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Fruiting bodies of *Ganoderma Pseudoferreum*
See Ogbebor et al., pages 304-307
THE GADGIL-KASTURIRANGAN REPORTS ON WESTERN GHATS AND CONCERNS OF THE PLANTATION SECTOR

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The Western Ghats Ecology Expert Panel (WGEEP) or the Gadgil Committee (March 2010 - August 2011) and the High Level Working Group (HLWG) or the Kasturirangan Committee (August 2012 – April 2013), both constituted by the Union government and now the Expert Committee of Kerala government (October 2013) are mandated with the responsibility to make recommendations for protecting and rejuvenating the ecology of the Western Ghats (WG). Each committee was constituted to look into the report of the previous one. Some of the best minds in the country served on these committees, but there was no balanced representation of the various sectors and stakeholders of WG. Ecological degradation of WG is mostly due to anthropogenic activities and cultivation of spices and plantation crops constitutes the most significant such activity in the region. Yet, this important sector’s concerns were not addressed in the reports submitted by these committees. WG ecology is too important to be delegated to one ministry or department or those who work on forests and ecology alone.

Reports of both WGEEP and HLWG contain sweeping and impractical recommendations that take care of only the ecological concerns of the region and not the genuine socio-economic apprehensions of the two million plus farmers who call WG their home. While WGEEP report put more than 278000 ha of rubber plantations under ecologically sensitive zones (EZZ), the HLWG report put about 74000 ha in ecologically sensitive areas (ESA) in the WG. Another 213000 ha of rubber plantations exist in the 10 km buffer zone outside the ESA. The case with other crops such as coffee, tea, cardamom etc. must be even worse.

According to the HLWG report, as much as 76 per cent of the geographical area of Kerala falls in the WG region and nearly 44 per cent of the WG region falls into ESA. In other words, nearly 34 per cent of the geographic area of Kerala will be under ESA. Classifying one-third of the state as ESA goes against common sense and practical wisdom and this will lead to serious social unrest in a small and populous state like Kerala.

While making recommendations on ecological protection, agriculture should not be treated on par with industries or activities such as mining or quarrying. Ecological sustainability should not be an end in itself, but this should lead to social and economic security of the people living in the region. Nature and mankind have to coexist, not one at the cost of the other. Hope the latest committee constituted by the Kerala government will come up with pragmatic and realistic recommendations that are in the best interest of ecology and agriculture in the WG region of Kerala.

Keywords: Agriculture, Ecology, Gadgil Committee, Kasturirangan Committee, Natural rubbers, Spices and plantation crops, Western Ghats
ROOT TRAINER PLANTING TECHNIQUE FOR HEVEA- A REVIEW

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Different aspects of root trainer planting technique such as root trainer containers, potting medium, filling of root trainers, in situ budding on stocks raised in root trainers, stump planting in root trainers, irrigation, fertilizer application, shading, disease control, hardening, transplanting etc. standardized for Hevea are discussed. In addition to improving the quality of planting materials, root trainer planting technique is labor-friendly and environment-friendly. Production of advanced planting materials of natural rubber in root trainers is cost effective also. The savings towards planting operations using root trainer plants add up to two third of the entire cost of polybag planting. This novel technique developed for natural rubber by the Rubber Research Institute of India is revolutionising rubber nursery industry in many countries.

Keywords: Coir pith, Hardening, In situ budding, Natural air pruning, Potting medium, Root coiling, Root trainer

INTRODUCTION

Introduction of natural rubber to India from Brazil via., Sri Lanka and development of natural rubber plantation industry are remarkable success stories of the Indian plantation sector. In the early years of rubber cultivation in India a century ago, assorted seeds collected at random were used as the planting material and naturally, productivity was very poor. Subsequently, improved seeds from selected high yielding mother plants were used. Since Hevea is a cross pollinated and highly heterozygous species, seed propagation has the inherent drawback of creating very high variation in growth, vigour and yield between individual trees in a plantation. This limitation was overcome by the successful introduction of bud grafting, which proved to be a breakthrough in enhancing the productivity of rubber plantations. With the perfection of the bud-grafting method by Van Helton in 1917 in collaboration with two planters, namely Bodde and Tass (Dijkman, 1951), the crop began to be propagated almost exclusively by cloning a limited number of high yielding trees. This method has been in practice in every rubber growing country for the past several decades. The budded plants could either be planted directly in the field (as budded stumps) or first established in polythene bags and transplanted at an advanced stage.
YIELD DECLINE IN HEVEA TREES: A COMPARATIVE EVALUATION OF SIXTEEN YEARS LATEX YIELD

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Yield of rubber tree varies over the years depending on many biological, environmental and management factors. In an experiment, the latex yield of 12 Hevea clones was monitored for 16 years under S/2 d2 6 d/7 system of tapping. The yield increased gradually in initial years of tapping and maintained a higher yield output from 3rd to 15th year. Yielding pattern of rubber trees varied among the clones. Clone PB 235 and RRII 118 showed a long duration of higher yield output for 15 years. Clones RRII 300, RRII 105, RRIM 501 and PR 107 exhibited higher yield output for 8 to 10 years. After a specific period of vigorous latex output, the yield started declining in all clones. The onset of yield decline was different among the clones and it varied from 11th to 16th year of tapping. In clones RRII 105 and RRIM 703, the yield decline commenced from 12th year of tapping, whereas this was between 15th to 16th year of tapping in clones PB 235, RRII 118, RRIM 600, GT1 and Gl 1. Generally, a drastic reduction in yield was observed after 16 years of tapping when the trees were 23 years old. Clones RRIM 703 and RRIM 501 showed the highest decline (40%) from peak yield at 16th year of tapping. The popular clone RRII 105 recorded around 20 per cent decline. This was almost negligible in clones RRII 118 and Gl 1. The decline in yield of rubber trees could be attributed to ageing, soil fertility, environmental and agro-management factors that might reduce the tree growth and shorten the economic life span of trees.

Keywords: Latex yield, Peak yield, Yield decline

INTRODUCTION

Hevea brasiliensis, a perennial tree crop attain tappability and become economically significant in six to seven years after planting and reaches full production potential in three to four years of tapping. After a period of vigorous latex output the productivity drastically declines, thereafter the trees are cut down from the plantations and are usually replanted with new clones. The yield per tree per tap increases with increase in girth of trees due to the increase in length of tapping cut (Dijkman, 1951; Karunaratnel et al., 2005). However, the growth of rubber trees tends to decline gradually during the later period. Moreover, the productivity of rubber tree is determined not only by its inherent genetic factors but also prevailing environmental conditions. Tree to tree variation and
FIELD PERFORMANCE OF POLYBAG AND ROOT TRAINER RUBBER PLANTS AT DIFFERENT STAGES OF GROWTH

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Received: 06 February 2013 Accepted: 25 April 2013

An experiment investigating the comparative field performance of polybag and root trainer rubber plants was initiated at the Central Experiment Station, Chethackal of the Rubber Research Institute of India representing the traditional rubber growing region in India during 2008 with clone RRII 105. The treatments comprised of combinations of two types of planting material viz., direct-seeded green-budded polybag plants and root trainer plants (raised by planting budded stumps) at three growth stages viz., one-whorl, two-whorl and three-whorl. Observations on growth were recorded for a period of four years. Success in establishment was hundred per cent in the field irrespective of the planting material and its growth stages. The variability in girth quantified using CV for polybag one-whorl, two-whorl, three-whorl and root trainer one-whorl, two-whorl and three-whorl plants was 12.7, 12.8, 12.4, 12.4, 12.7 and 11.1 per cent respectively. The significant difference observed in the girth of the plants among the types of planting material and its stages during the initial years progressively became less apparent and by two and a half years, only three-whorled polybag plants were significantly superior to others. The same trend continued in the four years also. The performance of all other planting materials viz., polybag - one-whorl, two-whorl, three-whorl and root trainer - one-whorl, two-whorl and three-whorl was comparable. However, among these, considering the practical convenience and cost involved, root trainer one-whorl plants appeared to be the ideal planting material for commercial planting of Hevea. The constraints and advantages of different planting materials are also discussed.

Keywords: Growth, Immature rubber, Number of whorls, Polybag, Root trainer

INTRODUCTION

Hevea brasiliensis, the principal source of natural rubber, is a tropical perennial tree crop with a prolonged gestation period ranging from five to ten years and the need for reducing the gestation period attained importance from the day of commencement of commercial planting. The duration of immaturity in H. brasiliensis depends on the inherent clonal characteristics, type and quality of planting materials used, edaphic and environmental factors, agromanagement practices adopted and biotic and abiotic stresses (George et al., 2009). Of these, the planting material, its type and quality, is of special significance as the extent of reversibility is limited considering the long gestation phase and the life span of 25-30 years. Since early 1960s, priorities of research have been directed to shorten the period of immaturity through...
BANANA GROWN AS AN INTERCROP IN RUBBER PLANTATION REQUIRES LESS FERTILIZER

Mrinal Choudhury and M.D. Jessy*

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An experiment was conducted to study the effect of sequential reduction of fertilizer doses for banana when grown as an intercrop with rubber in Assam. Rubber was manured as per the standard recommendation for the region throughout the experiment period. All banana plants received uniform recommended dose of fertilizers during first year. From second year onwards, different doses of fertilizers i.e. 0, 25, 50 and 100 per cent were applied to banana. Observations on growth of rubber, yield of banana, soil and leaf nutrient status were recorded. Intercropping with banana, irrespective of its fertilizer doses significantly improved the growth of rubber. Yield of banana was comparable in the treatments which received 100 per cent fertilizers throughout, 100 per cent fertilizer during first year, 50 per cent during second and third year and 100 per cent during first year, 50 per cent during second year and 25 per cent during third year. There were no significant differences in organic matter content and pH of soil, however, significant reduction in available phosphorus and potassium contents were observed in treatments which received lower dose of fertilizers. The study shows that the fertilizer dose for the second crop of banana can be reduced when cultivated as an intercrop in young rubber plantation, without adversely affecting the growth of rubber.

Keywords: Banana intercropping, BCR, North East India, Rubber, Soil and leaf nutrients

INTRODUCTION

Rubber (Hevea brasiliensis) is a perennial tree, latex of which is processed to produce the strategically important natural rubber. Of late, rubber cultivation in the North East India has become very popular. Rubber plants require approximately 7 to 8 years to attain maturity (Sethuraj et al., 1989; Vinod et al., 1996), and the comparatively long gestation period is one of the constraints for expansion of rubber cultivation in North East India. It is possible to effectively utilize the inter-row spaces in the rubber plantations for growing intercrops (Jessy et al., 1998; Roy et al., 2001). Banana is a very popular fruit crop in North East India and was found to be suitable as an intercrop in the region. When banana is cultivated as an intercrop, substantial quantities of nutrients are recycled through crop residues (Jessy et al., 1998), which will be available for the subsequent crops. This
A CROPPING SYSTEM FOR REDUCTION OF GESTATION PERIOD AND ENHANCED YIELD OF RUBBER TREES (*HEVEA BRASIILIENSIS*)

M.D. Jessy, Shankar Meti and N. Usha Nair
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A cropping system with altered spatial arrangement of planting that permits extended intercropping, reduced gestation period and enhanced yield of rubber was developed for smallholdings. Rubber was planted in paired rows of 9.0 m apart, at a spacing of 5.1 m between the rows within the paired row and 3.4 m between two plants within a row. The total number of rubber plants per hectare was 406 in the cropping system whereas it was 445 in the control. Diverse annual, short-term and perennial crops (banana, pineapple, *Amorphophallus*, *Dioscorea*, *Colocasia* and arrow root, coffee and pepper) were planted sequentially in the wider inter-row spaces, selecting the intercrops judiciously based on the light availability and shade tolerance. Legume cover crop, *Pueraria phaseoloides*, was established in the narrow inter-row spaces of rubber in the intercropped area and interspaces of rubber in the control plot. Intercrops were cultivated during the entire gestation period of rubber. Fodder grass (guinea grass) and teak were planted along the boundaries. In the cropping system, the soil nutrient status was maintained and soil moisture status was significantly higher during January. Altered spatial arrangement of planting and extended intercropping reduced the gestation period of rubber and enhanced yield by 25.6 per cent during the initial years of tapping compared to control plants under normal system of planting without intercropping.

**Keywords:** Cropping system, Gestation period, Intercrops, Rubber yield

INTRODUCTION

Rubber tree (*Hevea brasiliensis*) which yields one of the nature’s most versatile raw materials plays an important role in the economy of India and other countries where it is cultivated. Rubber plantation industry has great socio-economic relevance in India with more than one million small growers cultivating rubber and providing about 3,50,000 job opportunities in the plantation sector and almost an equal number in the industrial sector (Krishnakumar, 2003).

In India, smallholdings (less than 0.50 ha.) accounting for more than 90 per cent of the total area dominate the rubber plantation industry. In India rubber has a long gestation period of about seven years with no income from the plantation. High development cost and absence of any income from the plantation in the initial years are the major problems faced by small growers. Under the normal planting system of rubber, intercrops can be cultivated during the initial three years only and in later years, sunlight is a limiting factor. Altering the planting...
ROLE OF BACTERIAL STRAIN IN DETERMINING THE EFFICIENCY OF GENETIC TRANSFORMATION IN HEVEA BRASILIENSIS

R. Jayashree, K. Rekha, P. Venkatachalam*, S. Sushamakumari, S. Sobha, M. Vineetha, A.M Suni, P. Leda, A. Thulaseedharan and P.A. Nazeem**

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Genetic transformation offers a viable approach in Hevea brasiliensis for crop improvement by adding valuable genes for specific characters in a relatively short period. 3-Hydroxy 3-methylglutaryl Coenzyme A reductase (HMGR) is considered as a key enzyme in the rubber biosynthetic pathway. With a view to increase the yield potential in Hevea, attempts were made to over-express this rate limiting enzyme by Agrobacterium tumefaciens mediated genetic transformation. Selection of an appropriate bacterial strain is one of the key parameters required for an efficient genetic transformation system. To identify a suitable bacterial strain giving maximum transformation efficiency with the hmgr1 gene in Hevea, three Agrobacterium strains (EHA 105, LBA4404 and pGV 1301) harbouring the transgene were experimented. The binary vector contained hygromycin phosphotransferase gene (hpt) as the plant selectable marker. The effect of different explants (primary callus, embryogenic callus and embryogenic suspension cultures) as well as co-cultivation temperature on transformation efficiency was evaluated. Highest transformation efficiency was observed with the strain EHA 105, irrespective of the target tissues tried for transformation. Low temperature incubation (20 °C) of the infected tissues during co-cultivation period improved the frequency of transformation. Among the different target tissues tried, embryogenic suspension cultures gave the maximum number of transgenic cell lines (32%). The presence of the transgene was confirmed in the transgenic cell lines by PCR using gene specific primers.

Keywords: Agrobacterium tumefaciens, Embryogenic suspension cultures, Genetic transformation

INTRODUCTION

The ultimate objective of breeding in natural rubber includes the development of superior clones with increased dry rubber yield. As Hevea clones cultivated in the south Asian countries originated from a small number of plant sources collected by Wickham, the genetic diversity is rather limited (Dijkman, 1951). Controlled hybridization allowed an increase in the latex yield of recommended clones to 2000 to 3000 kg/ha yr during 1980's (Omokhaye
COLD RESPONSES OF HEVEA BRASILIENSIS
CLONES UNDER CONTROLLED
ENVIRONMENTAL CONDITIONS

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Low temperature during winter season is the major constraint for the extension of rubber cultivation in subtropical environments that are prevailing in north-eastern India. Cold stress strongly affects the growth and productivity of rubber plants. In the present study, four Hevea brasiliensis clones viz., RRII 105, RRIC 100, SCATC 88/13 and Haiken 1 were exposed to cold stress under controlled environmental conditions. Morphological symptoms such as yellowing and drying of leaves were more prominent in RRIC 100 followed by RRII 105 and less prominent in SCATC 88/13 and Haiken 1. Photobleaching of the photosynthetic pigments, chlorophyll and carotenoids were comparatively lesser in Haiken 1 and SCATC 88/13. Maximum photochemical efficiency of PS II (Fv/Fm) and effective quantum yield of PS II (ΦPS II) were stable in SCATC 88/13 followed by Haiken 1 under low temperature conditions. The rate of lipid peroxidation was severe in RRII 105 and RRIC 100, indicating that these two clones succumbed to cold mediated oxidative stress. Two stress proteins were found in the chloroplast protein profile of Haiken 1 and SCATC 88/13 that may probably be involved in conferring cold tolerance to these two clones.

Keywords: Chlorophyll fluorescence, Cold stress, Lipid peroxidation, PS II, Stress proteins

INTRODUCTION

Hevea brasiliensis, the most important commercial source of natural rubber (NR) grows in a warm humid climate (21–35 °C) with a fairly distributed annual rainfall of not less than 200 cm (Rubber Grower’s Companion, 2012). Temperature extremes are the major factors limiting the productivity and geographical distribution of this crop. Shortage of available land ensuing from competition with other crops and increasing national and international demand for NR led rubber cultivation to be extended to marginal and subtropical environments that are prominently located in north-eastern regions of India, highlands and coastal areas of Vietnam, southern China and Southern plateau of Brazil. Low temperature, typhoon and prolonged dry periods are frequently encountered in these areas (Priyadarshan and Goncalves, 2003). Among these factors, low temperatures (between 0 to 10 °C) strongly affect the development and latex production of rubber trees in South Central China and northeastern states of India (Priyadarshan...
VARIATION IN TIMBER VOLUME AND WOOD PROPERTIES OF HIGH YIELDING RRII 400 SERIES CLONES OF HEVEA BRASIILIENSIS


Breeding and selection of fast growing clones of rubber with high latex yield and timber with good wood quality traits is a priority area of research at the Rubber Research Institute of India. A study was undertaken on the clonal variability among certain newly released high yielding RRII 400 series clones and their parents with the objective of identifying clones with high timber yield and quality. Timber volume of clones was determined from tree stands at the age of 20 years from five clones viz., RRII 414, RRII 417, RRII 422, RRII 429 and RRII 430 along with their parents RRII 105 and RRIC 100. Six trees each were selected for estimating quality traits. Wood samples were prepared for physical, mechanical and anatomical properties and clonal variability was analyzed according to standard procedures. Timber volume of all the new clones in general, was higher than that of the parental clones. RRII 430 and RRII 417 recorded the highest wood density 664 kg m$^{-3}$. These two clones showed comparable strength properties with RRII 105, which is known for quality timber traits. Volumetric shrinkage values from air dry to oven dry condition of all the clones were on par with that of parental clones. The higher timber output of the RRII 400 series and quality traits comparable with those of RRII 105, especially for the clones RRII 430 and RRII 417, make them good candidates as latex timber clones.

Keywords: RRII 400 series clones, Timber volume, Wood quality

INTRODUCTION

The demand for rubber wood, the major renewable byproduct from rubber plantations, has been steadily on the increase both locally and globally. Rubber wood attributes mainly, medium texture, attractive colour, beautiful grain pattern, light weight and durability makes it comparable to any good tropical rain forest wood (Anon, 1991). Rubber wood is the more preferred wood in Malaysia, especially for the furniture industry (Naji et al., 2011) accounting for 80 per cent of their export revenue which is expected to touch RM 20 billion by 2020 (Said and Seng, 2011). In India, the suitability indices worked out for rubber wood vis-a-vis teakwood (Kamala and Rao, 1993) indicated that it is dimensionally

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GROWTH AND EARLY YIELD POTENTIAL OF A FEW RRII 300 SERIES, IRCA AND OTHER CLONES OF HEVEA BRASILIENSIS UNDER THE DRY SUB-HUMID CLIMATE OF ODISHA, EASTERN INDIA

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The growth, girth increment, early dry rubber yield and timber yield of RRII 300 series, IRCA and a few other promising clones in the dry sub humid climate of Odisha in eastern region of India is reported. Prolonged high temperature, low rainfall and soil moisture are the major environmental constrains affecting the growth, yield and adaptability of clones in the region. Clone RRII 351 recorded the initial highest mean rubber yield (31.03 g t⁻¹t⁻¹) followed by IRCA 109 (30.69 g t⁻¹t⁻¹), whereas popular clones RRIM 600 and RRII 105 recorded 26.59 and 26.75 g t⁻¹t⁻¹, respectively. Highest and lowest yield was recorded during winter and summer months, respectively. RII 300 attained highest girth (53.03 cm) and girth increment but yield was relatively low. Highest bark thickness was recorded in PB 28/59 (6.97 mm) followed by 6.75 mm in RRII 357 and RRII 51. Highest bole volume was recorded in RRII 300 (0.07 m³ tree⁻¹) followed by IRCA 111 (0.06 m³ tree⁻¹). IRCA 111 recorded medium yield of 26.03 g t⁻¹t⁻¹, on par with that of the popular clones. In general, the clones RRII 351, RRII 352 and IRCA 109 were found to be more promising than the popular clones RRII 105 and RRIM 600 for early yield. The results of the present study will aid in the identification of potential clones for possible commercial cultivation in the region.

Keywords: Clone performance, Dry sub-humid climate, Girth, Timber, Yield

INTRODUCTION

The Para rubber tree, *Hevea brasiliensis* (Willd.ex Adr.de Juss.) Muell. Arg. is a tropical tree native to Amazon rainforest. More than 90 per cent of the world natural rubber (NR) is obtained from rubber tree latex (Verheye, 2010). Rubber has been traditionally cultivated in the equatorial region, in a zone lying between 10° north and 10° south of equator.

Compared to other crops, rubber is a relatively new introduction, having been brought in to cultivation in India a century ago. In the country the traditional rubber belt (8-12° N) encompasses the southern tips of the peninsula, where it provide appropriate environmental conditions and has been grown on a plantation scale for nearly a century.

The shrinking availability of cultivable land in the traditional region and ever
EFFECT OF PANEL CHANGING ON LONG TERM YIELD RESPONSE OF HEVEA BRASILIENSIS (CLONE RRII 105) UNDER DIFFERENT FREQUENCIES OF TAPPING AND STIMULATION

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The effect of panel changing on long term yield response of *Hevea brasiliensis* (clone RRII 105) under different frequencies of tapping and stimulation was studied over a period of eleven years. There were eight treatments comprising of d2, d3 and d4 frequencies of tapping of half spiral cuts with and without panel change at different levels of stimulation. Considerable yield variation was observed among various treatments over the years. Effect of panel change on yield increase was more prominent in the initial five years. No significant beneficial impact of panel change on yield increase was observed under different systems of tapping. Higher yield could be obtained under d2 and d3 frequency of tapping with upper panel change (CUT). Comparable yield could be obtained under various frequencies of tapping. Cumulative yields observed within similar systems of tapping with or without panel change were also comparable. In general, similar trend was also noticed in kg per tree, g t⁻¹ t⁻¹ and kg tap⁻¹. Significant increase in yield per tap and g t⁻¹ t⁻¹ was noticed under d4 frequency of tapping. However, highest cumulative yield was observed under d2 frequency of tapping which was observed to be at par with d3 frequency of tapping with or without panel change. Panel change resulted in higher TPD under d2 frequency of tapping compared to lower frequency of tapping. Moreover, benefit of panel change was reflected only in the initial five years but panel management after first five years of tapping is difficult. Hence, continuous panel change cannot be considered for managing TPD or to get sustainable high yield over long period.

**Keywords**: Long term yield, Panel change, RRII 105, Rubber yield, Tapping panel dryness

INTRODUCTION

Natural rubber is collected from rubber trees by tapping, a process of controlled wounding, which may last for 20 to 50 years depending on the strategies and tapping systems adopted (Paardekooper, 1989; Gohet *et al.*, 1991). Panel changing is attempted in some plantations under the assumption that it helps to manage tapping panel dryness and yield increase. It is also considered to be useful for reducing the physiological stress generated in the panel particularly by high frequency tapping (Eschbach *et al.*, 1986). Bark consumption or panel consumption is an important component of any tapping system which determines land and labour productivity.
STAINING PROCEDURE FOR SIEVE TUBES IN THE BARK OF HEVEA BRASILIENSIS USING O-DIANISIDINE

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A specific stain for the identification of sieve tubes in the bark of Hevea particularly in transverse plane is lacking, hence a new staining procedure has been developed. Fresh sections of bark preserved in 4 per cent glutaraldehyde were treated with a mixture containing O-dianisidine 1 mg mL⁻¹ and 1 per cent hydrogen peroxide in 0.1 M phosphate buffer (pH 7), for about 0.5-1 minute. Observations and photomicrographs were taken by using Leica QWin V3 image analysis system attached to Leica DM 1000 microscope. Transverse sections of the soft bark when stained with O-dianisidine gave deep brown coloration for the cell walls of sieve tubes present in the inner soft bark, as well as the recently differentiated ones from the cambium. The cell wall of companion cells, axial and radial parenchyma, and laticifers remained unstained. The study revealed that the staining method using O-dianisidine is suitable for identifying sieve tubes in cross sectional plane of Hevea bark.

Keywords: Glutaraldehyde, O-dianisidine, Sieve tubes, Staining procedure

INTRODUCTION

Hevea brasiliensis, the prime source of natural rubber, is exploited commercially by severing the latex vessels present in the bark of the tree trunk (Dijkman, 1951). A number of anatomical and histochemical studies on Hevea bark have been carried out earlier using various stains viz., Sudan IV (Premakumari et al., 1996) and Oil red O (Omman and Reghu, 2003) for laticifers, Tannic acid-ferric chloride - lacmoid (Cheadle et al., 1953; Pramod et al., 2011) and Aniline blue (Johansen, 1940) for definitive callose, mercuric bromophenol (Mazia et al., 1953; Pramod et al., 2008) for P-protein, phloroglucinol-HCl (Jensen, 1962; Thomas et al., 1995) for lignin, silver nitrite (Johansen, 1940; Thomas et al., 2002) for crystals and amido black 10B (Weine, 1957; Thomas et al., 2010) for protein storing cells and Iodine-Potassium iodide (Johansen, 1940; Hebant and Fay, 1980; Thomas et al., 2002) for starch. Some of the above methods are commonly used for bark characteristic studies in the evaluation process of the newly developed clones of H. brasiliensis (Premakumari et al., 1996; Pramod et al., 2008; Thomas et al., 2010).

Sieve tubes of phloem tissues in the soft bark are functionally active for the downward translocation of photo-assimilates for the biosynthesis of latex in the laticiferous system. The survey of
CLONAL VARIATION IN QUANTITATIVE TRAITS OF LATICIFERS IN HEVEA BRASIILIENSIS

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Latex vessels form a very imperative tissue system in the secondary phloem of Hevea brasiliensis. They run in the longitudinal axis of the stem with a specific angle of inclination for a particular Hevea clone. Rubber particles are synthesized in the laticiferous system present in the bark tissue and exploited through controlled wounding of the bark called tapping. Most of the laticifer characters have great significance for latex yield in Hevea. A detailed investigation on the latex vessel characters of ten clones has been made in the present study. The secondary phloem consisted of soft bark (SB) region devoid of stone cells and inner hard bark (IHB) region with stone cells. Number of latex vessel rows in both the location was higher in PB clones. The distance between laticifer rows exhibited significant clonal variability. About 90 per cent of the latex vessels were running contiguous to phloic rays and only 10 per cent remained non-contiguous to phloic rays. The articulated and anastomosing nature of laticifers were well supported by inter-connections and it was the highest in the clone RRII 105. Significant superiority of PB clones with respect to latex vessel diameter and total cross sectional area of laticifers was also noticed.

Keywords: Latex vessel diameter, Latex vessel rows, Laticifers, Laticifer area index

INTRODUCTION

Latex vessels or laticifers are cylindrical tubes distributed in the form of rows or rings in the secondary phloem and running in the longitudinal axis of the stem with specific angle of inclination (Omman and Reghu, 2008). Laticiferous system has been considered as the site of rubber synthesis in H. brasiliensis (Gomez, 1966; Southorn, 1966) and can be well stained by Oil Red O (Omman and Reghu, 2003). The number of laticifer rows has been reported as a quantitative anatomical parameter pertaining to latex yield in H. brasiliensis (Bobilioff, 1923; Gomez, 1966). The correlation of this trait with yield in Hevea has already been proved (Narayanan et al., 1973; Narayanan et al., 1974). The number of laticifer rows has been identified as a clonal character (Vischer 1921; Sanderson and Sutcliffe, 1929; Gottardi et al., 1995) which varies considerably with tree age (Bryce and Campbell, 1917; Gomez et al., 1972) and height (Sanderson and Sutcliffe, 1929; Gomez et al., 1972) of the tree whereas the variability is not significant at young stages (Costa et al., 2000).

The distance between laticifer rows has been considered as a yield contributing...
ADOPTION OF INTERCROPS IN THE TRADITIONAL RUBBER GROWING REGIONS IN INDIA: EMERGING TRENDS IN THE SMALLHOLDER SECTOR

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The study confined to the smallholdings, which availed planting subsidy during 2004-10, showed that among the various intercrops, banana was the most popular intercrop in the traditional rubber growing region which spread over five agro-climatic zones. The results of the study revealed that there were notable differences in the extent of adoption of intercropping, choice of crops and size-class-wise preferences. The highest level of adoption of intercrops in rubber plantations was observed in Kanyakumari region (72.8%) followed by Central Kerala (72.2%) and South Kerala (68.2%) during the seven year period under study. Adoption of intercrops was the lowest in North Kerala (36.2%). The analysis revealed that pineapple replaced banana as the choicest intercrop in Central Kerala. The size of holding was a key determinant in the selection of intercrops. A positive relationship was observed between large size of holding and adoption of commercial crops such as banana and pineapple whereas subsistence crops such as tapioca, amorphophallus and colocasia were preferred in the smallest size-class.

Keywords: Adoption, Holding size-class, Intercrops, Smallholdings, Traditional belt

INTRODUCTION

The twin objectives of intercropping in the immature phase of rubber plantations are to generate income in the cash-trap period and to intensify cropping in the spatial and temporal dimensions. Intercrops such as pineapple, banana, vegetables and yams are cultivated during the immature phase of rubber whereas coffee, cocoa and medicinal plants are recommended for the mature phase (Rubber Board, 2011). In the traditional rubber growing regions, the popularity of intercropping and choice of crops varied significantly (Rajasekharan and Veeraputhran, 2002). The extent of intercropping during the immature phase of rubber plantations varied from 61.5 per cent (North Kerala) to 85 per cent (South Kerala) and the choice of intercrops depended mainly on the size of holdings, local preferences, marketing facilities, price of produce, availability of family labour, irrigation facilities etc. (Anilkumar et al., 2005).

Historically, rubber was grown as a monocrop in the traditional regions. The genesis of organised attempts to promote

Historically, price movements of all forms of natural rubber in India have been either directly or indirectly linked to the trends in the price of the dominant RSS 4 grade. Under the protected price policy regime, the prevailing interlinkages among the prices have ensured comparative stability and margins at various stages. The price movements of all forms of processed/unprocessed rubber including preserved field latex (PFL) and centrifuged latex (CL) have also been based on the price movements of RSS 4. However, instability in the RSS 4 prices consequent to the trade policy reforms since the early 1990s led to important structural adjustments in the domestic market. As a survival strategy, the latex processing industry has gradually delinked PFL price from RSS 4 and linked to CL price in order to protect the margins since the mid 2000s. The preliminary observations of the study highlighted the crucial role of the growing narrowness of the domestic market due to the significant growth in the import of latex based value added products rather than the import of CL for the segmentation of the latex market. Hence, a two pronged strategy of rehabilitating the latex based manufacturing segment so as to ensure commensurate rate of growth in latex consumption and rejuvenating the latex processing industry to reinforce the focus on exports is suggested.

**Keywords:** Centrifuged latex, Latex processing industry, Preserved field latex

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**INTRODUCTION**

Historically, the three important factors which had a strong bearing on natural rubber (NR) price movements in India had been: (i) growth of a large and diversified captive domestic market since the late 1930s, (ii) protected price policy regime since 1942 to 1991-92 and (iii) dominance of dry rubber products in the rubber products manufacturing sector (George and Joseph, 1992; George, 1999; Mohanakumar and George, 1999). The persistent dominance of the dry rubber products manufacturing sector and the growth of a captive domestic market during the past eight decades had important implications for the relative status of various forms of processed NR and the price movements [Among the various forms of processed NR in India, the combined share of ribbed smoked sheets (RSS) was more than 71 per cent during 2010-11 (Rubber Board, 2011)]. Conversely, the relative share
INCIDENCE OF RED ROOT DISEASE IN 
HEVEA CAUSED BY GANODERMA PSUEDOFERREUM: 
A FIRST REPORT FROM NIGERIA

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A field survey was conducted on 14,720 rubber trees in 32 ha clonal garden of Rubber Research Institute of Nigeria (RRIN) in July-September 2011, to evaluate the status of new root diseases by visual examination. The infection of red root rot was 0.02 per cent. Two varieties of red root rot were encountered; large one that caused infection on living rubber tree termed 'infective red root rot' and the second seen only on dead rubber trunk and subterranean or on dead rubber stumps already killed by white root rot termed as 'non-infective' red root rot. The size of the fruiting bodies of the 'infective red root rot' ranged from 27-30 cm by 17.5-19 cm (length x breadth) with shining dark red upper surface with narrow white margin and ash-light-yellow under surface and a prominent creamy-white fringe. The size of the ‘non-infective’ fructification ranged from 5.3 to 5.7 cm by 3.1 to 4.2 cm (length x breadth) with dark brownish red upper surface and wide white margin and white under surface and a prominent creamy-white fringe. This study confirms the incidence of red root disease in rubber plantations in Nigeria and report the existence of two varieties of Ganoderma psuedoferreum. The study also suggests further regular field inspection of plantations and adequate control measures to forestall epidemic outbreak of the pathogen in plantations in Nigeria.

Keywords: Disease incidence, Ganoderma psuedoferreum, Occurrence and diversity, Red root disease

The most important root rot pathogens of Hevea brasiliensis are the Basidiomycetes (Rigidoporus lignosus (Klotzsch) Imazeki, Phellinus noxius (Corner) G. H. Cunn., Ganoderma psuedoferreum (Wakef.) Over and Steinm.) and Ascomycetes (Ustulina zonata (Lév.) Sacc., Sphaerostilbe repens (Berk. & Br.) and Poria hypobrunnea (Petch). Of these six, R. lignosus, P. noxius and G. psuedoferreum are of economic importance causing white, brown and red root diseases, respectively, each capable of killing the trees directly (Rao, 1975). Their relative economic impacts vary considerably from one country to the next. G. psuedoferreum is less common than white root, being localized in areas where carry-over of infective material is substantial or deep seated (Rao, 1975). It has become an important root pathogen which brings about die-back of mature trees (Rao, 1975). The distribution of red root rot disease is worldwide and is especially serious in China and is reported as being the second most significant root disease in Malaysia and

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BLENDS AND COMPOSITES OF NATURAL RUBBER AND EPDM RUBBER WITH POLAR RUBBERS

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Recent developments in polymer blends and composites from non-polar/polar rubbers are reviewed in this article. Blending of elastomers is frequently used to enhance the performance-processing characteristics of rubber compounds. Many of the elastomer blends are characterized by a two-phase morphology, narrow interface, and poor physical and chemical interactions across the phase boundaries resulting in poor mechanical properties. To overcome this, compatibilizers and reactive blending are generally used which improve the interfacial adhesion and reduce the coalescence between non-polar/polar rubbers. These blend systems are immiscible and the compounding ingredients are nonuniformly distributed in two phases depending on their affinity, rate of diffusion and reactivity to different components.

**Keywords**: Composites, EPDM rubber, Polar rubbers, Rubber blends

INTRODUCTION

Initially synthetic rubbers, like styrene-butadiene rubber (SBR) and butadiene rubber (BR), were introduced as counterparts for natural rubber (NR) during World Wars I and II. Normally, synthetic rubbers provide inferior mechanical properties compared to NR due to the lack of strain-crystallization. Synthetic rubbers, like nitrile rubber (NBR), ethylene-propylene rubber (EPM and EPDM) and chlorinated polyethylene (CM) are widely used for their special properties, such as better ageing, ozone, oil and heat resistance. Along with the developments in synthetic rubbers, new vulcanization systems were also designed to achieve proper vulcanization with good properties.

Blending or mixing of two or more elastomers is carried out for three main reasons: improvement of the technological properties of an elastomer, for better processing behavior and for reducing the compound cost. Blending is thus a method of obtaining optimum properties and performance at a reasonable cost, if the technical properties are satisfied.

Mixtures and blends occur at different hierarchical scales in the material range employed in the rubber industry. Composite products such as tyres, hoses, beltings and air springs are composed of metal wire, textile cord and elastomeric compounds which form a rubber matrix. The rubber matrix itself may be a mixture of elastomers, fillers and plasticizers.
MECHANICAL PROPERTIES OF RUBBER OBTAINED BY SURFACTANT SENSITIZED COAGULATION OF FRESH NATURAL RUBBER LATEX

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Fresh natural rubber (NR) latex coagulates immediately by sensitization with suitable surfactants. When surfactants are added to latex, the surfactant anions displace a part of protein molecules and get adsorbed on the rubber particles. The surfactants retained on rubber during coagulation play a major role on the cure characteristics, mechanical properties and ageing characteristics of the recovered rubber. Better cure characteristics as revealed from a higher level of vulcanization are obtained for gum and carbon black filled compounds for NR prepared by immediate coagulation in comparison with the conventionally coagulated NR. Better mechanical properties and solvent ageing resistance are also observed. Carbon black filled vulcanizates give a higher modulus, tensile strength, hardness and significantly higher abrasion resistance as compared with conventional rubber vulcanizate. The compression set and heat build-up characteristics are comparable. The improvement in mechanical properties and solvent resistance obtained for the NR prepared by the new process is attributed to the surfactants retained in rubber, higher level of vulcanization and better dispersion of filler.

Keywords: Carbon black, Latex, Mechanical properties, Surfactant.

INTRODUCTION

NR latex is a colloidal dispersion of rubber particles in an aqueous medium obtained from latex vessels of Hevea brasiliensis tree. The dry rubber content of latex generally varies from about 28 to 42 per cent. In addition to rubber, latex contains non-rubber ingredients like proteins (2-2.5%), sugar (1-1.5%) resin (1-2%) and ash (0.7-0.9%). These non rubber ingredients play a major role in the colloidal stability of latex and in cure and mechanical properties of the recovered rubber. The composition of non-rubber ingredients change after latex leaves the tree and the obvious consequence of this is the coagulation of latex within a few hours of tapping. This is called spontaneous coagulation. Normally rubber is recovered from latex by a slow coagulation process after the addition of coagulants like formic acid, acetic acid, sulphamic acid etc. Earlier reports show that the process of spontaneous coagulation, which occurs in the absence of added coagulants, can be accelerated by addition of suitable surfactants (Van Gils, 1947; Blackley, 1997; Cockbain, 1952). The mechanism of this is believed to be due to displacement of the protective layer of proteins by added surfactants.

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