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# RUBBER RESEARCH INSTITUTE OF SRI LANKA

# ANNUAL REVIEW 1998


DNA fingerprinting of rubber clones

RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW 1998

**Cover:** Commercial planting of new RRISL clones.
DNA fingerprinting technique for identification of clones.

**Photographs by :** Wimal Amarathunge.

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# ANNUAL REVIEW 1998

January to December

Editors:
L M K Tillekeratne, PhD (Aston)
N Yogaratnam, PhD (Lond.)

May 1999

Headquarters and Laboratories
Dartonfield
Agalawatta

Board Office and Laboratories
Telawala Road
Ratmalana

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Mr Anusha Perera, Salawa Estate, Hanwella
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Attorney General's Department
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P O Box 502
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Chartered Accountants
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Colombo 8

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Bank of Ceylon
Corporate Branch
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Genetics and Plant Breeding Department
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**Rubber Research Institute - Substation**
*Kuruwita, Ratnapura*

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| General | 01 - 633351 |
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## RUBBER RESEARCH INSTITUTE OF SRI LANKA

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| *Junior Clerk* | D S Jayasinghe |

* On study leave overseas

** On no pay leave overseas

# RETIREMENT


Dr N Yogaratnam will be retiring from the post of Deputy Director (Research) of the Rubber Research Institute on 20th May 1999 after serving the organization for over 30 years.

A graduate in Agriculture of the University of Allahabad, he obtained his PhD in Tree Crop Nutrition from the University of London for his Thesis on the "Effects of nutrient sprays on fruit set, mineral composition and fruit quality of apple".

He joined the Institute in 1969 as an Assistant Soils Chemist and then functioned as Agronomist until 1976 when he was appointed as the Head of the Soils and Plant Nutrition Department. He then functioned as the Assistant Director from 1988 to 1992 and finally as the Deputy Director (Research) until his retirement.

He has done pioneering research into the use of, urea as a nitrogenous fertilizer for rubber, Eppawala Rock Phosphate as a source of phosphate for rubber, water soluble liquid formulations of fertilizers for young budding nursery plants and also on interplanting of rubber with tea. His other significant contributions are, increasing fertilizer use efficiency and perfecting of the technique of site specific fertilizer recommendations based on soil and foliar analysis, all of which result in an annual saving of several million rupees in the fertilizer cost of mature plantings. Also, he formulated MSMA based herbicide formulations as substitute to sodium arsenite for weed control under rubber when the use of sodium arsenite was banned in Sri Lanka.

He is a member of the research team that received the National Award for Scientific Achievement in 1990. He has published over 100 scientific articles most of them on Rubber Agronomy.

Also, he worked as a Tree Crop Agronomist for the Ministry of Agriculture and Water Development, Republic of Zambia, as a Fertilizer Consultant in Malaysia, as a Soil Science and Agronomy Consultant to a World Bank financed project on Forestry Development and on Tea Agronomy at the Tea Research Institute for a short period prior to joining this Institute.

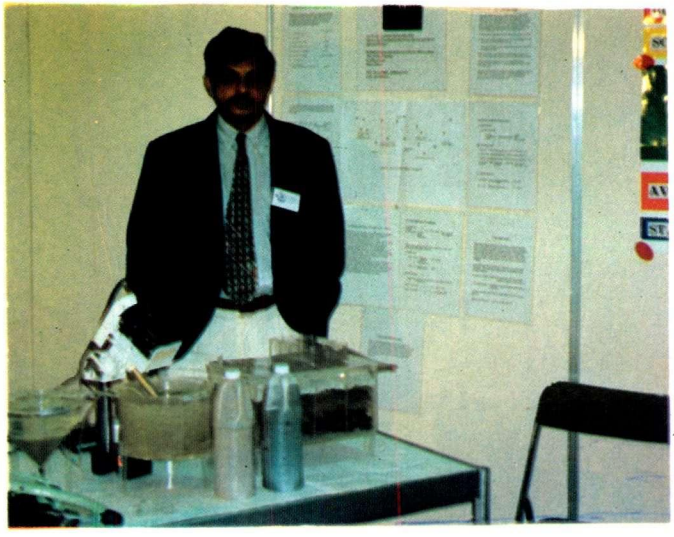
He was actively involved in other Agronomy and Soil Science related activities also and was the President of the Indian Society of Agronomy, Allahabad Branch, in 1962 and 1963 and the President of the Soil Science Society of Sri Lanka, which is affiliated to the International Soil Science Society (ISSS), in 1993 and 1994.

# ACHIEVEMENTS

## ISO 9002 Certification
*Dartonfield Factory*

The Rubber Research Institute Rubber Factory in Dartonfield was awarded the ISO 9002 quality system certification by the Sri Lanka Standard Institution in 1998. Hon. Ratnasiri Wickremanayake, Minister of Public Administration, Home Affairs and Plantation Industries, received the certificate from Dr A R L Wijesekera, Chairman of the Sri Lanka Standard Institution in the presence of Mr R I Obeyesekere, Chairman, RRB and Dr L M K Tillekeratne, Director, RRI.

## Industrial Waste Water Treatment Process
*Silver Medal*



Dr W M G Seneviratne, Head of the Raw Rubber Process Development and Chemical Engineering Department of the RRISL was awarded the Silver Medal for his new invention of a cost effective industrial waste water treatment process based on rubberized coir carrier matrix filled anaerobic digestion coupled with aerobic digestion mechanism, at the 26th International Inventors Exhibition held in Geneva, Switzerland in March 1998.

# OTHER ACHIEVEMENTS

*last five years*

* Presidential award for inventions 1995 - Dr L.M.K. Tillekeratne

* Silver Medal at the International Inventors' Exhibition Geneva 1996 - Dr L.M.K. Tillekeratne

* Gold Medal for Most Outstanding Citizen 1997 in the field of Commerce and Industry awarded by the Lions Clubs International - Dr L.M.K. Tillekeratne

* GRC award of the Sri Lanka Association for Advancement of Science, 1997 - Dr L.M.K. Tillekeratne

* Consolation Award of the Presidential Award for inventions 1998 - Mr P L Perera

* Most Innovative Award of the Plastics and Rubber Institute of Sri Lanka 1998 - Dr W.M.G. Seneviratne

# RUBBER RESEARCH INSTITUTE OF SRI LANKA

## DIRECTOR'S REVIEW

**L M K Tillekeratne**

The Natural Rubber prices dropped to a thirty year low figure in July 1997 due to the impact of the currency crisis in South East Asia. As a result, even INRO which is the international organization responsible for stabilizing the price of Natural Rubber came to an uncertain state with Malaysia and Thailand deciding to withdraw from it with effect from 15.10.1999.

After an average increase of more than 4% per year between 1994 to 1997, the world consumption of natural and synthetic rubber in 1998 arose only by 0.7%. The NR consumption alone in the world went up by 2% in 1998 compared to 1994-97 period. It appears that this slow growth has been caused by the Asian financial crisis. Nevertheless, the quite high growth of the consumption in European countries such as the European Union and North America which are not affected by the Asian crisis, did not allow the total elastomer consumption in the world to decline vastly, thereby offsetting the drop in consumption in Asia.

Asian rubber consumption grew by more than 3% in 1997, but declined by more than 3% in 1998. All the major Asian rubber consuming countries other than Thailand and Malaysia have performed better due to their continued export of latex products to strong economies in North America and in the European Union. India's NR consumption growth which was expected at 4% in 1997 has gone down far less than that. Nevertheless in Sri Lanka, due to the expansion of rubber based industries as a result of recognition of the rubber based industries as thrust industries by the government of Sri Lanka, the consumption has increased in 1998 by 2.5%.

Since 1978, BOI has approved 132 rubber based projects with an estimated investment totalling US$ 130 Mn., including a foreign investment of over 60%. As at end December 1998, 55 rubber product companies were in commercial operation producing a wide spectrum of products ranging from tyres, gloves and footwear to oil seals and moulded rubber components. These projects with investments from countries such as Australia, Sweden, Germany, Belgium, Malaysia, Korea, Japan, UK and USA have an employment capacity of more than 20,000 persons. The value of rubber products exported by BOI approved companies during January/November 1998 exceeded US$ 178 Mn.

The impressive growth in foreign exchange earnings (from Rs.18.4 Mn. in 1980 to Rs.10,513 Mn. in 1997) shown by BOI approved companies is a distinctive feature of the industry. High quality products such as solid tyres, surgical and

examination gloves continued to enjoy a wide consumer acceptance in sophisticated markets.

The rubber products industry, one of the priority sectors identified for active promotion by the BOI, was accorded "thrust industry" status in 1997. Several large scale rubber manufacturing companies have obtained BOI approval since 1997 to further expand their respective production capacities. Accordingly, a sharp rise in rubber consumption since the introduction of this scheme was evident. For instance, the demand for NR in the tyre retreading, flooring and dipped products sectors grew by 17.5%, 28.5% AND 36% respectively. This highlights the response to the incentive package on offer to inventors under the "thrust industry" scheme.

Further in 1998, the SR share in the elastomer market also dropped to the lowest level in 32 years.

With the increase in the domestic rubber prices in producing countries in Asia such as Indonesia, Malaysia and Thailand, the NR production has been increasing sharply. It increased by 2.5% to 6.57 million MT, except in Malaysia where the NR output fell sharply in 1998.

Price of latex crepe started declining from May 1998 and fell below RSS 3 price by November and December 1998. The reason for this decline has been attributed to the deterioration of quality of the end product produced by estates.

Although initially they believed that the quality of rubber chemicals available in the market were causing this discolouration, the survey done by the RRI revealed that except in a few cases of low strength reported on the active ingredient content of Formic Acid and the Bleaching agents, generally the quality of the chemicals were satisfactory and they did not have metal ion levels above the maximum recommended limit.

Nevertheless, it has been clearly observed that the quality of crepe rubber produced even in reputed large factories is poor due to the fact that they do central processing in order to lower their COP by bulking latex of many surrounding estates. In this process of central processing in a large factory, the following shortcomings have been observed:-

a. latex of some of the divisions arrive around 5.00 p.m. and hence by the time they add sodium bisulphite, the enzymatic discolouration has taken place to the maximum.

b. due to lack of milling facilities, blanketed coagula is kept for long periods of time for smooth milling, exposed to the atmosphere.

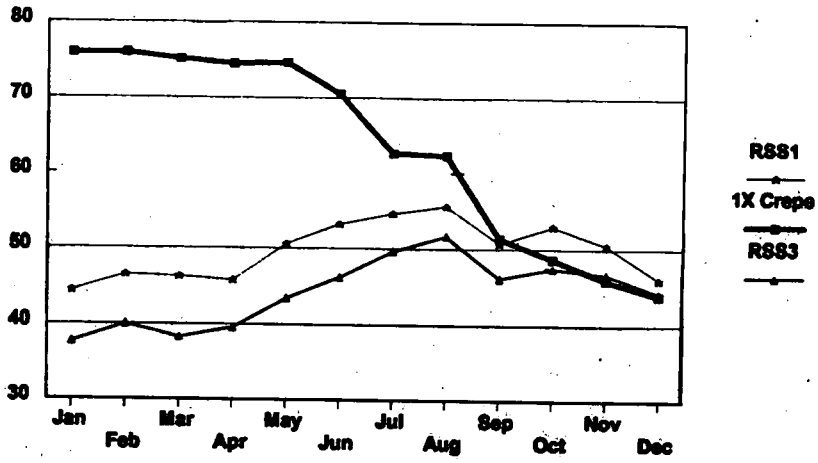
c. due to lack of drying tower capacities, laces are dried mainly in lofts thereby taking 5-6 days for drying.

The RRI, therefore, informed all crepe factories direct and through CRTA and the Planters' Association that the above steps should not be followed in factories where they lack facilities for bulking, milling and drying of rubber. By practising such procedures by which a few cents may be saved by lowering the COP, they lose heavily on the selling price. They were further enlightened that obtaining ISO 9002 registration is the solution for this type of quality variation in rubber. In 1998, Padukka Estate fulfilled the requirement for ISO 9002 in their factory. From this, it is clear that unless all management companies completely do away from the short cut methods of manufacturing crepe rubber, regaining the reputation of latex crepe rubber in the market will not be easy, specially when large quantities of TSR L grade are available at around US$ 0.59 per kg in most of the South East Asian countries.

Rainguards used by Bogawantalawa Plantation and Pussellawa Plantation during 1998 have been very successful and they have been able to tap on 326 days even on very heavy rainy days; thereby receiving 20-25% extra crop compared to other estates.

The other grade of rubber worst effected price wise during the year is concentrated latex; the purchasing of which was virtually stopped by multinational companies. With this reaction of multinationals and other factors such as detection of TSR Pallets of Indonesian origin in colombo has created suspicion among RRI officers that some traders import NR from other cheaper sources in SEA without properly declaring them in Customs documents and advised the Ministry to take precaution to stop this.

**Auction price variation of latex crepe ix and RSS in 1998**



As a result of this price drop, most of the rubber smallholders have already decided to diversify from rubber to tea. In many places, plantations are not tapped while certain others are blocking out prime rubber land for housing. In other SEA countries like Malaysia and Indonesia, most of the plantations have already gone for oil palm instead of rubber.

However, in order to protect this important agricultural crop from the point of view of providing rain forest and valuable timber for furniture manufacture, the Government of Malaysia has already increased tax on oil palm exports by RM 112 per MT to discourage the rubber farmers going into oil palm planting. They have even completely banned the import of raw rubber into Malaysia for processing to safeguard their local rubber producers. Usually, nearly 15% of the rubber produced and sold by Malaysia was the crude scrap rubber imported from neighbouring countries for upgrading. Even in Sri Lanka there are companies in the Southern region who have decided to uproot rubber and randomly plant oil palm. They have to be extra careful and study carefully the possible economic impact of diversification from rubber, even if they ignore the ecological impact of such diversification.

**Research**

The new RRISL 200 series clones *viz:* RRISL 200, RRISL 201, RRISL 205, RRISL 206 and RRISL 211, have shown very healthy and vigourous growth in blocks of commercial plantings. Among the clones received under the Smallholder Rubber Rehabilitation Project II, PB 235 and PB 260 showed very attractive immature vigour and uniformity in growth in all the experimental sites. Initial yield data show these two clones to be very high yielding and therefore special attention is being given to monitor the TPD incidence on these two clones.

Laboratory facilities to carry out a major part of the research work involving *Hevea* molecular biology were established at the Genetics and Plant Breeding Department. A method to genetically distinguish the presently recommended RRIC 100 series clones was developed by analysing the DNA of these clones using a PCR based technique, RAPD.

Crown budding could be undertaken in 2-3 year old clearings to replace the canopy with different genotype. The annual mean yield of a tree per tapping increases with increase in girth at opening. Although the intake per tapper is higher in clones when tapped on d3 system with stimulation but the yield per hectare is lower than with the conventional systems. Yields from base panel, BI-I are comparable to that from higher panel virgin bark. Planting densities higher than 500 per Ha appears to adversely affect girthing and bark thickness.

Bush legumes, *Flemingia congesta* and *Crotolaria anagyroides* could be grown successfully between the rows of rubber plants which would also provide

sufficient biomass for mulching. *Mucuna bracteata* has also been identified as an effective legume species as it tolerates drought condition and suppresses weeds very effectively. The soil and foliar survey programme for fertilizer recommendations continues to be very popular among the plantation companies, especially under the present adverse trading conditions of rubber when economy measures are to be continued.

Systemic fungicide Folicur (tebuconazole) has been found to be very effective in controlling white root disease under field conditions. This could be used as a substitute for the fungicide Anvil (hexaconazole) recommend to use as a drench application.

Among the fungicides tested against leaf diseases caused by *Colletotrichum acutatum* and *C. gloeosporioides*; benomyl, copper oxychloride, propiconazole, tebuconazole and thio-phanate methyl were found to be effective against *C. gloeosporioides* while fungicides, copper oxychloride, pencycuron, propiconazole and tebuconazole are effective against *C. acutatum.* In view of this, combination of two fungicides appears to be the best in controlling *Colletotrichum* leaf disease. Further, two more characteristics, slower growth at temperatures ranging from 15 to 32.5°C and high tolerance of three fungicides were shown to be as reliable characters in distinguishing rubber isolates of *Colletotrichum acutatum* from *Colletotrichum gloeosporioides* in addition to the characters reported earlier.

Adaptive research programs on clone evaluation, soil and moisture conservation practices, organic manure and young budding were continued for the benefit of the smallholders.

Powdered rubber is a modified rubber useful in high quality product manufacture using injection moulding facilities. Oil absorption properties of powdered rubber is also an added advantage. Initial trials on sticker type rainguards using powdered rubber and hot bitumen mixtures for road surfacing applications showed good results.

It was observed that some locally available fatty acid materials could replace stearic acid in compounding to provide better physical properties. A very high tear strength was recorded on samples containing the new fatty acid based materials.

A modified Lowry procedure for the analysis of leachable proteins in NR latex was established. Water-soluble proteins in irradiated NR latex and in a modified type of latex were found to be below the detectable levels; *i.e.* < 50 μg. NR latex from RRIC 130 clone was found to posses the highest green strength though the tensile strength of the same after irradiation was poor.

The effluent treatment system based on anaerobic septic tank with aerobic digestion principle has already been acclaimed both locally and internationally as the most cost effective process for the treatment of rubber and allied industrial waste water.

Effect of latex preservatives on metrolac reading was studied and it was found that none of the 4 common preservatives used for natural rubber latex has any effect on the metrolac reading, if the recommended dosage is not exceeded. It was found that by using a drying chamber completely enclosed with asbestoes and fitted with an exhaust fan at the top, crepe laces could be dried within two days under normal climatic conditions without employing any heat source creating an air flow by means of the exhaust fan. Viscosity stabilization of CV sheet rubber was much improved when the sheets are dried in the green house type solar dryer. A new cost effective brushable rainguard sealant was developed and introduced to the plantation.

## OVERSEAS VISITORS

Mr Maurice Cain, International Rubber Study Group, UK
Dr M R Sethuraj, Rubber Board, India
Mr Van Niekeru, SWEEPA, Netherlands
Ms Capucine Marida, France
Mr Laetitia Framberg, France

# GENETICS AND PLANT BREEDING

D P S T G Attanayaka

## SUMMARY

Budwood from three Thailand and three Indonesian clones were received under a bilateral clone exchange programme. The clones PB 235, PB 260 and RRIC 121 showed a vigorous growth when compared to the rest of the six clones tested under the SRRP clone trial. A new set of field trials was established to study the genetic, environment and interaction effects on RRISL 200 series clones.

A laboratory technique based on PCR was developed to identify the RRIC 100 series clones recommended for planting.

## DETAILED REVIEW

### Staff

Dr D P S T G Attanayake, Acting Head of Genetics and Plant Breeding Department, was appointed as the Head of Genetics and Plant Breeding Department with effect from 24th April 1998. Mrs S P Withanage, Trainee under the Graduate Training Scheme was recruited to the permanent staff and appointed as Assistant Geneticist and Plant Breeder with effect from 1st January 1998. Mrs S P Herath, Assistant Geneticist and Plant Breeder, Mr K W Rupatunga, Experimental Officer, Mr B M S G Peiris, Senior Experimental Assistant, Mr I D M J Sarath Kumara, Miss A K Gamage and Mr T M S K Gunasekera Technical Officers, Mrs S D P K L Pieris, Clerk/Typist were on duty throughout the year. Mr H P Peiris, Technical Officer was transferred to this Department with effect from 2nd February 1998.

### Meetings and Workshops

Dr D P S T G Attanayaka attended the following meetings and workshops.

- Central Scientific Committee of the RRI.
- Committee on specialist Group on Plant breeders, tissue culturalists and Biotechnologists
- National workshop on Rubber Breeding, 8-9 December 1998, Medan, Indonesia.

**Research students/training**

Mr P G Manawadu a final year student from faculty of Agriculture, University of Peradeniya completed his research training and submitted a report on "Investigation on the genomic organisation of the *ref* gene and inheritance of a RAPD markers in *Hevea brasiliensis*" under the joint supervision of Dr D P S T G Attanayaka and Prof. Eric H Karunanayake of the Colombo Medical faculty.

**Bilateral clone exchange programme**

Budwood from three Thailand clones *viz*; RRIT 218, RRIT 225, RRIT 226 and three Indonesian clones *viz*; TM 6, TM 8 and TM 9 was received in exchange to RRIC 117, RRIC 130 and RRIC 133 in August 1998. This exchange programme was arranged by the ANRPC.

## LABORATORY INVESTIGATIONS

**Molecular biology of *Hevea* GPB/MM/97**

Laboratory facilities for PCR work was established at this Department and a major part of the work that has been carried out at the Colombo Medical Faculty was gradually shifted to this Department. Sixty random primers were tested to assess for their suitability for RAPD work.

RAPD technique was used in the genetic differentiation of the currently recommended RRIC 100 series clones and two germplasm clones. Based on the RAPD banding pattern a key to identify the presently recommended RRIC 100 series clones was developed (D P S T G Attanayaka, S P Herath, Anusha Gamage and E H Karunanayaka, Colombo Medical Faculty).

## FIELD EXPERIMENTS

**Hand pollination programme for 1998 (GPB/BST/HP/98)**

Five trees of PB 260 clone from the Malaboda division and three mother trees of clones DP 878, DP 17 and GPS I were selected for cross pollination programme in this year. The number of pollinations done in each cross, number of pods harvested and seedlings obtained are given in Table 1.

Table 1. *Details of 1998 hand pollination programme*

| Cross | No. of pollinations | Fruit set after | | No. of pods harvested | No. of seedlings |
|---|---|---|---|---|---|
| | | 4 weeks | 8 weeks | | |
| PB 260 x PB 260 | 206 | 01 | 01 | 01 | 02 |
| PB 260 x RRIC 130 | 4361 | 305 | 166 | 163 | 278 |
| PB 260 x PB 235 | 34 | 02 | 00 | 00 | 00 |
| PB 260 xTree No. 119 | 20 | 00 | 00 | 00 | 00 |
| GPS I x RRIC 130 | 97 | 00 | 00 | 00 | 00 |
| DP 17 x DP 17 | 75 | 00 | 00 | 00 | 00 |
| DP 878 x DP 878 | 508 | 10 | 10 | 09 | 04* (seeds |
| DP 878 x illegitimate | 19 | 03 | 02 | 02 | mixed at planting) |
| Total | 5320 | 319 | 178 | 175 | 284 |

Apart from the above number of pollinations a mother tree of RRIC 130 was selfed using the standard pollination technique and using a pollen suspended in the pollen germination medium. The number of pollinations carried out was not sufficient to reach on any conclusion.

| | | |
|---|---|---|
| RRIC 130 x RRIC 130 (Standard method) | 35 | 0 |
| RRIC 130 x RRIC 130 (Pollen suspension) | 38 | 0 |

(D P S T G Attanayaka, K B Karunasekera, S P Withanage, I D M J Sarath Kumara and T M S K Gunasekera).

**Evaluation of hand pollinated progenies**

***Small scale clone trials***

The total number of hand pollinated progenies which are being tested at Small Scale Clone Trial stages to date, their locations and planting dates are given in the table 2.

Table 2. *Details of the small scale clone trials to date*

| HP year | Site | Planting date |
|---|---|---|
| 1974 | Kuruwita | May 1981 |
| 1975 | Clyde – Dorset | 18 May 1982 |
| 1976 | Hillstream – Tempo | 13 June 1985 |
| 1977 | No pollination programme | - |
| 1978 | Payagala | 16 June 1985 |
| 1979 | Eladuwa | 03 July 1980 |
| 1980 | Eladuwa - Miturugama | 03 July 1980 |
| 1981 | Eladuwa - Malaboda | 03 June 1981 |
| 1982 | Clyde – Kethhena | 28 September 1987 |
| 1983 | No pollination programme | - |
| 1984 | No pollination programme | - |
| 1985 | Hillstream – Tempo | 1989 |
| 1986 | Kuruwita | |
| 1987 | I) Clyde- Kethhena<br>II) Galawatta | 21 May 1993<br>03 June 1988 |
| 1988 | Dartonfield | 26 July 1993 |
| 1989 | No pollination programme | - |
| 1990 | Not yet planted | - |
| 1991 | Not yet planted | - |
| 1992 | Dartonfield | May 1993 |
| 1993 | Pollination programme not successful | - |
| 1994 | Pollination programme not successful | |
| 1995 | Sorana | 12 June 1998 |

**Evaluation of 1974 hand pollinated (H.P.) Seedlings at Kuruwita Sub-station (GPB/BST/HPS/74/3 )**

Eleven clones derived from the 1974 Hand pollinated programme have been planted in this trial, the rest being planted in other three sites *viz;* Moralioya, Perth and Yatadola. No selections were made from the trials planted at Moralioya, Perth and Yatadola since majority of the entries were susceptible for the *Corynespora* leaf disease.

Out of the eleven clones planted with four control clones at Kuruwita sub station, four clones have already been registered as RRISL 200, 201, 202 and 203. Three clones have been identified for further testing in large scale clone trials. They are 74-139, 74-180, 74-205. This trial was terminated in this year due to poor tapping stand resulting from TPD and loss of trees (D P S T G Attanayaka, B M S G Peiris, H P Peiris and K B Karunasekera).

**Evaluation of 1975 H.P. Selections - Clyde Estate (GPB/BST/HPS/75/2)**

Test tapping on the panel C was commenced in this year. Only two test tappings were carried out. Table 3 shows the mean yield and mean girth of the two RRISL clones, 204 and 205 along with the three control clones, RRIC 100, RRIC 121 and RRIC 130.

Table 3. *Mean yield in g/t/t and the girth in cm*

| Clone | Mean girth | Mean yield |
|---|---|---|
| RRISL 204 | 77.89 | 26.60 |
| RRISL 205 | 102.00 | 57.52 |
| RRIC 130 | 59.56 | 14.53 |
| RRIC 121 | 85.22 | 23.36 |
| RRIC 100 | 65.95 | 14.63 |

(D P S T G Attanayaka and I D M J Sarathkumara).

**Evaluation of 1976 H.P. Selections. Tempo Division, of Hillstream Estate. (GPB/BST/HPS/76/1)**

From 1996 only 10 clones including two control clones (RRIC 100 and RRIC 121) have been selected for further testing. Table 4 summaries the mean yield based on seven test tappings and the girth obtained from these clones.

Table 4. *Mean yield in grams per tree per tapping (g/t/t) and mean girth of promising clones and the control (GPB/BST/HPS/76/1)*

| Clone | Mean Yield (g/t/t) | Mean girth (cm) |
|---|---|---|
| 76-121 | 32.78 | 71.19 |
| 76-158 | 58.74 | 76.96 |
| 76-182 | 83.50 | 87.35 |
| 76-198 | 42.08 | 81.20 |
| 76-52 | 63.73 | 86.54 |
| 76-8 | 69.44 | 94.06 |
| 76-82 | 86.54 | 66.61 |
| 76-9 | 39.87 | 70.52 |
| RRIC 100 | 46.03 | 73.19 |
| RRIC 121 | 72.02 | 90.00 |

(D P S T G Attanayaka and K W Rupatunga).

**Evaluation of 1979/1980/1981 H.P. Seedlings Eladuwa Estate (GPB/BST/HPS/79/1), Eladuwa estate, (GPB/BST/HPS/80/2) Eladuwa Estate, (GPB/BST/HPS/81/2)**

These trials were terminated this year due to the loss of experimental trees (D P S T G Attanayaka, I D M J Sarathkumara and K B Karunasekera).

**Evaluation of 1982 H.P. Selections - Clyde Estate (GPB/BST/HPS/82/2)**

In this trial 61 new clones are being tested along with five control clones. Five test tappings were possible during this year which was the third year of tapping. Table 5 shows the mean yield of the new promising selections along with the performances of the control clones arranged according to the Duncan ' s multiple range test (DMRT).

Table 5. *Mean yield and the results of the DMRT of promising H.P. Seedlings Clyde Estate (GPB/BST/HPS/82/2)*

| Clone | Mean yield g/t/t | |
|---|---|---|
| 82 - 15 | 56.11 | A |
| 82 - 140 | 46.69 | A B |
| 82 - 124 | 43.88 | B C |
| RRIC 121 | 43.52 | B C |
| RRIC 110 | 41.07 | B C D |
| 82 - 110 | 39.52 | B C D E |
| RRIC 102 | 38.91 | B C D E F |
| 82 - 111 | 36.62 | B C D E F G |

(D P S T G Attanayaka, K W Rupatunga and K B Karunasekera).

**Evaluation of 1985 H.P. Selections - Tempo Division, Hillstream Estate. (GPB/BST/HPS/85/2)**

The mean girth and the g/t/t yield of the second year of tapping of promising HP clones along with the performances of the control clones are given in Table 6. Results of the DMRT test is given in superscripts.

Table 6. *Mean girth and the mean yield (g/t/t) of promising H.P. clones-Tempo division (GPB/BST/HPS/85/2)*

| Clone | Mean girth cm | Mean Yield g/t/t/ |
|---|---|---|
| 85-12 | 82.50 A | 47.50 A |
| 85-82 | 74.14 B | 20.43 C-M |
| 85-61 | 73.60 BC | 25.32 B-G |
| 85-33 | 72.47 BCD | 20.86 C-M |
| 85-59 | 69.53 B CDE | 24.12 B-J |
| 85-18 | 69.46 BCDE | 27.82 BCD |
| 85-14 | 69.44 BCDE | 15.84 M-H |
| 85-13 | 69.38 BCDE | 23.72 B-J |
| 85-25 | 68.82 BCDEF | 23.85 B-J |
| 85-60 | 68.62 BCDEF | 19.24 C-N |
| RRIC 110 | 68.28 BCDEFG | 28.21 B-C |
| RRIC 121 | 67.95 BCDEFGH | 31.95 B |
| 82-31 | 67.50 BCDEFGHI | 24.75 B-I |
| RRIC 102 | 67.18 BCDEFGH I | 26.57 BCDE |
| RRIC 100 | 65.50 BCDEFGH IJK | 23.70 B-I |

(D P S T G Attanayaka, K W Rupatunga and K B Karunasekera).

**Evaluation of 1986 H.P. Selections - Kuruwita (GPB/BST/HPS/86)**

In this trial 45 new HP clones along with five control clones are evaluated. The fifth year girth measurement was recorded in this year. The mean girth measurement and the results of the Duncan ' s multiple range test of promising genotypes are given in the table 7.

Table 7. *Mean girth in cm of promising H.P. clones – Kuruwita (GPB/BST/HPS/86/1)*

| Clone | Mean yield g/t/t | |
|---|---|---|
| 86 – 81 | 65.12 | A |
| 86-21 | 63.25 | AB |
| RRIC 121 | 62.23 | AB C |
| 86-77 | 61.28 | A B C D |
| 86-87 | 59.15 | B C D E |
| RRIC 110 | 58.47 | B C D E F |
| 86-22 | 58.32 | B C D E F |
| 86-24 | 57.82 | B C D E F |
| 86-76 | 57.70 | B C D E F |

(D P S T G Attanayaka, B M S G Peiris, H P Peiris and K B Karunasekera).

**Evaluation of 1987 H.P. Selections - Kethhena, Clyde Estate. (GPB/BST/HPS/87/1)**

In this trial 18 HP selections with four control clones have been planted in a randomized block design with four replicates. Each treatment plot consists of 8 plants. The trail has been planted in May 1993. The Analysis of variance of the girth data collected in 1998 showed that the variance between clones to be highly significant. Results of the Duncan Multiple Range Test (DMRT) are given in Table 8.

Table 8. *Mean girth and the results of DMRT of the 1987 HP selections*

| Clone | Girth in cm and DMRT grouping |
|---|---|
| 87-370 | 55.01[A] |
| RRIC 121 | 53.64[A B] |
| RRIC 110 | 53.21[A B C] |
| 87-371 | 50.21 [B C D] |
| RRIC 100 | 49.95 [C D] |
| 87-372 | 48.87 [D E] |
| 87-382 | 48.53 [D E] |
| 87-375 | 48.09 [D E F] |
| RRIC 102 | 47.62 [D E F] |

**Evaluation of 1988 H.P. Selections - Dartonfield Estate. (GPB/BST/HPS/88)**

The fifth year girth measurement was recorded in this trial. The mean girth arranged according to the Duncan ' s multiple range test is given in table 9.

Table 9. *Mean girth in cm of the 1988 HP progeny*

| Clone | Mean Girth and DMRT grouping |
|---|---|
| 88-36 | 50.36[A] |
| 88-32 | 48.01[A B] |
| RRIC 100 | 46.75 [B C] |
| 88-31 | 46.17 [B C] |
| 88-8 | 44.96 [B C D] |
| 88-28 | 44.20 [C D E] |
| 88-13 | 44.00 [C D E] |
| 88-40 | 43.45 [C D E F] |
| 88-39 | 43.37 [C D E F] |
| RRIC 110 | 43.29 [C D E F] |

**Evaluation of 1992 H.P. Selections - Dartonfield Estate. (GPB/BST/HPS/92)**

A total of 393 seedlings derived from 11 families have been planted in this trial. The family mean of the girth measurements from 1996- 1998 is given in Table 10.

Table 10. *Family means of the girth measurement of the 1992 HP progeny*

| Family | Mean girth in cm | | |
|---|---|---|---|
| | 1996 | 1997 | 1998 |
| RRIC 100 x RRIM 712 | 32.42 | 41.39 | 50.16 |
| RRIC 100 x PB 255 | 34.48 | 46.07 | 57.53 |
| RRIC 100 x PR 255 | 30.34 | 39.16 | 49.11 |
| RRIC 121 x PB 255 | 33.21 | 41.57 | 51.92 |
| RRIC 102 x PB 255 | 32.25 | 41.92 | 51.55 |
| BPM 24 x RRIM 712 | 30.58 | 39.58 | 47.66 |
| RRIC 100 x PR 309 | 31.29 | 40.66 | 51.31 |
| RRIC 121 x PR 255 | 30.13 | 37.32 | 45.96 |
| RRIC 102 x PR 309 | 36.50 | 46.00 | 61.00 |
| RRIC 121 x PR 309 | 26.78 | 33.57 | 40.00 |
| RRIC 121 x RRIM 712 | 16.00 | - | - |

**Testing of proven foreign clones received under SRRP (GPB/FC/SRRP/91/2)**

The experimental blocks planted at Salawa, Atale and Kuruwita sites were brought into tapping early this year. Test tappings were carried out on monthly basis. Mean yield (g/t/t) of the clones planted are given in Table 11.

Table 11. *Mean yield in g/t/t/ obtained from SRRP trials*

| Clone | Salawa | Kuruwita | Atale |
|---|---|---|---|
| PB 235 | 33.53 | 55.93 | 36.40 |
| PB 260 | 36.58 | 73.04 | 40.26 |
| PB 217 | 31.23 | - | - |
| RRIM 712 | 35.33 | 46.77 | 41.88 |
| PR 255 | 35.65 | 36.98 | 38.34 |
| PR 261 | 30.73 | 31.75 | 27.78 |
| BPM 24 | 36.22 | 34.01 | 49.25 |
| RRIC 100 | 27.83 | - | - |
| RRIC 110 | 33.37 | - | - |
| RRIC 121 | 23.31 | 25.00 | 34.09 |

The trial planted at the Malaboda division was also brought into tapping in the latter part of this year. No test tappings were done from this site.

A girth measurement was taken from all the experimental sites. A graphical representation of the mean girth of clones planted in all the sites are given in figure 1. It is evident from the figure that clones PB 235, PB 260 and RRIC 121 have maintain a vigorous growth in all the sites.

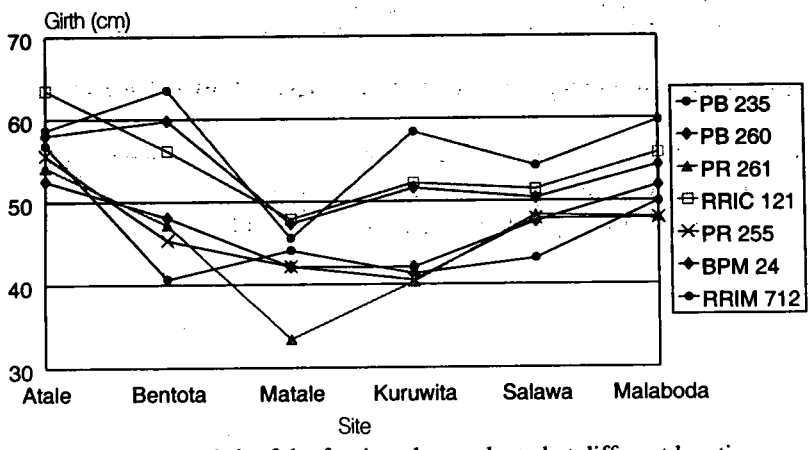



Fig. 1. Mean girth of the foreign clones planted at different locations

The details of the SRRP trial planted at Kumarawatta Group in Monaragala District in 1995 is given in the table 12. Figures in brackets indicate the number of plants in each plot.

Table 12. *SRRP clone trial - Monaragala*

| Clone | Rep 1 | Rep 2 | Rep 3 | Mean girth cm |
|---|---|---|---|---|
| PB 260 | 9.35 (17) | 12.23(17) | 10.97(17) | 10.85 |
| RRIC 121 | 12.38 (17) | 12.97(23) | 11.70(19) | 12.35 |
| PB 235 | - | 14.08(23) | 13.72(24) | 13.90 |
| PR 261 | 10.26 (15) | 12.10(19) | - | 11.18 |
| PR 255 | 9.33 (06) | 11.36(23) | 11.17(17) | 10.62 |
| BPM 24 | 12.16 (12) | 14.66(25) | - | 13.41 |
| RRIM 712 | 12.59 (22) | 10.62(12) | 12.25(14) | 11.82 |

(D P S T G Attanayaka, K W Rupatunga, I D M J Sarathkumara, B M S G Peiris, H P Peris and K B Karunasekara).

**Conservation and evaluation of the IRRDB germplasm (GPB/GP/85/2)**

The *Hevea* germplasm collection was maintained by adopting routine agronomic practices (D P S T G Attanayaka, S P Withanage, K B Karunasekera).

**Studies on clonal response to different combinations of N P K and Mg. (GPB/SPN/NUT/94/2)**

The fertilizer treatment due for this year was applied. A girth measurement was recorded in this experiment (D P S T G Attanayaka, S Dharmakeerthi, K B Karunasekera, K W Rupatunga and I D M J Sarathkumara).

**New planting**

***GPB/BST/HPS/95/1***

A Small Scale Clone Trial was planted at Sorana estate on 12th May 1998, to test the HP clones derived from the 1995 HP programme. In this experiment 41 HP clones were planted with two control clones PB 255 and RRIC 121 in a Randomized Block Design with four replicates. Each treatment plot consists of eight plants.

A G x E experiment designed to test the environmental sensitivity of nine RRISL 200 series clones and six foreign clones was established in this year. Nine sites were planted each with the clones, RRISL 201, RRISL 205, RRISL 206, RRISL 210, RRISL 215, RRISL 217, RRISL 218, RRISL 219, RRISL 220, RRII 105, RRIM 712, PB 260, RRIC 130, GPS I and Heiken 2 in a fully randomized design with 20 single tree plots from each clone. Planting details are given in the table 13.

Table 13. *Planting details of the 1998 G x E experiment*

| Site | District | Agroecological zone and rainfall | Planted on |
|---|---|---|---|
| Sorana | Kalutara | WL3 > 1525 mm | 30-06-98 |
| Muwankande | Kurunagala | IL1 > 1020 mm | 02-07-98 |
| Atale | Kegalle | WL2 > 1900 mm | 03-07-98 |
| Palmgarden | Ratnapura | WL1 > 2540 mm | 15-07-98 |
| Ganepalla | Avissawella | WL1 > 2540 mm | 16-07-98 |
| Pelmadulla | Ratnapura | WL2 > 1900 mm | 17-07-98 |
| Baddegama | Galle | WL3 > 1525 mm | 21-07-98 |
| Nalanada estate | Matale | IM3 > 875 mm | 08-12-98 |
| Bibile | Bibile | IL2 > 1125 mm | 17-12-98 |

# PLANT SCIENCE

A Nugawela

## SUMMARY

Crown budding could be undertaken in 2-3 year old clearings to replace the canopy with a different genotype when necessary. Tappability is achieved early through young buddings than from other types of planting material.

Generally, g/t/t is high when opened at a higher girth. Trees tapped later after reaching a higher girth, yields less than trees which reached same girth earlier. The intake per tapper is high whilst the yield per hectare is marginally less through d/3 tapping with stimulation. A similar yield per hectare is possible through six rounds of stimulations per annum with no adverse effect to the plant. The response to yield stimulants is poor in d/3 clones, *eg.* RRIC 101.

Base panel, B1-I gave yield levels comparable to higher panel virgin bark. This may be due to the difficulty of doing technically correct tapping in higher virgin panels. The performance of novel yield stimulants, Ethrel Super and Ethilin is similar to that of Ethrel.

Fifth year girth data indicates girthing and bark thickness to be adversely affected at densities higher than 600/Ha.in all clones tested.

Planting of rubber in triple rows to have a wider interrow for intercroping retards growth of rubber. Double row system appear to be suitable for both intercroping and growth of rubber. Alstonia appears to be a suitable timber species to inter plant with rubber.

Around 67% of plants in the budwood nurseries of the Plantation Sector belongs to Group 1 clones. Around 9700 plants were distributed to establish budwood nurseries during the year. 24, 15, 13 and 48 percent of them were from Group 1,2,3 and 4 respectively.

## DETAILED REVIEW

### Staff

Mr L S S Pathiratna, Botanist, Mr K M G S N Kaluwewa, Assistant Botanist, Mr R B Gunaratne and Mr L S Kariyawasam, Experimental Officers, Mr K A G B Amaratunge, Mr R P Karunasena and Mrs G A S Wijesekera, Senior Technical Officers, Mrs C W Ranasinghe, Mr U S Weerakoon, Mrs R K Samarasekera, Mr T U K Silva, Mr M K P Perera, Mr M de Alwis and Mr L Zoysa, Technical Officers and Mrs D E Jayawardena, Clerk/Typist were on duty throughout the year.

The Head of Department, Dr A Nugawela was on sabbatical leave from 08.03.1998 to 10.04.1998 and from 13.11.1998 to 18.12.1998. He was attached to the Agricultural Research Station, University of Ghana as an expert on Rubber Cultivation during his Sabbatical leave.

Dr (Mrs) P Seneviratna, Botanist reported for work on 25.05.1998 after been on maternity leave.

Dr V H L Rodrigo, Botanist visited Rubber Research Institute of India during 24.09.1998 to 05.10.1998.

Mr A M W K Seneviratne, Assistant Botanist, left to the Institute of Terrestrial Ecology, UK for an inital training with regard to his post graduate studies on 29.07.1998 and returned to the institute on 24.12.1998.

Mr S Wilbert, Senior Experimental Assistant was sent to Rubber Research Institute of Indonesia for a training on Exploitation of Rubber during the period of 07.08.1998 to 06.11.1998.

Mr K A G B Amaratuange, Mr R P Karunasena, Mrs G A S Wijesekera, Mr S Wilbert, Mrs R K Samarasekera and Mr U S Weerakoon were promoted to the post of Experimental Officer with effect from 27.04.1998.

Mr H P Peries, Technical Officer was transferred to the Genetics and Plant Breeding Department with effect from 12.02.1998.

**Research Students**

Mrs H K L K Gunasekera, an under graduate student from the University of Peradeniya completed her final year project on "Effect of tapping systems on yield and some yield related parameters of different *Hevea brasiliensis* Muell. Arg. clones" under supervision of Dr A Nugawela.

**Meetings and Conferences**

The Head of Department addressed at the following meetings:

* Scientific Committee Meetings. Dr (Mrs) P Seneviratne, Dr V H L Rodrigo and Mr L S S Pathiratna also participated.
* Avissawella District Planters Association on use of Rainguards.
* Human Resource Development Committee, Bentota Estate, on Exploitation and Nursery Management.
* Planting Executives of Kahawatta Plantations on Exploitation.
* Planting Executives of Horana Plantations Ltd., on Nursery Management.

* Field day on Nursery Management and New Clearing Activities at Udabage Group.
* Field day at Pitiyakande Group on Nursery Management and New Clearing Activities.
* Field day at Mahaoya Group on Nursery Management and New Clearing Activities.
* Field day at Sapumalkande Group on Harvesting.
* Galle District Planters Association on Yield Decline in some Plantations.
* Field day at Udabage Group on Harvesting
* Field day on Tapping for Planting Executives of Agalawatta Plantation.
* Field day on Tapping at Atale Estate.
* Field day on Harvesting, Stimulation and Use of Rainguards at Pitiyakande Estate.
* Field day on Tapping at Udapola Estate.
* Dr (Mrs) P Seneviratne conducted a workshop on Nursery Management and Planting Techniques for the Pussellawa Plantations Ltd.

The Department Staff also conducted the following programmes.

* Training programmes on Budgrafting and Young budding.
* Tapper Training Programmes.
* Training programmes on Use of Rainguards.

## LABORATORY INVESTIGATIONS

### Tissue culture

Studies on micropropagation of juvenile and mature *Hevea* were continued. The growth of plants derived from axillary buds and embryos and established in the field was monitored.

Explants harvested from stock plants grown in incubators prior to harvesting showed better results in culture establishment (P Seneviratne, W Seneviratna and G A S Wijesekera).

## FIELD EXPERIMENTS

### Seed germination

In the seed germination beds, placing the seeds using different methods, *i.e.*

flat side down, round side down and side-ways gave similar results with regard to germination percentage and growth of seedlings.

Placing seeds in a mist propagator for germination gave a germination percentage similar to that from the currently recommended sand bed method (P Seneviratna and M de Alwis).

**Polybag plants**

An experiment carried out to study the effect of the length of the tap root of a budded stump on the survival and the growth of the scion indicated no significant difference among the treatments.

The effect of various materials inserted at the base of the polybag to prevent the tap root penetrating the base of the bag to the ground, showed that even placing a circle of aluminium sheet is not effective (P Seneviratna and G A S Wijesekera).

**Mixed planting**

Girth measurments were taken during the year in all three clearings established (P Seneviratna and M de Alwis).

**Crown budding**

The growth of RRIC 110 plants crown budded with clones RRIC 100, 102, 117, 130 and *Hevea spruciana* at Padukka Estate is given in Table 1.

Table 1. *Mean girth (cm) of RRIC 110 plants crown budded with different RRIC clones and* Hevea spruciana

| Clearing | Crown | Girth (cm) |
|---|---|---|
| 1996 | RRIC 100 | 27.69 |
| Minnerigama Division | RRIC 102 | 27.86 |
| | RRIC 117 | 22.92 |
| | RRIC 121 | 25.35 |
| | RRIC 130 | 24.82 |
| | *H. spruciana* | 21.64 |
| 1994 | RRIC 100 | 38.46 |
| Main Division | RRIC 102 | 38.70 |
| | RRIC 117 | 35.07 |
| | *H. spruciana* | 37.40 |

(P Seneviratne, R B Gunaratna and M de Alwis)

## Planting techniques

The objective of this study is to compare the performance, *i.e.* establishment rate and early growth of different types of planting material.

### *Pallegama (PT/93/1)*

The trial was established during South West 1993. The establishment success (%) of different types of planting material and the girth after 5 years of growth are given in Table 2.

Table 2. *The different types of planting material tested and their establishment success and growth after 5 years*

| Planting material | Establishment Success (%) | Girth (cm) |
|---|---|---|
| Bare root green budding | 91.0 | 45.8 |
| Bare root brown budding | 82.3 | 45.7 |
| Green budding polybags | 99.2 | 45.1 |
| Young buddings | 100.0 | 48.6 |
| Brown budding polybags | 98.8 | 48.5 |

When both establishment success and growth are considered young buddings are superior to other types of planting material tested (A Nugawela and K A G B Amaratunga).

## Girth at Opening

***RRIC 130, 1990 Replanting - Dartonfield (TG/95/1)***
***RRIC 121, 1990 Replanting - Dartonfield (TG/95/2)***
***RRIC 100, 1990 Replanting - Dartonfield (TG/95/3)***

From each clone above trees from girth classes 42-44cm (GC1), 44-46cm (GC2) and 49-51cm (GC3) were selected. The following treatments were introduced randomly (single tree plots) for each clone. Twenty trees were assigned for each treatment. The trial was commenced in 1995, and the data gathered to-date are reported in the Annual Reviews of the respective years.

**Treatments**

$T_1$ Commencing tapping at GC1
$T_2$ GC1 untapped trees
$T_3$ Commencing tapping at GC2
$T_4$ GC2 untapped trees
$T_5$ Commencing tapping at GC3
$T_6$ GC3 untapped trees
$T_7$ GC1 trees to be tapped when reach GC 2
$T_8$ GC 2 trees to be tapped when reach GC 3.

The mean yield, *i.e.* g/t/t for different clones and girth classes are given in Table 3.

Table 3. *The mean yield, i.e. g/t/t in 1998 when tapping commenced at different girths in different clones*

| | Clones and Mean g/t/t | | | |
|---|---|---|---|---|
| Treatment | RRIC 130 | RRIC 121 | RRIC 100 | Mean |
| T1 | 45.90 | 26.80 | 36.56 | 36.42 |
| T7 | 42.93 | 25.94 | 36.05 | 34.97 |
| T3 | 53.66 | 29.69 | 39.85 | 41.06 |
| T8 | 52.69 | 24.97 | 39.87 | 39.01 |
| T5 | 66.24 | 37.98 | 46.65 | 50.29 |

Generally, in all clones the g/t/t increases with increase in girth class. Trees that reach a higher girth class later yields relatively less than those reached the same girth earlier.

Girth increment during the 3rd year after tapping is relatively less in clone RRIC 130. The retardation of growth after tapping continues to be less in clone RRIC 121 among the different clones tested (Table 4).

Table 4. *Influence of girth at opening on the subsequent growth in clones RRIC 100, 121 and 130*

| Clone | Treatment | Initial Girth (cm) | Girth Increment (cm) | | |
|---|---|---|---|---|---|
| | | | 1st year | 2nd year | 3rd year |
| RRIC 100 | $T_1$ | 41.9 | 4.5 | 3.5 | 4.8 |
| | $T_2$ | 41.7 | 8.2 | 6.5 | 5.7 |
| | $T_3$ | 44.6 | 4.8 | 3.5 | 4.8 |
| | $T_4$ | 45.1 | 8.8 | 7.0 | 6.7 |
| | $T_5$ | 50.2 | 3.7 | 4.5 | 5.1 |
| | $T_6$ | 49.3 | 9.3 | 6.6 | 6.7 |
| | $T_7$ | 42.0 | 8.3 | 3.9 | 3.4 |
| | $T_8$ | 45.0 | 8.9 | 3.8 | 3.9 |
| RRIC 121 | $T_1$ | 42.2 | 5.1 | 4.3 | 4.1 |
| | $T_2$ | 42.6 | 6.3 | 5.5 | 4.6 |
| | $T_3$ | 44.9 | 5.2 | 4.2 | 3.8 |
| | $T_4$ | 44.6 | 6.6 | 5.2 | 4.4 |
| | $T_5$ | 49.6 | 6.2 | 4.5 | 4.2 |
| | $T_6$ | 49.6 | 7.6 | 5.8 | 4.4 |
| | $T_7$ | 42.6 | 7.1 | 4.1 | 4.1 |
| | $T_8$ | 44.7 | 6.1 | 4.3 | 4.3 |
| RRIC 130 | $T_1$ | 42.9 | 4.9 | 4.2 | 2.2 |
| | $T_2$ | 42.4 | 8.1 | 6.2 | 3.9 |
| | $T_3$ | 44.6 | 5.7 | 5.5 | 2.1 |
| | $T_4$ | 45.1 | 8.8 | 6.8 | 4.5 |
| | $T_5$ | 49.5 | 5.7 | 5.0 | 1.5 |
| | $T_6$ | 49.8 | 9.6 | 7.6 | 4.6 |
| | $T_7$ | 42.6 | 8.2 | 3.9 | 2.0 |
| | $T_8$ | 44.7 | 8.5 | 4.2 | 1.8 |

(A Nugawela, S Wilbert and R K Samarasekera).

***RRIC 100, 1992 Replanting - Yatadola***

A girth at opening trial, similar to the one described above was initiated at Yatadola Estate, RRIC 100, 1992 replanting during 1997.

The mean yield (g/t/t) and girth increment for different treatments during the years 1997 and 1998 are given in Table 5.

Table 5. *The yield and girth increment at different girths of opening in genotype RRIC 100*

| Treatment | Yield (g/t/t) | | Girth increment (cm) | |
|---|---|---|---|---|
| | 1997 | 1998 | 1997 | 1998 |
| $T_1$ | 18.73 | 22.3 | 5.9 | 4.2 |
| $T_2$ | - | - | 7.8 | 6.4 |
| $T_3$ | 21.57 | 23.5 | 5.3 | 4.0 |
| $T_4$ | - | - | 7.9 | 6.7 |
| $T_5$ | 26.89 | 30.5 | 5.7 | 4.1 |
| $T_6$ | - | - | 8.7 | 7.4 |
| $T_7$ | - | - | 8.1 | 6.5 |
| $T_8$ | - | - | 8.3 | 6.3 |

The annual mean yield of a tree per tapping (g/t/t) increases with increase in girth at opening. The annual girth increment in tapped trees is about 4 cm for all girth classes (Table 5).

**Low frequency tapping**

The objective of these trials is to find out whether it is more economical to exploit newly introduced clones with low frequency tapping with stimulation than through the presently recommended ½S d/2 system. Low frequency tapping systems can have the advantages of low tapping costs, low tapper requirement and longer tapping cycles.

***RRIC 121, 1985 Replanting - Kiriwanaketiya (LFT/91/1)***

Though the yield per tree per tapping (g/t/t) is highest in the ½S d/3 + E* system, the annual total yield is highest in the conventional ½S d/2 systems (Table 6).

Further, the annual total yields from the low frequency tapping systems with stimulation is low as only 50% of the scheduled stimulation rounds were possible due to wet weather.

Girth increment during the year is marginally high with conventional tapping. Incidence of tapping panel dryness is comparable in all tapping treatments tested (Table 6).

Table 6. *Effect of low frequency tapping with stimulation on yield, growth and tapping panel dryness in clone RRIC 121*

| Tapping system | Yield | | Growth | | TPD |
|---|---|---|---|---|---|
| | g/t/t | kg/t/year | Girth (cm) | Increment (cm) | (%) |
| ½S d/2 | 38.2 | 6.13 | 89.8 | 4.3 | 15.3 |
| ½S d/4+ E*(6/y) | 47.8 | 3.80 | 84.3 | 4.0 | 11.7 |
| ½S d/3+E*(6/y) | 38.2 | 4.05 | 84.0 | 3.3 | 13.1 |
| ½S d/3+ E*(4/y) | 40.5 | 4.29 | 82.5 | 3.8 | 15.2 |

E* 2.5% ET, Ba 1.6(2.5)
(A Nugawela, S Wilbert and R K Samarasekera)

***RRIC 102, 1981 Replanting - Neuchatle (LFT/88/2)***

The annual mean dry rubber yield per tree per tapping (g/t/t) is highest in the two ½S d/3 systems tested with 4 and 6 rounds of stimulations per annum. Further the total annual dry rubber yield per tree is also highest in these two systems (Table 7).

Table 7. *Effect of low frequency tapping with stimulation on yield, growth and tapping panel dryness in clone RRIC 102*

| Tapping system | Yield | | Girth (cm) | BRC (cm) |
|---|---|---|---|---|
| | g/t/t | kg/t/year | | |
| ½S d/2 | 25.6 | 2.69 | 72.2 | 19.7 |
| ½S d/3 | 42.6 | 2.94 | 73.8 | 16.5 |
| ½S d/3+E*(4/y) | 65.6 | 4.59 | 73.7 | 16.8 |
| ½S d/4+ E*(6/y) | 40.0 | 1.88 | 74.1 | 13.0 |
| ½S d/3+ E*(6/y) | 63.4 | 4.44 | 74.0 | 16.4 |

E* 2.5% ET, Ba 1.6(2.5)

The annual bark consumption rates are significantly less in low frequencytapping systems tested (A Nugawela and K A G B Amaratunga).

***RRIC 100, 1981 Replanting - Gallewatta (LFT/88/1)***

The yield per tree per tapping (g/t/t) and the total annual yield per tree are both highest in ½s d/3 +E* tapping system. There is no evidence for decline in growth in stimulated trees. Incidence of tapping panel dryness is high in both ½S d/2 and ½S d/3 + E* tapping systems (Table 8).

Table 8. *Effect of low frequency tapping with stimulation on yield, growth and tapping panel dryness in clone RRIC 100*

| Tapping system | Yield | | Growth | | TPD |
|---|---|---|---|---|---|
| | g/t/t | kg/t/year | Girth (cm) | Increment (cm) | (%) |
| ½S d/2 | 29.1 | 3.58 | 81.81 | 1.67 | 15 |
| ¼S d/2 + E*(6/y) | 29.2 | 3.58 | 91.20 | 0.40 | 9 |
| ½S d/3 + E*(6/y) | 57.0 | 4.62 | 87.14 | 1.23 | 15 |
| ½S d/4 + E*(6/y) | 49.0 | 3.53 | 87.28 | 2.97 | 4 |

E* 2.5% ET, Ba 1.6 (2.5).
(A Nugawela, S Wilbert and R K Samarasekera)

***RRIC 100, 1991 Replanting - Ambetanna (LFT/97/1)***

½S d/3 system of tapping with different frequencies of stimulation is tested with ½S d/2 system of tapping.

Treatments are as follows;

1. ½S d/3 2.5 ET, Ba 1.6(2.5)4/y
2. ½S d/3 2.5 ET, Ba 1.6(2.5)5/y
3. ½S d/3 2.5 ET, Ba 1.6(2.5)6/y
4. ½S d/2

Three tapping blocks were selected for each d/3 system whilst two blocks were selected for the d/2 system. One tapper was assigned for each treatment. The task size is 275 trees and the trial was commenced in 1997.

The tapper productivity, *i.e.* kg/annum/tapper and yield per unit land area, *i.e.* kg/annum/block are both marginally high in the conventional d/2 system (Table 9). The mean intake tapper and the yield per tree per tapping are similar in all treatments.

Table 9. *The total crop per tapper and per tapping block, mean intake per tapper (IPT) and yield per tree per tapping (g/t/t) for different treatments*

| | Total Crop (Kg) per annum | | | |
|---|---|---|---|---|
| | Tapper | Block | IPT | g/t/t |
| 1. ½S d/3+E*(4/y) | 1227.4 | 409.1 | 5.84 | 21.24 |
| 2. ½S d/3+E*(5/y) | 1203.7 | 401.2 | 5.82 | 20.44 |
| 3. ½S d/3+E*(6/y) | 1324.7 | 441.6 | 5.71 | 20.76 |
| 4. ½S d/2 | 1349.4 | 674.7 | 5.69 | 20.69 |

E* 2.5%, Ba 1.6 (2.5)

Scheduled rounds of stimulations were not carried out due to wet weather (A Nugawela, S Wilbert and R K Samaraskera).

**Low frequency tapping of clone PB 86 in the smallholder sector**

Trials were commenced in 1996 in Kalutara, Ratnapura and Kegalle Districts. For each trial holdings with atleast 5 tapping tasks were selected to test the following treatments.

$T_1$ ½S d/2 (2 tasks)
$T_2$ ½S d/3 + 2.5%ET, Ba 1.6(2.5) 4/y (1 task)
$T_3$ ½S d/3 + 2.5%ET, Ba 1.6(2.5) 6/y (1 task)
$T_4$ ½S d/3 + 1.0%ET, Ba 1.6(2.5) 6/y (1 task)

Above treatments were introduced randomly to the 5 tapping tasks. Two tappers, *i.e.* one for the two d/2 blocks and the other for the three d/3 blocks, were employed.

Trial at Kalutara district had to be abandoned due to a dispute over the land ownership.

The tapper productivity continues to be high in d/3 systems with 2.5% Ethrel stimulation. Anyhow, the productivity per unit land area is less than in conventional ½S d/2 system (Table 10). There is no evidence for a higher incidence of TPD in stimulated trees. Bark consumption is less with d/3 tapping (Table 10) (A Nugawela, K A G B Amaratunga and S Wilbert).

Table 10. *Intake per tapper (IPT,kg), annual crop per task (Crop/Task,kg), percentage incidence of dryness (% TPD) and annual bark consumption (BCR,cm) in different tapping treatments*

| District | Treatment | IPT (kg) | Crop/Task (kg) | % TPD | BCR (cm) |
|---|---|---|---|---|---|
| Ratnapura | T1 | 7.23 | 669 | 3.1 | 22.0 |
| | T2 | 8.02 | 503 | 3.6 | 18.7 |
| | T3 | 8.73 | 544 | 2.9 | 17.2 |
| | T4 | 6.86 | 389 | 4.4 | 17.0 |
| Kegalle | T1 | 5.29 | 450 | 3 | 25.6 |
| | T2 | 5.93 | 362 | 3 | 22.5 |
| | T3 | 5.77 | 340 | 4 | 21.8 |
| | T4 | 5.78 | 341 | 4 | 21.8 |

**Low frequency tapping systems and clones - Eladuwa (F/76/5)**

The conventional ½S d/2 system is compared with ½S d/3 system with 4 and 6 rounds of stimulation per annum using clones RRIC 100, RRIC 101 and PB 86.

It is apparent that the response to stimulation is less in clone RRIC 101 when comparing with that of clone RRIC 100. In clone RRIC 100 the mean yield per tree per tapping (g/t/t) is highest in ½S d/3 system with stimulation (Table 11).

There is no evidence for treatment differences with regard to TPD (Table 11).

Table 11. *Effect of different tapping systems on the yield per tree per tapping (g/t/t), annual yield per tree (kg/t/annum) and incidence of TPD (%) in clones RRIC 100, PB 86 and RRIC 101*

| | Clones and Yield | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | RRIC 100 | | | PB 86 | | | RRIC 101 | | |
| Tapping System | g/t/t | kg/t/y | %TPD | g/t/t | kg/t/y | %TPD | g/t/t | Kg/t/y | %TPD |
| ½S d/2 | 30.7 | 5.53 | 2.7 | 25.2 | 4.54 | 0.6 | 25.8 | 4.64 | 2.8 |
| ½S d/3 + E° | 37.4 | 4.49 | 1.0 | 25.6 | 3.07 | 0.6 | 27.5 | 3.30 | 1 |
| ½S d/3 + E*° | 34.2 | 4.10 | 1.2 | 28.8 | 3.46 | 0.6 | 24.7 | 2.96 | 1.8 |

E* 2.5% ET,Ba 1.6 (2.5) 4/y
E** 2.5% ET,Ba 1.6 (2.5)6/y (A Nugawela and C W Ranasinghe).

## Low frequency tapping systems and frequency of stimulation (LFT/95/1)

½S d/3 tapping system with different frequencies of stimulation, *i.e.* 12/y with 1% ethrel, 6/y with 2.5% ethrel, and 4/y with 2.5% ethrel is tested on clones RRIC 100, 102, 121 and 130.

The mean g/t/t recorded during 1998 for the four clones tested are given in Table 12.

Table 12. *Annual mean g/t/t for different frequencies of stimulation in clones RRIC 100, RRIC 102, RRIC 121 and RRIC 130*

| | Clone and Yield (g/t/t) | | | | |
|---|---|---|---|---|---|
| Treatment | RRIC 100 | RRIC 102 | RRIC 121 | RRIC 130 | Mean |
| 1% ET,Ba 1.6(2.5)12/y | 47.3 | 60.0 | 49.2 | 40.2 | 49.2 |
| 2.5%ET,Ba 1.6(2.5)6/y | 62.2 | 49.1 | 49.4 | 51.0 | 52.9 |
| 2.5%ET,Ba 1.6(2.5)4/y | 56.0 | 44.4 | 38.2 | 42.9 | 45.4 |

Among the different frequencies of stimulation tested, 2.5%ET, Ba 1.6(2.5)6/y gives a better yield response generally in all clones (A Nugawela and R P Karunasena).

## High intensity tapping of virgin panels

Trials on the above were initiated during 1993 with the objective of finding out whether total yields obtained during the presently recommended 24 year tapping cycle could be realized during a shorter tapping cycle and if so, whether such tapping systems are more economical.

### *RRIC 100, 102, 121 and 130, 1988 Replanting - Dartonfield (HIT/93/1)*

The experimental details are given in Annual Review 1993. Generally, in all clones the g/t/t is lowest in ½S d/1 tapping and it is highest in ½S d/2 + E*. The g/t/t is only marginally less in ½S d/1 when comparing with ½S d/2 (Table 13). Among the different tapping systems tested ½S d/1 gives the highest annual yield per tree (kg/t/year)in all clones.

Different tapping systems tested have not affected the girthing of plants so far.

Table 13. *Effect of tapping systems at different fertilizer levels on dry rubber yields of different clones. Annual girth increment is given within brackets*

| Tapping system | Fertilizer level | Yield (g/t/t) | | | |
|---|---|---|---|---|---|
| | | RRIC 100 | RRIC 102 | RRIC 121 | RRIC 130 |
| ½S d/1 | Level -1 | 47.1 (2.4) | 39.4 (1.7) | 36.1 (1.2) | 43.2 (4.7) |
| | Level -2 | 45.8 (1.3) | 39.6 (2.3) | 32.3 (1.5) | 36.1 (4.5) |
| ½S d/2 | Level -1 | 47.6 (1.9) | 40.9 (2.8) | 39.5 (0.9) | 58.9 (3.3) |
| | Level -2 | 62.9 (2.7) | 39.4 (3.4) | 57.5 (3.2) | 30.4 (3.6) |
| ½S d/2 +E* | Level -1 | 66.8 (1.9) | 48.9 (2.7) | 50.2 (0.8) | 35.8 (2.2) |
| | Level -2 | 60.4 (1.2) | 46.7 (2.9) | 53.9 (1.0) | 52.1 (3.1) |
| ½S d/3+E* | Level -1 | 61.9 (2.3) | 46.2 (2.3) | 58.2 (1.3) | 45.1 (3.0) |
| | Level -2 | 74.2 (1.9) | 43.9 (2.4) | 69.6 (2.3) | 60.3 (7.2) |

E* 2.5% ET, Ba 1.6(2.5) 4/y.

Clones RRIC 130 and RRIC 102 appear to be susceptible to TPD among the four clones tested (Table 14). Incidence of TPD is marginally high with d/1 tapping. It is apparent that additional fertilizer has no significant influence on either yield or TPD.

Table 14. *Effect of tapping systems at different fertilizer levels on the incidence of tapping panel dryness (TPD) in different clones*

| Tapping system | Fertilizer level | TPD (%) | | | | Mean |
|---|---|---|---|---|---|---|
| | | RRIC 100 | RRIC 102 | RRIC 121 | RRIC 130 | |
| ½S d/1 | Level -1 | 28.6 | 28.6 | 0 | 14.3 | 17.8 |
| | Level -2 | 0 | 25.0 | 0 | 14.3 | 9.8 |
| ½S d/2 | Level -1 | 0 | 12.5 | 0 | 0 | 3.1 |
| | Level -2 | 0 | 0 | 14.3 | 28.6 | 10.7 |
| ½S d/2 +E* | Level -1 | 0 | 0 | 0 | 14.3 | 3.6 |
| | Level -2 | 0 | 0 | 37.5 | 25.0 | 15.6 |
| ½S d/3+E* | Level -1 | 0 | 12.5 | 0 | 12.5 | 6.3 |
| | Level -2 | 0 | 14.3 | 14.3 | 28.6 | 14.3 |
| | Mean | 3.6 | 11.6 | 8.3 | 14.1 | |

(A Nugawela and R P Karunasena in collaboration with the Soils and Plant Nutrition Dept.)

**Exploitation of renewed bark**

The objective of this trial is to identify suitable bark for tapping once the virgin panels, *i.e.* BO-1 and BO-2 are tapped.

***PB 86, 1971 Replanting - Payagala Estate (ERB/93/1)***
***PB 86, 1971 Replanting - Perth Estate (ERB/93/2)***

The experimental details are given in the Annual Reviews of 1993 and 1997.

The annual mean yield per tree per tapping, *i.e.* g/t/t for different tapping treatments are given in Table 15.

Table 15. *The dry rubber yield (g/t/t) of the different treatments in trials ERB/93/1 and ERB/93/2*

| Treatment | Annual Mean Yield (g/t/t) | |
|---|---|---|
| | ERB 93/1 | ERB 93/2 |
| $T_1$ Panel BI-1 | 33.3 | 33.1 |
| $T_2$ 6" above BI-1 | 32.4 | 28.6 |
| $T_3$ Upper Virgin Bark (↑) | 28.2 | 33.7 |
| $T_4$ Upper Virgin Bark (↓) | 31.4 | 31.7 |
| $T_5$ Puncture Tapped Bark as $T_3$ | 32.8 | 39.2 |
| $T_6$ Puncture Tapped Bark as $T_4$ | 25.5 | 36.3 |

It is apparent that the yields from higher virgin panels are similar to yields obtained from lower renewed panels. Previously puncture tapped upper panels give yields comparable to that of non puncture tapped panels (Table 15) (A Nugawela and R P Karunasena).

**Tapping panel dryness**

The objective of this study is to identify factors that may be associated with the incidence of tapping panel dryness.

***RRIC 100, 1986 Replanting - Eladuwa Estate (TPD/93/1)***
***RRIC 110, 1986 Replanting - Eladuwa Estate (TPD/93/2)***

The experimental details are given in the Annual Review 1994. The percentage incidence of tapping panel dryness for different treatments and clones are given in Table 16.

Table 16. *Effect of different agronomic practices on incidence of tapping panel dryness (% TPD) in clones RRIC 100 and RRIC 110*

| Treatment | Fert. Level | % incidence of TPD | |
|---|---|---|---|
| | | RRIC 100 | RRIC 110 |
| Rainguarding | 1 | 0 | 0 |
| | 2 | 6.7 | 0 |
| Rainguarding and stimulation | 1 | 0 | 6.7 |
| | 2 | 0 | 13.3 |
| Stimulation | 1 | 6.7 | 6.7 |
| | 2 | 0 | 0 |
| Control | 1 | 0 | 13.3 |
| | 2 | 0 | 6.7 |

When individual clones are considered a correlation between agronomic practices and incidence of dryness is not apparent.

The percentage incidence of tapping panel dryness recorded for different treatments at the end of each year since 1994 is given in Table 17.

Table 17. *Effect of agronomic practices on the (%) incidence of dryness over a period of 5 years*

| Practice | Treatment | TPD (%) | | | | |
|---|---|---|---|---|---|---|
| | | 1994 | 1995 | 1996 | 1997 | 1998 |
| Rainguarding | With | 10.0 | 6.7 | 17.5 | 14.2 | 13.3 |
| | Without | 13.3 | 6.7 | 11.7 | 14.2 | 16.7 |
| Stimulation | With | 16.7 | 9.2 | 16.7 | 17.5 | 16.7 |
| | Without | 6.7 | 4.2 | 12.5 | 10.8 | 13.3 |
| Clone | RRIC 100 | 16.7 | 5.0 | 11.7 | 10.8 | 6.7 |
| | RRIC 110 | 6.7 | 8.3 | 17.5 | 16.7 | 23.3 |

Incidence of dryness is consistently high in stimulated trees. In clone RRIC 110, it is relatively higher than in clone RRIC 100 and could be due to *Corynespora* infestation in clone RRIC 110 (A Nugawela and C W Ranasingha).

**Survey on tapping panel dryness (TPD)**

This study was designed to findout the propensity of present extensively grown clones to the incidence of Tapping Panel Dryness and also to investigate the possible factors responsible for this disorder.

For each clone, five clearings were selected from each panel, *i.e.* B0-1, B0-2 and B1-1 and from each clearing two tapping blocks, tapped by different tappers were selected for the survey.

The study is being conducted, initially at the Kalutara District (A Nugawela,W Seneviratna,V H L Rodrigo and S Wilbert).

**Exploitation of dry trees**

***RRIC 100 1982 Replanting Neuchatle (TPD/97/1)***
***RRIC 102 1982 Replanting Neuchatle (TPD/97/2)***

The trial was commenced during May 1997 at Neuchatle Estate with the objective of finding ways of exploiting trees affected with Tapping Panel Dryness. Thirty two trees affected with Tapping Panel Dryness were selected from each tapping block with tapping frequencies of $D_2$, $D_3$ and $D_4$ and following different tapping systems were used as treatments. Eight trees were assigned for each treatment.

Treatment 1 - Resting dry trees for six month period
Treatment 2 - Continuous tapping of already dry panel
Treatment 3 - ½S (↓) cut on opposite base panel
Treatment 4 - 1/4S(↑) cut on opposite higher panel

After 12 months rest period tapping was commenced in T1 treatment above using following methods and four trees were assigned for each method.

T1 A - ¼S ( ↑ ) cut on same panel
T1 B - ½S ( ↓ ) cut on same panel

Continuous tapping of the dry panel, at all frequencies tested yielded lowest. The dry panel when tapped after a 12 months rest period yielded and the yields and

% yielding trees were highest at relatively high frequencies. Nevertheless, yields were even higher and 100% trees were yielding when such trees were exploited using a ¼S(↑) upper cut on same panel.

In the ¼S ↑ cut on opposite panel yield was higher when tapped at low frequency, *i.e.* d/4. Among the ½S(↓) cut in the opposite panel and ¼S(↑) cut in the opposite higher panel, the yields and percentage yielding trees continue to be highest in the latter (Table 18).

Table 18. *The mean yield i.e. g/t/t of already dry trees and percentage number of trees with latex with different tapping systems (clone RRIC 102)*

| | Tapping Frequency | | |
|---|---|---|---|
| Treatment | D/2 | D/3 | D/4 |
| Tr.1A ¼S(↑) | $49.30^{a*}$(100%) [ ] | $42.65^{a**}$(100%) [ ] | $61.51^{a***}$(100) [ ] |
| Tr.1B (½S(↓) | $47.05^{a*}$(95%) [ ] | $22.61^{ab**}$(75%) [ ] | $2.05^{c***}$(45%) [ ] |
| Tr.2 (Continues Tapping) | 7.36a*(40%) [$9.58^{b*}$] | 6.88b**(44%) [$5.54^{b**}$] | $4.7^{bc***}$(52%) [$1.61^{b***}$] |
| Tr.3 (½S(↓) Opp. Panel) | $10.56^{a*}$(71%) [$30.45^{a*}$] | 4.19b**(42%) [$15.48^{c***}$] | $3.32^{c***}$(45%) [$40.58^{a***}$] |
| Tr.3 (1/4S(↑)( Opp Higher Panel) | $19.78^{a*}$(994%) [$23.38^{a*}$] | $11.89^{ab**}$(93%) [$20.47^{a**}$] | $31.32^{b***}$(90%) [$22.98^{a***}$] |

abc- Duncan Multiple Range Test
($p<0.005$)
-[ ] - 1997 g/t/t

(A Nugawela, N Kaluwewe, K A G B Amaratunga and S Wilbert)

**Yield stimulants (YS)**

***RRIC 100, 102 and 121 - 1992 Replanting***
***Gallewatte Division (YS/97/1)***

The objective of the trial is to compare the performance of Ethrel with new stimulants "Ethrel Supper" and "Ethlin" under two fertilizer levels. However Ethepon is the basic compound of all three stimulant types tested.

From each clone above, trees of even growth stage and being tapped on BOI panel were selected. Twenty trees were assigned for each treatment from each clone. The trial was commenced during May 1997 with the following treatments.

**Fertilizer level I- Normal fertilizer applications**

Treatment 1 - "Ethrel" 2.5% with normal fertilizer application
Treatment 2 - "Ethrel Supper 946" with normal fertilizer application
Treatment 3 - "Ethlin" with normal fertilizer application

**Fertilizer level II - 25% more fertilizer**

Treatment 4 - "Ethrel" 2.5% with 25% more fertilizer
Treatment 5 - "Ethrel Supper 946" with 25% more fertilizer
Treatment 6 - "Ethlin" with 25% more fertilizer

Generally, the use of stimulants have increased the yield and it is more apparent in clone RRIC 121. There is no evidence for differences between the different types of stimulants tested (Table 19).

Table 19. *The mean yield i.e. g/t/t with three stimulant types*

| | | Yield Stimulant | | |
|---|---|---|---|---|
| Clone | Control | Ethrel | Ethrel supper | Ethlin |
| RRIC 100[1] | 29.97[a1] | 29.93[a1] | 30.68[a1] | 32.10[a1] |
| RRIC 102[2] | 33.76a[a2] | 36.45[a2] | 32.27[a2] | 32.27[a2] |
| RRIC 121[3] | 28.13[b3] | 35.57[a3] | 35.47[a3] | 35.47[a3] |
| Mean[4] | 30.62[b4] | 33.98[a4] | 33.28[a4] | 33.28[a4] |

a, b, c Duncan's Multiple Range test

($p < 0.005$)

The treatment x fertilizer level interaction was not significant for any clone tested (A Nugawela, N Kaluwewe, S Wilbert and R K Samarasekara in collaboration with Soils and Plant Nutrition Dept.).

## Recovery tapping

***RRIC 100 1981 Replanting - Gallewatte Division (RT/97/1)***
***RRIC 121 1981 Replanting - Gallewatte Division (RT/97/2)***

The trial was commenced during May 1997 and following treatments are tested with the objective of studying the annual yield gain and other related parameters when recovery tapping is undertaken.

Treatment 1 - Tapping with recommended level of recovery tapping.
Treatment 2 - Tapping without recovery tapping.

From each clone two tapping blocks were selected for each treatment. Yield data were collected from estate records.

The annual total crop per block is highest in blocks where recovery tapping is done in both clones. Further, the annual mean intake per tapper is also highest in same blocks (Table 20).

Six recovery tapping days per month (recommended level) was not achieved during any of above months mainly due to rain interference (A Nugawela, N Kaluwewe and K A G B Amaratunga).

Table 20. *Monthly crop per tapper per block with and without recovery tapping (Clones RRIC 100 and RRIC 121)*

| Month | RRIC 100 | | | RRIC 121 | | |
|---|---|---|---|---|---|---|
| | Tr.1 | Tr. 2 | Significance | Tr.1 | Tr.2 | Significance |
| January | 53 (5*) | 48 (5*) | S | 41 (3*) | 35 (3*) | NS |
| February | 58.5 (9*) | 53.5 (9*) | S | 48.25 (8*) | 41.5 (8*) | NS |
| March | 98.5 (16*) | 80 (14*) | S | 73.75 (14*) | 71 (13*) | NS |
| April | 96.75 (14*) | 68.50 (12*) | NS | 84.75 (13*) | 83 (12*) | NS |
| May | 43.5 (7*) | 39 (7*) | NS | 33.5 (6*) | 29.5 (6*) | NS |
| June | 29.75 (5*) | 22 (5*) | NS | 35.25 (6*) | 29 (6*) | NS |
| July | 67 (8*) | 35.5 (6*) | S | 69.87 (9*) | 61.50 (7*) | NS |
| August | 106.75 (12*) | 74 (10*) | S | 102 (12*) | 84.5 (10*) | S |
| September | 75.75 (9*) | 68 (8*) | NS | 75.5 (10*) | 67.50 (9*) | NS |
| October | 100.5 (11*) | 73.5 (9*) | NS | 81.5 (9*) | 75.5 (8*) | NS |
| November | 134.25 (13*) | 88 (11*) | S | 112.5 (13*) | 100 (11*) | NS |
| December | 111 (10*) | 80 (9*) | S | 97.5 (10*) | 78 (9*) | S |
| Intake/tapper | 8.19 | 6.95 | | 7.56 | 7.41 | |

( * ) - Number of tapping days
S- Significantly different at 0.05% level
NS - Not Significantly different at 0.05% level

## Planting density

The objective of these trials is to examine the possibility of increasing the planting density of rubber to increase productivity and profitability per unit area of land.

## High density

### *Kuruwita, 1992 Replanting - PD/92/1*

Treatment details and the experimental layout are in the Annual Review 1992. In 1998, effect of planting density of rubber became significant with highest values of girth and bark thickness in the lowest density and vice versa (Table 21a). Though not statistically significant, the percentage of tappability followed the same pattern. However, the light interception by the canopy of all densities were comparable with values showing over 85% interception. Girth, hence tappability and bark thickness of clone RRIC 110 were inferior to those of other clones indicating the effect of Corynespora infestation (Table 21b). On average, only ca. 25% of trees of clone RRIC 110 has reached tappability. Light interception was highest in the canopy of RRIC 100 and that of clones RRIC 110 and 121 was comparable. This may be explained by the Corynespora infestation in RRIC 110 and erectophile branching habit with smaller leaves in RRIC 121. For any of the assessment made, no significant density* clone interaction was found.

Table 21a. *Effect of planting density on growth and yield parameters. Values of only girth and bark thickness are significantly different and those with same letter (as the superscript), are not significantly different*

| Planting density (trees/ha) | Mean girth (cm) | Tappable trees (%) | Bark thickness (mm) | Light interception (%) |
|---|---|---|---|---|
| 500 | $49.8^{a}$ | 47.1 | $4.39^{a}$ | 86.4 |
| 600 | $48.9^{ab}$ | 42.9 | $4.31^{a}$ | 88.8 |
| 700 | $47.6^{bc}$ | 34.0 | $4.01^{b}$ | 87.8 |
| 800 | $46.4^{c}$ | 27.6 | $3.87^{b}$ | 87.9 |

Table 21b. *Effect of clone on growth and yield parameters. Values with same letter (as the superscript) in each category, are not significantly different*

| Clone | Mean girth (cm) | Tappable trees (%) | Bark thickness (mm) | Light interception (%) |
|---|---|---|---|---|
| RRIC 100 | 49.9[a] | 44.0[a] | 4.36[a] | 91.4[a] |
| RRIC 110 | 45.5[b] | 25.2[b] | 3.96[b] | 86.2[b] |
| RRIC 121 | 49.2[a] | 44.5[a] | 4.11[b] | 85.7[b] |

(V H L Rodrigo, A Nugawela, L S Kariyawasam and T U K Silva in collaboration with the Genetics and Plant Breeding Department)

**Low density**

The objective of the study is to findout whether planting at low densities will enhance the economic return through the income generated from both latex and timber.

***Gallewatta (Dartonfield Group) 1996 Replanting - PD/96/1***
***Nivitigalakale (Dartonfield Group) 1996 Replanting - PD/96/2***

The experimental details are described in Annual Review of 1996. In filling was done to maintain the densities being tested and the growth of plants are being monitored (A Nugawela, L S Kariyawasam and U S Weerakoon).

**Intercropping**

***Spatial arrangements***

Planting rubber with different spatial patterns are tested in order to provide more light for a longer period to facilitate intercropping.

***Usk Valley, 1992 Replanting - IC/S/92/1***

Details of the experiment were reported in the Annual Review 1992. The growth and yield parameters with respective girth and bark thickness of the triple row system (3) were significantly poor, when compared to those of all other systems (Table 22). Despite less yearly girth increase, growth of the double row system (2) which appears to be more suitable for intercropping, was comparable with that of the

traditional 2.8 m x 8.1 m single row system (1). Growth of cluster systems (4 & 5) was the best, but they do not show greater advantages in intercropping and soil management.

Table 22. *Mean girth and bark thickness of rubber at 90cm in different spatial systems. Values with same letter (as the superscript) within each category, are not significantly different*

| System | Girth (cm) | | Bark Thickness (mm) |
|---|---|---|---|
| | 1997 | 1998 | |
| 1 | $40.34^{ab}$ | $51.60^{bc}$ | $5.107^{a}$ |
| 2 | $38.03^{b}$ | $48.26^{cd}$ | $4.580^{a}$ |
| 3 | $37.28^{b}$ | $46.35^{d}$ | $3.917^{b}$ |
| 4 | $43.70^{a}$ | $55.93^{a}$ | $5.127^{a}$ |
| 5 | $41.38^{ab}$ | $53.34^{ab}$ | $4.863^{a}$ |

(V H L Rodrigo, L S Kariyawasam and T U K Silva)

***Perth 1992 Replanting - IC/S/92/2***

This experiment was established in 1992 and the objective and experimental details are described in annual review of the same year.

The growth of the rubber trees was not affected significantly by the spatial arrangements, *i.e.* row or contour planting. But the growth of rubber in grass plots, irrespective of the spacial arrangement, was lower than those under the other two intercrops (Table 23). The growth of Coffee, the yield of grass and g/bush yield of Cinnamon was unaffected by the spacial arrangements at this stage (Table 24). The yield of Coffee was also unaffected by either spacial arrangements or by the proximity to the rubber trees (Table 24) (L S S Pathiratna and M K P Perera).

Table 23. *Effect of intercrop on the growth of rubber*

| Treatments | Girth of rubber (cm) |
|---|---|
| Rubber + grass | 44.2 B |
| Rubber + Cinnamon | 50.9 A |
| Rubber + Coffee | 47.8 A |
| Rubber only | 48.7 A |
| (Values with the same letter are not significantly different) | |

Table 24. *Effect of rubber spatial arrangement on the growth of Coffee, cumulative bark yield of Cinnamon and the yield of grass*

| Treatments | Stem diameter of Coffee (cm) | Cumulative bark yield (g/bush) | Yield of grass kg/ha | Yield of Coffee g/row |
|---|---|---|---|---|
| Row planting - Rubber + Grass | - | - | 1550.0 | 417.8 |
| Row planting - Rubber + Coffee | 4.1 | 26.7 | - | - |
| Contour planting - Rubber + Grass | - | - | 1587.0 | 329.2 |
| Contour planting - Rubber + Coffee | 3.9 | 22.0 | - | - |

## Intercropping systems

### *Rubber and timber*

*Usk Valley, 1992 Replanting - IC/RT/92/1*
*Ambatenna, 1992 Replanting - IC/RT/92/2*

Details of the experiment appear in the Annual Review of 1992. Alstonia performed better than other timber species. The establishment of Halmilla, Mahogani and Teak was extremely poor, therefore, after consultation with the Forest Department, it was decided to replace Halmilla with Alstonia and Teak with Mahogani (the establishment of Mahogani would be better under the shade) at Ambetenna Estate. Effect of timber species on the growth of rubber was not marked, however though not significant, the mean girth of rubber in the Alstonia intercrop was less than that of other intercrops (Table 25a). Overall treatment effect on rubber

planting systems, *i.e.* spatial arrangements of single and double row systems, showed no significant difference, despite mean girth and the yearly girth increase tended to be lower in the double row system. However, data analysis with respect to overall planting density, confirmed that effect of spatial arrangement of rubber planting was stronger than that of planting density on the growth of rubber (Table 25b). Similar to girth values, bark thickness of rubber in the Alstonia intercrop was lowest.

Table 25a. *Treatment effect on mean girth of rubber at 90cm and bark thickness. Values with same letter (as the superscript) within each category, are not significantly different*

| | Treatment | 1997 Girth (cm) | 1998 Girth (cm) | Bark Thickness (mm) |
|---|---|---|---|---|
| Overall effect on, | Single row system | 40.6* | 47.3* | 4.71* |
| (Main Treatments) | double row system | 39.5* | 44.8* | 4.32* |
| Intercrops, | No timber | 39.8$^{b}$ | 45.7$^{b}$ | 4.64$^{ab}$ |
| (Sub Treatments) | Halmilla | 40.4$^{b}$ | 46.4$^{b}$ | 4.51$^{b}$ |
| | Alstonia | 39.2$^{b}$ | 44.5$^{b}$ | 4.15$^{c}$ |
| | Teak | 39.1$^{b}$ | 45.1$^{b}$ | 4.47$^{b}$ |
| | Mahogani | 41.8$^{a}$ | 48.6$^{a}$ | 4.81$^{a}$ |

*Overall effect on main treatments was not significant.

Table 25b. *Cropping density effect on mean girth of rubber at 90cm and bark thickness. Values with same letter (as the superscript) within each category, are not significantly different*

| Treatment | 1997 Girth (cm) | 1998 Girth (cm) | Bark Thickness (mm) |
|---|---|---|---|
| Single row system (sole crop) | $41.2^{a}$ | $47.7^{a}$ | $4.7^{a}$ |
| Double row system (sole crop) | $38.4^{b}$ | $43.7^{bc}$ | $4.5^{a}$ |
| Alstonia intercrop in single row system | $40.0^{ab}$ | $46.4^{ab}$ | $4.4^{a}$ |
| Alstonia intercrop in double row system | $38.4^{b}$ | $42.3^{c}$ | $3.9^{b}$ |
| High density rubber = single row intercrop system | $42.7^{a}$ | $47.5^{a}$ | $4.4^{a}$ |
| High density rubber = double row intercrop system | $41.8^{a}$ | $46.8^{a}$ | $4.4^{a}$ |

(V H L Rodrigo, L S Kariyawasam and T U K Silva)

***Rubber and cardamom - Dartonfield (IC/RC/96/1)***

Objectives and treatments of the experiment appear in the annual review of 1996. Cardamom began to flower and fruiting occurred. However, cardamom showed location specific performance, therefore further in depth studies were proposed to investigate the reasons for it. Double row planting system for cardamom provided more yields in a given extent of land, when compared with single row system. Though rubber appear not to be affected by the cardamom in this experimental site, further studies to determine whether cardamom affects growth and yield of rubber, in other rubber/cardamom sites, were proposed for 1999. (V H L Rodrigo, L S S Pathiratne, L S Kariyawasam and T U K Silva). This is an collaborative project between the Department of Export Agriculture and the Rubber Research Institute and funded by CARP).

***Rubber x Banana intercrop and smallholder on-farm trials***

Experimental details including the summary of results and discussion for the first phase of the project appears in the annual review 1997. Based on this, next phase of the project was geared with following objectives.

- To test whether the findings are robust at smallholder level with researcher-led on-farm trails.

- To identify true constraints and possible solutions for intercropping at smallholder level through Participatory Rural Appraisal (PRA) tools and anthropological approach together with farmer-led on-farm trials.

- To identify the indigenous/local knowledge of rubber smallholders on intercropping and plan on-station experiments for key processes which have not been proven by earlier scientific works.

From traditional rubber growing areas, Kegalle and Kalutara districts where most of rubber is grown in wet zone and from non-traditional areas, Monaragala and Hambantota which covers some areas under intermediate zone as well, were selected for the study. Preliminary data collection was undertaken in three to four villages from each district for detailed PRAs coming up later.

In addition, long-term effects of banana intercropping on rubber were assessed in the old on-station experiment established in 1993. Banana in this experiment was in termination, and girth at 90cm height, bark thickness and canopy spread of rubber were studied. Girth measurements revealed that improved performance of rubber with intercrops during early stages, has continued (Table 26). Bark thickness and exposed area of rubber canopy, *i.e.* canopy spread were comparable in all treatments (V H L Rodrigo, A M W K Senevirathna, P D Pathirana, T U K Silva and L S Kariyawasam in collaboration with Universities of Wales, Durham in UK and Sri J'pura in Sri Lanka. The project was funded by the Department For International Development, UK).

Table 26. *Treatment differences with respect to girth, bark thickness and exposed canopy area at the centre. Only the girth values showed a significant difference and those with same letter (as the superscript), are not significantly different*

| Treatment | Girth in 1998 (cm) | Bark thickness (mm) | Exposed area of the canopy (m) |
|---|---|---|---|
| Sole rubber | $48.1^{c}$ | 5.43 | 0.86 |
| Intercropped with single row banana | $51.5^{a}$ | 5.44 | 0.56 |
| Intercropped with double row banana | $50.4^{ab}$ | 5.36 | 0.61 |
| Intercropped with triple row banana | $49.9^{b}$ | 5.44 | 0.81 |

***Rubber and Grass/Legume - Neuchetal IC/GL/91/1***

The trial was started in 1991 and the experimental details are reported in the Annual Review of the same year.

The grasses were completely eradicated by the shade of rubber trees.

Treatment effect on the growth of rubber was not apparent at this stage (Table 27). The rubber trees in this area is now in tapping (L S S Pathiratna and M K P Perera).

Table 27. *Effect of cropping system on the growth of rubber*

| Treatment | Girth of rubber (cm) |
|---|---|
| 1. Rubber (Control) | 53.7 |
| 2. Rubber + Panicum maximum (PM) | 56.5 |
| 3. Rubber + Brachiaria brizantha (BB) | 49.7 |
| 4. Rubber + Gliricidia | 51.4 |
| 5. Rubber + Ipil Ipil | 53.4 |
| 6. Rubber + PM+Gliricidia | 53.2 |
| 7. Rubber + PM + Ipil Ipil | 54.0 |
| 8. Rubber + BB+ Gliricidia | 54.1 |
| 9. Rubber + BB+ Ipil Ipil | 50.3 |

## *Rubber and Cocoa/Cinnamon*

*Dartonfield - IC/CC/91/2*

This trial was established in 1991 (Annual Review 1991) to investigate the possibility of intercropping Cinnamon and Cocoa with rubber.

The growth of rubber is not affected by the intercrops at this stage (Table 28). Per bush bark yield of Cinnamon is also not affected significantly by the different spacing systems tested (Table 28) (L S S Pathiratna and M K P Perera).

Table 28. *Effect of intercrops on the growth of rubber (cm) and yield of Cinnamon under different spacing treatments*

| Treatments | Girth of rubber (cm) | Bark yield of Cinnamon g/bush |
|---|---|---|
| 1. Rubber only | 49.7 | - |
| 2. Rubber + Cinnamon (spacing 1) | 52.9 | 35.6 |
| 3. Rubber + Cinnamon (Spacing 2) | 54.7 | 58.6 |
| 4. Rubber + Cinnamon (Spacing 3) | 54.9 | 39.6 |
| 5. Rubber + Cocoa (Spacing 1) | 46.5 | - |
| 6. Rubber + Cocoa (Spacing 2) | 47.5 | - |
| 7. Rubber + Cocoa (Spacing 3) | 48.9 | - |

*Cocoa Trials - Perth, Neuchetal, Tempo and Miriswatta*

The growth of rubber is not affected by Cocoa in single or double rows in these trials (Table 29) (L S S Pathiratna and M K P Perera).

Table 29. *The effect of intercrop on the girth of rubber (cm) in the different sites*

| Treatment | Parameter | Perth | Neuchatal | Tempo | Miriswatta |
|---|---|---|---|---|---|
| Rubber and Cocoa double row | Girth(cm) | 74.7 | 68.3 | 74.6 | 77.5 |
| Rubber and Cocoa single row | Girth(cm) | 73.6 | 67.8 | 73.2 | 77.1 |
| **Rubber only** | Girth(cm) | 72.0 | 71.4 | 75.8 | 70.6 |

***Rubber - Rattan***

*Kuruwita - IC/RR/96/1*

This trial was established in October 1996 with three indigenous species of rattan *viz. Calamus zeylanicus, C.ovoideus and C. pseudotenuis* in a 1984 rubber clearing. The experimental details and the objectives are given in Annual Review 1996. The growth of rattan was satisfactory (L S S Pathiratna and M K P Perera).

***Rubber and Cinnamon***

The objective of the trial is to investigate the possibility of intercropping Cinnamon under immature and mature rubber.

Two trials were established at the Kuruwita Sub-Station and one at a smallholding in Kamburupitiya to investigate the possibility of intercropping Cinnamon under mature and immature rubber.

*Kuruwita - IC/RC/98/1*

In this experiment single rows and double rows of rubber (clone RRIC 121) was planted with inter row spacings varying from 7.2m - 18.0 m. The 1st six treatments with rubber spaced 2.4m along the rubber row had interrow spacings of 7.2, 8.4, 9.6, 10.8, 12.0 and 13.2 m. The number of cinnamon rows included in these treatments were 4,5,6,7,8 and 9 respectively. The other five treatments had paired rows of rubber 2.4 m triangularly spaced and inter row spacing of 13.2, 14.4, 15.6, 16.8 and 18.0m. The number of cinnamon rows included in these treatments were 9, 10, 11, 12 and 13 respectively. All these treatments were included in a systematic design and replicated four times. Control plots with monocrop cinnamon was also included. Spacing for cinnamon in all the treatments was 1.2 x6m.

A further was established under mature rubber in a 1984 clg. at Kuruwita RRISL Sub Station. The spacing for rubber here is 9.1m x 2.4m and four spacial arrangements for cinnamon *viz.* 1.2m x .91m, .9mx .61m, 1.7m x 1.2m and 1.1m triangularly spaced was used. The number of Cinnamon rows in these treatment were 5,6,3 and 5 respectively. These treatments were replicated four times.

*Kamburupitiya IC/RC/98/2*

The treatments included in the smallholder plot established at Kamburupitiya were 8.2 m x 2.4 m and 2.4m triangularly spaced paired rows of rubber with an interrow space of 13.2 m. The two treatments had five and nine rows of cinnamon respectively.

Mono crop cinnamon plots with the same spacial arrangements were also established for comparison (L S S Pathiratna and M K P Perera in collaboration with Dept. Export Agriculture with CARP funding. CARP Grant 12/378/285).

**Expansion of rubber into areas marginal with regard to elevation, *viz.*, mid country wet zone**

The objective of the study is to test and recommend area specific technology for growing rubber beyond the traditional areas.

In this trial clones RRIC 110, RRIC 102, RRIC 130 and PB 260 were planted, replicated 4 times to accommodate the different micro-environment conditions. From each replicate 50 plants were selected randomly for annual growth measurements. Girthing of clones RRIC 102, RRIC 130 and RRIC 100 is comparable and superior to that of PB 260 (A Nugawela, R B Gunaratna, K A G B Amaratunga, S Wilbert in collaboration with all Biology Departments and Free Lanka Management Company Ltd. The project is funded by CARP Research Grant 12/296/260).

Table 30. *Girth classes and percentage of trees in each girth class in the different clones*

| | Girth classes and percentage in each class | | | |
|---|---|---|---|---|
| Clone | 0-5 cm | 6-10 cm | 11-15 cm | 16-20 cm |
| RRIC 102 | 0.5 | 21 | 42.5 | 36 |
| PB 260 | 0.5 | 37 | 50 | 12.5 |
| RRIC 130 | 1.0 | 20 | 63 | 16 |
| RRIC 100 | 0 | 19 | 54 | 26 |

**Nursery Inspection Unit**

***Inspections***

*Estate Sector*: Budwood nurseries were inspected mainly for clone identification in 60 estates belonging to 12 plantation companies, during the year.

Out of the total of 26365 source bush plants inspected, 20.9% was of overaged nurseries, *i.e.* above 10 years age.

The clonewise distribution indicated that 67% of the total source bush plants inspected belong to the 5 clones in group I of the clone recommnendation.

Out of this 90% is of three RRIC clones, of which 44% is RRIC 100. This is about 27% of the total stand.

Group II and group III of the clone recommendation each consisting 3 clones had 13% and 5% respectively. Only 15% of the total stand was of 15 clones in Group IV in the clone recommendation.

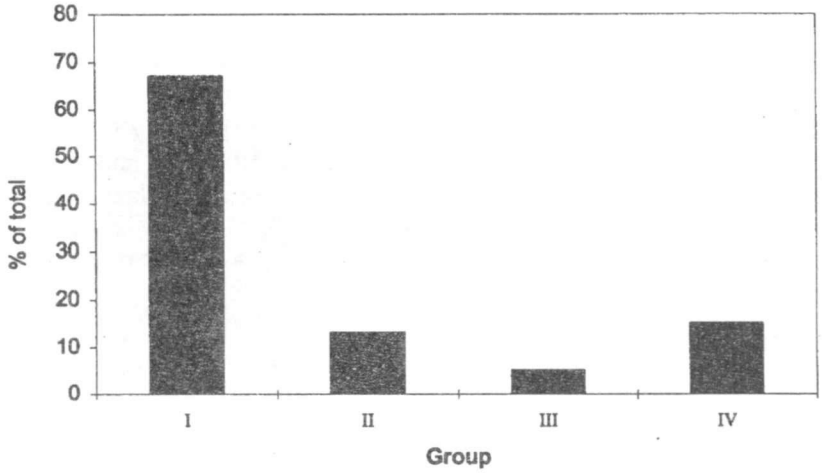



Fig. 1. Clone distribution of recommended clones

*Private sector*: A total of 171 private commercial nurseries were inspected and reports were submitted to the Rubber Development Department for the issue of permits (Table 31).

Table 31. *The number of private commercial nurseries inspected in different regions*

| Region | No. of nurseries inspected |
|---|---|
| Kegalle | 103 |
| Homagama | 24 |
| Kalutara | 23 |
| Ratnapura | 18 |
| Galle | 03 |
| Total | 171 |

Budwood nurseries of Gurugoda and Egaloya Rubber Development Department nurseries were also inspected during the year.

### *Issue of budded stumps for establishment of budwood nurseries*

A total of 9671 budded stumps were issued to both the plantation sector and private commercial nurseries for the establishment of multiplication nurseries (Table 32).

Table 32. *The clones and number of plants issued from each clone to both estates and Smallholder Sector*

| Group | Clone | No. of budded stumps | Total |
|---|---|---|---|
| I | RRIC 100 | 150 | |
| | RRIC 102 | 652 | |
| | RRIC 121 | 727 | |
| | PB 217 | 397 | |
| | PB 28/59 | 385 | 2311 (24%) |
| II | RRIC 117 | 610 | |
| | RRIC 130 | 583 | |
| | PB 235 | 243 | 1436 (15%) |
| III | RRIC 131 | 87 | |
| | RRIC 133 | 447 | |
| | PB 260 | 693 | 1227 (13%) |
| IV | BPM 24 | 325 | |
| | RRIM 717 | 185 | |
| | PB 255 | 243 | |
| | PR 255 | 54 | |
| | PR 305 | 477 | |
| | RRII 105 | 171 | |
| | RRISL 200 | 330 | |
| | RRISL 201 | 281 | |
| | RRISL 202 | 478 | |
| | RRISL 203 | 644 | |
| | RRISL 217 | 605 | |
| | RRISL 218 | 393 | |
| | RRISL 219 | 430 | |
| | GPS 1 | 50 | |
| | GPS 2 | 30 | 4693 (48%) |
| | | Total | 9671 |

(A Nugawela, P Seneviratna, R B Gunaratna, U S Weerakoon and M N de Alwis)

# PLANT PATHOLOGY AND MICROBIOLOGY

C K Jayasinghe

## SUMMARY

The incidence of secondary leaf fall was extremely low during the refoliation period except on highly susceptible clones in isolated areas where the wintering had been delayed. The abnormal leaf fall due to *Phytophthora* spp. reached epidemic proportions during the latter part of the South West monsoon period causing severe defoliation on susceptible clones (PB 86 and RRIC 121) in Avissawella and Kalutara regions.

Arrangements were made to stress the importance of adhering to correct cultural practices in the management of nurseries to prevent collar rot and target leaf spot disease. Systemic fungicide Folicur (tebuconazole) was shown to be highly effective in controlling the white root disease under field conditions.

Since two species of *Colletotrichum* namely *C. acutatum* and *C. gloeosporioides* have shown to be responsible for *Colletotrichum* leaf disease (CLD) in Sri Lanka, 19 fungicides were evaluated against both species. Among the fungicides tested; benomyl, copper oxychloride, propiconazole, tebuconazole and thio-phanate methyl were found to be effective against *C. gloeosporioides* while fungicides; copper oxychloride, pencycuron, propiconazole and tebuconazole were effective against *C. acutatum*. In view of this situation a combination of two fungicides appears to be the best in controlling CLD. Further, two more characteristics, slower growth at temperatures ranging from 15 to 32.5 °C and high tolerance of three fungicides were reported to be reliable characters in distinguishing rubber isolates of *Colletotrichum acutatum* from *Colletotrichum gloeosporioides* in addition to the characters reported last year.

Mock exercise was repeated using low concentrations of triclopyr and found these tested concentrations were not effective in causing defoliation.

## DETAILED REVIEW

### Staff

Dr C K Jayasinghe, Head of the Department and Plant Pathologist, Dr R Jayaratne were on duty throughout the year. Mr K E Jayasuriya and Miss W P K Silva, Pathologists continued their PhD programmes with the collaboration of the

University of Colombo. Mr W Amaratunge, Audio Visual Production Officer continued to work in the Department.

Experimental Officers Messrs D S Wettasinghe and E B Fernando; Senior Technical Officer Mrs J L P C Wettasinghe' Technical Officers, Mrs B I Tennakoon, Misses T H P S Fernando, D Siriwardene, U M S Priyanka; Clerk/Typist Mrs P Amarasekera, Temporary Technical Officer Miss K D S Samararatne were on duty throughout the year. Mr C Wijeratne joined the Department on 22nd January 1998 as a Technical Officer and Mrs H S L de S Rajapakse assumed duties as a temporary Technical Officer with effect from 1st of June under the CARP Project 12/373/299.

Mr Thilak de Silva, undergraduate from the University of Ruhuna successfully completed his final year project entitled "Cyanogenisis in *Hevea* rubber". Mr S T R J Gunawardena, Rubber Development Officer submitted his dissertation entitled reasons and the remedial for the loss of trees during immature phase in smalholdings" (Sinhalese medium) to the Institute of Plantation Management as a partial requirement for the Diploma in Plantation Extension. Mr S L Hewavitharana, a graduate from Sri Venkateswara College, India engaged on a project entitled "*In vitro* evaluation of fungicides against *Helminthosporium heveae*". All these projects were completed under the supervision of the Head of the Department.

## Visits

The Department staff made 24 advisory visits, 182 for experimental and 148 for other purposes.

## Training/Lectures/Seminars

Dr R Jayaratne, Plant Pathologist attended the International Training course on Crop Protection at South China Agricultural University, China from 7th May to 8th July.

Dr C K Jayasinghe, Dr R Jayaratne, Mr K E Jayasuriya and Miss W P K Silva were involved in training Superintendents, Asst. Superintendents, Field Officers, Undergraduates, Post-graduate students and NDT Trainees. Messrs S Wettasinghe and E B Fernando also participated in the training programmes conducted for Asst. Superintendents and Field Officers.

Dr C K Jayasinghe addressed the members of the Rubber Traders Association on "Current situation of the foliar diseases of rubber" at Taj Samudra on 21st February, 1998. He also addressed the members of several plantation companies on "History and Management of *Phytophthora* epidemics" and "Nursery diseases discovered in the recent past".

**Committees**

Dr C K Jayasinghe served in several national level committees; Pesticides Technical and Advisory Committee, Steering Committee on National Plant Quarantine (present Chairman) and Specialist Committee on Plant Protection. He also served as a member of the advisory committee on "Rapid decline of coconut palms", a new disease of unknown etiology.

Dr C K Jayasinghe, Dr R Jayaratne, Mr K E Jayasuriya and Miss W P K Silva attended Scientific Committee meetings of the Rubber Research Board.

Dr C K Jayasinghe and Dr R Jayaratne were appointed as visiting lecturers of the University of Ruhuna.

## GENERAL

The wintering which occurred early, was generally uniform and the weather conditions during the refoliation period were not conducive for the propagation of the pathogens. The incidence of secondary leaf fall was extremely low during the refoliation period except on highly susceptible clones in isolated areas where wintering had been delayed. However, abnormal leaf fall caused by *Phytophthora* spp. reached the epidemic proportions during the latter part of the SW monsoon and a severe defoliation was noticed on susceptible clones; PB 86 and RRIC 121 in Avissawella and Kalutara regions. An interim circular was sent warning all estate- managing companies and Rubber Development Department about bark rot disease, the second phase of the abnormal leaf fall.

The attention of the Directors, Estate Managers and Officers of the Rubber Development Department was drawn to the importance of the management of *Corynespora* infections in nurseries especially in polybag plants (circular dated 1.6.98 entitled "Management of *Corynespora* leaf fall in nurseries reduces risk of resistant clones becoming susceptible to CLF"). It was shown that heavy inoculum produced in affected plants may enhance the possibility of mutating the pathogen resulting new virulent strains capable of attacking resistant clones. Severe infection of *Corynespora cassiicola* with defoliation were noticed in the budwood nurseries of the clone RRIC 121 at Nakiyadeniya and Bibile estates. Surprisingly, RRIC 100 and RRIC 102 budwood nurseries were also found to be affected with *C. cassiicola* in both estates. But the infection was not severe as on RRIC 121.

Special article was published in International Rubber Research and Development Board News letter (1998 issue, part 2 : 6-7 pp) after the discovery of *Thanatephorus cucumeris* (a fungus considered to be a pest of quarantine importance to Asian continent) in poorly maintained immature clearings in Sri Lanka, stressing the importance of adhering to correct cultural practices. Further, arrangements were

made to circulate an interim circular entitled "The adoption of correct cultural practices prevents collar rot and target leaf spot in *Hevea* rubber" among the rubber growers through Planters' Association of Ceylon (30.6.98) and Director General, Rubber Development Department (31.8.98) as the spread *of T. cucumeris* in Sri Lankan rubber plantation is a matter of concern.

The observations of the mock exercise showed that the recommended dosage (500 g of triclorpyr in 40 liters of diesel per ha) for defoliation by the Technical Committee on South American Leaf Blight was lethal to rubber plants. This matter will be brought to the notice of the Technical Committee on SALB during its 13th Meeting planned to be held in Africa.

Two more characters were brought to the notice of the *Hevea* pathologists in Asian and African Continents in addition to the characters shown in 1997 for the reinvestigation of the causative agent responsible for Colletotrichum leaf disease in their respective countries (Mycopathologia **143**, 93-95).

The theme of the lectures delivered to Estate Managers and Asst. Superintendents during the latter part of the year was "History and management of *Phytophthora* Epidemics". This title was selected to increase the awareness on diseases caused by *Phytophthora* spp. As *Phytophthora* leaf fall reached the epidemic proportions during 1998 after five years.

## LABORATORY AND FIELD INVESTIGATIONS

### Chemical Control of *Hevea* diseases (CC/89/1)

### A. *Screening of fungicides against* Rigidoporus microporus.

$A_1$ The field experiment initiated at Dartonfield estate, Gallewatta division and Malaboda estate, Matugama to ascertain the efficacy of the fungicide Folicur (tebuconazole) revealed that this chemical is quite effective in controlling the disease under field conditions (Table 1) (R Jayaratne, C K Jayasinghe and P C Wettasinghe).

Table 1. *Effectiveness of 'Folicur' in controlling White root disease under field conditions*

| Estate | Pretreatment Assessment Number of trees with disease score | | | | | **Assessment after 15 months | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *0 | 1 | 2 | 3 | 4 | 0 | 1 | 2 | 3 | 4 | D |
| Malaboda | - | 11 | 5 | 2 | - | 17 | 1 | - | - | - | - |
| Dartonfield | - | 4 | 3 | 3 | - | 9 | - | - | - | - | - |

* Disease score,

0- Collar free of infection
1- Collar slightly affected with no foliar symptoms
2- Collar half circumference rotted with light foliar symptoms
3- Collar badly rotted with severe foliar symptoms
4- Collar completely rotted with fully wilted leaves
D- Dead

** After two applications of the fungicide at 6 months interval.

$A_2$ A new field experiment was initiated at Dewalakanda estate to further test the effectiveness of fungicide 'Folicur' in controlling white root disease. About 40 plants with various stages of infection were treated with 20 ml of Folicur in a litre of water. A second application will be given within 3-4 months (R Jayaratne, C K Jayasinghe and P C Wettasinghe).

**B. *Screening of fungicides against* Corynespora cassiicola**

*B1. Management of the disease in clearings*

Long term field trials to develop an economical management system to control *Corynespora* leaf fall in the year 1997 were continued. The clone under investigation is RRIC 110 and spraying of fungicides (benomyl/mancozeb/thiophanate methyl) is in progress at four locations namely; Dartonfield, Kuruwita, Lagos and Salawa estates (C K Jayasinghe, R Jayaratne, E B Fernando and C Wijeratne).

*B2. Management of the disease in nurseries*

Trials were conducted in polybag nurseries with freely available fungicides in the market after evaluating their efficiency under *in vitro* conditions. Experiments were completed and observations suggested that fungicides; benomyl (Benlate, 50% a.i., Du Pont), mancozeb (Dithane M 45, 80% a.i., Rohm & Haas), propineb (Antracol, 70% a.i., Bayer), copper 21% + mancozeb 20% (Tri Miltox Forte, 40% a.i., Sandoz), propineb 56% + oxadixyl 10% (Fruvit, 66% a.i., Bayer), propiconazole (Tilt 25 EC) and thiophanate - methyl (Topsin M 70, 70% a.i., Nipon) were the most effective in controlling common nursery diseases (C K Jayasinghe, T H P S Fernando and S Uhanowita).

## C. *Screening of fungicides against* Colletotrichum acutatum *and* Colletotrichum gloeosporioides

*Colletotrichum acutatum* was shown to be the major cause of *Colletotrichum* leaf disease (CLD) of rubber contrary to the belief that *Colletotrichum gloeosporioides* is the only pathogen responsible for causing CLD in Sri Lanka. In view of this situation total of 19 fungicides were evaluated against both species employing two screening techniques; conidial germination inhibiting test (CGIT) and poisoned food technique (PFT). Five fungicides; benomyl, copper oxychloride, propiconazole, tebuconazole and thic-phanate methyl were found to be effective (attained $EC_{100}$ in both tests) against *C gloeosporioides* while four fungicides (copper oxychloride, pencycuron, propiconazole and tebuconazole) reached the $EC_{100}$ in both screening techniques when tested against *C. acutatum*. Further, it was shown that analysis of the results depending on a particular technique is more apparent when identifying a potential chemical/s to manage CLD. In view of this situation, combination of two fungicides, conidial germination inhibitor for both *C. acutatum* and *C. gloeosporioides* (captan, thiram, copper 21% + mancozeb 20%, propineb 56% + oxadixyl 10%) and a fungicide for checking mycelial growth of both species (tebuconazole or epoxiconazole) can be identified as potential chemicals. However, the best combination is captan ($EC_{100}$ = 1 µg/ml for both species in CGIT) and tebuconazole ($EC_{100}$ = 5 & 50 µg/ml for *C. acutatum* and *C. gloeosporioides* respectively in PFT) in the management of CLD of rubber (C K Jayasinghe and T H P S Fernando).

## D. *Screening of fungicides against common pathogens in* Hevea *nurseries*

Several projects have been initiated to screen presently available fungicides

in Sri Lanka against *Phytophthora* spp. and *Drechslera heveae*, two common diseases in rubber nurseries. Experiments are in progress (C K Jayasinghe, E B Fernando, C Wijeratne and S L Hewavitharana).

**Biology of common pathogens (BCP/90/1)**

**A. Phytophthora *spp.***

$A_1$. *Studies on the genetical variations of* Phytophthora *species on rubber in Sri Lanka and defense responses of some clones against them*

A comparative study on variations of 40 isolates of *P. meadii* was completed and a paper was submitted to a journal with the following abstract: Forty-one *Phytophthora meadii* isolates were obtained from different *Hevea brasiliensis* clones grown in different climatic regions in Sri Lanka. Growth, morphology and pathogenicity of the isolates were examined. Growth and pathogenicity showed variation among the isolates. Some isolates obtained from moderately susceptible rubber clones were highly pathogenic than isolates obtained from resistant clones. However, it was not possible to group isolates according to the clone or the region from where they were obtained. This project was partially funded by the Council of Agricultural Research Policy (CARP) by the grant 12/373/299 awarded to the principal author. This is a collaborative study with the University of Colombo leading to a PhD degree (K E Jayasuriya, R L C Wijesundera, C K Jayasinghe and B I Thennakoon).

$A_2$. *Preliminary studies on anatomical and biochemical reactions involved in* Hevea *plants against* Phytophthora *infections*

Petiole washings of the 3 clones, RRIC 100, RRIM 600 and PB 86 were taken and the compounds presents were separated by using thin layer chromatography with cellulose powder. Ultra violet sensitive spots were detected in all three clones. *Cladosporium* bioassay was carried out to detect antifungal activity of these compounds. *Phytophthora* zoospore germination studies were also carried out using these compounds present in the UV active regions and also with the compounds present in antifungal activity areas found in the bioassay.

Same experimental procedures were also carried out with petiole and leaf extracts obtained with $C_2H_5OH$ and $CHCl_3$. An antifungal area was found in clone RRIC 100 and PB 86 which was absent in clone RRIM 600. Therefore this experiment was repeated with clone RRIM 623 which is also a highly susceptible clone to *Phytophthora* infections to confirm the absence of this compound in highly susceptible clones.

The separation of these compounds that are found only in tolerant/resistant clones will be done using NMR techniques in collaboration with the University of Colombo, Botany Dept. (R Jayaratne, R L C Wijesundera and P C Wettasinghe).

$A_3$. *Studies on molecular variations of* P. meadii *isolates*

Crude DNA was extracted from 11 selected isolates and the samples were quantified using spectrophotometry. Preliminary arrangements were made to carryout RAPD-PCR studies. This project was funded by the Council of Agricultural Research Policy of Sri Lanka, (CARP), by the grant 12/373/299 awarded to the principal author. This is a part of a collaborative study with the University of Colombo leading to a PhD degree (K E Jayasuriya, D P S T G Attanayake and R L C Wijesundera).

**B. Corynespora cassiicola**

$B_1$ *Molecular characterization of* Corynespora cassiicola

*Corynespora cassiicola*: RAPD-PCR profiles generated by 10 oligonucleotide primers revealed genetic variability among isolates of *Corynespora cassiicola*. Unique RAPD-PCR bands present in different genetic groups of *C. cassiicola* will be sequenced and specific primers will be designed to use on genetic probes to identify the specific groups of *C. cassiicola* (W P K Silva, E H Karunanayake and U M S Priyanka).

$B_2$ *Antifungal activity of* Hevea *leaf extract*

*Hevea* leaves of RRIC 100 and RRIC 104 which were inoculated with *Corynespora cassiicola* was extracted with hexane, $CCl_4$, $CHCl_3$, ethyl acetate and MeOH. Ethyl acetate and MeOH fractions contained a antifungal compound which reduces the germination percentage of *C. cassiicola* spores. Purification and characterization of these antifungal compounds is in progress (W P K Silva, R L C Wijesundera and U M S Priyanka).

$B_3$. *Pathogenesis related proteins in* C. cassiicola *infection process*

There were evidences to prove the involment of pathogenesis related proteins in *Corynespora cassiicola* infection. This experiment is in progress (W P K Silva, R L C Wijesundera and U M S Priyanka).

$B_4$. *Production of pectic enzymes by* C. cassiicola *isolates*

*C. cassiicola* isolates obtained from papaw, tomato and rubber were used in this study. It was found that all the isolates produced pectin lyases and polygalacturonases in liquid culture media, tomato isolate produced significantly higher PG concentration than other isolates. Molecular weight determinations of these enzymes are in progress (W P K Silva, R L C Wijesundera and U M S Priyanka).

$B_5$. *Clonal susceptibility to* Corynespora cassiicola

All the recommended clones were susceptible to *C. cassiicola* infection in the laboratory screening test (detached leaf test) against *Corynespora cassiicola* (W P K Silva, C K Jayasinghe and U M S Priyanka).

**Micro-Organisms and pests associated with the rubber plantation (MP/89/1)**

**A. Colletotrichum acutatum:** ***the major cause of*** **Colletotrichum** ***leaf disease in Sri Lanka***

Two more characteristics to distinguish *Colletotrichum* species pathogenic to rubber were identified.

Slower growth at temperatures ranging from 15 to 32.5 °C and high tolerance of three fungicides; benomyl, carbendazim and thio-phanate methyl were shown to be reliable characters in distinguishing rubber isolates of *Colletotrichum acutatum* from *Colletotrichum gloeosporioides* in addition to the characters reported last year (C K Jayasinghe and T H P S Fernando).

$A_1$. *Factors affecting the spore production, germination and viability of* C. acutatum

Investigations on spore production of *Colletotrichum acutatum* revealed that five isolates out of six cultures tested, sporulated profusely on potato dextrose agar under normal light and dark regimes at room temperature (26 ± 2 °C). Spore production commenced at 10 °C and was inhibited at 40 °C showing two peaks around 10-20 °C and 27.5-30 °C indicating the ability to sporulate under both temperate and tropical conditions. Spore germination occurred above 10 °C and below 40 °C having around 90% germination at a range above 15 °C and below 35 °C. Studies on effect of temperature on the viability of spores showed that *C. acutatum* spores can withstand temperatures up to 40 °C for 3 hrs. With regard to the humidity requirements, it was found that free water is not essential for spore germination. More

than 85% spore germinated at high relative humidities as 96%. However, germination was markedly inhibited (dropped to 10%) when spores were exposed to 91% RH (C K Jayasinghe, T H P S Fernando and S Samararatne a collaborative project with Prof. R L C Wijesundera, University of Colombo leading to a MPhil degree).

$A_2$. *Cell wall degrading enzymes from* C. acutatum

All three isolates under investigation produced significant amounts of both pectolytics, PG and PL in culture media. Infected rubber leaves (Tjir 1) did not show PG activity at any stage, however PL was detected. Molecular weight determination of PG and PL is in progress (T H P S Fernando and C K Jayasinghe, a collaborative project with Prof. R L C Wijesundera, University of Colombo leading to a MPhil degree).

$A_3$. *Toxic metabolites from* C. acutatum

*C. acutatum* isolates grown on modified fries medium secreted toxic metabolites to the media. Studies on the characterization of the toxin is in progress (C K Jayasinghe, T H P S Fernando and S Samararatne).

**B. Cylindrocladium candelabrum**

Investigations were carried out on morphological and reproductive characteristics of *C. candelabrum*, a pathogen reported recently on *Hevea* rubber in Sri Lanka (C K Jayasinghe and E B Fernando).

**Biological control of *Hevea* diseases (BC/89/1)**

***Biological control of white root disease***

Repetition of the experiment was temporarily suspended due to inadequacy of manpower. Work on the project will commence after the completion of the projects under BCP/90/1/A (K E Jayasuriya and B I Thennakoon).

## Improvement of cultural practices in management of *Hevea* diseases (CP/89/1)

### A. *Effect of an additional dose of fertilizer on yield of* Hevea *plants defoliated due to* Phytophthora *epidemics*

The above experiment initiated in 1993, continued at Halwatura, Sirikandura, Eladuwa and Padukka estates. Application of an additional doze of fertilizer soon after defoliation and collection of yield data throughout the year were carried out (R Jayaratne, C K Jayasinghe and D Siriwardene).

## Studies on VA mycorrhizal (M/86/1)

A. The field experiment initiated to ascertain the effect of inoculation of arbuscular mycorrhiza in competition with natural populations was continued. The growth of the established plants were monitored once in six months (Table 2) (R Jayaratne and D Siriwardene).

Table 2. *Mean diameter of the field established plants after 16 months (cm) (Mean of 5 replicates consisting 10 plants for each replicate)*

| Mycorrhizal type | + P (added P) | - P (no addition of P) |
|---|---|---|
| 1. *Gigaspora margarita* | 5.16 | 5.01 |
| 2. *Acaulospora* sp. | 4.63 | 4.50 |
| 3. Natural population | 4.61 | 4.47 |
| Non-mycorrhizal (initially) | 4.07 | 4.06 |

LSD (P = 0.05) = Between P treatments - 0.199
Among species - 0.289

$A_1$ An experiment was commenced with the collaboration of soils and plant nutrition dept to ascertain the effect of newly developed Arbuscular mycorrhizal (*Acaulospora* sp.) inoculum on young budding nursery *Hevea* plants. The following treatments were carried out.

1. T1 - No fertilizer added (control)
2. T2 - Recommended Inorganic fertilizer + mycorrhizal inoculum
3. T3 - Cow dung + mycorrhizal inoculum
4. T4 - Compost + mycorrhizal inoculum
5. T5 - Mycorrhizal inoculum only

The plants arranged according to a randomized block design inside a glasshouse. These were allowed to grow with regular watering. Girth and height measurements were taken at monthly intervals (Table 3 and 4). Plants were budgrafted (young budding) successfully after 6 months (R Jayaratne, L Samarappuli, D Siriwardene and A Theravapperuma).

Table 3. *Girth of seedling (mm). Each treatment was replicated for 5 times with 4 plants per each replicate (mean of 20 plants)*

| Treatment/Age | 2 months | 3 months | 4 months |
|---|---|---|---|
| T1 | 5.94 | 7.04 | 8.10 |
| T2 | 5.16 | 7.02 | 8.22 |
| T3 | 5.58 | 6.86 | 7.64 |
| T4 | 5.44 | 6.72 | 7.62 |
| T5 | 5.18 | 6.70 | 7.66 |
| LSD P (0.05) = | 0.599 | 0.517 | 0.705 |

Table 4. *Height of seedlings (cm). Mean of 5 replicates consisting of 20 plants*

| Treatment/Age | 2 months | 3 months | 4 months |
|---|---|---|---|
| T1 | 51.84 | 69.26 | 76.42 |
| T2 | 50.42 | 66.86 | 76.94 |
| T3 | 52.32 | 64.56 | 71.10 |
| T4 | 49.82 | 65.48 | 70.47 |
| T5 | 46.34 | 61.46 | 70.02 |
| LSD P (0.05) = | 7.146 | 9.480 | 7.559 |

$A_2$ The nutrient analysis of roots and shoots of the experiment carried out in collaboration with soils and Plant Nutrition Dept. to ascertain the effect of arbuscular mycorrhiza on uptake of phosphorus from different sources in polybags was completed (Table 5) (R Jayaratne, A Dissanayake, D Siriwardene and C Maheepala).

Table 5. *Nutrient levels of leaf, shoot, petioles and roots (%) (Each value represents a mean of 12 plants, 6 replicated per each sub treatment)*

| Treatment | | N% | | | | P% | | | | K% | | | | Ca% | | | | Mg% | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | S | P | R | L | S | P | R | L | S | P | R | L | S | P | R | L | S | P | R |
| No.P | -M | 3.94 | 2.20 | 0.93 | 2.20 | 0.277 | 0.13 | 0.19 | 0.04 | 1.56 | 1.09 | 1.15 | 0.76 | 0.19 | 0.31 | 0.60 | 0.29 | 0.369 | 0.38 | 0.25 | 0.13 |
| | +M | 3.76 | 1.90 | 0.96 | 2.05 | 0.257 | 0.13 | 0.22 | 0.03 | 1.25 | 0.98 | 1.44 | 0.82 | 0.15 | 0.34 | 0.54 | 0.16 | 0.41 | 0.31 | 0.26 | 0.19 |
| | | 3.85ab | 2.04a | 0.95c | 2.12b | 0.27a | 0.13c | 0.20c | 0.39b | 1.55a | 1.03b | 1.31a | 0.79b | 0.17cb | 0.32b | 0.57a | 0.19c | 0.39a | 0.35a | 0.26a | 0.16a |
| ERP | -M | 4.07 | 1.95 | 1.32 | 2.16 | 0.269 | 0.14 | 1.19 | 0.072 | 1.31 | 1.04 | 1.43 | 1.095 | 0.14 | 0.33 | 0.68 | 0.07 | 0.29 | 0.23 | 0.30 | 0.15 |
| | +M | 4.10 | 2.20 | 1.72 | 2.21 | 0.24 | 0.16 | 0.24 | 0.11 | 0.94 | 1.45 | 1.96 | 1.34 | 0.13 | 0.37 | 0.56 | 0.36 | 0.32 | 0.27 | 0.41 | 0.20 |
| | | 4.09a | 2.09a | 1.54b | 2.19b | 0.25a | 0.15b | 0.22c | 0.9a | 1.13b | 1.26ab | 1.72a | 1.23a | 0.14c | 0.35b | 0.61a | 0.26bc | 0.31b | 0.25b | 0.28a | 0.18a |
| IRP | -M | 4.52 | 1.77 | 2.55 | 2.40 | 0.21 | 0.18 | 0.27 | 0.09 | 0.84 | 1.55 | 1.98 | 1.23 | 0.15 | 0.42 | 0.73 | 0.40 | 0.30 | 0.2 | 0.56 | 0.14 |
| | +M | 3.71 | 2.05 | 2.26 | 1.88 | 0.22 | 0.18 | 0.29 | 0.08 | 0.74 | 1.56 | 1.94 | 1.04 | 0.28 | 0.45 | 0.40 | 0.37 | 0.06 | 0.24 | 0.21 | 0.13 |
| | | 3.69ab | 2.14a | 2.39a | 2.13b | 0.21b | 0.18a | 0.28b | 0.08a | 0.72c | 1.56a | 1.96a | 1.05ab | 0.23a | 0.46a | 0.55a | 0.37ab | 0.29ab | 0.23b | 0.28a | 0.25a |
| ERP+ IRP | -M | 3.53 | 1.78 | 2.02 | 2.31 | 0.21 | 0.17 | 0.32 | 0.08 | 0.75 | 1.22 | 1.69 | 1.07 | 0.20 | 0.37 | 0.83 | 0.40 | 0.32 | 0.20 | 0.25 | 0.24 |
| | +M | 3.51 | 2.33 | 2.56 | 2.73 | 0.21 | 0.22 | 0.34 | 0.09 | 0.84 | 1.17 | 1.88 | 1.07 | 0.22 | 0.46 | 0.23 | 0.41 | 0.27 | 0.23 | 0.22 | 0.21 |
| | | 3.52b | 2.06a | 2.17a | 2.54a | 0.21b | 0.19a | 0.33a | 0.09a | 0.80c | 1.20ab | 1.79a | 1.07ab | 0.21ab | 0.41ab | 0.53a | 0.41a | 0.29b | 0.22b | 0.24a | 0.22a |

No. P - No added phosporus
ERP - Eppawela rock phosphate
IRP - Imported rock phosphate

L-Leaf, S-shoot, P-Petioles, R-Roots
+M – Mycorrhizal plants
-M – Non-mycorrhizal plants

$A_3$ Arbuscular mycorrhizal inoculum that can be used in commercial scale was successfully patented in Sri Lanka. This product can be used successfully as a cheap "bio fertilizer" to improve the growth and the vigour of plants and seedlings (R Jayaratne and D Siriwardene).

## Screening of *Hevea* clones for leaf and panel diseases (SC/89/1)

### A. *Maintenance of recommended and potential clones in different agro-climatic zones*

Weeding, fertilizer application and numbering were done at Atale, Polatagama, Padukka, Pitiyakande, Nakiyadeniya, Bibile, Hapugastenna and Dartonfield estate nurseries (C K Jayasinghe, W P K Silva and D S Wettasinghe).

### B. *Screening of clones against* Phytophthora *leaf fall*

The rubber clones; PR 255, PR 261, PB 235, PB 260, RRIM 712, BPM 24, RRIC 121, PB 217, RRIC 110 and RRIC 100 were evaluated for disease severity during the *Phytophthora* epidemic in 1998. RRIM 712 was found to be most susceptible clone while RRIC 121 and PR 261 were moderately susceptible. RRIC 100 showed very high resistance to the abnormal leaf fall. Kelani Valley region was found to be the most severely affected area (C K Jayasinghe and E B Fernando).

### C. *Field surveys for* Corynespora *leaf fall*

Island wide field surveys were carried out to find the CLF situation on potential and existing clones. Summaries of the observations are given below.

| | | |
|---|---|---|
| ***RRIC 100*** | - | Mild infections were noticed on budwood nurseries only at two locations, Bibile & Nakiyadeniya estates. |
| ***RRIC 121*** | - | Plants in the budwood nurseries of Bibile and Nakiyadeniya were found to be severely affected causing defoliation. |
| ***RRIC 102*** | - | Severe infections were noticed in the budwood nurseries of Bibile and Nakiyadeniya estates. |

Observations on the plants in nurseries established for screening purposes revealed that RRIC 110, RRIC 132 were highly susceptible with defoliation and stem die-back. RRIM 600, BPM 24 and PR 261 are moderately susceptible to infections caused by *C. cassiicola* (C K Jayasinghe and D S Wettasinghe).

## MISCELLANEOUS

### Mock exercise

During the mock exercise carried out in 1997 it was noticed that the concentration of the defoliant used was lethal to rubber plants. The concentration, 500g of triclopyr in 40 litres of diesel per ha. used was the recommended dosage by the Technical Committee of the SALB of ANRPC. In view of this situation a series of experiments was conducted using the lower dilutions than the recommended concentration by the ANRPC Technical Committee on SALB, to cause the defoliation of rubber plantations. The concentrations used were 100 g, 200 g, 300 g and 400 g of triclopyr in 40 l of water/ha. It was found that concentrations 300 g and 400 g were appropriate for successful defoliation. However, refoliation was very poor and later it was observed that shoots have been killed resulting the die-back of trees. "ASPEE" Mistblower was used for the spraying purposes and chemical reached a height of 55 feet (C K Jayasinghe, R Jayaratne, E B Fernando and C Wijeratne).

### *Effect of "Kohomba" seed extract on the colony growth of* Colleltotrichum, Phytophthora *and* Rigidoporus

The fungicidal activity of "Kohomba" seed extract was tested using Poisoned Food Technique and found that $LD_{100}$ of the both test organisms could be achieved only at a concentration of 50,000 ppm. The test sample was provided by Dr. K.De Silva, Deputy Director, RRISL. Further studies were carried out to test the chemical against *Rigidoporus lignosus* during the latter part of the year. Observations showed no inhibitory effect on *R. lignosus* hyphae (C K Jayasinghe, R Jayaratne and D S Wettasinghe).

### *Cyanogenic glucosidase activity of different* Hevea *clones*

HCN-potential and ß-glucosidase activity of eight *Hevea* clones namely Tjir 1, RRIC 100, RRIC 102, RRIC 121, PB 86, PB 28/59, IAN 717 and IAN 873 were evaluated with the view of establishing a correlation between disease resistance and cyanogenic glucosidase activity. Both activities were significantly high in copper brown leaves compared to apple green stage. With regard to clonal response a great deal of variation was observed in activities among the different clones. Experiment is in progress with presently recommended clones (C K Jayasinghe, T N de Silva, T H P S Fernando).

# SOILS AND PLANT NUTRITION

**Lalani Samarappuli**

## SUMMARY

Research on improvement in soil fertility, increasing fertilizer use efficiency, economizing on fertilizer use, improved methods of soil, water and nutrient conservation and weed control have been the main objectives of this Department.

It has been confirmed that *Flemingia congesta* and *Crotolaria anagyroides* could be grown successfully between the rows of rubber plants which would provide sufficient biomass for mulching. *Mucuna bracteata* has been identified as a successfull legume species that can be grown with rubber plants. It can withstand drought and suppresses weeds very effectively.

The soil and foliar survey programme provided data for fertilizer recommendations for 6000 hectares in the estate sector. Revised fertilizer recommendations based on soil and foliar survey done in the previous years were provided to the estates that were interested in adopting some economy measures due to the present unfavourable trading conditions for rubber.

## DETAILED REVIEW

### Staff

The Head of the Department, Dr (Mrs) Lalani Samarappuli was on duty throughout the year. Soils Chemist, Dr D M A P Dissanayake returned from Malaysia in April after participation in a training programme organized by the IAEA. Assistant Soils Chemist, Mr S Dharmakeerthi proceeded to Canada in September for his post graduate studies.

The Experimental Officers, Messrs A M A Perera, H D S P Perera, G de Mel and R Hettiarachchi, C Maheepala, S N Silva, P Karunadasa, U Mitrasena, A N Yakandawela and T B Dissanayake were on duty throughout the year. Technical Officers Messrs, V Edirimanne, A Thevarapperuma and P R Puhambugoda, Senior Testing Officer Mr T M Ahamadeen and the English Stenographer Mrs L Rupasinghe were on duty throughout the year. Technical Officer Mrs D Senaratne resigned from the institute in March. Miss K Jayanetti joined the institute as a Technical Officer in January.

## Visits

Dr Lalani Samarappuli participated in the Seminar on Soil Degradation organized by the Asian Productivity Organization of Japan from 19th to 24th October, held at the Department of Soil Science, University of Agriculture, Faisalabad, Pakistan.

The Departmental staff paid advisory visits to plantations and smallholdings and routine visits to experimental areas where necessary.

## Seminars, Meetings, Workshops and Training

Dr (Mrs) Lalani Samarappuli addressed the following:

> Seminar on Soil Degradation organized by the Asian Productivity Organization of Japan, on "Soil Degradation and Land Development practices in Sri Lanka."

Dr (Mrs) Lalani Samarappuli[1] and Dr D M A P Dissanayake[2] attended the following seminars, meetings and workshops:

* Fertilizer Advisory Committee[1].
* The Working Group on Fertilizer Mixtures of the Sri Lanka Standards Institution[1].
* Central Scientific Committee[1,2].

## Training Programmes

Lalani Samarappuli, D M A P Dissanayake and S Dharmakeerthi were involved in the following training programmes as resource personnel:

* Superintendents, Assistant superintendents and Field Officers of Plantation Management Companies
* Superintendents/Assistant Superintendents and Rubber Development Officers for the Diploma Course in Plantation Management
* University Students/NDT Trainees

# LABORATORY AND FIELD INVESTIGATIONS

## 1. Soil fertility and moisture conservation

### 1.1 *Agronomic practices in relation to moisture conservation*

#### 1.1.1 *Use of live and dead mulch*

##### 1.1.1.1 Comparison of different management practices

Investigations on the effect of mulching under during the immature period, on latex production and girthing of trees done under experiment SMC-Ag/M/82/5 were completed and four research papers and an advisory circular (no.1997/04) were published.

In experiment SMC-Ag/M/88/1, application of mulching was continued during mature phase. The effect of this treatment in comparison with the residual effect of mulching on yield of rubber plants is given in Table 1. No significant difference was observed among the two treatments for yield (L Samarappuli, P Karunadasa and U Mitrasena).

Table 1. *Effect of different soil management practices on yield*

| Treatment | Yield | |
|---|---|---|
| | (g/t/t) | (kg/ha/yr) |
| Legumes | 21.46[a] | 1352[a] |
| Mulching discontinued | 23.60[a] | 1487[a] |
| Mulching continued | 23.39[a] | 1474[a] |

##### 1.1.1.2 Optimum N P K levels for rubber mulched with rice straw

In this experiment (SMC-Ag/M/83/1), the N,P,K requirements for rubber, mulched with rice straw, was studied in a 3x3x3 factorial design in which three levels of N,P and K were applied with and without mulching in the sub-plots. This experiment was discontinued (L Samarappuli, P Karunadasa and U Mitrasena).

1.1.1.3 Different mulching materials

A field experiment (SMC-Ag/M/97/1) is in progress at Sapumalkanda estate, Deraniyagala to study the effect of different quantities of refuse tea and wood ash on growth of *Hevea* plants. Treatments consisted of three quantities of refuse tea and wood ash; no refused tea (T0), 1/2kg refuse teas/plant (T1), 1kg refuse tea/plant (T2), no wood ash (W0), 1/2kg wood ash/plant (W1) and 1kg wood ash/plant (W2). Plant girth at 18 months after planting is given in Table 2 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 2. *Effect of refused tea and wood ash on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| $T_0W_0$ | 18.6 |
| $T_0W_1$ | 19.6 |
| $T_0W_2$ | 16.9 |
| $T_1W_0$ | 18.4 |
| $T_1W_1$ | 17.2 |
| $T_1W_2$ | 19.6 |
| $T_2W_0$ | 17.5 |
| $T_2W_1$ | 20.8 |
| $T_2W_2$ | 17.4 |

*1.1.2 Fertilizer practices for overcoming moisture stress*

A field experiment (SMC-Ag/F/88/3) is in progress at Nalanda Estate, Ulpotha to study the effect of different levels of potassium on growth and yield of *Hevea* plants in a comparatively drier area. The effect of different K levels on girth and girth increment is given in Table 3. Test tapping was not done during the year 1998.

In experiment SMC-Ag/M/88/1, with and without K, yield data indicated higher yield (Table 4) with potassium at K1 level.

In field experiment (SMC-Ag/F/95/1), the effect of both potassium and mulching on moisture stress and growth of *Hevea* was studied. Treatments consisted of three mulching techniques; no mulch (M0), surface mulching (M1) and sub surface mulching (incorporation) (M2) and four potassium levels; half the recommended level

(K1), recommended level (K2), one and half the recommended level (K3) and double the recommended level (K4). Girth measurements at three and a half years after planting are given in Table 5 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 3. *Effect of different K levels on girthing of* Hevea

| Treatment | Girth (cm) | Girth Increment (cm) |
|---|---|---|
| $K_0$ | 51.7 | 3.1 |
| $K_1$ | 51.8 | 3.9 |
| $K_2$ | 51.4 | 3.3 |
| LSD | 4.9 | - |

Table 4. *Effect of potassium on girth and yield of rubber plants*

| K levels | Yield | |
|---|---|---|
| | (g/t/t) | (kg/ha/yr) |
| $K_0$ | 25.57 | 1606 |
| $K_1$ | 29.72* | 1872* |
| LSD | 3.25 | 205 |

*1.1.3 Rubber based cropping systems to increase water use efficiency of rubber plants*

Two experiments are in progress at the RRI Sub Station in Kuruwita (SMC-Ag/I/93/1) and at Perth estate, Ingiriya (SMC-Ag/I/96/1) to study the water use efficiency of rubber plants when multicropped with tea. Access tubes were installed in each plot in the experimental area to monitor soil moisture content using Neutron Moisture Meter (L Samarappuli, N Yogaratnam, S M Iqbal, P Karunadasa and U Mitrasena).

Table 5. *Effect of potassium and mulching on girth of rubber plants*

| Treatment | Girth (cm) | Girth Increment (cm) |
|---|---|---|
| $K_4M_1$ | 33.63[a] | 11.15 |
| $K_3M_1$ | 33.40[a] | 11.20 |
| $K_2M_2$ | 32.45[ab] | 10.87 |
| $K_1M_1$ | 32.43[ab] | 10.85 |
| $K_1M_2$ | 32.38[ab] | 10.88 |
| $K_2M_1$ | 32.30[ab] | 10.18 |
| $K_3M_0$ | 32.28[ab] | 10.38 |
| $K_4M_0$ | 32.28[ab] | 10.96 |
| $K_4M_2$ | 32.25[ab] | 10.25 |
| $K_3M_2$ | 31.95[ab] | 9.33 |
| $K_2M_0$ | 31.55[ab] | 9.55 |
| $K_1M_0$ | 31.18[b] | 9.86 |

*1.1.4 Fertilizer and soil moisture requirement of rubber under different densities*

An experiment (SMC-Ag/D/96/1) was started at Mucalana Division, Sirikandura Estate to study the fertilizer and soil moisture requirement of rubber under different densities. Treatments consisted of (a) Four different densities; (i) 500 trees/ha [4.5m x 4.5m], (ii) 600 trees/ha [4.2m x 4.2m], (iii) 700 trees/ha [3.8m x 3.8m] and (iv) 800 trees/ha [3.5m x 3.5m] (b) Three fertilizer treatments; (i) recommended level, (ii) reduced level and (iii) 1st three years recommended level and thereafter reduced level. Another experiment (SMC-Ag/D/97/1) was also started at Dorset Division, Clyde Estate to study the fertilizer and soil moisture requirement of rubber under different densities with same treatments. Effect of different densities on girth of rubber plants at the end of two and a half years and one and a half years from planting is presented in Table 6 (L Samarappuli, P Karunadasa and U Mitrasena in collaboration with the Plant Science Department).

Table 6. *Effect of different plant densities and fertilizer treatments on girth of rubber plants*

| Treatment | Girth after planting (cm) | |
|---|---|---|
| | 1½ years | 2½ years |
| 500 trees/ha [4.5m x 4.5m] | 10.1[a] | 18.7[a] |
| 600 trees/ha [4.2m x 4.2m] | 10.4[a] | 17.9[a] |
| 700 trees/ha [3.8m x 3.8m] | 10.0[a] | 19.4[a] |
| 800 trees/ha [3.5m x 3.5m] | 10.3[a] | 20.2[a] |
| Recommended fertilizer level | 10.2[a] | 19.7[a] |
| Reduced fertilizer level (1) | 10.2[a] | 18.4[a] |
| Reduced fertilizer level (2) | 10.1[a] | 19.0[a] |

### *1.2 Feasibility of growing rubber in drier areas*

A field experiment (SMC-Ag/F/88/3) is in progress at Nalanda Estate, Ulpotha to study the feasibility of growing rubber in a comparatively drier area. Two other field experiments (SMC-Ag/F/98/1) and (SMC-GC/TL/98/1) are in progress at Bibile Estate, Bibile and at Kumarawatta estate, Monaragala, respectively, to study the same with different soil management and fertilizer practices (L Samarappuli, P Karunadasa and U Mitrasena).

### *1.3 Ground cover management and nutrient recycling*

#### *1.3.1 Ground cover management*

1.3.1.1 Comparison of different cover types

Experiment, SMC-Ag/M/88/1, was started to study the influence of creeping, bush and tree legumes on some soil characteristics and their effects on the performance of rubber in *Boralu* series soils. Effect of different types of legumes on girth and yield rubber is given in Table 7 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 7. *Effect of different types of legumes on girth and yield of* Hevea

| Treatment | Girth (cm) | Yield (g/t/t) | Yield (kg/ha/yr) |
|---|---|---|---|
| *Pueraria* (creeping type) | 57.0[a] | 21.5[a] | 1355[a] |
| *Desmodium* (bush type) | 54.6[ab] | 18.7[ab] | 1178[ab] |
| *Stylosanthus* (bush type) | 54.9[ab] | 16.7[b] | 1052[b] |
| *Tephrosia* (tree type) | 52.5[b] | 19.9[ab] | 1254[ab] |

Another field experiment is in progress at Perth Estate, Horana to compare the effectiveness of tree legumes with the conventional creeping type *Pueraria phasioloides*. Effect of these legumes on girth of rubber plants at the end of two and a half years from planting is presented in Table 8 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 8. *Effect of different tree legume species on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| *Pueraria phasioloides* | 18.1[a] |
| *Crotolaria anagyroides* | 21.6[b] |
| *Flemingia congesta* | 20.4[b] |
| *Tephrosia vogellie* | 18.5[a] |

1.3.1.2 Comparison of different tree legumes

A field experiment (SMC-GC/TL/96/1), was started to study the comparative efficiency of *Tephrosia vogellie, Crotolaria anagyroides and Flemingia congesta* as successful tree legume species that can be grown between the rows of rubber plants which could provide enough material for mulching in Kalutara District. Although the growth rate of *Flemingia congesta* during the early stages appeared to be slow, it was observed that the growth rate and recovery after lopping of *Flemingia congesta* is much higher than the other two species. Soil moisture content and leaf water potential of rubber plants under different tree legume species are presented in Table 9 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 9. *Effect of different tree legume species on soil moisture content and leaf water potential (LWP)*

| Treatments | Soil moisture content (kg/M$^3$) | LWP (bars) |
|---|---|---|
| *Crotolaria anagyroides* | 516[a] | 10.6[a] |
| *Flemingia congesta* | 528[a] | 11.3[a] |
| *Tephrosia vogellie* | 489[a] | 10.8[a] |

1.3.1.3 Phosphate fertilizers for cover crops

A field experiment, (SMC-GC/P/97/1) was started in Weniwella estate, Kegalle to study the effectiveness of Eppawela rock phosphate as a source of P for leguminous ground covers, both creeping and bush/tree types. Treatments consisted of three P sources: no P, ERP and IRP and two cover types: *Mucuna bracteata and Flemingia congesta.* Effect of these treatments on girth of rubber plants at the end of 18 months from planting is presented in Table 10 (L Samarappuli, A Dissanayake, N Yogaratnam, P Karunadasa, U Mitrasena and E A T Senadeera).

1.3.1.4 New cover crop species

At Perth Estate, Horana an experiment (SMC-GC/C/96/1)) was started to study the efficiency of *Mucuna bracteata*, on growth, nutrient enrichment and other desirable characteristics in comparison with *Pueraria.* Effect of two different types of legumes on girth of rubber plants at the end of two and a half years from planting is presented in Table 11 (L Samarappuli, P Karunadasa and U Mitrasena).

At Sapumalkanda estate, Deraniyagala an experiment (SMC-GC/C/97/1)) was started to study the efficiency of *Wedelia biflora* (Arunadevi), on growth, nutrient enrichment and other desirable characteristics in comparison with *Pueraria.* Effect of this cover crop on girth of rubber plants at the end of 18 months from planting is presented in Table 12 (L Samarappuli, P Karunadasa and U Mitrasena).

Another field experiment (SMC-GC/C/98/1), was started to study and identify leguminous cover crop species with multiple advantages and which would satisfy a dual function of being a cover crop and a cash crop at the same time (L Samarappuli, P Karunadasa and U Mitrasena).

Table 10. *Effect of different sources of phosphate on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| $R_0C_0$ | 10.7 |
| $R_0C_I$ | 10.1 |
| $R_0C_E$ | 9.4 |
| $R_1C_0$ | 10.8 |
| $R_1C_I$ | 11.2 |
| $R_1C_E$ | 10.5 |
| $R_2C_0$ | 9.6 |
| $R_2C_I$ | 11.0 |
| $R_2C_E$ | 10.1 |

Table 11. *Effect of two different legume species on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| *Mucuna bracteata* | 19.4[b] |
| *Pueraria phaseoloides* | 18.1[a] |

Table 12. *Effect of Wedelia biflora (Arunadevi) on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| *Pueraria phaseoloides* + P | 11.4 |
| *Wedelia biflora* + P | 9.8 |
| *Wedelia biflora* + NPKMg (level 1) | 10.2 |
| *Wedelia biflora* + NPKMg (level 2) | 10.7 |

*1.3.2 Nutrient recycling*

1.3.2.1 Sludge as a potential fertilizer for *Hevea*

An experiment was started at Payagala estate to evaluate sludge as a fertilizer for immature rubber (SMC-GC/RC/93/2 & SMC-GC/RC/93/3), and for legume covers (SMC-GC/RC/93/1). Different levels of fertilizers and sludge were applied according to the design. Effects of treatments on girth of rubber plants are given in Tables 13 and 14 (L Samarappuli and A M A Perera).

Table 13. *Effect of application of sludge on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| $F_0S_1$ | 47.8 |
| $F_0S_2$ | 47.1 |
| $F_1S_1$ | 47.6 |
| $F_1S_2$ | 46.0 |
| $F_2S_1$ | 46.7 |
| $F_2S_2$ | 49.2 |

Table 14. *Effect of application of sludge to covers on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| No P fertilizer | 49.7[a] |
| IRP (recommended level) | 49.8[a] |
| Sludge (normal level) | 50.7[a] |
| Sludge (double level) | 49.3[a] |

## *1.4 Soil conservation and development of degraded lands*

This project was continued (L Samarappuli, N Yogaratnam, P Karunadasa and U Mitrasena).

### *1.5 Weeds and weed control*

#### *1.5.1 Weed control under smallholder condition*

A field experiment was started to compare manual and chemical weeding during immature phase of rubber under smallholder conditions. Treatments consisted of (1) manual weeding, (2) chemical weeding (level 1), (3) chemical weeding (level 2), (4) chemical weeding (level 3) and (5) chemical weeding (level 1) and legume covers. Herbicides were sprayed according to the experimental design (L Samarappuli, P Karunadasa and U Mitrasena).

#### *1.5.2 Chemical control of weeds*

A field experiment was started to study the performance of different types of Glyphosate weedicides on weed control during the immature stage of rubber. Treatments consisted of five different types of Glyphosates and two controls: no weed control (T1), Manual control + establishment of cover crops (T2), Wallop (T3), Roundup (T4), Spark (T5), Burndown (T6) and Weedol (T7) (L Samarappuli, V Edirimanna and S Aravinna).

#### *1.5.3 Weed control in rubber nurseries*

A field experiment was started to study the effects of different weed control methods in rubber seedling nurseries. Treatments consisted of six different weed control practices: manual weeding (T1), manual weeding + mulching with green manure (T2), Diuron as pre-emergent weedicide (T3), Diuron as pre-emergent weedicide + mulching with green manure (T4), Diuron as pre-emergent weedicide + Diuron after 3 months (T5) and manual weeding + post-emergent weedicide after 3 month (T6) (L Samarappuli, V Edirimanna and S Aravinna).

## 2. Fertilizer use and plant nutrition

### *2.1 NPKMg requirement of rubbern*

#### *2.1.1 Fertilizers to nursery plants*

2.1.1.1 Application frequency

An experiment was carried out to evaluate the efficiency of a more soluble fertilizer mixture for young budding at the Eladuwa Estate. Following treatments

were allocated in a randomized complete block design with 25 poly bags per treatment and 4 replicates.

Treatment 1 - no fertilizer control

Treatment 2 - 50g RP + biweekly application of currently recommended liquid formulation

Treatment 3 - 50g RP + monthly application of currently recommended liquid formulation

Treatment 4 - 75g RP + biweekly application of SA/SOP/CES liquid formulation

Treatment 5 - 75g RP + Monthly application of SA/SOP/CES liquid formulation

(R S Dharmakeerthi, L Samarappuli and S N Silva).

2.1.1.2 Requirement of a basal application when young budding are planted in the field

This experiment was continued (R S Dharmakeerthi, L Samarappuli, S N Silva and A Yakandawela).

*2.1.2 Fertilizer requirement of new clones*

This experiment was continued (R S Dharmakeerthi, L Samarappuli, S N Silva and A N Yakandawela)

***2.2 Phosphate nutrition***

*2.2.1 ERP as a source of P for nursery, immature and mature plants*

2.2.1.1 Nursery plants

2.2.1.1.1 Seedling nurseries

The experiment started at Nivitigalakele Sub Station to study the suitability of different P fertilizers from Eppawela *viz.* CERP,HERP,SERP and PAERP in comparison with that of IRP and Ridigama rock phosphate (RRP) for nursery plants

was terminated. Results are being analyzed (A Dissanayake, T Dissanayake and Peter Perera).

2.2.1.1.2 Poly bag nurseries

A new experiment was started at Dartonfield to study the suitability of Eppawala rock phosphate and IRP in comparison with Fused Magnesium Phosphate, "YOORIN", a Japanese product for polybagged plants. Several treatment combinations were allocated in this experiment with 8 replicates and plants were arranged in a randomized block design. This experiment was continued (A Dissanayake, C K Maheepala and Peter Perera).

2.2.1.2 Immature rubber

2.2.1.2.1 Effect of different sources and levels of P

This experiment (P/IM/87) was continued (A Dissanayake, T Dissanayake and Peter Perera).

2.2.1.3 Mature rubber

2.2.1.3.1 Residual effect of added rock phosphates

This experiment (P/M/76) was continued for a further period of one year (A Dissanayake, T Dissanayake and Peter Perera and C Maheepala).

*2.2.2 Evaluation of clonal differences in phosphate utilization*

Experiment P/IM/93-01

This experiment that was started at Devalakanda Estate was continued.

Experiment P/IM/94.

This experiment started at Lagos Division, Payagala Estate to study the ability of different RRIC clones (RRIC 110 and 121) in utilization of ERP was continued for the 4th year (A Dissanayake, T Dissanayake, Peter Perera and C Maheepala).

Experiment P/IM/96 - 01

This experiment was started at Ambadeniya Division, Aranayake of

Ambadeniya estate to study the possibility of using Eppawala and IRP in Parambe soils. Three different clones namely RRIC 100, 102 and 121 planted according to the experimental design and fertilizer treatments were applied (A Dissanayake, T Dissanayake, Peter Perera and C Maheepala).

Experiment P/IM - 93 - 02

The experiment started at Vogan Estate to study the possibility of using both Eppawala and imported rock phosphates was continued (A Dissanayake, T Dissanayake and Peter Perera).

2.2.3 *Techniques to increase availability of P from ERP*

2.2.3.1 Mulching and liming

The experiment (P/Ag/93) started at Culloden Estate to study the effect of different agronomic practices on availability of P from ERP was continued (A Dissanayake, L Samarappuli, T Dissanayake and Peter Perera).

2.2.3.2 Suitability of ERP to cover crops (Mycorrhizal aspect)

The experiment started to study the effect of mycorrizae on the efficiency of P uptake from Eppawela rock phosphate by rubber plants grown in poly bags was continued (A Dissanayake, R Jayaratne, T Dissanayake and C Maheepala).

2.2.4 *Phosphate status and availability from soils*

2.2.4.1 P fixation in rubber soils

Soils collected to represent all the rubber growing areas were analyzed for some of physical and chemical parameters. Interpretation of data was continued (A Dissanayake, T Dissanayake and C Maheepala).

### *2.3 Sulphur nutrition*

An experiment was started in a replanting of Pallegoda Estate to study the effect of sulphur on the performance of clone RRIC 100 and 121. Three different sources of sulphur containing fertilizers (Ammonium sulphate, kieserite and Elemental S) are being tested in a randomized block design with 4 replicates (A Dissanayake, T Dissanayake and Peter Perera).

### *2.4 Micro nutrients*

Effect of different commercial foliar fertilizres with micro nutrients on the performance of rubber plants raised by young budding technique is studied in this experiment with a randomized complete block design with five replicates (L Samarappuli and A Thevarapperuma).

### *2.5 Foliar nutrients*

Effect of different commercial foliar fertilizers on the performance of rubber plants raised by young budding technique was studied in this experiment with a randomized block design with five replicates. The initial data on girth is presented in Table 15 (L Samarappuli and A Thevarapperuma).

Table 15. *Effect of foliar fertilizers on diameter of rubber plants*

| Treatment | Diameter (mm) |
|---|---|
| Soluble fertilizer+Wokozim | $9.0^{a}$ |
| Soluble fertilizer+Maxicrop | $8.7^{ab}$ |
| Soluble fertilizer+Nitrophoska 10-4-7 | $8.7^{ab}$ |
| Soluble fertilizer+Melspray 20:20:20 | $8.5^{abc}$ |
| Soluble fertilizer+Nutraphos Super K | $8.5^{abc}$ |
| Soluble fertilizer+Vitagreen | $8.4^{abc}$ |
| Soluble fertilizer+Macksalt 20:20:20 | $8.4^{abc}$ |
| Soluble fertilizer+Bayfolan (1) | $8.3^{abc}$ |
| Wokozim only | $8.1^{abc}$ |
| Soluble fertilizer+Bayfolan (2) | $8.1^{abc}$ |
| Nutraphos Super K only | $7.9^{abcd}$ |
| Soluble fertilizer (control) | $7.9^{abcd}$ |
| Nitrophoska 10-4-7 only | $7.9^{abcd}$ |
| Maxicrop only | $7.7^{bcd}$ |
| Vitagreen only | $7.6^{bcd}$ |
| Macksalt 20:20:20 only | $7.6^{bcd}$ |
| Bayfolan only | $7.5^{bcd}$ |
| Melspray 20:20:20 only | $7.4^{cd}$ |
| No fertilizer | $6.9^{d}$ |

### *2.6 Use of rubber factory effluent*

A field experiment was started at Eladuwa Estate to study the effect of rubber factory effluent on the performance of young rubber plants. The efficiency of ERP and IRP in the presence of rubber factory effluent will also be evaluated in this experiment. Treatments were allocated in a randomized block design with 5 replicate. Approximately a litre of rubber factory effluent was applied weekly per plant in addition to normal fertilization (A Dissanayake, T Dissanayake and C K Maheepala).

### *2.7. Organic fertilizers*

#### *2.7.1. Use of organic materials in poly bagged nursery plants*

An experiment (FPN-Org/98/1), was started to study the possibility of using organic materials in the nursery stage and also to study the effect of these organic manures on the performance of rubber plants raised by young budding technique in poly bagged nursery plants. Treatments consisted of (T1) no fertilizer, (T2) inorganic fertilizer (recommended level), (T3) inorganic fertilizer (recommended level) + ¼ cowdung, (T4) inorganic fertilizer (3/4 recommended level) + ¼ cowdung, (T5) inorganic fertilizer (½ recommended level) + ½ cowdung, (T6) cowdung only (no inorganic fertilizer), (T7) inorganic fertilizer (recommended level) + ¼ poultry litter, (T8) inorganic fertilizer (3/4 recommended level)+ ¼ poultry litter, (T9) inorganic fertilizer (½ recommended level)+ ½ poultry litter, (T10) poultry litter only (no inorganic fertilizer), (T11) inorganic fertilizer (recommended level) + ¼ compost, (T12) inorganic fertilizer (3/4 recommended level) + ¼ compost, (T13) inorganic fertilizer (½ recommended level) + ½ compost, (T14) compost only (no inorganic fertilizer), (T15) inorganic fertilizer (recommended level) + ¼ WRS organic fertilizer, (T16) inorganic fertilizer (3/4 recommended level) + ¼ WRS organic fertilizer, (T17) inorganic fertilizer (½ recommended level) + ½ WRS organic fertilizer and (T18) WRS organic fertilizer only (no inorganic fertilizer). The initial data on girth is presented in Table 16 (L Samarappuli and A Thevarapperuma).

Table 16. *Effect of organic manures on growth (diameter) of rubber plants*

| Treatment | Diameter (mm) |
|---|---|
| Inorganic fert. (½ rec. level) + ½ poultry litter | 9.2[a] |
| Inorganic fert. (rec. level) + ¼ poultry litter | 9.2[a] |
| Inorganic fert. (½ rec. level) + ½ WRS organic fert. | 9.0[ab] |
| Inorganic fert. (½ rec. level) + ½ cowdung | 8.9[ab] |
| Inorganic fert. (3/4 rec. level) + ¼ compost | 8.8[abc] |
| Inorganic fert. (3/4 rec. level) + ¼ WRS organic fert. | 8.7[abc] |
| Inorganic fert. (3/4 rec. level) + ¼ cowdung | 8.7[abc] |
| Inorganic fert. (rec. level) + ¼ WRS organic fert. | 8.7[abc] |
| Inorganic fert. (½ rec. level) + ½ compost | 8.6[abc] |
| Inorganic fert. (rec. level) + ¼ compost | 8.5[abc] |
| Inorganic fertilizer (recommended level) | 8.5[abc] |
| Inorganic fert. (3/4 rec. level) + ¼ poultry litter | 8.4[bcd] |
| Inorganic fert. (rec. level) + ¼ cowdung | 8.3[bcde] |
| Cowdung only (no inorganic fertilizer) | 8.2[cdef] |
| No fertilizer | 8.1[cdef] |
| Poultry litter only (no inorganic fertilizer) | 8.1[cdef] |
| Compost only (no inorganic fertilizer) | 8.1[cdef] |
| WRS organic fertilizer only (no inorganic fertilizer) | 7.6[ef] |

### *2.7.2 Use of animal wastes in rubber cultivations*

A field experiment (FPN-Org/An/95/3), is in progress at Dorset Division, Clyde Estate to study the effect of poultry litter as an organic manure for rubber. Treatments consisted of (a) Inorganic fertilizer (recommended level), (b) Inorganic fertilizer (½ recommended level) + poultry litter, (c) Inorganic fertilizer (¼ recommended level) + poultry litter, (d) Poultry litter only, (e) Poultry litter + IRP + MOP, (f) Poultry litter + IRP + paddy straw and (g) Poultry litter only with natural cover. Effects of treatments on girth and girth increment of rubber plants at the end

of three and a half years are given in Tables 17 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 17. *Effect of different treatments on girth of rubber plants*

| Treatment | Girth (cm) | Girth Increment (cm) |
|---|---|---|
| Inorganic fertilizer (¼ recommended level) + poultry litter | 32.9[a] | 11.9 |
| Poultry litter + IRP + paddy straw | 32.8[a] | 13.3 |
| Inorganic fertilizer (½ recommended level) + poultry litter | 32.3[a] | 12.0 |
| Poultry litter only | 31.8[ab] | 11.5 |
| Poultry litter + IRP + MOP | 31.6[ab] | 11.8 |
| Inorganic fertilizer (recommended level) | 30.8[ab] | 11.3 |
| Poultry litter only with natural cover | 29.9[b] | 9.6 |
| No fertilizer (control) | 23.5[c] | 8.1 |

### *2.7.3 Use of green manure in rubber cultivation*

Two field experiments FPN-Org/Gm/97/1 and FPN-Org/Gm/97/2 are in progress at Dartonfield estate (*Agalawatta* series) and Dorset Division, Clyde estate (*Boralu* series) to study the effect of plant materials as an organic manure for rubber. Ten different treatments were applied in a randomized block design with four replicates. Effects of treatments on girth of rubber plants at the end of 18 months are given in Table 18 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 18. *Effect of different treatments on girth of rubber plants*

| Treatment | Girth (cm) | |
|---|---|---|
| | *Agalawatta* soil | *Boralu* soil |
| N (full inorganic) + K (full inorganic) | 10.9[a] | 11.0[ab] |
| N (full inorganic) + K (½ inorganic + ½ straw) | 8.7[bc] | 11.3[a] |
| N (full inorganic) + K (full straw) | 9.1[abc] | 11.3[a] |
| N (½ inorganic + ½ green manure) + K (full inorganic) | 9.4[abc] | 11.0[ab] |
| N (½ inorganic + ½ green manure) + K (½ inorganic + ½ straw) | 9.8[abc] | 11.3[a] |
| N (½ inorganic + ½ green manure) + K (full straw) | 10.4[ab] | 11.4[a] |
| N (full green manure) + K (full inorganic) | 7.7[c] | 9.4[bc] |
| N (full green manure) + K (½ inorganic + ½ straw) | 9.2[abc] | 10.9[ab] |
| N (full green manure) + K (full straw) | 9.2[abc] | 10.5[ab] |
| No fertilizer (control) | 8.0[c] | 8.3[c] |

### *2.7.4 Organic rubber*

An experiment is in progress to develop a sustainable system which is commercially suitable for plantation as well as for small holders to produce an environmentaly friendly new grade rubber (organic rubber) to meet the increasing demand for "bio-market". No adverse effects were observed in growth of rubber plants in the field by using only organic and natural (mined) fertilizers (Table 19) (L Samarappuli, N Yogaratnam, L M K Tillekeratne, P Karunadasa and U Mitrasena).

Table 19. *Effect of different treatments on girth of rubber plants*

| Treatment | Girth after planting (cm) | |
|---|---|---|
| | 6 months | 18 months |
| Chemical fertilizer only | 4.5[a] | 8.7[a] |
| Organic fertilizer only | 4.7[a] | 8.8[a] |

## *2.8 Efficiency of fertilizer utilization*

### *2.8.1 Reduced frequency of fertilizer applications*

A field experiment (F/Ap/95/1), is in progress to the study the effect of reduced frequency of fertilizer applications during the immature period on the growth of rubber plants. Treatments consisted of (a) 25 applications/immature six year period (urea based), (b) 20 applications/immature six year period (SA based), (c) 19 applications/immature six year period (urea based), (d) 14 applications/immature six year period (SA based) and (e) 14 applications/immature six year period (urea based). Effects of treatments on girth of rubber plants at the end of three and a half years are given in Table 20 (L Samarappuli, P Karunadasa and U Mitrasena).

Table 20. *Effect of different treatments on girth of rubber plants*

| Treatment | Girth (cm) | Girth increment (cm) |
|---|---|---|
| 20 applications/immature six year period (SA based) | 30.2[a] | 10.4 |
| 25 applications/immature six year period (urea based) | 30.3[a] | 10.5 |
| 14 applications/immature six year period (SA based) | 28.0[a] | 9.5 |
| 14 applications/immature six year period (urea based) | 28.6[a] | 9.9 |
| 14 applications/immature six year period (urea based) | 28.8[a] | 10.7 |
| No fertilizer | 21.8[b] | 8.1 |

### *2.8.2 Economics of fertilizer use in mature rubber*

This experiment was continued (L Samarappuli, N Yogaratnam, P Karunadasa and U Mitrasena).

### *2.8.3 Dolomite as a source of Mg for mature rubber*

An experiment (F/Mg/94/1), is in progress in Dorset Division, Clyde Estate to study the feasibility of using Dolomite even during the mature stage. Treatments consisted of kieserite throughout the immature and mature period, kieserite in immature period and dolomite in mature period, dolomite throughout the immature and mature period, dolomite in immature period and kieserite in mature period. Latex samples collected during the year are being analyzed (L Samarappuli, P Karunadasa, U Mitrasena and V Edirimanna).

### 2.8.4 *SUL-PO-MAG based fertilizer mixtures*

An experiment (F/SPMg/94/1), was started in Culloden Estate, Neboda to study the effectiveness of SUL-PO-MAG based mixtures in comparison with the conventional mixtures 12:14:14 and 7:9:9:3 in immature rubber. SUL-PO-MAG based treatment was formulated by adding urea, rock phosphate and muriate of potash to SUL-PO-MAG to meet the nutrient ratios of N,P,K and Mg recommended for rubber in conventional mixtures. Growth was significantly higher in plants that received fertilizers compared to no fertilizer treatment. However, there was no significant difference in girth between the three fertilizer treatments (Table 21) (L Samarappuli, N Yogaratnam and J G de Mel).

Table 21. *Effect of different fertilizer mixtures on girth of rubber plants*

| Treatment | Girth (cm) |
|---|---|
| Control (no fertilizer) | 40.7[a] |
| Urea based | 46.0[b] |
| SA based | 45.5[b] |
| Sulpomag based | 45.9[b] |

### 2.8.5 *Slow release fertilizers*

A joint project (F/SR/95/1) with Polymer Chemistry Department was started to study the possibility of using encapsulated coir blocks during the first year of planting. Effect of different quantities of encapsulated fertilizers on the growth of rubber plants is being studied (L Samarappuli, K G K de Silva, R Hettiarachchi and M Wijesekera).

## 2.9 *Soil and foliar survey programme*

### 2.9.1 *Improvements to soil and foliar survey programme*

An experiment (F/SF/95/2), is in progress to further substantiate the early findings of sampling intensity for formulation of appropriate practices in sampling technique for soil and foliar survey programme. Fourteen different sampling intensities are being evaluated and this experiment further examines the sub sampling procedures and leaf nutrient variation pattern of different clones of rubber with the time. The results are being analyzed (L Samarappuli, N Yogaratnam, W Wijesuriya, V Edirimanne, P Karunadasa and U Mitrasena).

*2.9.2 Soil and foliar survey programme - Fertilizer recommendation*

Estate sector

The soil and foliar survey programme for 1997 commenced in July and approximately 6000 ha were surveyed this year. As requested by the Estate sector revised fertilizer recommendations based on soil and foliar survey done in the previous years and this year, was provided as an economy measure due to the present poor trading conditions for rubber. The revised recommendations were sent to the estates concerned. This very clearly confirms the usefulness of this exercise in providing fertilizer recommendations to mature rubber depending on the need of the rubber industry (L Samarappuli, N Yogaratnam, V Edirimanne, A M A Perera, G de Mel and T Ahamadeen).

Smallholder sector

The soil and foliar survey programme for the small holder sector was not done this year, for the above mentioned reason (L Samarappuli, A M A Perera, V Edirimanne, G de Mel and T Ahamadeen).

## 3. Land use planning

### *3.1 Soil survey and classification*

This experiment was continued (A Dissanayake and C K Maheepala).

## 4. Analytical services and techniques

Routine chemical analysis of soil, leaf, latex and fertilizer samples collected for experimental and advisory purposes were carried out. Samples from other Departments and Organizations were also analyzed (L Samarappuli, A M A Perera, V Edirimanne and A Thevarapperuma).

## 5. Adaptive research programme

This programme was continued (L Samarappuli, A Dissanayake, N Yogaratnam, S M M Iqbal and E A T Senadeera).

# BIOCHEMISTRY AND PHYSIOLOGY

M T Warnakula

## SUMMARY

The main focus of the department was on development of appropriate technology for environmentally friendly management of rubber factory waste. Several commercial scale treatment systems were designed and implemented.

### Staff

Assistant Biochemist, Mr M T Warnakula and Technical Officers, Miss K V V S Kudaligama, Mr D Ramawikrama and Mr P D J Rodrigo were on duty throughout the year.

### Research students

Mr Kapila Lanarole a student from the Department of Agricultural Engineering, University of Peradeniya carried out his final year project on Mathematical modeling of waste water treatment systems.

### Patent applications

A patent application on "*In situ* coir based biological odour filter for controlling the odour from waste water treatment facilities and polluted natural environments" was submitted.

## LABORATORY AND FIELD EXPERIMENTS

### 1. Development of appropriate technology for Environmentally friendly management of rubber factory waste

#### *1.1 Research and development*

*Bio-Brush media*

A simple manually operated machine was developed for accelerating the production of Bio-Brushes. The production efficiency increased to twice the previous

system after developing this machine, thus bringing down the cost of production significantly (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Odour filter*

Research on developing odour filters for controlling possible odour emissions from waste treatment systems was continued. The performances of this filter is highly successful and reduced odour significantly from waste water treatment systems at Rayigam Estate and Thotamune Mills (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Low cost treatment system configurations*

"Covered Activated Ditch (CAD)"

This system configuration was further developed for accommodating higher number of ditches per unit land area. Ditches were constructed with cement blocks and lined with a polythylene sheet inorder to get the maximum volume at the lowest cost (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

"Covered Activated Honey Comb"

This is a comparatively low cost system which is more suitable for factory sites with limited available flat land for a treatment system (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Deammoniation and continuous coagulation of skim latex with organic acids*

As developing appropriate techniques for removing and continuous coagulation of skim latex with organic acids is of great interest, several possible methods were identified (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Use of marshy plants as oxygenation devices for waste water treatment*

The possibility of using the roots of some marshy plants for supplying oxygen for biological waste water treatment was investigated. Marshy plants were successfully

used to enhance the activity of odour filter of waste water treatment plants at Rayigam Estate and Thotamune Mills (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

### *1.2 Computer software developments*

*Programme for designing Covered Activated Ditch (CAD) system*

A programme was developed to obtain the most economical CAD configuration and the predicted approximate cost for construction of the same for a particular rubber factory, depending on the:

* Factory capacity
* Dimensions of available land area

(M T Warnakula, A K B Naranpanawa, K V V S Kudaligama, P D J Rodrigo, D Ramawickrama and M A D K Jayasumana).

*Programme for obtaining the best treatment system for a rubber factory*

Work has been started for developing a programme to select the most economical treatment system for a particular rubber factory, based on

* Covered Activated Ditch system
* Covered Activated Honey Comb system
* Other system configurations which use Bio-Brushes as the media
* Other standard systems suitable for rubber waste treatment

and also to obtain

* Detailed engineering design and drawings
* BOQ and the approximate cost
* Detailed guide for construction

(M T Warnakula, A K B Naranpanawa, K V V S Kudaligama, P D J Rodrigo, D Ramawikrama and M A D K Jayasumana).

### *1.3 Implementation of new developments*

All the systems were designed and constructed, using the "Bio-Brush media as the biomass retainer.

*Rayigam Estate Crepe Rubber Factory*

*Thotamune Rubber Mills*

Supervision and the analytical assessments were done during this period. In both systems COD and BOD of treated effluent always met CEA standards with anaerobic treatment alone (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Pallegama state Sole Crepe Rubber Factory*

This system is designed to treat the waste load of 4000 kg/day of sole crepe production. Civil constructions of the effluent treatment system for the factory was completed (M T Warnakula, K V V S Kudaligama, D Ramawikrama, P D J Rodrigo).

*Atala Estate Crepe Rubber Factory*

The submitted design of effluent treatment system for Atala Estate Crepe Rubber Factory was accepted for construction (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Kiriporuwa Estate Centrifuge Factory*

A low cost advanced type of CAD system was designed and construction was also started. A deammoniation system and a continuous coagulation process using organic acid are also planed to couple with the system, prior to treatment. This system is designed to treat the waste load of 38,000 l/day of centrifuge latex production (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Arapolakanda Estate Crepe Rubber Factory*

*Payagala Estate Crepe Rubber Factory*

Low cost advanced type of CAD systems were designed for the above two factories. Detailed engineering designs and other relevant documents were submitted to the management company (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Yatadola Estate Crepe Rubber Factory*

Low cost advanced type of CAD system were designed. Detailed engineering design and other relevant documents were submitted to the management company (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

*Treatment of meat processing effluent*

A treatment system was designed on the request of CCS poultry farm. Construction was completed and within 8 weeks the system was biologically matured to operate at its designed full capacity (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

**2. Other methods of waste utilization and disposal**

Several commercial possibilities of waste utilization/disposal were identified. Practicability of these are being studied (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

**3. Biological and biochemical treatment of rubber wood**

Preliminary studies on biological and biochemical treatment of rubber wood were continued during the quarter. Possibility of selective biological and biochemical staining of rubber wood was also investigated for masking the blue stain due to fungal attack (M T Warnakula, C K Jayasinghe, K G K de Silva, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

**4. Biological and biochemical carving of rubber wood**

Studies on biological and biochemical carving of rubber wood were continued (M T Warnakula, K V V S Kudaligama, D Ramawikrama and P D J Rodrigo).

# RUBBER TECHNOLOGY AND DEVELOPMENT

N M V Kalyani Liyanage

## SUMMARY

Modified Lowry procedure for the analysis of leachable proteins in NR latex was established.

Water-soluble proteins in irradiated NR latex and in a modified type of latex were found to be below the detectable levels; *i.e.* < 50 μg.

NR latex from RRIC 130 clone was found to posses the highest green strength though the tensile strength of the same after irradiation was poor.

A latex foam suitable for cushions used in wheel chairs of disabled people was developed.

Use of Rice Husk Ash (RHA) and calcined quartz as fillers in retreading industry was evaluated.

Raw rubber characteristics and technological properties of sun dried sheet rubber were evaluated and compared with those of smoked sheet rubber.

Effects of acid and hydrogen peroxide concentration on the epoxy content of epoxidised natural rubber were evaluated.

## DETAILED REVIEW

### Staff

Dr (Mrs) N M V Kalyani Liyanage, Head, Rubber Technology and Development was on duty throughout the year. Mrs D G Edirisinghe, Assistant Rubber Chemist who was doing her postgraduate studies at the University of Loughborough, UK, vacated the post on 10th November 1998.

Mrs M M Jayasooriya, Assistant Rubber Chemist was on duty throughout the year.

Mrs Manel Mahanama, Senior Technical Officer, Mr K M U Mithrananda and Mrs Sriyani Yapa, Technical Officers were on duty throughout the year.

### Research students

Miss Tamara Senanayake, an undergraduate from the Institute of Chemistry, Mr P G S C Gallage, Samantha Wijenayake, G D M P Kumara and S Karunaratne, students from the University of Moratuwa under the Apprenticeship Board In-Plant

Training Scheme, and Mr S Mahagama and Mr R A P N Perera, undergraduates from the University of Colombo were trained on various aspects of Latex Technology and Dry Rubber Technology.

**Meetings, Seminars and Lectures**

Dr (Mrs) N M V Kalyani[1] and Mrs Madupani Jayasooriya[2] participated in the following;

* Committee meetings of the Sri Lankan research group on "Radiation Prevulcanisation of Natural Rubber Latex" held at the Atomic Energy Authority. [1,2]

* The MSc course on "Rubber Technology" conducted by the University of Sri Jayawardenepura as a lecturer.[1]

* The BSc degree course of the University of Colombo as a lecturer.[1]

* The Diploma course on "Rubber Technology" organized by the Plastics and Rubber Institute as a lecturer.[1]

* A workshop on "Competitiveness of Sri Lankan Rubber Industry" organised by the TIPS held at the Hotel Taj Samudra.[1]

* A meeting of Sectoral Committee on Chemicals and Polymer Technology held at the Sri Lanka Standards Institution.[1]

* A meeting of working group of rubber examination gloves held at the Sri Lanka Standards Institution.[1]

* A workshop on Rubber based Products organised by the Ministry of Industrial Development held at the hotel Taj Samudra.[1]

* Central Scientific Committee Meetings held during this year.[1]

* The Department organised and conducted 8 courses on "Rubber Products Manufacture" at following areas during this year:
Hanwella, Maharagama, Kegalle, Deraniyagala, Gampaha, Agalawatta, Kamburupitiya and Bandaragama.

* The Department organised a stall for the Science and Industrial Exhibition organised by the SLAAS held during 15-18 December 1998 at the University of Sri Jayawardenapura.

## LABORATORY INVESTIGATIONS

### 1. Latex technology

#### *1.1 Latex bitumen emulsions in road construction*

A few lab scale trials were carried out to seek the possibility of incorporation of modified positex to CRS2 bitumen emulsion since it is the most widely used bitumen emulsion type (N M V Kalyani Liyanage, M M Jayasooriya and G D M P Kumara (NDT Student).

#### *1.2 Radiation prevulcanisation of natural rubber latex*

##### *1.2.1 Latex protein analysis*

The modified lowry procedure for the analysis of total proteins in NR latex using BCA reagent kit was established. Calibration curves of precipitation technique and non precipitation techniques were obtained. The protein contents of a few latex samples processed according to widely varying procedures and some irradiated latex samples were detected by using this technique. Some of the samples had no detectable proteins (N M V K Liyanage, M M Jayasooriya, L Karunanayake, H N K K Chandralal, M K Mahanama, S I Yapa and S S Kulathunge (Atomic Energy Authority).

The total water extractable protein content of a new type of latex was found to be below the detection level. However, the water extractability of proteins of this latex was found to be increased with leaching and the extent of this increase depended upon the leaching medium. Nirogen contents of the unleached, extracted films remained the same indicating that the proteins in the new latex are denatured by the stabilisers with consequent reduction in the water solubility of the proteins (N M V K Liyanage, Tamara Senanayake (Institute of Chemistry), P G S G Gallage (NDT Student), S H S Mahagama and R A P N Perera (University of Colombo).

### *1.2.2 Radiolysis of* Hevea *proteins*

A project proposal titled "Radiolysis of *Hevea* Proteins' submitted to the Polymer Group of University of Queensland, Australia for consideration to carryout as a colloborative research project has been accepted. The principal objective of this project has been to carryout a systematic investigation of the radiation effects on Sri Lankan NR latex proteins and to formulate the possible mechanisms involved therein. It is anticipated that a better understanding of the mechanism involved in the radiolysis of proteins would help to produce a low cost RVNRL of less or no protein allergens with mechanical properties equivalent to those of conventional sulphur prevulcanised latex (N M V Kalyani Liyanage).

### *1.2.3 Clonal effects*

A study was undertaken to investigate the effects of clones on physical properties of unirradiated and irradiated latex. Various clones such as RRIC 100, 102, 121, 130, PB 86 and RRIM 600 were used for this study. It became clear that the clone RRIC 130 posses the highest green strength. However, the tensile properties of the latex from this clone after irradiation were found to be poor.

In addition attempts were made to investigate the effects of irradiation and centrifugation on the soluble protein content in RVNRL films. It became evident that when the irradiation was carried out in field latex it helps to reduce the protein content to undetectable levels (M M Jayasooriya, N M V K Liyanage, M K Mahanama, Tamara Senanayake, Sriyani Yapa, H N K K Chandralal and S S Kulathunge (Atomic Energy Authority).

### *1.2.4 Optimisation of n-BA level*

Attempts were made to investigate the optimum concentration of n-BA for radiation vulcanisation of natural rubber latex at low dose levels. Preliminary investigations indicated that higher levels such as 7phr and 9phr tend to impart better physical properties. In addition experiments were conducted to reduce the protein level in RVNRL films by enzymatic treatments and the results are encouraging. Futher work is in progress (Madupani Jayasooriya, Samantha Kulathunge (Atomic Energy Authority), Manel Mahanama, Sriyani Yapa and Samantha Wijenayake (NDT student).

## 1.3 *Latex foam*

A request came from a British based voluntary service designer organisation called Motivation for a suitable latex compound to be used in cushions of specially

designed wheel chairs. A latex foam compound ideal for this purpose with DPG as the secondary gelling agent was developed (N M V Kalyani Liyanage and Sriyani Yapa).

## 2. Dry rubber technology

### *2.1 Artificial limbs for disabled soldiers*

It was reported by "Ranaviru Sevena" that the abrasion properties of the NR based feet were much better than that of imported samples. As such, a request for a batch of 800kg was made by them and arrangements were made to supply this stock free of charge in smaller batches weekly (N M V Kalyani Liyanage and K M U Mithrananda).

### *2.2 Application of various filler/filler combinations in retread compounds*

Some trials on the use of Rice Husk Ash (RHA) as a filler in tyre tread compounds have been carried out. The incorporation of fillers into the rubber was done using a masterbatch. However, the flow properties of the resultant compounds were found be poor. Rheological characteristics indicated that the RHA could be used to produce high modulus vulcanisates.

Electronic microscopic studies on RHA produced under various conditions, indicated less clustering effects of RHA when compared with silica fillers.

Applicabilty of RHA as a filler in latex compounding was also tested but the results were not satisfactory.

The performance of calcined quartz as a filler in tread compounding was also compared with a commercial silica filler such as $VN_3$ . The tensile properties of calcined quartz based vulcanisates were found to be poor than those of $VN_3$ based vulcanisates. However, the tear properties and the abrasion properties of both types of vulcanisates were more or less the same.

Attempts were made to see whether the use of coupling agents such as DEG would improve the reinforcing characteristics of RHA and calcined quartz. No improvements have been observed for the combinations tested so far (N M V Kalyani Liyanage, K M U Mithrananda and S Karunarathne (NDT student).

### *2.3 Sundried rubber*

Use of sun light was not permitted in raw rubber manufacturing process since

it tends to deteriorate the rubber. Smoking of rubber sheets are carried out not only to accelerate the drying but also to prevent the mould contamination on sheet surface, during storage. Rubber sheets were prepared by sundrying and/or smoking up to 2,4,6 days to investigate the possibilities of using sun dried rubber in tyre industry. Results indicated that the plasticity retention index (PRI) of rubber sheets which were subjected to sun drying were greater than the recommended minimum PRI values. Furthermore, significant differences in physical properties of rubber compounds prepared using sundried samples and smoked samples could not be observed, specially in hardness, abrasion resistance and tensile properties. Paper based on this study will be published in near future (Madupani Jayasooriya, K M U Mitrananda, Sriyani Yapa and G D M P Kumara (NDT student).

### *2.4 Epoxidised Natural Rubber*

A study was conducted to evaluate the effects of acid and hydragen peroxide concentration on the epoxy content. It was found that a higher reaction rate can be obtained by using a rubber: acid: $H_2O_2$ ratio of 1 : 0.5 : 1.5. In addition when epoxidation of NR latex was carried out using high concentrations of formic acid, a fine powder could be obtained. Attempts were made to investigate the possibilities of using this powder as a filler in rubber compounds. It was found that this filler can impart more or less similar properties to that of silica especially in properties like tensile strength, resilience and abrasion resistance. On the contrary, the physical properties such as hardness and modulus are comparatively slightly inferior when compared to silica fillers. Further work is in progress (Madupani Jayasooriya, Sriyani Yapa, K M U Mithrananda, Surath Seneviratne and Samantha Wijenayake (NDT students).

### Industrial extension

The following industrialists have requested the services of the Department in product development and testing:

| | |
|---|---|
| Plymouth Industries | Testing of chemicals |
| Atomic Energy Authority | Testing of latex gloves |
| Asia Industries (Pvt). Ltd | Development of shoe sloe compounds |
| State Engineering Corporation | Compounding of nitrile rubbers |
| Hemali Concrete Works | Development of casting compounds |
| Ceytra Limited | Testing of rubber bands |
| Associated Motorways Ltd. | Testing of tread compounds |

| | |
|---|---|
| Roadgrip | Testing of tread compounds |
| Irrigation Engineer's Office | Testing of rubber beadings |
| Lanka Products Export Corporation Ltd. | Testing of foam rubber samples |
| Midlands (Pvt) Ltd. | Testing of tread compounds |
| Modivation | Development of foam rubber compound |
| Ranaviru Sevana | Compounding of artificial foot rubber compounds |
| Korea Ceylon Foot Wear Ltd. | Testing of rubber compounds |
| Precision Rubber Developments | Testing of rubber compounds |
| Richard Peiris Company Ltd. | Testing of foam rubber samples |
| Hanwella Rubber Products | Testing of rubber gloves |

# POLYMER CHEMISTRY

**K G Karnika de Silva**

## SUMMARY

Research on waste and used tyre crumbs started in Malaysia was continued. A project proposal to utilize tyre crumbs and polypropylene blends for injection moulding in road surfacing applications and as a low cost reinforcing filler was forwarded to NARESA for funding.

A project to find a suitable preservative/bactericide to replace toxic TMTD in low ammonia TZ latex was initiated. Preliminary trials showed encouraging results with low percentage of VFA and acceptable values for mechanical stability for centrifuged latex.

Work on powdered rubbers was reactivated with some major modifications to the manufacturing process. Powdered rubber is a modified rubber useful in high quality product manufacture using injection moulding facilities. Oil absorption properties of powdered rubber is also an added advantage. Initial trials on sticker type rain guard using powdered rubber and hot bitumen mixtures showed good results.

Commercial scale manufacture of conductive rubber pads for muscle tonning machines is in progress. The project on NR/NBR latex blends was reactivated to study the performance of the blends in view of reducing the extractable proteins in dipped products. Blends of NR latex with NBR together with a latex compatibilizer were subjected to FTIR analysis to study the shifts of characteristic peaks due to blending and heating. Some interesting observations were made on the spectra due to possible crosslinking of phases.

Several samples from the industry were analyzed for their base elastomer and the materials in the blooms using FTIR spectrophotometer.

It was noted that some locally available fatty acid materials could replace stearic acid in compounding to yield better physical properties. It was possible to get very high tear strength for samples containing new fatty acid based materials.

Work on hard reinforced shoe soles with low density and injection mouldable properties, creaming of field latex to obtain latex with high DRC using tamarind seeds, mosquito coils with rubber wood charcoal, saw dust and a natural pesticide were continued.

## DETAILED REVIEW

### Staff

Department staff except Mr Ananda Samarakoon who was on sick leave after a motor cycle accident, were on duty throughout the year.

Mr H N K K Chandralal, Experimental Officer was on duty throughout the year. Mr S S Warnapura and Mrs W C M Kuruppu, were redesignated as Experimental Officer with effect from 27.4.98. Messers R S Wijesundara and S L G Ranjith, were redesignated as Experimental Officer. Mrs Renuka Wijeratne, Clerk/Typist was on duty throughout the year. Messers Sunil Weerasiri, P R Sigera, L L Piyasena, W D S Dharmawardena Laboratory Attendents were on duty throughout the year. (Messers L L Piyasena, and W D S Dharmawardena were redesignated as Lab Attendents with effect from April 1998). Six students from Universities of Colombo, Kelaniya and Moratuwa commenced their projects in the Polymer Chemistry department.

### Meetings, Seminars, Programmes and Workshops

Dr K G Karnika De Silva participated at the following meetings/seminars:

* Scrap Rubber - an unpredictable waste or a useful raw material by Dr Jan Asplund organized by PRI held at Hotel Taj Samudra.
* Plastics, Rubber and the Environment - seminar organized by PRI held at Hotel Taj Samudra.
* Familiarization Programme to utilize Funds from JICA to Developing Countries organized by JICA held at Hotel Intercontinental.
* Scientific Committee meetings of RRISL held at SLAAS Auditorium.
* A committee meeting on ISO 9000 Standards.
* Research meetings and Meetings on Administrative and Financial Matters held at Dartonfield.
* Committee meetings on Standards for Examination Gloves held at SLSI.
* Seminar on Project Management organized by NARESA.
* Seminar on NR markets jointly organized by RRISL, TIPS and PRI held at Taj Samudra, Colombo.
* Seminars on Rubber Products Manufacture held at Sarvodaya organized by Bank of Ceylon, Mathale.
* Discussion on NR industry in Sri Lanka held at USAID Mission Office.

H N K K Chandralal served as a committee member in RVNRL Committee. He conducted two lectures on Rubber Product Manufacture at a seminar held in Kamburupitiya.

## GENERAL

A project proposal entitled "A project to provide active technological co-operation to encourage industrial standardization, quality control, productivity improvement and environment protection measures for sustainable development of the rubber industry in Sri Lanka" was submitted through the Ministry of Plantation Industries and External Resources Department to Japan International Cooperation Agency for evaluation. The proposal has been forwarded to the Government of Japan for consideration for funding.

A proposal to set up Sri Lankan Standards for latex examination gloves was made by the Director RRISL to SLSI and latex gloves manufacturers. As a result several meetings were held at SLSI together with the glove manufacturers to discuss about the standards. This is a timely effort as they have to be competitive in the international market with the threats on latex protein allergies. It was noted that a lot of modifications have to be done to the existing SL Standards and introduce new tests such as latex protein analysis tests, conductivity test, oil absorption, tear resistance and powder content. It was decided to set up a glove testing laboratory at RRISL.

## LABORATORY INVESTIGATIONS

### Tyre crumbs and poly propylene blends

A project on utilization of tyre crumbs in PP blends was continued. Pretreatment method of inert tyre crumbs involved blending of a commercialized de-linking agent with tyre crumbs. The morphology of the blends improved with efficient blending techniques. The blends showed a significant improvements in physical properties too. A project proposal to utilize tyre crumbs and polypropylene blends for injection mouldable applications, road surfacing applications and as a low cost reinforcing filler was forwarded to NARESA for funding.

A paper titled "Blends of Waste Tyre Crumbs and Polypropylene - An Ideal Way to Recycle Used Tyres" was submitted to IRC'99 to be held in Seoul in April 1999 (K G Karnika de Silva, H N K K Chandralal, S L G Ranjith and Dhammi Perera).

## Powdered rubber

Trials on the manufacture of powdered rubber by an economical method starting with field latex were continued. It was found that the particle size depends on concentrations of the chemicals, total agitation, speed, maturation period of latex etc. Alginates and commercially available acrylic copolymers and alums were used in some trials. Further trials with different percentages of active ingredient were carried out and the properties of the samples are being tested.

The end product can be used as s suitable form for injection moulding and as an excellent medium for absorbing oils. Samples of Powdered rubber were handed over to the Road Development Authority to see the blending properties with hot tar. Initial trials to blend powdered rubber with tar to turn out sticker type rain guard was successful. Further trials on the project is in progress.

Another sample was sent to Lever Brothers (Pvt.) Ltd. for testing on oil spills in their factories where oil spills have become a major problem. Rubber powders could be used successfully in solving this problem by absorbing the oil completely from the oil spills (K G Karnika de Silva, S S Warnapura, Chitra Kuruppu and W Wimaladasa).

## Creaming with Tamarind seed

The main purpose of this project is to develop a suitable method to cream field latex using a technically and economically viable process for the benefit of the small holders. Use of sodium aliginate as a creaming agent is a known process but it takes a longer time for creaming and the stability of latex seems to be not satisfactory. The tamarind seed powder however is a natural substance which shows a better performance than sodium alginate. The light pink colour develops in latex due to outer crust of the seeds was also reduced using a naturally occurring material. The property evaluation and the suitability of creamed latex in rubberized coir manufacture was tested. Attempts made to improve the continuous process seemed to be satisfactory.

The problem of destabilization of creamed latex was closely monitored and certain steps were taken to prevent this. The systems with tamerind seed powder have shown better and faster creaming with slight modifications to the latex medium. Experiments were also conducted to see the performance of dried films and compounded and prevulcanized lattices out of creamed latex.

The smallholders dealing with the Kaluthara Regional Office have shown interest in creaming latex and a few trials were conducted for them to familiarize with the process. A student from the University of Kelaniya was involved in this project

(K G Karnika de Silva, H N K K Chandralal, Chitra Kuruppu and N M A Bandara (Project student from University of Kelaniya).

**Mosquito coils**

Rubber wood saw dust and rubber wood charcoal were used together with neem oil to produce a base for mosquito coils. Extraction of active ingredients of neem oil was also looked into. Different percentages of materials were used to get the correct consistency of the base. Further work on the project is in progress (K G Karnika de Silva, S S Warnapura, S L G Ranjith and Indra Denawake).

**Toxicity of rubber compounds**

Various samples from the industry were tested for their toxicity in food and water contact applications by using FTIR Spectrophotometer. .Comprehensive reports were submitted as requested by the industrialists. A Literature survey was done on the chemicals permitted in the food and Pharmaceutical industry for the benefit of the rubber based industries (K G Karnika de Silva and Indra Denawake).

**Rubber floor mats based on NR/NBR blends**

This project was reactivated on a request made by Microcells Co. Tests were conducted to find the values and to minimize the corn oil absorption properties of end products at 25$^{0}$C. Certain modifications were done to improve the properties of the blends. Collaborative work was carried out with the Microcells to improve the quality of NR/NBR blends.

Formulations used for Rubber mats out of NBR for restaurants were modified by incorporating about 20% NR in to the formulations. To make the two NR and NBR phases compatible a small percentage of Chloroprene rubber was incorporated. Specifications of these blends satisfied the needs of the customer who placed the order with Microcells. Tests on oil, water and detergent resistance were carried out to issue the certificates. Routine tests on these properties will be carried out in the future.

Information on non toxic dyes and some testing standards were provided as requested. Further trials are in progress to improve some properties of these materials to meet the standards requested by the buyers from USA and Germany (K G Karnika de Silva, H N K K Chandralal and S L G Ranjith).

**Natural oils as stabilizers, processing aids and pesticides in rubber industry**

Locally available palm and neem oil based materials, emulsions and

derivatives were tested for their suitability as stabilizers and/or processing aids in rubber processing. Certain materials were found to be very effective in latex and dry rubber processing to replace the imported materials currently used for these purposes. Palm oil based materials available from a reputed firm were also tested for their performance in dry rubber compounding. The results obtained were very encouraging and further work on the project is in progress (K G Karnika de Silva, Indra Denawake and D N P Wickramasinghe - University of Colombo).

The materials derived from some herbal oils were tested for their effectiveness in stabilizing field latex. Bacterial counts of latex containing these materials were closely monitored and compared with current high ammonia and low ammonia/TMTD/ZnO systems. Neem derivatives were also incorporated in formulations used in foam rubber and rubberized coir manufacture to repel mites from mattresses. Initial trials showed promising results. Attempts have been made to patent these findings (K G Karnika de Silva, Chitra Kuruppu and H N K K Chandralal).

The derivatives in different types were also tested in laboratory scale for their effectiveness as nematocides for rubber and tea plantations (K G Karnika de Silva, C K Jayasinghe, Chitra Kuruppu, S S Warnapura, Wettasinghe and R E P Chandrasena (Project Student - University of Kelaniya).

**NR/NBR latex blends**

The project on NR/NBR latex blends was reactivated to study the performance of the blends in view of reducing the extractable proteins in dipped products. Blends of NR latex with NBR together with a latex compatibilizer were subjected to FTIR analysis to study the shifts of characteristic peaks due to blending and heating. Some interesting observations were made on the spectra due to possible crosslinking of the phases. Further work on the project is in progress (K G Karnika de Silva, Laleen Karunanayake and W I N de Silva (Project student from University of Colombo).

**Thermoplastics**

A new thermoplastic materials with low density and high hardness were prepared in the laboratory with an ethylene Octene copolymer (Engage) obtained from McWoods Pvt. Ltd. This project was initiated on a request made by the industry to test the sample for its properties. The results were useful in developing a suitable low density formulation for shoe soles for Leather Corporation.

Bata Shoe Co. Pvt. Ltd. has also shown interest on this material and few FTIR spectra of different elastomers were obtained experiments with different percentages of fillers and elastomer were carried out to study the performance of the blends (K G Karnika de Silva, S L G Ranjith and J M C B Jayasundare (NDT student from University of Moratuwa).

**Blends with waste materials**

A few trials were conducted to find the possibility of utilizing waste foam rubber in useful application on a request made by the industry. The aim is to produce rubber based injection mouldable materials with a softer finish. The incorporation of ethylene octene copolymer was expected to give thermoplastic characteristics to the material. Further work on the project is in progress (K G Karnika de Silva and S L G Ranjith).

**Conductive rubber pads**

Commercial scale manufacture of conductive rubber pads for muscle tonning machines is in progress. The formulation developed contains high dosage of conductive blacks and the moulding operations were carried out at the IDB Peliyagoda. Several inquiries made by the interested parties were entertained (K G Karnika de Silva and S S Warnapura).

**Rubberized coir**

Several requests from the industry to develop, improve and to solve industrial trouble shooting with rubberized coir were entertained. Development and further research work on new formulations for Microcells, Proflora Pvt. Ltd. and Green Soils Pvt. Ltd. were done on their request (K G Karnika de Silva, H N K K Chandralal and Indra Denawake).

**Latex protein allergies**

Samples from Textrip and Lalan Rubbers were analyzed for extractable latex proteins using Bradford method and Modified Lowery method. Several trials were carried out to reduce extractable proteins in dipped products (K G Karnika de Silva and S L G Ranjith).

## Purity of chemicals

Chemicals from the industry were analyzed for purity by using titration methods. FTIR spectra, melting point, cloud point *etc.* were done on sample and compared with the standards. Test reports were issued as requested by the customers from Microcells, Hanwella Rubber Products, Lalan Rubbers, DSI and Bata Shoe Company Ltd. Several samples from the industry were analyzed for their base elastomer using FTIR spectrophotometer. The results obtained with samples from DSI, SLSI and City Cycle Stores were very valuable to overcome some problems experienced by them in the past (K G Karnika de Silva, Indra Denawake and S L G Ranjith).

## Industrial extension

Various samples were analyzed for the rubber based industries on request.

| | |
|---|---|
| Standards Institution | Bicycle tubes |
| Durampitiya Estate | Latex stability |
| AMW | Toxicity of rubber compound |
| Eco Management | Neem oil |
| Plymouth Industries | Bloom analysis |
| Leather Corporation | Elatomer Analysis, new materials |
| Richard Pieris | Toxicity of rubber compounds |
| AMW | Toxicity of rubber compound |
| Free Lanka Management | Information on latex and dry rubber testing, latex stability |
| City Cycle Industries | Bicycle tubes |
| Microcells | NR/NBR blends, mats |
| Textrip | Latex stability, latex proteins |
| Lalan Rubbers | Latex proteins |
| Ansell Lanka | Chemicals |

| | |
|---|---|
| Hanwella Rubber Products | Chemicals, latex proteins |
| McWoods Ltd. | New elastomer |
| Bata Shoe Co. | Bloom analysis, elastomer analysis |
| Proflora | Development of coating medium for magic coins |
| Green Soils | Rubberized Coir pots |
| Mal Lanka | Foam rubber, rubberized coir, latex |
| Sanasa | Creamed latex |

# RAW RUBBER AND CHEMICAL ANALYSIS

L Karunanayake

## SUMMARY

The following activities were performed during the year:

a. Analysis, grading and issuing shipping certificates for all TSR produced in the country.

b. Analysis and issuing quality certificates for latex, sheet and crepe rubber produced in the country for local industries and exports.

c. Analysis of chemicals and water used in the rubber and rubber products industries.

d. Testing of finished products such as.
   1. Rubber gloves for SPP content
   2. Rubber content in vulcanized products.
   3. Rubber and other polymer contents in foam rubber.
   4. Contaminations of metal iron in dipped products.

e. Participation in Round Robin cross check on standard dry rubber testing for regional laboratories conducted by Rubber Research Institute of Malaysia.

f. Organizing demonstrations on preparation of new brushable rainguard sealant for plantation companies and small holder sector.

g. Analysis of dry rubber, latex, chemicals finish products *etc.* for other research departments.

h The following research projects were in progress.
   1. New brushable sealant for rainguards.
   2. Manufacture of rubber wood charcoal.
   3. Properties of blends of reclaimed rubber with virgin raw rubber.
   4. A new technique to study the cross-link density of pre-vulcanized latex.
   5. Effects of $Mg^{2+}$ and $PO_4^{2-}$ levels on NR latex properties.
   6. Blends of NR, NBR and Polychloroprene latex.

## DETAILED REVIEW

### Staff

Dr L Karunanayake was awarded the degree of Doctor of Philosophy with

effect from 25th March 1998 and was promoted to Research Officer Grade I with effect from 15th April 1998.

Mrs Sriyanthi Weeraman, Experimental Officer was on duty through out the year.

Mrs Leela Wanigatunga, Senior Technical Officer was redesignated as an Experimental Officer with effect from 27 April 1998.

Mrs N Baduge, Graduate Assistant (Technical) was on duty throughout the year.

Mr Gamini Wanigatunga, Technical Officer, was on duty until his sudden death on 12 April 1998.

Technical Officers, Mrs H V K Gamage, Mrs C S Lokuge, and Messrs L P Vitharana, P L Perera were also redesignated as Experimental Officers with effect from 27 April 1998.

Mr P Lelwala, Instrument Technician completed his overseas assignment for which he was given unpaid leave and resumed duties on 02 September 98.

Messrs B Gunasiri, W Vithanage, W W Nandasena, N Karunatilake and J A Sarath Chandrasiri were redesignated as Technical Officers with effect from 27 April 1998. Mr R S Samaradivakara was transferred to Polymer Chemistry department with effect from 1 April 1998. Miss Medavi Wijesekara was transferred on the temporary basis to this department from Polymer Chemistry Department with effect from 1 April 1998.

Mrs I Wijesinghe, Clerk/Typist was on duty throughout the year.

Mr Sirisena Gallege, the Laboratory Attendant was on duty throughout the year. Messers G H Somasiri and P Vithana were redesignated as Laboratory Attendants with effect from 27 April 1998.

**Meetings, Seminars and Lectures**

Dr L Karunanayake delivered a lecture series on Industrial polymers for Polymer Science, MSc course organised by University of Sri Jayawardenapura.

Dr L Karunanayake attended the following;

* A workshop organized by NIPM to train the trainers in Plantation sector.
* A seminar organized by PRI on "Plastics rubber and the environment".
* Three drafting committee meetings organized by SLSI on revision of Sri Lanka Standard for examination gloves.
* A workshop organized by NSF on Research project management.
* A workshop organized by SLAAS on research paper writting.

* Delivered a lecture on manufacture of new brushable rainguard sealent at a workshop organized by Bogawanthalawa Plantations Ltd.
* A committee meeting of RVNRL research group.
* SLAAS annual sessions to present a paper.
* Two scientific committee meetings of the RRI.

Mr P L Perera demonstrated his new electrically controlled automatic burett at an exhibition organized by Peoples Bank.

**Training progammes**

Following students under went their inplant training in this department.

1. W I N de Silva, University of Colombo.
2. K Manjula D Silva, University of Colombo.
3. N M P J Nilanthi S K Navaratne, University of Moratuwa.

## LABORATORY INVESTIGATIONS

**New brushable rainguard sealant**

A new sealant to fix rainguards in a very economical way was introduced. This new sealant is a further development of the sealant introduced earlier and has many advantages over earlier used sealant such as:

* It can be applied with a brush or finger
* Very small quantity is required to fix a rainguard (*i.e.* less than 10% of the quantity required from old formula)
* Cost per tree is reduced
* Easy to handle and apply
* manufacturing process is much safer and easier

Demonstrations were carried out in the following locations on the preparation of new rainguard sealant:

1. Panawatta Estate
2. Elston Estate
3. Eladuwa Estate

4. Newchatel Estate
5. Iluktanne Estate

(L Karunanyake, N Karunatilake, L M K Tillekeratne and L P Vitharana).

**Manufacture of rubber wood charcoal**

Another large scale trial was carried out at Sapumalkanda estate. It was found that charcoal can be obtained quickly if dry rubber wood is used as the raw material in this process. However, the output seems to be much lower when dried wood is used (L M K Tillekeratne, K G Karnika de Silva and P L Perera).

**Evaluation of properties of blends of reclaimed rubber with virgin raw rubber**

Blends containing 20%, 30%, 40%, 50% and 60% reclaimed rubber were mixed with a standard compound (ACS1). Technological properties such as tensile strength, modulus, hardness, resilience, abrasion resistance, compression set and ageing properties were evaluated.

It was found that the cure time of blend samples is shorter than that of the virgin rubber sample. This could be due to the presence of residual vulcanizing chemicals in reclaimed rubber. Further, results obtained shows significant adverse effects on physical properties due to use of reclaimed rubber even in small amounts (L Karunanayake, H S Weeraman, L P Vitharana and B V Priyantha).

**Effects of Magnesium levels on NR latex properties**

Objectives of this research is to evaluate the effect of level of Mg present in NR latex on properties and the effect of the presence of excess $PO_4^{2-}$ ions in latex on properties.

Mangesium and Phosphate levels of a series of latex samples were adjusted by incorporating $MgSO_4$ and $H_2NH_4PO_4$. Latex properties such as chemical stability, viscosity and mechanical stability time (MST) and viscosity were monitored with time (L Karunanayake, W W Nandasena, Wasantha Gamage and K Manjula D Silva).

**Blends of NR, NBR, and Polychloroprene Latex**

Main objectives of this project are to obtain homogeneous systems to be used in various applications. For instance these blends could be a ideal solution to the current NR latex protein allergy problems where a certain % of NR could be replaced with a non protein allergic synthetic rubber latex while retaining the excellent film properties of natural rubber.

Finding of optimum blend composition could be utilized in dipped products industry, with desirable technological properties.

A series of samples were made with changing blend composition. FTIR spectra of latex blends are being studied in detail. Preliminary studies show significant changes in IR spectra showing interaction among the components of blends.

Effect of blending temperature on miscibility of polymers is under study. Samples were sent to Australia for further analysis (K G Karnika de Silva, L Karunanayake, W I N de Silva and W W Nandasena).

**Analytical services**

Table 1. *The Number of samples tested from each TSR Factory during this year*

| Producer | No. of samples |
|---|---|
| Statcon Block Rubber Factory, Getahetta | 2234 |
| Sherman Block Rubber Factory, Ingiriya | 414 |
| Ceymac Block Rubber Factory, Horana | 958 |
| Mawanella Block Rubber Factory, Getahetta | 651 |
| Total | 4257 |

Table 2. *Other samples tested during this year*

| | |
|---|---|
| Rubber samples | 689 |
| Latex samples | 182 |
| Chemical samples | 198 |
| Master batch samples | 147 |
| Gloves samples | 48 |
| Water samples | 52 |
| Bleaching agent | 304 |
| Total | 1620 |

# RAW RUBBER PROCESS DEVELOPMENT AND CHEMICAL ENGINEERING

W M G Seneviratne

## SUMMARY

Dartonfield rubber factory received the ISO 9000 quality system certification from the Sri Lanka Standards Institution.

A very successful 3 day workshop was conducted for the planters on ISO 9002 document preparation for crepe rubber factories.

Effluent treatment system based on anaerobic septic tank with aerobic digestion principle has already been acclaimed both locally and internationally as the most cost effective process for the treatment of rubber and allied industrial waste water. International Natural Rubber Organization (INRO) in collaboration with the IRRDB has already taken action to develop and disseminate this technique in natural rubber producing countries.

Effect of latex preservatives on metrolac reading was studied and it was found that none of the 4 common preservatives used for natural rubber latex has any effect on the metrolac reading if the recommended dosage is not exceeded.

In an experiment carried out using a drying chamber completely enclosed with asbestoes and fitted with an exhaust fan at the top, it was found that crepe laces could be dried within two days under normal climatic conditions without employing any heat source creating an air flow by means of the exhaust fan.

Results of an experiment carried out on the manufacture of CV sheet rubber indicate that viscosity stabilization is much improved when the sheets are dried in the green house type solar dryer.

Several advisory visits were made to rubber factories for factory development, product quality improvements and waste water treatment.

## DETAILDED REVIEW

### Staff

Dr W M G Seneviratne, Head of the Department was on duty throughout the year. He attended an International Exhibition of Inventions which was held from 26$^{th}$ March to 8$^{th}$ April and was awarded a Silver Medal for the cost effective treatment system developed by him for rubber factory effluents.

Mr Susantha Siriwardena was promoted to the post of Rubber Chemist with effect from 02.05.1997. Mr Upul Ratnayake, Research Assistant, left for Japan on

28th July to work on a research project on "Production of soluble protein free latex by irradiation" at the Atomic Energy Research Institute in Japan. Mr P P Jayasinghe, Development Officer was on duty throughout the year.

Mr P H Sarath Kumara, Experimental Officer and Messrs C D Senanayake, T A S Siriwardena, Mahesh Gamage, Waranajith Prasad and Mrs W K C Nalini, Miss V C Rohanadeepa, Technical Officers were on duty throughout the year.

Mr J A Amaranath Jayakody who was recruited as a temporary Technical Officer in April to work on the Research project jointly funded by National Science Foundation and Energy Conservation Fund titled "*Developing an efficient and cost effective treatment system for the serum water that is discharged when skim latex, a byproduct from centrifuged latex industry, is processed into skim rubber and also to use bio gas generated in the process of treatment as a source of energy*" vacated the post on 10th August. Miss Imali Koralege was recruited as a Temporary Technical Officer on 1st of September to work on the same project.

Mrs S A Paranavitane, Clerk/Typist and Mrs L Rukmani, Stores Assistant were on duty throughout the year.

Messrs U Dharmasena and N L D Priyantha Chandarasiri were also on duty throughout the year.

**Trainees**

The following were trained in the department:

| | |
|---|---|
| T D S A Jayasena | NDT student. |
| H L A D Fernando | NDT student. |
| M S M Roomi | BSc Eng student. |
| G Sageeswaran | BSc Eng student. |
| P K B Jayampathi | NDT student. |
| Rishani Tillekeratne | NDT student. |
| Thilak Chaminda Kumara | NDT student. |

**Meetings, Seminars, Lectures and training programmes**

The Head of the department was involved in the following;

- Conducted lectures as a Visiting Lecturer on Polymer Science and Technology for MSc course on Polymer Science and Technology.
- Coordinated and organized the exhibition held at BMICH on 50th Independence Day Celebrations.

- Participated in a laboratory assessment programme for two days conducted by the SLSI (ISO Guide 25)
- Participated in 5 Scientific committee meetings held at the SLAAS.
- Participated in 3 environmental sub committee meetings and 4 educational sub committee meetings at PRI.
- Addressed the factory personnel at Lalan Rubbers, Warakapola on waste water treatment techniques.
- Conducted lectures as a Visiting Lecturer in Polymer Science and Technolgoy for MSC course on Polymer Science and Technology at University of Moratuwa and Jayawardenepura.
- Participated in one research meeting held at Dartonfield.
- Delivered a lecture on "New Developments in Waste Water Treatment in the Rubber Industry conducted by the Plastics & Rubber Institute on 25th of June at Taj Samudra in Colombo.
- A National Laboratory Accreditation Meeting held at SLSI.
- Three sittings at the Evaluation panel of 8th Diploma in Plantation Management course held at NIPM.
- A meeting at CRTA.
- Attended a project evaluation seminar at National Science Foundation.
- Participated in the workshop and two days seminar held from 23rd to 24th November on Agricultural Management at PGIA in Peradeniya.
- Attended a meeting at CDA to discuss the setting up of Effluent Treatment Plant at DC Mills at Wadduwa.
- Delivered a lecture on " Waste minimisation and Effluent treatment techniques in rubber manufacturing and processing industry" at a workshop held from 26th 28th November conducted by the IDB at Galadari Hotel.

Dr W M G Seneviratne[1], Messrs Susantha Siriwardena[2] and P H Sarath Kumara[3] were involved in the following.

- Delivered lectures for Samurdhi Animators at a workshop held at Dadigama Agrarian Services Centre on manufacture of latex based products.[3]
- Addressed the members of the Kalutara Co-operative Society on "DRC estimation by the use of metrolac"[3]
- Addressed the youth at Maharagama Youth Council on "DRC estimation and manufacture of rubberized coir.[3]
- Conducted lectures as a Visiting Lecturer at the University of Moratuwa for part - time Polymer Technology course.[3]
- Addressed the small holders of Gampaha District on "Manufacture of Latex Based Products on a small scale" at a workshop organised by Gampaha Regional Office of the Rubber Development Department. [3]

- Seminar on "Rubber Manufacture and related problems" held at Udapolla Estate at Deraniyagalla for the planters, factory staff and field staff of Bogawanthalawa Plantations Ltd.[1,2& 3]
- Delivered lectures for a group of smallholders from Deraniyagala area at Deraniyagala.[2]
- Addressed the estate staff on" Implementation of ISO 9002 at the Rubber Factory[1,2&3]
- Conducted a 3 day residential workshop on :Installation of ISO 9002 Quality system in Rubber Factories in Sri Lanka" for the planters from 11 plantation companies with the assistance of the staff of the department.[1,2 & 3]
- Addressed the staff at Devalakanda Estate on "Implementation of ISO 9002 Quality System"[1 & 2]
- Meeting at Keels Plantations Ltd. to discuss the quality of chemicals used in plantations[3]
- Addressed the planters at Regional Scientific Meeting held at Morawaka Korale Club at Deniyaya on 'Installation of ISO 9002 Quality System in Crepe rubber factories' and 'Important Aspects of crepe manufacture'. [2 &3]
- Conducted lectures for Diploma course for Extension Officers from RDD and CDA conducted by NIPM.[1, 2 & 3]

**Advisory visits**

The rubber factories and other industries listed below were visited during the year in order to investigate their problems with regard to processing and manufacturing of raw rubber, factory development work and waste water disposal problems. Detailed reports were submitted to most of these factories. Comprehensive reports were furnished to Pitiyakande and Dalkeith estates in order to construct new rubber factories. Both these factories were completely gutted by fire. A detailed report was forwarded to Udabage estate with recommendations for complete refurbishment of the factory, installation of new machinery and change of the pattern of bulking and processing of rubber.

**1. *Raw rubber processing and development***

| | | |
|---|---|---|
| 1. Frocester Estate | - | Bulathsinhala |
| 2. Pallegoda Estate. | - | Darga Town |
| 3. Rambukkanda Estate | - | Ratnapura |
| 4. Galatura Estate | - | Ratnapura |
| 5. Delkeith Estate | - | Baduraliya |

6. Usk Valley Estate - Baduraliya
7. Gikiyanakanda Estate - Matugama
8. Pambegama Estate - Godagampola
9. Talduwa Estate - Avissawella
10. Pitiyakanda Estate - Mawathagama
11. Muwankanda Estate - Mawathagama
12. Udabage Estate - Deraniyagala
13. Woodend rubber factory - Deraniyagala
14. Maha Oya rubber factory - Dehiowita
15. Delkeith Estate - Badureliya
16. Hapugastenna rubber factory - Ratnapura
17. Ruwanwella rubber factory belonging to Moralioya estate
18. Hewij Rubber Industries - Welipenna
19. Atale rubber factory - Atale
20. Peenkande rubber factory - Nivithigala

## 2. *Waste water treatment and disposal*

The following rubber factories and other industries were visited during the year to look into their waste water disposal problems and also for necessary advice to improve the efficiency of the existing treatment plants.

1. Lak Latex centrifuged factory - Baduraliya
2. SRMEC Crepe rubber factory - Baduraliya
3. Daisin Lanka Ltd. - Makandura
4. J.L. Industries. - Wadduwa
5. Dipped Products Ltd., - Brahamanagama
6. Venigross factory. - Weliweriya
7. Hanwella Rubber Products - Hanwella
8. Mackwoods. - Ja Ela
9. Glenross factory. - Neboda
10. S & C Centrifuged (Pvt) Ltd., - Horana
11. Maha Oya Estate - Dehiowita
12. Sapugastenna Estate. - Ranapura
13. SRMEC Centrifuged latex factory - Mawanella
14. Samaraweea rice mill - Polonnaruwa
15. Jayanthipura rice mill - Polonnaruwa
16. Lalan Rubbers - Warakapola
17. Paiyagala estate. - Dodangoda
18. Galatura estate. - Galatura
19. Rambukkanda estate. - Ratnapura

| | | |
|---|---|---|
| 20. Dewalankanda estate. | - | Dehiowita. |
| 21. Panawatte estate | - | Yatiyantota. |
| 22. Langsland rubber factory | - | Neboda. |
| 23. SRMEC foam rubber factory | - | Wawulugala. |
| 24. Suraal Lanka (Pvt)Ltd., | - | Yatiyantota. |
| 25. Morontota Scrap Crepe rubber factory | - | Undugoda. |
| 26. Boseang Lanka Limited. | - | Ja-Ela |

**Testing of rubber processing water and waste water**

Large number of samples were received during the year from various treatment plants and factories for testing of effluent quality parameters. The department's laboratory has already been recognized by the CEA as a standard effluent testing laboratory and now in the process of preparing manuals required for obtaining ISO 25 certification.

15 rubber processing water samples and 137 waste water samples have been analyzed during the year. 85 test reports and certificates were issued (P P Jayasinghe, W K C Nalini, Warnajith Prasad and V C Rohanadeepa).

**ISO 9002 Quality Assurance Scheme**

Dartonfield rubber factory was accredited under the ISO 9000 Quality certificate scheme of SLSI in June, to become the first ISO 9002 certified rubber factory in Sri Lanka.

Padukka rubber factory also has been identified at the trial audit carried out by the SLSI to be accredited under the above scheme and will be certified in early 1999.

Assistance was extended to statcon rubber factory also to work towards achieving this status.

A very successful 3 day residential workshop was conducted in September for a batch of 23 planters from 11 plantation companies on installation of ISO 9002 quality system in rubber factories.

Several meetings and seminars were conducted at Pussella Plantations Limited, Balangoda Plantations Limited and Kelany Valley Plantations Limited to educate factory personnel and the management on the ISO 9000 concept (W M G Seneviratne, Susantha Siriwardane and P H Sarath Kumara).

## LABORATORY AND FIELD INVESTIGATION

### Effluent treatment and disposal

#### *Waste water treatment and disposal*

Effluent treatment system based on anaerobic septic tank with aerobic digestive principal has been acclaimed both locally and internationally as the most cost effective process for the treatment of rubber and allied industrial waste water. Significant achievements on the subject are;

- Silver medal - awarded at the 26th International exhibition of inventions, new techniques and products held in Geneva, Switzerland in April 1998.

- Merit award and most innovative award 1998 - awarded by the Plastics and Rubber Institute (PRI) of Sri Lanka.

- UNDP recognition - Selected by the Third World Network of Scientific Organization (TWNSO) a special unit of the UNDP for the technical cooperation among developing countries as an effective treatment process to be implemented in developing countries. Complete details were furnished to TWNSO.

- International Natural Rubber Organization (INRO) in collaboration with the IRRDB has already taken initiative to propagate this technique in the rubber producing and manufacturing countries.

A project was undertaken by the department to upgrade the efficiency of the existing effluent treatment plant at Lalan Rubber factory, Warakapola. Mechanism of operation of the plant is primarily chemical in nature with biological aeration of subsequent reduction of the organics. This leads to very high operational and maintenance cost involved in operating the plant. Designs for conversion to primarily a biological treatment mechanism including the anaerobic septic tank has been forwarded with a comprehensive report to Ms. Lalan rubbers. This project is sponsored by the Asia foundation and also deals with matters connected with cleaner production concepts.

During the year construction of four treatment plants have already commenced namely Ranbukkanda, Galatura, Padukka and Piyagala crepe rubber factories and two of them were nearing completion by the end of the year. Plans are now underway to construct few more treatment plants at the end of the year (W M G Seneviratne and T A S Siriwardane).

## Generation of bio-gas from skim serum

Work on a project jointly funded by National Science Foundation and Energy Conservation Fund titled "*Developing an efficient and cost effective treatment system for the serum water that is discharged when skim latex, a byproduct from centrifuged latex industry, is processed into skim rubber and also to use bio gas generated in the process of treatment as a source of energy*" commenced in April and continued throughout the year.

Process and production details of six centrifuged latex manufacturing factories selected from different areas of the country were compiled.

Effluent samples were collected from each of the six factories selected and they were analyzed for all effluent quality parameters. Spectrophotometric studies were carried out to determine the metal ion levels in untreated and treated effluents.

The volume of gas generated in the process of anaerobic digestion of each of the effluent was measured using a laboratory scale gas collection set up. It was observed that 1g of COD removal generally resulted in 250-300 ml of bio-gas.

Trials were initiated for treatment of skim serum in a laboratory model anaerobic/aerobic treatment system. Treated effluents were tested for effluent quality parameters (W M G Seneviratne, Upul Ratnayake and Imali Koralage).

## Effect of preservatives on metrolac reading

Effect of the use of preservatives on metrolac reading was investigated. It was found that use of sodium sulphite up to a concentration of 0.20% has no any effect on the metrolac reading. However increasing the concentration beyond this limit showed a gradual reduction in metrolac readings. The use of sodium carbonate upto a concentration of 0.075% showed no effects on the matrolac reading. Use of ammonia upto a concentration of 0.5% on latex had no effect on the metrolac reading which is in contrary to widely believed misconception. Ammonia upto a concentration of 0.75% on latex in combination with 0.025% TMTD/ZnO also showed no effect on the metrolac reading. Formaldehyde upto a concentration of 0.075% on latex was also showed no effect.

*Table 1. Effect of preservatives on metrolac reading and the recommended dosage*

| Preservative | Effect on metrolac reading | Recommended dosage as an anti-coagulant. |
|---|---|---|
| Ammonia | No any effect up to a concentration of 0.5% ammonia on latex checked during investigation | 0.01 - 0.05% as an anti-coagulant. |
| Ammonia with 0.025% TMTD/ZnO | No any effect up to a concentration of 0.75% ammonia on latex checked during investigation | 0.2% for LA con. Latex. 0.7% for HA con. latex. |
| Sodium Sulphite | No any effect up to a concentration of 0.2%. Concentration beyond 0.2% gradually decreases the metrolac reading. | 0.05 - 0.15% |
| Sodium carbonate | No any effect up to a concentration of 0.075% checked during the investigation. | 0.025% |
| Formaldehyde | No any effect up to a concentration of 0.075%.. | 0.02% |

(P H Sarath Kumara and Warnajith Prasad).

**Development of drying systems for rubber**

A modification was done to the green house type drying chamber by introducing two layers of polythene to cover the structure creating an air gap in between. An experiment was carried out to compare the drying rates of rubber in the two types of dryers. The drying rate of rubber was found to be higher in the dryer which consisted of a double layer of polythene. The values of PRI also were compared and no significant difference of these values were observed.

Another dryer of similar type was constructed using asbestos as the cover material. A 50 kW exhaust fan of diameter 6" was incorporated into this dryer to suck out air from the chamber. This dryer could accommodate 30 kg of normal crepe laces. The laces were dried in an air flow which was created using the exhaust fan, for twelve hours per day using the maximum speed of the fan. The laces could be dried within 4 days during heavy rainy weather. The second trial showed that laces could be dried within two days in normal climatic conditions without employing any heat source. The volatile matter content of dried laces was determined to be within the acceptable limits (W M G Seneviratne, Susantha Siriwardane and M S M Roomi).

**Manufacture of CV sheet rubber**

Attempts were made to manufacture CV sheet rubber using different types of drying systems, and also at different dilution levels of latex. Very interesting results have been obtained by the analysis of sheets for raw rubber properties. The results

indicate that dilution of latex has no significant effect on viscosity reduction and stabilization. However, drying of sheets in sunlight has a significant bearing on reduction of Mooney Viscosity in the presence of a chemical stabilizer. Results also indicate that viscosity stabilization is much improved when the sheets are dried in the green house type solar drier.

Further trials have been planned in order to provide a firm recommendation on this subject (W M G Seneviratne, P H Sarath Kumara, K T Kanchana and T A S Siriwardane).

# ADAPTIVE RESEARCH

N Yogaratnam

## SUMMARY

Adaptive research programs on clone evaluation, soil and moisture conservation practices, organic manure and young budding were in progress. Experiment on Interplanting of rubber with tea started to study the nutritional aspect on rubber and tea was also continued.

## DETAILED REVIEW

### Staff

The Deputy Director (Research), Dr N Yogaratnam coordinated the activities of the Unit. Mr S M M Iqbal, Research Assistant in Agronomy, Mr K B Karunasekera, Development Officer and Mr E A T Senadeera, Senior Technical Officer were on duty throughout the year.

### Meetings

The Adaptive Research unit staff participated in the following:

* Joint meeting of Rubber Development Department and RRI Scientific Staff
* Monthly conferences of the Regional Rubber Development Department in Kegalle region.
* Advisory visit to Matara region.

### Training programs

Mr S M M Iqbal delivered a lecture on "Interplanting of rubber with tea" under a refresher training program for NIPM trainees and also participated in a "Training of trainers" workshop organized by NIPM.

Mr S M M Iqbal participated in a Rupavahini documentary program on interplanting of rubber with tea organized by RDD and the Rupavahini unit.

# FIELD INVESTIGATION

## Clone evaluation

Four clones, *viz*; of RRIC 100, RRIC 102, RRIC 110 and RRIC 121 were tested in comparison with the smallholder management practices (smp) and RRI recommended practices (RRI) at Kegalle and Kalutara regions. Fertilizers were, issued for the RRI plots. Yield of rubber was recorded from these plots (D P S T G Attanayaka, S M M Iqbal and K B A Karunasekara).

## Soil and moisture conservation practice

**a)** ***Effectiveness of bush/tree legumes***

**b)** ***Use of poultry litter***

The above programms were in progress.

**c)** ***Use of paddy straw***

Yield of rubber was recorded.

## Young budding

***Programme - Planting techniques***

| | | |
|---|---|---|
| Treatment | : | Young budded polybag plants (YB) |
| Control | : | Brown budded bare root plants (BR) |

Programme started in 1994 and 1995 were in progress at all regions. Messurments of rubber girth was continued.

## Inorganic fertilizer (Eppawala Rock Phosphate)

Suitability of Eppawala rock phosphate as a phosphorus source for smallholdings.

Three trials were continued in the Kalutara regions. Fertilizer was applied according to the RRI recommendation (A Dissanayaka and H D S P Perera).

**Intercropping of rubber with cinnamon**

Programs on intercropping of rubber with cinnamon were in progress at Ratnapura and Galle regions (L S S Pathiratna).

**Interplanting of rubber with tea**

***State sector I (1985)***

Girth of the rubber plants were recorded in 2 observation trials at Kegalle and Kalutara regions. Yield data of tea and rubber were collected (S M M Iqbal and N Yogaratnam).

***State sector II***

*Experiment 1 (RRISL Sub Station - Kuruwita)*

The following were done:

a) Recording of tea yield
b) Measurement of rubber girth
c) Collection of leaf samples and soil samples
d) Test tapping of rubber

Yield of tea in unrehabilitated plots were recorded in 1997 and 1998 (Table 1).

Table 1. *The effect of multicropping of rubber lands with tea on yield of tea planted without rehabilitation*

| | Made tea yield | |
|---|---|---|
| Treatments | Actual Kg/ha/97 | Actual Kg/ha/98 |
| Rubber 8'x27'+Tea | 949a | 988a |
| Rubber 8'x40'+Tea | 1040a | 1090a |

Yield of tea in rehabilitated plots was recorded in 1997 and 1998 (Table 2).

Table 2. *The effect of multicropping of rubber lands with tea on yield of tea planted after rehabilitation*

| Treatments | Made tea yield Actual Kg/ha/97 | Actual Kg/ha/98 |
|---|---|---|
| Tea only | 2940a | 3740a |
| Rubber 8'x27'+Tea | 500b | 400b |
| Rubber 8'x40'+Tea | 720b | 800b |

Means with the same letters are not significantly different.

Yield of rubber in this experiment is presented in table 3.

Table 3. *The effect of multicropping of rubber lands with tea on yield of rubber in 1998*

| Treatments | g/t/t |
|---|---|
| Rubber Only 12'x 18' 100% | 43.29 A |
| Rubber 8'x 27' 100% + Tea (rehab) (4 rows) 65% | 43.63 A |
| Rubber 8'x 27' 100% + Tea (unrehab) (4 rows) 65% | 48.55A |
| Rubber 8'x 40' 70% + Tea (rehab) (7 rows) 75% | 54.13A |
| Rubber 8'x 40' 70% + Tea (unrehab) (7 rows) 75% | 55.15A |

Means with the same letters are not significantly different (S M M Iqbal and N Yogaratnam in collaboration with TRI).

*Experiment II - (RRISL - Agalawatta)*

Experiment II started at RRISL, Gallewatta Division to study the effect of interplanting of rubber with tea on the growth and yield of rubber with tea was in progress.

Assessment for shot hole borer was done by TRI.
Girth of the rubber plant was recorded in 1998 (Table 4).

Table 4. *The effect of multicropping of rubber lands with tea on growth of rubber*

| Treatments | Mean Girth (cm) 1998 |
|---|---|
| Rubber Only 12' x 18' 100% | 56.82A |
| Rubber 8'x 27' 100% + Tea | 58.59A |
| Rubber 8'x 32' 100% + Tea | 59.55A |
| Rubber 8'x 36' 70% + Tea | 57.79A |
| Rubber 8'x 40' 70% + Tea | 59.30A |
| Rubber 8'x 40' 70% + Tea | 60.80A |

Means with the same letters are not significantly different.

Rubber and tea leaf samples and yield of tea were also collected (S M M Iqbal, N Yogaratnam, C Seneviratne and G D Piyathilake, Tea Inspector, TSHDA, Matugama).

*Experiment III - Perth Estate, Horana (Meenapalana Division)*

This experiment was in progress. The following were done.

* Manuring of rubber and tea
* Growth assessments of tea and rubber
* Collection of leaf and soil samples
* Centering of tea bushes
* Tipping of tea
* Tea yield data collection

(S M M Iqbal and N Yogaratnam)

*Experiment IV*

Another experiment was started in May/June 1998 at Vogan Estate Matugama. Due to lack of labour it has been decided to rearrange the experimental design. Design and treatments are follows.

1. Design: CRD with 03 replicates.
2. Treatments:

Fertilizer Levels:

F1 - ½ of the recommended rubber fertilizer
F2 - normal recommended rubber fertilizer
F3 - 1½ of the recommended rubber fertilizer

Cropping systems:

T1 - Rubber only 12'x18' 100% (1998)
T2 - Rubber 8'x 8' x 46' 100% (double row) + Tea (8 rows) 66%
T3 - Rubber 8'x 8'x 60' 80% (double row) + Tea (12 rows) 76%

A sole plot of tea (4'x2') with standard agro management practice also included in each main plot (T4).

The following were carried out.

* TRI/St. Jochim Estate and TSHDA Matugama supplied tea plants
* Planting of tea and rubber according to the treatments
* Pre treatment growth assessments and soil samplings
* Using weedicide did weeding of tea interrow areas

(S M M Iqbal and N Yogaratnam).

***Smallholder sector***

Smallholder trials at the Kegalle and Ratnapura Region were in progress. Girth of the rubber and yield of tea were collected (S M M Iqbal, N Yogaratnam and E A T Senadeera).

# AGRICULTURAL ECONOMICS

**P H M U Herath**

## SUMMARY

Studies on social cost associated with rubber effluent, impact of trade blocks, exchange rate liberalization and macro and micro economic policies, market channel of rubber sector, impact of replanting and new planting subsidy and labor economics of rubber sector were in progress.

## DETAILED REVIEW

### Staff

Dr I N Samarappuli resigned from the post of Assistant Agricultural Economists with effect from 1st October 1998. Mr P H M U Herath was promoted to the Senior Research Officer grade 1 with effect from 1st February 1997. Assistant Agricultural Economist Mr A K B Naranpanawa was on duty throughout the year.

### Presentations/Seminars/ Meetings

P H M U Herath attended the meetings of the Socio Economists and Policy Analysis group of the CARP.

- P H M U Herath attended the scientific committee meetings.

- P H M U Herath and A K B Naranpanawa delivered lectures on Some local aspects of rubber industry and "Global rubber industry" respectively for the students of NIPM diploma (extension) at the Auditorium, Dartonfield, Agalawatta.

- A K B Naranpanawa attended the following training programs during the year 1998:

    - Two-day workshop on computable general equilibrium modeling (CGEM) held at the Ministry of Plantation Industries, Colombo.
    - Two-day workshop on information for agricultural research managers (INFORM) conducted by CARP held at PGIA, University of Peradeniya.

- A workshop on training of trainers conducted by NIPM held at Dartonfield, Agalawatta.

- A K B Naranpanawa and P H M U Herath attended a seminar on "Euro and its implications" conducted by the Central Bank of Sri Lanka held at the Rural Banking and Staff Training College, Sri Jayawardenapura.

**Research Students/Lectures**

P H M U Herath served as a visiting lecturer for the Plantation Management specialization course of the Faculty of Agriculture of the Rajarata University.

## RESEARCH

**Micro economic policies and their impact on the plantation sector of Sri Lanka**

This study to quantify the impact of different policy measures on the plantation sector development was continued. The necessary data collection since 1948, was carriedout to study the impact of different land policies of the plantation sector (P H M U Herath).

**Study on rubber market channel**

In view of studying the impact of imposing/removing of cess a detail study has planned to conduct on structure of rubber marketing channel. Estimating market margins at different points will also be carriedout in this study. To conduct a survey, questionnaires were prepared and pre tested with some rubber dealers, brokers and manufacturers (P H M U Herath and A K B Naranpanawa).

**Economic impact of replanting and new planting subsidy on rubber**

The Rubber Replanting Subsidy Scheme (RRSS) has functioned for around 45 years since its inception in 1953. This study was conducted on the rubber subsidy scheme in terms of financial, economic and social gains to the sector. The secondary data on the different aspects of RRSS were gathered and were analyzed to study the cost of subsidy to the economy, the impact of replanting in monetary terms, the actual and the potential performances of the scheme in terms of area replanted, comparative study of actual and optimum replanting performances have been employed in this study (P H M U Herath).

## Information dissemination in rubber sector

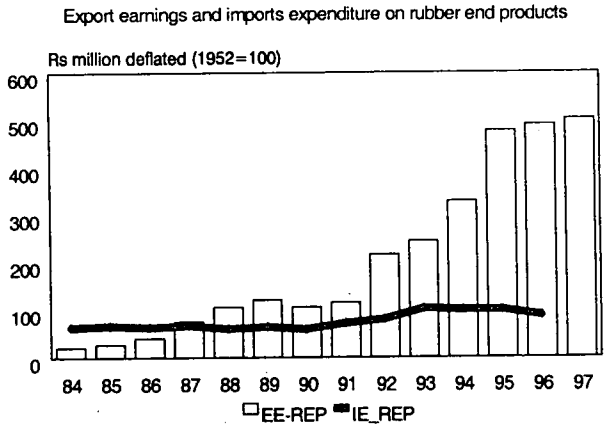
A situation analysis was conducted on information dissemination in rubber sector. Based on the preliminary studies a detail study is on progress on effectiveness of different modes, characterization of different modes, quantification intensity of farmer knowledge and adoption of selected practices, quantification of constraints and impact evaluation of adaptive research (P H M U Herath).

## Comparative study of management at Estate and Smallholder Sector

A project proposal on feasibility study on possibility of managing RDO ranges as an estate was prepared based on the information gathered by surveys conducted by the Agricultural Economics Unit. This study intends to carryout financial economic and administrative aspects and the constraints based on production function frontier analysis of the sectors (P H M U Herath and V H L Rodrigo).

## Factors affecting local consumption of rubber

Quantification of factors, future trends, potential areas to improve and constraints on local consumption are planned to be studied under this program. Initially consumption trend data was gathered since 1960 and with and without policy techniques in regression analysis was employed to quantify the impact of open market policies implemented since 1977, on local consumption. Also study indicates that the returns by local consumption in real monetary terms has stagnated since 1995 compared to the period 1992-95, also imports expenditures on rubber end products has not shown any significant decline during the period (P H M U Herath).




Source - Dep of Customs

**Labor economics in rubber sector**

Present status of labor absorption, potential labor absorption of the sector, impact of labor migration, socio economic aspects of Indian Tamil labor and determination of optimum wage rate policies was designed under this program. A preliminary study conducted using data from 3 estates shows that the present tapping wage rate is higher than the optimum wage rate suggested by marginal value product analysis. This result indicates the low tapper productivity in these estates. However, further investigations are necessary to generalize these results (P H M U Herath).

**International trade blocks and exports of raw and manufactured rubber products of Sri Lanka**

A study that was undertaken on this sector is in progress. The necessary data are being gathered and an analytical framework using general equilibrium approach is being developed to understand the possible welfare consequences of trade liberalization at sector level (A K B Naranpanawa).

**Impact of macro-economic policies (monetary and fiscal) on the performance of agricultural sector with special reference to natural rubber industry**

Under this broad area, a study that was initiated in identifying and quantifying macro-economic impacts especially the impacts of macro-monetary instruments, *i.e.*, money supply and real exchange rate on the rubber sector is in progress. A conceptual model has been developed on the export supply and demand for Sri Lankan natural rubber in a partial equilibrium framework. An empirical testing is being carried out using general to specific econometric methodology (A K B Naranpanawa).

**Environmental linkages of rubber industry**

A study that was initiated in collaboration with the biochemistry department in estimating the social cost of rubber effluents is in progress. A preliminary investigation is being started using a pre-tested structured questionnaire (A K B Naranpanawa and M T Warnakula).

## Economic evaluation of conventional plant breeding program

All the cost items involved in the conventional plant-breeding program were estimated in this study. Further studies are in progress to evaluate the real economics returns in the conventional plant breeding of rubber (P H M U Herath in collaboration with Plant Breeding Dept).

## Clone adaptability and related productivity and cost of production aspects of the Estate Sector

In view of studying the adaptability rate of different clones and their impact on productivity and Cost of Production aspects a mail survey was conducted covering all the rubber growing estates in Sri Lanka. Around 75 estates replied and the analysis of the data is in progress (P H M U Herath in collaboration with the Plant Breeding Department).

# BIOMETRY

Wasana Wijesuriya

## SUMMARY

The main responsibility of the Biometry Section is to provide support services to the research departments including designing of experiments, analyses and interpretation of results. Statistical and other mathematical problems which arise frequently are also referred to this section, including curve fitting, estimations and predictions of quantities of biological interest. Assistance is also given to the scientists who attempt to perform their own statistical computing by providing sample programs for statistical analyses. Research during this year were mainly focused on developing statistical methodologies for on-farm research.

Initial steps were taken to install a meteorological station at Kegalle. The database on meteorological factors at Dartonfield was successfully maintained.

## DETAILED REVIEW

### Staff

The Assistant Biometrician, Ms Wasana Wijesuriya was promoted to the grade of Senior Research Officer with effect from 23.09.1997, and was on duty throughout until 21st December when she went on maternity leave. Ms Chintha Munasinghe was promoted as an Experimental Officer with effect from 27th April 1998, and was on duty throughout the year along with the Technical Officer, Mr Vidura Abeywardene. Ms Nandanie Wanigatunga, Experimental Officer was on no pay leave since 27th July 1998.

### Staff training

On a special request, a one day training programme was organized by the meteorological department to Messrs E A T Senadheera and Vidura Abeywardene on "monitoring and recording of meteorological data" at the Central Meteorological Station on 27th July 1998.

## SERVICES

### 1. Statistical analysis and interpretation

Designing of experiments, analysis and interpretation of results for research departments and statistical assistance to undergraduate and postgraduate students on their specialized training were among the statistical services. The areas covered in statistical analyses were; biometrical genetics, analysis of variance and covariance, linear and non-linear regression, applied multi-variate methods, categorical and non-parametric methods and time series techniques.

### 2. Meteorological database management

Daily meteorological observations of the Dartonfield station was maintained successfully and monthly reports were sent to the central meteorological station (C Munasinghe and V Abeywardene).

The preliminary work including, designing, site selection and ordering of meteorological equipment have been done during this year. It was decided to station the above in the premises of the Department of Agrarian Services, and to give the authority of monitoring and data recording to Mr E A T Senadheera of the Adaptive Research Unit.

### 3. Management information

The INFORM database with personnel, project information and budgetary involvement was updated for the year 1998 and data collection is in progress for the year 1999 (W Wijesuriya and A K B Naranpanawa).

## RESEARCH

### 1. Analysis of spatial variability

The objective of this study is to provide some guidelines to model spatial variability which in turn would help the researchers to design their experiments precisely. Initial studies have been started in collaboration with the Soils and Plant Nutrition Department using the restricted maximum likelihood method available in Genstat 5.

## 2. Suitable statistical methodologies for on-farm research

Initially, a study was carried out to model the adoption behaviour of new technologies in rubber cultivation. A pertinent literature collection was made on this regard and further studies are in progress.

# LIBRARY AND PUBLICATIONS

**Ramani Amaratunga**

## SUMMARY

The Library and Publications Section continued to collect and disseminate information on Natural rubber and related areas. It was also engaged in maintaining, processing and publishing of the Institute's regular publications such as Annual Review, Journal, Bulletin, Rubber Puwath *etc*.

## DETAILED REVIEW

### Staff

Library Assistants & Assistant Publications Officers Mrs Thilaka Dantanarayana (Colombo Office), Mrs Ramani Amaratunga and two Library Attendants were on duty throughout the year.

Mr P M Prema Jayantha, Library Attendant was promoted to the post of Clerk/Typist with effect from 27.03.1998.

Dr N Yogaratnam, Deputy Director (Research), was in over-all charge of the Section.

### Seminars and Workshops

Mrs Thilaka Dantanarayana and Mrs Ramani Amaratunga, Library Assistants & Assistant Publications Officers attended the following:

* "The use of Windows based Office Automative Software" conducted by CINTEC.

* Workshop on "Advanced ISIS" organized by Sri Lanka Library Association from 20 to 22 November 1998 at the OPA Auditorium.

### Resource Development Activities

#### *Book/Serial acquisition*

The Library stock increased to 4939 books by the end of the year.

The Library subscribed for 76 journals and about 30 journals were also received as gift/exchange. We are very grateful to all those who donated these publications to the RRISL Library collection.

**ILL Service**

Twenty two articles were sent to various agricultural libraries at their request and vice versa 18 articles were requested for our users. Literature surveys based on *Hevea*/rubber were done using CD-ROM databases available at CARP Library.

**Equipment/Furniture**

The following office equipment were purchased during the year.

* Lexmark Optra Printer
* Datamini Cesky cs Series 233 Computer
* Merlin Gerin Pulsar Uninterrupted Power Supply Unit.
* Citizen CT 500 Calculator

**Publications**

The following publications were published during the year under review.

Annual Review 1997
RRISL Bulletin Vol.37, 1998
RRISL Bulletin Vol.38, 1998 (in press)
RRISL Journal Vol.80, 1997
RRISL Journal Vol.81, 1998 (in press)
Rubber Puwath Vol.20, 1997

**Library Automation**

Following databases were updated using CDS/ISIS package.

| | | |
|---|---|---|
| AGRI | - | Book Accessions from 1995 |
| RUB | - | Journal Analytical Entries |

**Information Services**

Computerized bibliographic data of 1998 were sent to the National Library of Sri Lanka for compilation of the National Union Catalogue.

**AGRINET SDCP Services**

Content pages of 60 Journal titles were received according to our user requirements and we also forwarded contents of 12 Journal titles to AGRINET Libraries.

# DARTONFIELD GROUP

## Jehan Perera

## SUMMARY

Mr Anusha S Perera relinquished his duties as Officer-in-charge of Dartonfield Group from 31st August, 1998 and Mr Jehan Perera assumed duties on 1st September, 1998 as Superintendent.

A crop of 158121 kg was harvested from 163.90 hectares during season 1998, a reduction of 8406 kg in comparison with the previous year.

The yield per hectare was 965 kg, a decrease of 41 kg over last year. This was mainly due to heavy rains that prevailed during the cropping months. The average intake per tapper for the group was 7.3 kg per tapper, an increase of 0.8 kg above last year.

The annual rainfall was 5790.1 mm as against 4501.2 in the previous year.

The cost of production and the net sale average for the season was Rs.43.25 Rs.53.45 respectively. The profit per hectare was Rs.9840/= and the total profit realised was 1.61 million.

## DETAILED REVIEW

### Staff

Mr Jehan Perera, Estate Superintendent, Mr P Kannangara, Chief Clerk, Mr K K P Gunewardena, Senior Clerk, Mrs C Dissanayake, Mr A K D A Wickramasinghe and Mrs S I K Pathirage, Junior Clerks, Mr J A Wimalasena, Mr S K S de Silva, Mr T Somaratne and Mr N L D Reggie, Field Officers, Mr H M J Premalal and Mr S R Vadivel, Assistant Field Officers, Mr J K Nakandala, Mr K A Sarath Kumara, Mr B M Siriwardena and Mr N L D Nihal, Junior Assistant Field Officers, Mr D S K Ranaweera, Rubber Factory Officer, Mr W D D Senanayake, Assistant Factory Officer, Mrs C S Hettiarachchi, Creche Attendent, Mr N V Premawanse, Tractor Driver and Mr A K Piyasene, Office Peon were on duty.

Mr Anusha Perera relinquish his duties as Officer-in-charge with effect from 31st August, 1998 and Mr Jehan Perera was appointed as the Superintendent with effect from 1st September, 1998.

The Group cadre that stood at 21 at the end of the year, is made as follows:

| | |
|---|---|
| Senior Staff | 1 |
| Assistant Staff | 18 |
| Minor Staff | 2 |
| Total | 21 |

**Hectarage**

A summary of the hectarage is given in Table 1.

Table 1. *Land distribution (Ha.) in Dartonfield Group*

| | Dartonfield | Gallewatte | Nivitigalakele | Total |
|---|---|---|---|---|
| Mature area | 24.21 | 107.85 | 31.84 | 163.90 |
| Immature area | 14.81 | 52.05 | 17.04 | 83.90 |
| Budwood nurseries | 6.54 | | 2 | 8.54 |
| Seedling nurseries | 0.73 | | 5.69 | 6.42 |
| Uprooting area | | 4.51 | 7.36 | 11.87 |
| Abandoned 53/54 | | | 3.06 | 3.06 |
| State land taken | 0.27 | | | 0.27 |
| Paddy/Deniya | | 1.22 | 1.22 | 1.22 |
| Waste land | 0.19 | 0.18 | | 0.37 |
| Earth slipped area | 3.01 | 1.26 | 2.62 | 6.89 |
| Jungles | 0.8 | . | 0.71 | 1.51 |
| Rocks/Streams | 2.14 | 2.81 | 2.17 | 7.12 |
| Buildings | 18.67 | 5.07 | 7.79 | 31.53 |
| Roads | 2.92 | 6.86 | 0.32 | 10.1 |
| Others total | 35.27 | 21.91 | 31.72 | 88.9 |
| Grand total hectare | 74.29 | 184.35 | 73.24 | 331.88 |
| Grand total acres | 183.57 | 455.53 | 180.98 | 820.08 |

## Crop

A total crop of 158121 kg was harvested from an extent of 163.90 during the year. When compared with the actuals of last season, there is a decrease of 8406 kg.

## Yield per hectare

The yield per hectare of the past 5 years is given in Table 2 for the entire group and separately for each division.

Table 2. *The yield per hectare (YPH Kg) at Dartonfield Group from 1994 to 1998*

| Division | Year | | | | |
|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 |
| Dartonfield | 1037 | 714 | 900 | 1059 | 790 |
| Gallewatta | 1077 | 1039 | 1073 | 1067 | 926 |
| Nivitigalakele | 876 | 804 | 723 | 800 | 1106 |
| Group average | 939 | 912 | 953 | 1006 | 965 |
| Group estimate | 884 | 887 | 1020 | 1038 | 979 |

Table 3. *The yield per hectare recorded in 1998 Division wise*

| Month | Dartonfield | Gallewatta | Nivitigalakele |
|---|---|---|---|
| January | 100 | 134 | 126 |
| February | 48 | 61 | 75 |
| March | 83 | 86 | 129 |
| April | 65 | 73 | 109 |
| May | 32 | 38 | 60 |
| June | 19 | 34 | 27 |
| July | 43 | 70 | 62 |
| August | 74 | 103 | 104 |
| September | 54 | 68 | 81 |
| October | 65 | 87 | 91 |
| November | 86 | 101 | 103 |
| December | 181 | 108 | 138 |

**Intake per tapper**

Table 4. *The average intake per tapper (kg) division wise for the last 5 years*

| Division | Year | | | | |
|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 |
| Dartonfield | 6.96 | 7 | 6.5 | 6.9 | 7.4 |
| Gallewatta | 6.35 | 6.7 | 6.2 | 7 | 7.9 |
| Nivitigalakele | 5.78 | 5.4 | 4.5 | 4.9 | 6.5 |
| Group average | 5.97 | 6.21 | 6.2 | 6.5 | 7.3 |

The intake per tapper has increased due to increase in the tapping task from 250 to 275 trees per tapping block. The new tapping task was introduced in September, 1997.

**Tapping cost**

Table 5. *A break-down in total tapping cost per kilo for 3 years*

| Cost item | Cost (Rs.) | | |
|---|---|---|---|
| | 1996 | 1997 | 1998 |
| Tapping | 16.9 | 16.32 | 15.46 |
| Double tapping | - | 0.28 | .48 |
| Kanganies | 0.12 | 0.05 | .03 |
| Over kilos | 1.12 | 0.92 | .92 |
| Scrap pay | 0.32 | 0.29 | .20 |
| Incentive to Field Staff | 0.1 | 0.07 | .07 |
| Total | 18.56 | 17.93 | 17.24 |

## Rainfall

Table 6. *Annual rainfall and the number of wet days for the last five years*

| | Year | | | | |
|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 |
| Rainfall (m.m.) | 3884.7 | 4369.5 | 3696.9 | 4501.2 | 4622.6 |
| Wet days | 185 | 185 | 165 | 164 | 232 |

Table 7. *The number of tapping days, relative tapping intensity, average intake per tapper and yield per hectare for the last four years in Dartonfield Group*

| | | Year | | | |
|---|---|---|---|---|---|
| | | 1995 | 1996 | 1997 | 1998 |
| 1. | Tapping days | | | | |
| 1.1 | Normal | 205 | 238 | 252 | 199 |
| 1.2 | Late | 54 | 49 | 29 | 30 |
| 1.3 | Double | 8 | - | 7 | 12 |
| 1.4 | No | 106 | 78 | 80 | 135 |
| 2. | Average intake tapper (Kg) | 6.2 | 6.0 | 6.5 | 7.3 |
| 3. | YPH (Kg) | 912 | 953 | 1006 | 979 |

## Manufacture

Table 8. *The details of the crop manufactured during the year 1998*

| Grade | Quantity (Kg) | Grade (%) | Latex (%) | Scrap |
|---|---|---|---|---|
| Crepe No.1 | 129917 | 82.2 | 91 | |
| Crepe No.3 | 12947 | 8.1 | 9 | |
| Scrap Crepe No.1 | 11070 | 7.1 | | 73 |
| Scrap Crepe No.2 | 3847 | 2.4 | | 25 |
| Scrap Crepe No.3 | 340 | 0.2 | | 2 |

Unfractioned unbleached rubber was manufactured through out the season. However, on the requirement of the buyers we had to manufacture 1 X No.1 rubber also.

Dartonfield Rubber Factory was awarded the ISO 9002 quality system certification in 1998, by the Sri Lanka Standard Institution.

Table 9. *Labour rate (LR,RS) and a break down of cost of production (COP)*

| | | * 1994 | * 1995 | ***1996 | *1997 | ***1998 |
|---|---|---|---|---|---|---|
| 1. | Labour | 72.24 | 72.24 | 83.00 | 83.00 | 95.00 |
| 2. | COP | 33.45 | 36.60 | 38.72 | 39.74 | 43.25 |
| 2.1 | Tapping | 14.76 | 16.23 | 18.56 | 17.93 | 17.24 |
| 2.2 | Manufacture | 7.32 | 6.47 | 6.15 | 5.38 | 8.75 |
| 2.3 | General charges | 7.34 | 9.17 | 9.09 | 12.75 | 11.21 |
| 2.4 | Upkeep | 4.03 | 4.03 | 4.92 | 5.28 | 6.05 |
| 3. | NSA | 55.22 | 80.73 | 70.49 | 72.68 | 53.45 |
| 4. | Profit | 21.77 | 44.73 | 31.77 | 32.94 | 10.20 |

Table 10. *Comparative statement of the mature extent, profit per kg and profit per hectare*

| | Year | | | |
|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 |
| Mature extent | 167.11 | 167.11 | 165.59 | 163.90 |
| Total profit (Rs.Mn.) | 6.84 | 5.06 | 5.48 | 1.61 |
| Profit/Ha (Rs.) | 40957.59*** | 302979.50* | 33126.40*** | 9840.00*** |

* Profit without depreciation

*** Profit with depreciation

# Meteorological Summary - 1998
# Dartonfield Station

**Wasana Wijesuriya**

A total of 4623mm of rain was experienced during the year 1998 compared to the previous long-term average of 4243mm. The distribution differed from the usual bimodal pattern as shown in figure 1. The highest rainfall was observed in July, a departure of nearly 588mm from the long-term average for this month. A fairly dry weather was observed during the first quarter of the year, with the lowest value experienced in February. Number of rainy days for the year equaled 232 with several months exceeding 20 rainy days (Table 1).

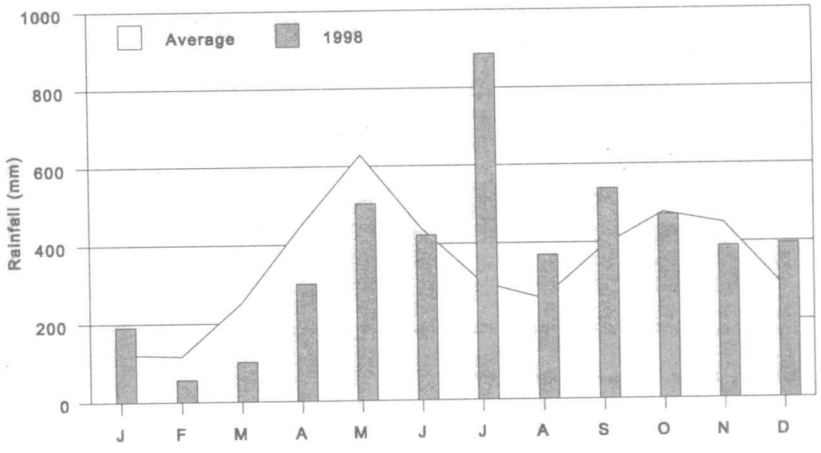



Fig. 1. Monthly variation in rainfall

The distribution of weekly rainfall is depicted in figure 2. Only 3 dry weeks were observed this year. The highest rainfall experienced during the 29th standard week (late July) coincided with the South West monsoon period. The rainfall distribution in different seasons also exhibit deviations from the long-term average. Substaintial increase of around 10% was observed in South-West (SW) rains. The first inter-monsoonal period (IM1) was slighty decresed by about 7% (Fig. 3).

The amount of rainfall and number of rainy days under low, moderate and high rainfall categories are listed in table 1. Table 2 depicts the monthly values of some important meterological observations together with averages for 1980-1992. The soil temperatures at four different depths are given in table 3.

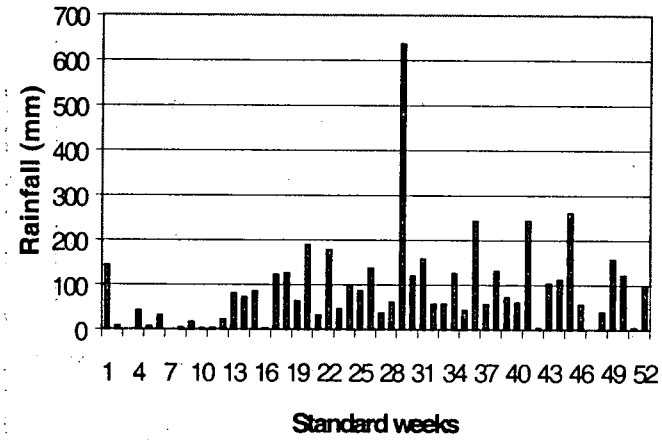



Fig. 2. Weekly variation in rainfall

**Long –term average** **1998**

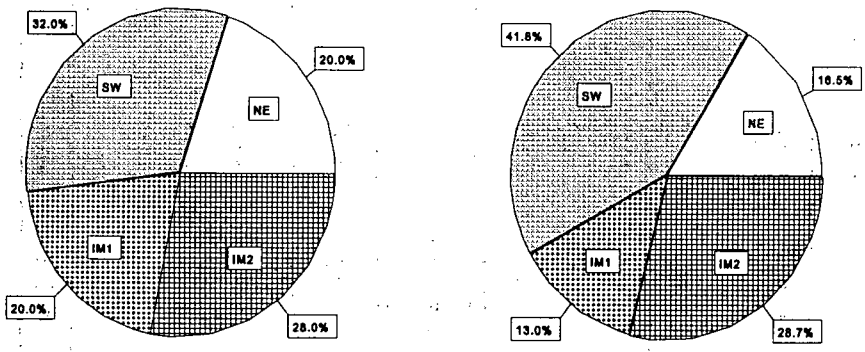



Fig. 3. Seasonal variation in rainfall in Dartonfield

Table 1. *Monthly variation of rainfall and rainy days in 1998*

| Month | Rainfall (mm) | Average** (mm) | No. of rainy days* | Avg.** days | No. of days under each category | | |
|---|---|---|---|---|---|---|---|
| | | | | | 0.3 - 2.5 (mm) | 2.5 - 50 (mm) | >50 (mm) |
| January | 190.9 | (121) | 12 | (10) | 04 | 06 | 02 |
| February | 56.5 | (116) | 09 | (09) | 04 | 05 | 00 |
| March | 101.6 | (252) | 10 | (17) | 05 | 05 | 00 |
| April | 299.1 | (449) | 19 | (21) | 05 | 12 | 02 |
| May | 504.2 | (629) | 22 | (24) | 03 | 17 | 02 |
| June | 422.3 | (440) | 30 | (24) | 06 | 23 | 01 |
| July | 887.0 | (299) | 23 | (22) | 02 | 17 | 04 |
| August | 369.0 | (257) | 22 | (21) | 03 | 17 | 02 |
| September | 538.0 | (391) | 27 | (22) | 08 | 15 | 04 |
| October | 470.2 | (476) | 21 | (22) | 01 | 16 | 04 |
| November | 389.4 | (448) | 17 | (20) | 04 | 11 | 02 |
| December | 394.4 | (282) | 20 | (17) | 05 | 13 | 02 |
| Total | 4622.6 | (4160) | 232 | (229) | 50 | 157 | 25 |

* Rainy days are defined as those with 0.3 mm or more ** Average values for 1980-1992 are shown in parentheses

Table 2. *Variation of observed meteorological factors at Dartonfield*

| Dartonfield | (Latitude 6°32'; Longitude 80.09 E; Altitude 65.50 m) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Temperature (°c) | | | | Relative Humidity (%) | | | Wind speed |
| Month | Mean Max | Mean Min | Mean | No. of days min temp <20 | 9.00 am | No. of days RH 9.00>90% | 4.00 pm | Mean (kmph$^{-1}$) |
| Jan | 33.5 (32.3) | 22.0 (20.8) | 27.8 (26.5) | - | 86 (87) | 08 | 68 (67) | 1.3 |
| Feb | 34.4 (33.3) | 22.3 (21.1) | 28.4 (27.2) | - | 85 (85) | 03 | 63 (64) | 1.6 |
| Mar | 35.5 (33.5) | 22.8 (21.7) | 29.2 (27.6) | - | 82 (84) | 02 | 62 (66) | 1.6 |
| Apr | 34.7 (32.9) | 23.6 (27.8) | 29.2 (27.8) | - | 83 (84) | 02 | 68 (73) | 1.4 |
| May | 33.2 (31.6) | 24.2 (23.3) | 28.7 (27.5) | - | 90 (87) | 14 | 80 (77) | 1.4 |
| Jun | 31.5 (30.8) | 23.8 (23.1) | 27.7 (26.9) | - | 89 (88) | 13 | 76 (76) | 1.8 |
| Jul | 30.7 (30.2) | 23.3 (22.8) | 27.0 (26.5) | - | 91 (88) | 16 | 77 (74) | 2.1 |
| Aug | 31.0 (30.2) | 23.2 (22.7) | 27.1 (26.5) | - | 91 (87) | 14 | 75 (74) | 1.9 |
| Sep | 31.2 (30.6) | 23.0 (22.4) | 27.1 (26.5) | - | 89 (86) | 11 | 78 (74) | 2.0 |
| Oct | 31.1 (30.9) | 21.9 (22.1) | 26.5 (26.5) | - | 87 (85) | 10 | 75 (77) | 1.7 |
| Nov | 31.9 (31.4) | 22.7 (21.8) | 27.3 (26.6) | - | 86 (84) | 07 | 72 (77) | 1.4 |
| Dec | 32.5 (32.0) | 21.8 (21.4) | 27.2 (26.7) | 01 | 88 (84) | 12 | 70 (74) | 0.9 |

** Average values for 1980-1992 are shown in parentheses

Table 3. *Soil temperatures recorded at different depths at Dartonfield - 1998*

| Month | 09.00hrs | | | | 16.00 hrs | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 cm | 10 cm | 20 cm | 30 cm | 5 cm | 10 cm | 20 cm | 30 cm |
| January | 27.5 | 27.3 | 28.3 | 28.6 | 34.4 | 32.3 | 30.0 | 28.8 |
| February | 29.0 | 28.5 | 29.4 | 29.8 | 37.4 | 34.8 | 31.8 | 30.0 |
| March | 30.4 | 29.6 | 30.8 | 31.0 | 39.5 | 36.6 | 33.1 | 31.3 |
| April | 30.6 | 29.3 | 30.3 | 30.5 | 37.9 | 35.4 | 32.6 | 30.9 |
| May | 29.8 | 28.8 | 29.6 | 29.8 | 34.7 | 32.8 | 31.2 | 30.0 |
| June | 28.7 | 28.3 | 29.1 | 29.3 | 33.8 | 31.8 | 30.4 | 29.5 |
| July | 27.2 | 26.9 | 27.6 | 27.8 | 32.4 | 30.7 | 29.3 | 28.0 |
| August | 27.9 | 27.3 | 28.1 | 28.1 | 33.6 | 31.3 | 29.9 | 28.4 |
| September | 28.0 | 27.3 | 27.9 | 28.3 | 33.1 | 31.1 | 29.8 | 28.4 |
| October | 27.9 | 27.1 | 27.6 | 27.9 | 33.0 | 30.6 | 29.4 | 28.1 |
| November | 27.5 | 26.9 | 27.5 | 27.8 | 32.7 | 30.3 | 29.3 | 28.0 |
| December | 26.9 | 26.5 | 27.1 | 27.7 | 32.7 | 30.2 | 29.2 | 27.9 |

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