: NR Industry: Responding to Globalization, 7-8 September 2004. Kunming, China.

The rubber trees (RRIM600 and PR 107) were grown in the experimental farm of our Academy. The 170 trees were tapped on s/2 d/2. About one year after the experiment began rapid

whole cut dryness appeared in 10 trees. Histological and cytological aspects of the rapid whole cut dryness process were studied using light microscopy and transmission electron microscope. The disease with rapid whole cut dryness was characterized by the tissue necrosis that developed rapidly in the tapping panel. Electron microscopy observations showed that there were normal nucleus, rubber particles and lutoids but abnormal myelin-like structures in most of the laticifers that were closely near cambium and just derived from it. In the young laticifers some distance from cambium more abnormal ultra structures were frequently found. A large number of myelin-like structures appeared, most of which were associated with endomembrane system. Lutoid membrane was broken. A part of membrane of mitochondria became vesicles. The chromatin of nucleus was condensed or the nucleus had poor contents and broken nuclear envelope. Tylosoids formed in the young laticifers as long as *in situ* latex coagulation occurred in the laticifers. Around diseased laticifer hyperplasic tissues were produced. The disease had the symptoms like the usual brown bast but there were more necrotic plots and the disease could expand quickly. Comparison was made between the rapid whole cut dryness and the TPD induced by overstimulation. The causes of the disease were discussed.

Key words: Brown bast; Bark necrosis; Tylosoids; Whole cut dryness

197 **Wu Jilin; Hao Bingzhong; Tan Haiyan, and Chen Shoucai** (2004)

Histological and cytological aspects of tapping panel dryness induced by overstimulation with ethrel in *Hevea brasiliensis*

IRRDB Conference: NR Industry: Responding to Globalization, 7-8 September 2004. Kunming, China.

The twenty-five year old PB86 and RRIM 600 rubber trees grown in the experimental farm of our Academy were tapped on s/2 d/3 and stimulated with 8% ethrel at fifteen day intervals. Histological and cytological aspects of tapping panel dryness (TPD) induced by the overstimulation were studied using light microscopy and transmission electron microscopy. With the course of over stimulation tapping laticifer death occurred near tapping cut first in the outer bark and gradually towards the inner bark. Senescence of organelles was accelerated in the survived laticifers. Myelin-like structures appeared in the laticifers. Some lutoids became residual bodies and F-W particles became electron dense. Nuclei had broken membrane and condensed chromatin. The content of the nuclei could finally disappeared. *In situ* latex coagulation was an essential characteristic of laticifer senescence. It was quite different from the process normally occurring at laticifer wounds after tapping. Along with the *in situ* latex coagulation, it was found that lutoids abnormally accumulated in the laticifer vessels at some distance from tapping cut and that empty laticifer vessels appeared in the middle and inner bark. In the laticifers the quantity of rubber particles was less, most of which were smaller. Senescence of bark tissue was accelerated.The onset of the TPD induced by over stimulation with ethrel is a process of accelerated senescence. Disorganization of membrane structures of organelles is an essential characteristic of senescent laticifers. The laticifers of TPD induced by over stimulation might loss their defense function. The overstimulation induced TPD could develop the necrotic symptom when trees continued to be exploited with over stimulation.

Keywords: Accelerated senescence; Ethrel: Over stimulation

198 **Wu JiLin; Tan Haiyan; Tian Wei Min and Hao Bing Zhong** (1997)

Tapping panel dryness related to root wounding in *Hevea brasiliensis*: Macroscopic, microscopic and electron-microscopic observations

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 1997, Hainan, China. pp.31-39.

Five trees of the *Hevea brasiliensis* clone RRIM 600 tapped 1/2S d/2 on panel BO-1 were affected by bark dryness. It occupied almost all of the tapping cut 15 days after the appearance of bark dryness. Field observations were made on the trees, using bark puncturing and cutting, after 5-30 days of dryness and further observations were made after 12-15 months. In coordination with the field observations, samples were collected for light- and electron-microscopic investigation. Almost immediately after all of the tapping cut had dried up, the whole tapping panel and half of the rootstock under the panel manifested the symptoms of bark dryness with tissue necrosis, and the closer to the rootstock was the bark then the higher the degree of symptoms shown. Bark dryness was also found in one or more lateral roots of each tree and the higher the degree of symptoms shown. Bark dryness was also found in one or more lateral roots of each tree and the dryness was always traced downward to a wound with little cover. It is suggested that the primary lesion of the bark dryness might originate from the root wound from whence the lesion spread to the tapping cut. A model is proposed to explain the origins and spreading of rapidly-spread tapping panel dryness.

Keywords: Root wounding

199 **Wu JiLin; Tan Haiyan; Tian Wei Min and Hao Bing-Zhong** (1997)

Tapping panel dryness syndrome in *Hevea brasiliensis* associated with wounds in the roots

Indian Journal of Natural Rubber Research, 10(1&2): 102-106.

Keywords: Root wounding

200 **Wu Xiaoping; Xiangdong He; Wu Juqun and Zhiyu Niu**

Studies on the protective coating for Tapping panel against winter cold

Proceedings of IRRDB symposium 1999, Hainan, China (Eds. Chen Quibo and Zhou Jiannan). Hainan Publishing House, China, pp.236-244.

Many years of large-scale trials of a newly developed protective coating for rubber panel against winter cold reveal that it is more effective than the conventionally used protective coatings such as the vegetable oils (rubber seed oil, palm oil, castor oil), waxes (paraffin wax, beeswax) and rosin mixture coating, the petrolatum coating and the wet clay and cattle dung mixture coating. It can protect not only the rubber panel against cold in winter, but also increase rubber yield in the early period of the next year promote the growth of the regenerated panel bark and the recovery of the dry panel. Application of the new protective coating is convenient and has not caused any disease in the panel up to now.

Key words: Protective panel coating; Tapping panel rate; Bark cracking; Regenerated bark

201 **Xiaodi, W; Xu Wenxian,; Wanlin, Y and Chengxu, W** (1997)

Re-exploitation of tapping panel dryness trees of *Hevea brasiliensis*

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, Hainan, China, 1997, pp.55-62.

Resting trees affected by tapping panel dryness were treated and retapped for three successive years by employing vertical puncture tapping, upward tapping plus puncture tapping, and S/4 upward tapping after isolation of the infected patch and application of antibiotic compounds. Results showed that upward tapping plus puncture tapping of the treated trees gave a dry rubber yield of 1.546 kg/tree/year, 67 of that of the control (healthy trees), but the tapping frequency was only 30 of that of the control. Upward tapping plus puncture tapping gave more yield, consumed less bark and a less recurrent rate of TPD than conventional upward tapping or vertical puncture tapping. The tapping system is practical and easy to use.

Keywords: Re-exploitation; Tapping system

202 **Xu Wenxian and Xiao, X** (1988)

Studies on peroxidase and superoxidase dismutase isozymes in dry rubber trees

Chinese Journal of Tropical Crops 9(1): 31-36.

A comparison was made of peroxidase isozyme patterns between dry rubber trees and healthy rubber trees of clone GT1. It was observed that the activity of peroxides isozyme in the region with a quickly migrating rate in bark or latex of dry trees was much stronger than that of healthy trees, while other bands of isozyme showed no significant difference. The difference of peroxidase isozyme of latex between dry trees and healthy trees of clone RRIM600 was more significant. In the latex of dry trees there were three isoperoxidase bands, which are wider, and quick and deep staining, indicating a stronger activity, while in the latex of healthy trees there were only two isoperoxidase bands with a very weak activity. The activity of peroxidase was very strong in the dry part of the bark, less strong in the transition part, and fairly weak in the adjacent healthy bark, indicating a trend that the nearer to the dry par, the stronger the activity of enzyme will be. The inducement of dryness and the activity of peroxidase seemed synchronous. Determination results of RRIM600 were similar to that of GT 1, which corresponded with the electrophoresis results of isoperoxidase. The activity of superoxide dismutase (SOD) was weaker in dry bark than in healthy bark. 6-8 SOD bands could be separated from the latex of healthy bark of RRIM600, but only 4-5 bands from the latex of dry bark with rather weak activities, indicating a deficiency of some isozyme bands. It is suggested that dryness of the rubber tree was a wound response for self-defence.

Key words: Isozyme pattern; Superoxide dismutase

203 **Xu Wenxian; Xiaodi, W; Xiao, X; Luo S and Shizhong, Liu** (1994)

Physiological effects of stimulation and exploitation intensities and tapping patterns on tree dryness

IRRDB TPD Workshop, 26-28 July 1994, SCATC, Hainan, China.

Occurrence of tree dryness of *Hevea brasiliensis* was closely related to stimulation and

exploitation intensities and even tapping patterns. When exceeding the endurance of the rubber tree, the physiological damages caused by stimulation or tapping would give rise to physiological imbalance between latex production and latex flow in that dry rubber content, total solids, thiols, initial velocity of latex flow and plugging index were remarkably reduced while late drip ration and the isozymatic activities of peroxidase reflecting degrees of trauma were enhanced significantly. Continuous physiological imbalance resulting from over intense flow of latex would invoke self-destruction of latex vessel cells, leading to functional failure of latex regeneration and subsequently formation of tree dryness. The commercial scale experiments proved that the dynamic balance between latex regeneration and latex flow could be regulated by stimulation intensity, exploitation intensity or tapping patterns, and hence occurrence of tree dryness is also controllable. This paper puts forward a series of practices for controlling tree dryness initiation.

Key words: Exploitation, Physiological parameters; Stimulation; Tapping patterns; Tree dryness; China

204 **Yang Shaoqiong** (1989)

Tapping panel dryness in China's rubber plantations

Proceedings of the IRRDB workshop on Tree dryness, 26-27 June 1989, Penang, Malaysia. pp.61-69.

In China rubber plantations are all located at the northern part of the tropics beyond the traditional world rubber area. This review provides a general picture of panel dryness in China's rubber plantations. The screening of effective but less poisonous anti-senescence agents and the development of compound ethephon formulation with senescence retarding agents should be considered

Key words: Status report; China

205 **Yang Shaoqiong; Yeyong, Mo and Siwei Fan** (1994)

Physiological response of PR107 to intensive tapping with stimulation at early exploitation stage

IRRDB TPD Workshop, 26-28 July 1994, SCATC, Hainan, China.

This study tried with S/2 d/1 + 3% ethrel stimulation on clone PR 107 trees under exploitation for three years to cause tapping panel dryness, and observed dynamically some physiological and biochemical changes possibly related with the tapping panel dryness. By 36th tapping after three applications of ethrel at a total dosage of 180 mg 2-chloroethrylphosphonic acid each tree, the tapping panel dryness incidence reached 73%. It was found that in all cases dryness first appeared from upper and lower end of tapping cut. As compared with the control, the treated trees had a lower initial flow rate, dry rubber content and total acid phosphatase activity but higher inorganic phosphorus level. No dropping was noted on the level of ascorbic acid- the cytosolic scavenger during the experiment period, and the decline in thiols content occurred quite late. The total phenol level and peroxidase activity in latex increased, particularly in the latter case. The proline content rose with the increase in water loss with latex extraction, but no accumulation of proline was detected after the appearance of dryness. The present

paper discussed these physiological and biochemical changes. It is considered tentatively that the tapping panel dryness in the experiment may be ascribed to the consequence of extreme physiological fatigue of the treated rubber trees.

Key words: Intensive tapping; Physiological fatigue; Stimulation; Yield

206 **Yang Shaoqiong; Mo Yeyong; Li Yu and Pan Yanqing** (1997)

Onset and development process of whole-cut dryness and physiological expression

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 1997, Hainan, China, pp.3-16.

The physiological changes in the onset and development process of whole-cut dryness were investigated on *Hevea* trees of clones RRIM 600 and PR 107 under a conventional tapping system. The dryness incidence and expansion rate of clone RRI 600 are more than double when compared with clone PR 107. Some affected trees displayed a short time increase in initial flow rate and latex yield prior to dryness. The latex inorganic phosphorus (Pi) content increased considerably in the course of the onset and development of dryness. All the affected trees had a low latex sucrose content before the occurrence of dryness. Some affected trees had an elevated content of thiols (R-SH) before dryness occurred but no abnormal regeneration of latex was observed. This paper also discusses the possible causes of rapid whole-cut dryness on rubber trees.

Key words: Initial flow rate; Inorganic phosphorus; Whole cut dryness

207 **Yeang, H Y; Sivakumaran, S and Hamzah, Z** (1994)

Latex copper content in relation to the onset of tree dryness

IRRDB TPD Workshop, 26-28 July 1994, SCATC, Hainan, China.

Latex from trees suffering from partial dryness had significantly lower copper content as compared with controls of the same clones. When intensive tapping induced partial dryness, trees that had initially showed high latex copper were the ones more susceptible to the onset of dryness subsequently. In observations on commercially tapped fields, latex copper was higher in the tapping tasks that recorded a high incidence of totally dry trees. Clonal propensity to tree dryness was also associated with latex copper. Clones susceptible to dryness were found to have higher latex copper than clones that were relatively more resistant. The observations in this study suggest that excessive loss of copper in the exuded latex might create a physiological stress situation that renders the tree more prone to dryness.

Key words: Clonal susceptibility; Latex copper; Physiological stress

208 **Yunxia, Zhang; Chenshoucai, and Peng Shiqing** (2004)

Cloning of a gene that regulates the expression of the TPD associated gene *HBMYB1* by yeast one hybrid

IRRDB Conference: NR Industry: Responding to Globalization, 7-8 September 2004, Kunming, China.

Tapping panel dryness of rubber tree is a complex physiological disorder in the bark wildly

found in rubber plantations and causes severe yield losses. The mechanism underlying TPD is still unknown and no effective prevention or treatment is found presently. To characterize the molecular mechanism of TPD, authors isolated and characterized genes associated with TPD. Our previous study had found a Myb transcription factor *HbMyb1* whose expression is significantly decreased in the barks of TPD trees. It is reported here that the identification and characterization of the genes that regulate *HbMyb1*. Based on the previous study, they isolated the promoter of *HbMyb1* as the bait, and cloned a cDNA fragments by yeast one-hybrid named Hb2. The Hb2 had two homologys in the GENBANK, but not the same as any of them. No information of the function of the homology's was known. Hb2 may be a new type gene that act as a role not been known presently.

Key words: Gene expression; Myb transcription factor

209 **Yusof, F; Arija, M A Siti; Ghandimathi, H; Hamzah, Z; Sivakumaran, S and Yeang, H Y** (1995)

Changes in some physiological latex parameters in relation to over-exploitation and the onset of induced tapping panel dryness

Journal of Natural Rubber Research **10**(3): 182-198.

As tapping panel dryness of the rubber tree developed in response to various stress treatments, significant changes in invertase and polyphenol oxidase activities, total sugars and total solids in the latex were found to be associated with the intensive tapping and ethephon treatments. These changes appeared to be related more to the exhaustion of the laticifer system (over-exploitation) than to the basic causes of dryness. They were unreliable predictors of dryness in situations where the dryness was not accompanied by increased yield output, as exemplified by the pin-pricking stress treatment. In the early stages of the stress treatments, latex proline and copper content increased with all the experimental treatments attempted, irrespective of whether yield output was increased. These results suggest that an increase in latex proline or latex copper might serve as a warning indicative of incipient or impending dryness.

Keywords: Over-exploitation; Physiological latex parameters

210 **Zainab, H and Sivakumaran, S** (1996)

Nutrient status in relation to tree dryness.

Symposium on Agronomy Aspects of the Cultivation of Natural Rubber (Hevea brasiliensis), 5-6 November 1996, Beruwela, Sri Lanka, pp. 54-63.

The objective of this study was to determine the change in nutrient status in the laticiferous system in relation to the onset of tapping panel dryness (TPD). In a field experiment in Bangi, Malaysia, designed to study the effects of intensive stimulation, *Hevea* trees of clone PB 260 were tapped using 2 systems, 1/2S d/3 stimulated with 2.5% ethephon and the novel RRIMFLOW system with a gaseous stimulant. Controls were tapped with the 1/2S d/3 system without stimulation. Latex was collected for a period of 12 months for nutrient analysis. Macronutrients (N, P, K, Ca and Mg) and micronutrients (Mn, Cu, Fe, Al, Zn and B) in the latex were analysed. Latex flow after tapping, pH, dry rubber content and total solids content

were determined. Micronutrient and macronutrient contents in bark samples collected from the same experiment were also determined. Yields per tapping per tree in the ethephon-stimulated trees and RRIMFLOW trees were 148 and up to 347% of those in controls. Latex pH decreased markedly with stimulation. The dry rubber and total solid contents of the latex were highest in the control trees, followed by trees stimulated with 2.5% ethephon, and lowest in the RRIMFLOW treatment. Percentage dryness was highest for RRIMFLOW, followed by 2.5% ethephon stimulation and then the control (mean percentage dryness 9.83, 2.38 and 0%, respectively, over a one year period). Latex N concentration was highest in the RRIMFLOW treatment and a marked increase in P concentration was also observed. Generally, there was a declining trend for Mg, K and Ca concentrations in all treatments. Cu and Zn concentrations decreased, while Fe, Al and B concentrations fluctuated. Bark samples were similarly analysed for macro- and micronutrient contents; N, P and Mg were highest in the RRIMFLOW treatment and lowest in the control. It was also noted that the concentrations of N, K, Cu and B decreased with increased percentage dryness.

Key words: Nutrient status; Tree dryness

211 **Zheng, X; Liu, Z; Deng, X; Hu, D; Chen, M and Luo, Daquan** (1997)

Amplification of 16S rDNA of MLO/BLO associated with tapping panel dryness (TPD) of *Hevea*

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 1997, Hainan, China, pp. 28-30.

This paper reports the preliminary progress of our research on the characterization and detection of the TPD associated microorganism at the molecular level using a novel gene cloning method. In order to characterize the prokaryotic organisms and establish a detection method, a novel method was developed to amplify the prokaryotic 16S rDNA. According to the conservative regions of the 16S rDNA sequences of the known MLOs, a pair of degenerate primers were designed and synthesized for polymerase chain reaction (PCR). The total DNA used as the template for PCR were extracted from the bark of healthy and diseased *Hevea* trees, respectively, and the PCR reactions were carried out at 94° C- denaturing for 30 secs., 58° C- annealing for 1 min. and 72° C- elongating for 2 min. After 30 cycles amplification, the products were subjected to 1% agarose gel electrophoresis. The results showed that all of the TPD affected samples gave a band approximately 865bp in length, while the healthy ones gave none. This result further demonstrated that NLOs or BLOs are closely related to TPD of *Hevea*, which supports authors previous work involving electron microscopy, grafting and an effective therapy using tetracyclines. Cloning and sequencing of the amplified PCR products is being carried out and, subsequently, work to search for available regions and the generation of oligonucleotide probes and specific PCR primers. The molecular diagnostic technique for TPD of *Hevea* can be expected to be developed in the future.

Keywords: Polymerase chain reaction; Prokaryotic organisms

212 **Zheng Guanbioa; Chen Murong; Chen Zuoyi and Shen Juying** (1982)

A preliminary report on the study of causative agents of Brown bast

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The solutions of tetracycline and penicillin were injected into GT 1 buddings under tapping,

while for the check trees only water or nothing was injected. Tapping test showed that trees treated once or twice with penicillin and tetracycline tend to give higher yields of both latex and dry rubber, as compared with the check trees. Moreover, the effect of the two chemicals injected lasted over half a year. Electron-microscopic examination revealed that Rickettsia like organisms (RLO) generally occurred in the sieve tubes and on the sections of latex vessel cells in GT1 and RRIM 600 trees infected with brown bast. The RLO in GT1 trees were 100-2.400 nm in size and those in RRIM 600 trees were 275-1,395 nm in size, but the limiting membranes in both cases were about 20 nm in thickness. In healthy GT 1 and RRIM 600 trees, no RLO were found in the phloem tissues such as sieve tubes and latex vessels. Accordingly, RLO may possibly be one of the causative agents of brown bast disease.

Key words: Brown bast; Causative agents; China

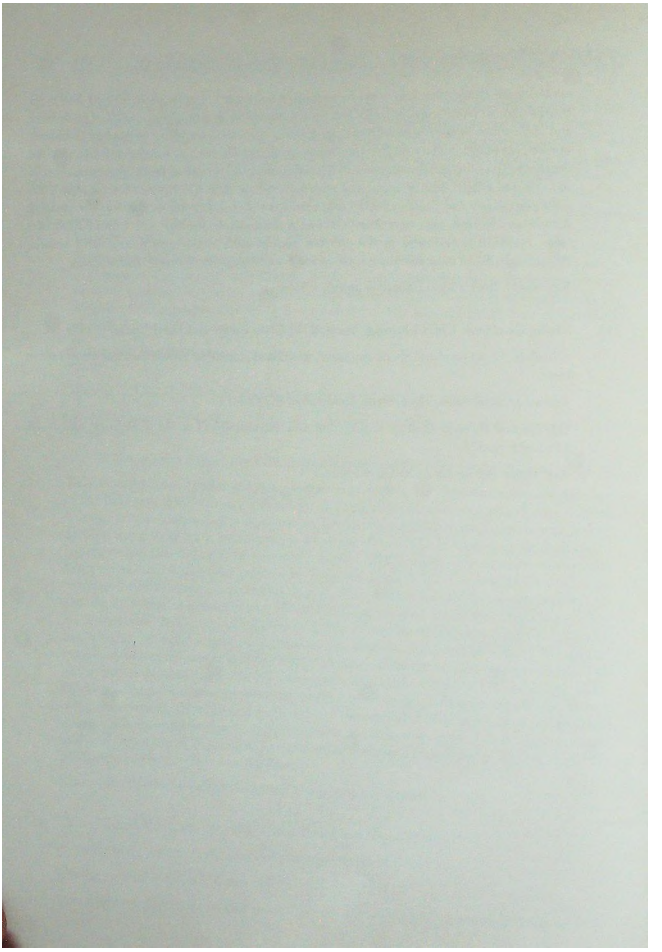
213 **Zheng Guanbioa; Chen Murong; Yung, S W; Chen Zuoyi and Shen Juying** (1988)

A further report on the study of causative agents and control of brown bast disease of rubber trees.

Journal of South China Agricultural Universities, 9(2):22-23.

(In: Natural Rubber: Biology, Cultivation and Technology, (Eds. M R Sethuraj and N M. Mathew). pp.323

Key words: Brown bast; Causative agent



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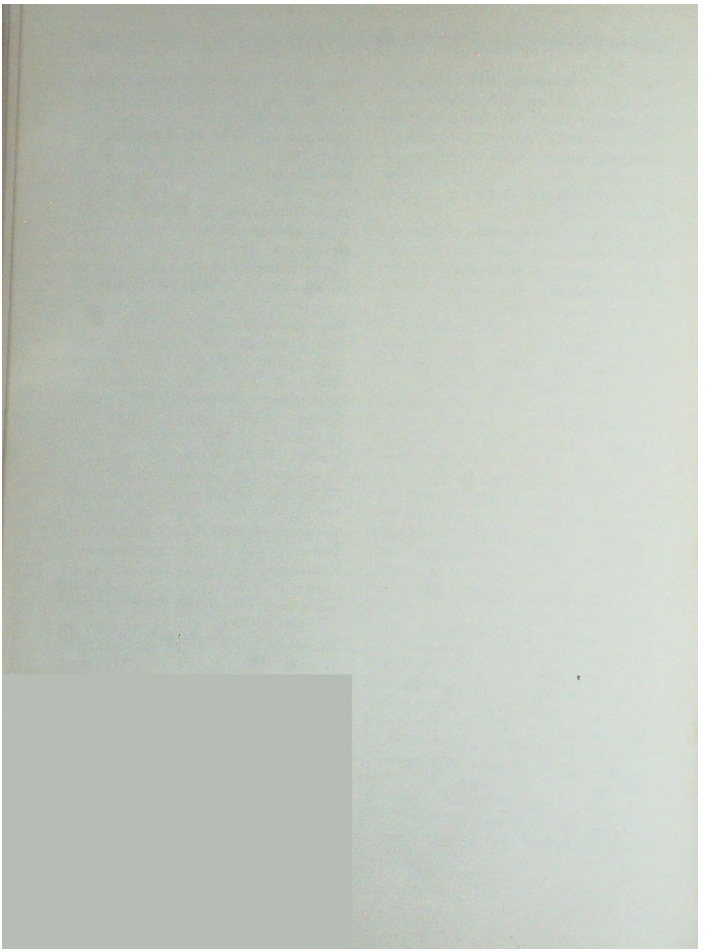

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