



**THE RUBBER RESEARCH
INSTITUTE OF SRI LANKA**

ANNUAL REVIEW 1985

RUBBER RESEARCH INSTITUTE OF SRI LANKA.



**Annual
Review 1985**

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

ANNUAL REVIEW 1985

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- ** On sabbatical leave overseas
- *** On no pay leave overseas

THE RUBBER RESEARCH INSTITUTE OF SRI LANKA

DIRECTOR'S ANNUAL REVIEW

By

O. S. PERIES

This will almost certainly be the last Director's Annual Review I write for the Institute; therefore, it will be useful to review the work of the past 18 years, in which I have served the Institute as Director, highlighting the achievements as well as the problems encountered, so as to help perpetuate the first and avoid the latter in future. Even more important is to give some suggestions for the future research and direction of the Institute, so that they can be used as a basis for planning the work of the next few years. Research is an extremely expensive area of human endeavour, and all countries have had to reduce their programmes in order to keep costs to manageable levels. In the USA fortunately, this has not gone beyond cost control; but in the UK whole Research Stations have been closed down, throwing thousands of people out of employment. Therefore, it is important to start thinking ahead

Developments 1968—1985

Some of the more important developments during the period 1968—1986 are recorded here, to be used as an index for comparison with future strategies for change and innovation at the Institute. It must be accepted that planning and direction are essential for rapid progress in research.

Staff

Training of staff: The core senior staff is the most important asset of any Research Institute; laboratory buildings, equipment, supplies, stores and other infra-structural services can always be provided by a concerned management—but there is no quick method of getting talented staff. Therefore, one of the most important primary functions of a Director of research in a developing country is to upgrade staff capability, keep up their morale and make every endeavour to retain the services of outstanding individuals, who must then be welded into a close-knit team. Brilliant individuals have their place; but with the present trend towards multi-disciplinary research projects, it is teamwork that counts as much as the outstanding loner. The RRI is happy to record that it now has a core research staff of nearly 30 Officers, who have all had specialized training abroad. All Heads of Departments and Sections and Senior Research Officers have been with us for well over 10 years after completing post-graduate studies. The Board must make every endeavour to retain this staff, by the personal touch, a keen interest in their work and finding solutions for their individual problems. Often, it is not merely the money that takes people away, it is poor man management and downright apathy. Human relationships are far more important than cash in the pocket, in certain situations and we have exploited this syndrome to the hilt at the RRISL.

Sabbatical leave: The scheme of sabbatical leave for research officers, introduced recently, has done much to help the younger staff to keep in touch with overseas scientists and with the latest research developments abroad. All research staff has made use of this facility, gaining in research stature in the process and learning a good deal. Their research work too has improved in the process; because Post Doctoral research grants are becoming more scarce daily and getting a placement abroad for such work, in itself, is highly competitive, depending on high quality work at the Institute. This has encouraged research officers to strive for the highest standards in work at home, for competitive assessment when seeking overseas grants.

Overseas visits: As a matter of urgent policy even in the present state of stringent financial restrictions, the RRI has endeavoured to maintain an active programme of overseas visits, made possible very often by the generosity of a large number of overseas sponsors and donors. We must thank the agencies such as FAO, UNIDO, IAEA, ADAB, the Royal Society, the British Council and many others for open handed support in this connection. These visits, to attend conferences workshops and short-term training courses, give our staff the chance to disseminate their knowledge to their overseas colleagues; they also ensure that our scientists get the chance to observe the latest developments in science and technology abroad.

Training of Technical Officers: A large number of the technical staff of the Institute has been trained overseas in subjects as varied as interpretation of aerial photographs, genetics, disease control, computer science, technical photography, maintenance of electronic equipment, laboratory arrangement and a host of others. To date about 30 have been trained, which has enabled the senior research officers to spend more time in thinking, planning and writing up; as the technical staff is now quite competent to carry out routine research work with little supervision. This has led to a vast increase in the number of research projects going on at any time at the Institute.

Post-graduate courses: The Institute took the initiative to start a course leading to the degree of MSc in polymer chemistry at one of the Universities just outside Colombo. This has been very successful and our research staff still provide the manpower for the bulk of the teaching and demonstration work for this course.

We have also played a very active role in setting up MSc courses in forestry, plant pathology and polymer chemistry in other Universities and assisted in demonstrations in various courses taught at the four Universities in and around

Colombo. Some of these courses cannot possibly be taught by those Universities without the teaching assistance of our staff.

University teaching: Our research officers have also assisted in under-graduate teaching at several universities and we consider this a most useful interaction between the two types of institutions: teaching and research.

We also regularly take on several final year students each year to carry out short-term investigations on selected subjects, to give prospective graduates an initiation in the planning and execution of research work. This has been very successful and mutually beneficial: as the students get a training and we get a great deal of data on specific aspects of several problems each year.

Higher degrees: Another important contribution we make in the field of education is the training we provide for post-graduate students. In the last 5 years we have had two PhDs and about 15 MSc students who successfully completed their higher degrees, under the supervision of our staff. This is an exceptional record for a Sri Lankan research institute as the number of PhDs awarded by local universities is perhaps less than one per year and MScs: about 10; therefore, our success rate is better than that of any single university for post-graduate degrees, awarded on research, as compared to course work. This is a very exceptional record indeed.

Journal and Editorial Board: The RRI is the only academic institution in Sri Lanka that has maintained a regular issue of its Annual Reviews and Journals throughout the last 18 years without a break. This is an exceptional achievement and we are justly proud of it.

The quality of our Journal has also been improved by the appointment of a highly qualified Editorial Board, consisting of both local and foreign scientists. Each paper submitted for consideration for publication is reviewed by at least two members of the panel of editors. This has improved the standard of our publications, which can now compare favourably with those of research stations abroad. Publication of a research paper now, in our Journal, is not a mere matter of submission, it must reach a very high standard, to satisfy the Editors.

International conferences: We have held five international conferences during the period under review. Starting on a modest scale our conferences have improved

with each one and the last two have been accepted in all rubber growing countries as the best on natural rubber, held anywhere in the world. This we consider an achievement, seeing the limitations of funds, facilities, transport, support staff and other factors essential for organizing high level conferences.

Research Work

The Institute is now working on a carefully developed research programme, with heavy emphasis on multi-disciplinary research, that has been whetted by the full research staff and a select group of university teachers and research scientists from outside. The progress of work is reviewed from time to time by groups of scientists invited for the specific purpose. New investigations can be started only after their importance has been carefully assessed by the Heads of Departments and the Director. The scientist is under constant pressure to show results; the Director and the Heads of Departments help with frequent discussions and review of progress. This system has brought good results; as it has been found necessary to keep up this constant interest in work in our context of family responsibilities and the ever increasing problems of day to day living. A few of the most important programmes are referred to below, with brief comments on progress made:

Reduction of disease control costs: One of our major areas of success is in the field of plant disease control, where the RRISL is acknowledged in the NR world as the leader. It is most satisfying to be able to record here that we have developed time-tested methods for the control of all diseases of *Hevea* recorded in the Island: in most cases these measures are based entirely on biological manipulation, so that little or no cost is involved.

Oidium and Phytophthora leaf diseases are now controlled at no cost at all, the first by breeding disease resistant clones and the latter by reducing pod set: because the causal fungus grows and sporulates mainly on rubber pods.

White root disease is the most important disease of *Hevea* at present in Sri Lanka; but the method of control, recommended by the RRI, is very straight forward, depending entirely on ensuring that the soil is disease free before replanting. This can be done at minimal cost by vigilance at the time of uprooting the old stand, marking infected old trees and paying special attention to those sites. This method of prophylactic action has brought down the incidence of root disease in replanted areas from 10 percent to below 5 percent in the period 1978 to 1985.

The Plant Pathology Department is well staffed and equipped at present, with the result that, when a new disease, *Corynespora* leaf disease, was observed for the first time in Sri Lanka in December 1985, studies on the biology of the fungus, clonal resistance to the disease and fungicide tests were completed in the short space of 5 weeks and a leaflet on the disease was issued, giving the symptoms, weather conditions conducive to spread, clonal susceptibility, methods of dissemination and control measures to be adopted. I am sure that this establishes a world record in plant pathology.

Economics of disease control: The RRISL has always kept disease control costs well in mind, when recommending control measures against any disease. We have constantly aimed for "economic" control *i.e.* a control method that will bring in more cash in return than that spent on disease control. Therefore, we have always stopped short of "full" control of leaf diseases as impracticable and uneconomic, advocating measures that will bring in returns, in growth or yield, that will more than compensate for the combined expenditure on fungicides and application. We have played this hunch, but have not yet been able to give figures on profit and loss on "economic" and "full" control, as the experiments themselves would be costly to perform. Now Rothamsted Experimental Station, in the UK, has given full details on such studies, on cereals, and we quote the figures for their exceptional interest:

Grade of control	Cost	Extra yield	Value of extra yield
	Rs.		Rs.
"Economic"	... 1,225	... 0.6 tonnes/ha	... 3,850
"Full"	... 23,450	... 0.5 tonnes/ha	... 3,080

(From: Rothamsted Annual Report for 1984, Page 35):

Therefore, the expenditure of Rs. 23,450 - for full control brought in a gain of only Rs. 3,080 -, resulting in a net loss of Rs. 20,370/-. This shows how correct our calculations have been.

Rationalisation of fertilizer use. Planters do not wish knowingly to spend excess funds on their inputs, whether they are fungicides, fertilizers, manufacturing acids or any other. The development of the method of fertilizer application on the basis of soil and foliar analyses, so as to provide the correct quantity of each element to the plant, rather than use compound fertilizers, has saved the industry millions of rupees every year from the time of its introduction. At present all

estates belonging to the two Government Corporations are provided this service by the Institute. We are now in the process of extending it to smallholdings, and this will be completed in 1986.

Biological fixation of nitrogen. Methods are being developed to inoculate legume covers with strains of rhizobia to improve their ability to fix atmospheric nitrogen. This method has a long history, and some NR growing countries are using it on purely theoretical grounds. However, we have found that most inoculant preparations prove unreliable in practice and do not fix any nitrogen at all. Our studies go deeper and we are selecting special local varieties of rhizobia which will compete successfully with indigenous species and contribute to the N supply to plants. Our pioneering studies on this subject have shown that local rhizobia can compete with the varieties already in the soil more successfully than exotic varieties.

Plant breeding—new clones: We take pride in reporting here that four of the clones bred by our scientists have been found to be the best four clones in international clone trials planted in Indonesia, Malaysia and Thailand. Some foreign countries have been so impressed with their preliminary results that they have already recommended the small scale planting of some of our clones in their countries.

One of our new clones has been found to be susceptible to infection by *Corynespora cassiicola* in Indonesia and Malaysia; but the same clone is susceptible to this disease only under special conditions in this country. Therefore, there is no reason for a panic reaction. The clone has high potential and must be given a chance to prove itself, by planting on a small scale in this country.

Studies on the effect of environment on the potential characters of the clone, again pioneered by us, have given very important information on the advisability of planting selected clones in the different climatic regions of Sri Lanka. These findings are being used in clone recommendations.

Yield stimulants. Chemical yield stimulation has a definite place in rubber cultivation; but it is important to take a rational view of the whole subject, and use stimulants to the grower's advantage rather than put all rubber trees in jeopardy, by attempting to extract 2—3 times the normal yield of latex from trees, on a permanent basis. Our views on yield stimulation have now been accepted by all NR producing countries, although some persons were critical of our natural

caution with stimulants, to begin with. Now Ethrel yield stimulant is used essentially as a labour saving device, by all countries, to tap at long intervals like once in 7 to 14 days and conserve on tapping costs. We advocate the use of Ethrel 2—3 times per year to get a 15—20 percent annual increase in yield.

Rubber Chemistry and Technology. There have been many advances in the Chemistry and Technology of NR, too numerous to recount individually in a short review of this nature. However, it is important to refer to at least a few for the record:

1. *Modified rubbers* — we have produced several types of modified rubber with special properties e.g. *constant viscosity (CV) rubber low nitrogen natural rubber (LNNR) deproteinised rubber (DPNR) and cyclised rubber*, to name a few. All these have specific advantages over the usual grades; however, some of them have to be introduced into the market along with a special market promotion effort and an after sales service, in order to establish a permanent market for them. The Institute has neither the financial resources nor the necessary staff, at present, to mount a marketing campaign. The Government must follow up this important line of activity to get the optimum benefits of research. The story of cyclised rubber is a case in point. This material has the potential to displace imported synthetic resins for use as an ingredient in the paint industry. Unfortunately, before the local product made a mark in the industry, the duty structure on imported resins was lowered, with the result that the material lost the market edge it had gained. The government must make special provisions to take care of such contingencies and remedy them in future.

The method developed by us, for the production of *liquid rubber*, was found to be the best, at a recent Conference held, to assess the progress in this line of research. This is another product with a great deal of potential and we will pursue it diligently during the coming months.

We have also produced a *tellurium grafted NR* that is highly resistant to abrasion, has a low heat build up and many other desirable properties, for tyre building. There have been interested manufacturing industries already inquiring after this product and we have decided to put in an extra effort into this area of research.

We are also developing an *oil resistant NR* and our work on the use of NR as an *impact resistant material* on military vehicles has already had a favourable reaction from the Sri Lankan Army. These studies are continuing.

2. *Specifications for NR.* The Specifications Laboratory was set up in 1975 and we have done a great deal of work to upgrade the image of Sri Lanka rubber. Our recommendation is that a major part of our sheet rubber, particularly that produced by smallholders, should be heated, pressed, technically specified and packed in block form for export, commanding a better price and obviating mould growth, one of the major defects in our sheet rubber. Our scrap rubber too should be hammer milled and washed to remove dirt, dried, pressed, technically specified (TSR) and exported in block form to get a higher price.

3. *Upgrading crepes.* The Institute has worked hard to keep in touch with all crepe factories to upgrade the quality of our crepes. Our scheme to produce five grades of thin crepe (a) bleached (b) unbleached (c) fractionated (d) non-fractionated, and (e) fraction rubber should be revived as all these can be sold as TSR, with each having its own curing properties. This will give our crepes a better image overseas and fetch a much higher price.

There is also a vast potential for the sale of sole crepe, if Sri Lanka is willing to make the necessary marketing investment.

4. *Marketing.* This is the most important area of weakness of NR, as far as the Sri Lankan product is concerned. Marketing does not come within our ambit of responsibility; but if we are to make the most of the NR industry, this is an area that calls for early attention. We must make more contact with the consumer abroad, manufacture NR grades to satisfy his needs and provide him with technical information on getting the best from our product. We do not advocate the massive investment on marketing that Malaysia makes with 15 NR bureaux abroad; but we certainly think that marketing teams composed of a producer, broker, marketing expert and a rubber technologist, making frequent visits to the NR consuming countries, will have a significant impact on the price we can command for our product. This matter must be pursued by the Rubber Research Board with the Ministries and Government Departments involved.

Rubber Wood

The RRISL was responsible for bring out the importance of rubber wood as a high quality timber, if the wood was treated with an insecticide soon after felling and sawing. Malaysia and Thailand have gained much more from this development than Sri Lanka and both countries have set up multi-million dollar industries to exploit the potential of rubber wood as a good quality timber; but at least one Government Department and several local businessmen are exploiting the potential of the wood. This is most satisfying.

Patents

The Institute filed its first patent for a new process rubber during the period under review. We now have over 15 patents filed in our name for new processes of production and new products. It is difficult to develop these processes further without the facilities for pilot plant scaling up of new techniques. This is one of the areas of development and investment the Rubber Research Board must give serious consideration to, in the years to come. It is certain that a vast area of development will open up, when these facilities are provided.

Equipment

There is no doubt that the RRI has some of the best equipped laboratories in Sri Lanka today. We have got this equipment almost entirely from various donor agencies abroad. It is with great pleasure that we record our thanks to the FAO, IAEA, UNIDO World Bank, the British Government through the British Council and the Australian Government through ADAB, for generous grants for equipment. On our part, we have made very good use of the instruments provided so that Aid Donors have been more than willing to repeat the experience with us with new programmes.

Block Rubber Factory

It is important to draw attention to the fact that UNIDO aid for the Block Rubber Factory at Mawanella, was negotiated and the Factory was completely built by the RRI, during the early part of the period under review. This was at a time when the Institute was short staffed and whatever staff was available was inexperienced. Under the circumstances, it was a unique achievement and the factory is still a model for block rubber factories anywhere in the world.

New Building Programme

The Rubber Chemistry Department was moved from Agalawatta to more spacious buildings in Colombo in 1974/75. This building programme, to construct laboratories with a total floor area much larger than all the laboratories at Dartonfield, Agalawatta, was also undertaken during a period of acute staff shortage, with many Officers abroad on post graduate studies and building material was hard to come by. It is a tribute to the few Officers available at the time that the laboratories were built in a comparatively short time and the shift from Agalawatta to Colombo was effected smoothly without any disruption to research work. This shift of the Rubber Chemistry Department has proved to be most useful as the officers now have much more contact with the Universities,

Technical Institutes, the CISIR, NERD centre, IDB and others for an exchange of ideas and mutual help on engineering and technological problems.

Advisory Services Department (ASD)

The ASD was set up as a separate Department under the Rubber Research Board in 1981/82, but continued to work under the supervision of the Director RRI up to October 1984, when a new Director was appointed to be in charge of this Department.

A major part of the work in setting up the Department with World Bank aid was carried out by the RRI. The Training Centre 68 residential houses for field staff, Regional Offices, and Fertilizer Stores were built and the recruitment of Staff was carried out under the personal supervision of the Director RRI. This was a period of great stress and responsibility, but the execution of the job was entirely satisfying.

The work of the ASD is now continuing smoothly, with the Training Centre acting as a source of vital information to both extension staff and smallholders. The field staff is now much more conscious of their responsibilities and are better equipped both mentally and vocationally to carry out their onerous job of imparting new knowledge to farmers, supplying them with plants and fertilizers and helping them with the manufacture of high quality rubber for export.

Scientific achievement

There is no doubt that the image of the Institute is high both in this country and abroad, in other rubber growing countries: as there are numerous requests for training the staff of other Institutes with us. However, we are acutely aware that our acceptance and profile is only as high as the scientific calibre and the achievements of the Officers on our staff. The Rubber Research Board can take pride in the fact that our staff, at present, can compare with the best anywhere in the world, and will often surpass most of them. The results produced by the RRISL will also be found to be far more than that produced by any Institute of comparable size working on a similar budget.

All this is possible only because the men and women are there and as long as they are available, no matter where the Institute is located, under what roof or

in what building, the results will be forthcoming. The important task for the Rubber Research Board, therefore, is to take an interest in the personnel — spend time on them, see to their welfare and treat them as the asset they are. Human beings respond to the personal touch, and this is essential in Sri Lanka, where money and the other prerequisites of employment are hard to come by.

Scientific awards

A review of this nature will not be complete unless it is rounded off with some detail of hard core scientific achievement showing the recognition of the general public. Therefore, I list with unalloyed pride the scientific awards won by our staff members during the last 5 years; because to win to accolade of your colleagues is the acme of scientific achievement.

- 1975 — 1976 — President Plastics and Rubber Institute — Dr. O. S. Peries
- 1977 — 1978 President Plastics and Rubber Institute — Mr S. W. Karunaratne
- 1978 — Fellow of the National Academy of Sciences — Dr O. S. Peries
- 1978 — Fellow of the Plastic and Rubber Institute—Mr. M. Nadarajah
- 1979 — Fellow of the Plastics and Rubber Institute — Mr. S. W. Karunaratne
- 1978 - 1980 — President Plastics and Rubber Institute—Mr. M. Nadarajah
- 1980 — Nuffield Foundation, Postdoctoral Research Fellowship — Dr. L. M. K. Tillekeratne
- 1980 — Institute of Chemistry Gold Medal -- Mr. M. Nadarajah
- 1981 — President's Award for Scientific Achievement — Dr. O. S. Peries
- 1981 — President's Award for Scientific Achievement — Mr. M. Nadarajah
- 1981 — General President, Sri Lanka Association for Advancement of Science — Dr. O. S. Peries
- 1981/82 — President Institute of Biology, Sri Lanka— Dr. O. S. Peries
- 1982 — FAO, Ceres Medal for Outstanding Contribution to Research on Agriculture — Dr. O. S. Peries
- 1985 — Institute of Chemistry Gold Medal—Dr. L. M. K. Tillekeratne
- 1985 — Plastics and Rubber Institute, Silver Jubilee Merit Award—Dr. O. S. Peries
- 1985 — Royal Society, UK, Postdoctoral Research Fellowship — Dr. A. de S. Liyanage

This is a record that no other Scientific Institute, including Universities, in this country has even approached, leave alone surpassed. Therefore, the RRI is happy for its staff.

In recent years rubber cultivation in Sri Lanka has been very successful, when assessed according to any criteria, especially those of providing income to the national coffers and high production per capita of those engaged in the industry. This commendable situation has been achieved by the intelligent and dynamic application of the findings of research by the Sri Lankan planter, who has shown his willingness to test and adopt new practices useful under their circumstances. This shows that the advances in research have been well accepted by the industry. Thus new clones, new methods of assessing fertilizer requirements, controlling diseases and weeds and techniques of manufacture have all been checked and seen an improvement. This can be considered a national achievements, based on an effective partnership between research scientists, advisory officers and rubber growers. We are happy to have made our contribution to this national effort.

The Future of the Institute

The recent spate of land slides in the Agalawatta area has clearly shown that further expansion of the Institute at Dartonfield would be inadvisable. The Rubber Research Board should therefore study this problem carefully and in depth, so as to formulate a long-term plan to shift certain sections of the Institute to a new location; perhaps, close to Kalutara. Clearly, it would be unwise to shift the Institute completely out of Dartonfield, as the investment made at the place is too large to think of this. The shift out should be done in stages so that no Department will suffer from the move.

World Bank funds have already been approved for setting up sub-stations in various rubber growing districts. These funds can be used judiciously for the gradual relocation of certain selected disciplines in a new central situation. The important matter now is planning and the Board must set its mind on this immediately. Perhaps, a technical person in charge of the operation, or, in fact, a technical Chairman of the Board would be a useful innovation; as he can then plan and advise the Board on the most appropriate measures to be taken.

Plans for the Future

It is important to assess the future prospects of natural rubber (NR) at present to plan exactly where we are going. The paper presented by Dr P. W. Allen, Secretary General of the International Rubber Research and Development Board (IRRDB) at the 1984 International Rubber Conference, held in Colombo, Sri Lanka, gives a good

over-view of the situation, and is recommended reading for all those interested in the future of the NR industry (Allen, 1986). The days of the NR industry were practically numbered by the late 1960s, our share of the world elastomer market had by then fallen from 100 percent in 1940 to 30 percent, and the quality of synthetic rubber (SR) produced from cheap oil was improving rapidly, so the NR was doomed to sudden death or a sort of lingering death where its use would dwindle to some minor residual level, for uses for which SR was technically unsuited. So SR was virtually writing the epitaph for NR.

Then came the 1973 oil crisis, which many regarded as a shot in the arm of NR as it would improve the latter's competitive ability. But few assessed the long term effects of the crisis, particularly the back lash of the developed countries, which were the major users of all elastomers (NR and SR) and energy. The high price of oil had a major effect on the demand for elastomers, and Allen points out that the world consumption of rubber which had grown at the rate of 7 percent, per year during the decade of the 1960s, dropped to almost 1 percent since 1974. Therefore, the oil crisis of the 1970s virtually killed the growth of the world rubber industry. The trend is still continuing and it would appear that the situation will deteriorate still further, before it gets better, in view of the steep downward trend in oil prices.

The low prices for crude oil will encourage the manufacture of cheap SR, and, unfortunately, the downward trend in world rubber consumption will most likely not correct itself, as the population in the developed world is not likely to be caught in the same trap twice. Therefore, we must struggle on to survive in a world of declining markets.

All present price trends and the history of the elastomer market since SR entered it indicate that NR producers must be prepared to sell their product at a minimum of 10 percent less than the market price of SR—the two major reasons here being the: (a) captive market for SR and (b) the limited transport for SR from manufacturer to consumer, compared to NR which has to be transported across half the world. There are other factors too, which are apparent to anyone interested in NR; but these two will do.

This is the point at which to plan a strategy for the future of the NR industry. To my mind, the most important single factor is increasing *production efficiency* and the fundamental key to the problem is *increasing, yield per tree*. This must be a rapid, short-term but long lasting solution, to be applied to the trees already standing in the field. The yield must be increased by at least 100 percent or a

permanent basis *i.e.* with something like Ethrel, but with long lasting results, that will continue through the life of the tree. NR Research Institutes of all countries must put their maximum effort into this research. The rubber tree has at least 200 cm of bark with latex, the drainage area for each cut is only about 50 cm; therefore, we have 150 cm of unexploited bark. The present system of tapping is 95 years old, and virtually no improvement has been achieved. Latex is very much like milk from the human breast or a cow's udder and we do not slash either of them to extract milk, but we do the tree. Surely, there must be some other way. Ethrel has given us a useful clue, we can get more from point sources by applying it; therefore, why not a simulated teat? And several of them on each tree to exploit more than one drainage area. This is the basic idea.

The RRISL should engage a special team of scientists to study this task and get rapid results. I suggest a team of two plant physiologists and two biochemists to study the problem, with the Director being personally in charge of the project to give it constant encouragement and pressure. All the research staff of the Institute should be actively engaged in some aspect of the work: nutrition, physiology, biochemistry, disease control and just thinking on the subject to bring up new ideas. My estimate is that we can get a break-through here in 2 years at the outside — much less, if we beat our head enough. I leave this idea as my special contribution to the Institute.

The Rubber Research Board should give its full support and backing to this project, with the Chairman taking a special interest in the progress of the research. It would have been an ideal project for the personal interest and supervision of a technically qualified person as Chairman. The Board should think of this the next time round.

RESEACH HIGHLIGHTS

Each of the Departments have been requested to write careful summaries of their work, so that there is no necessity to give the usual brief reference here again.

STAFF

Dr A. de S. Liyanage, Deputy Director (Research) and Head of Plant Pathology Department attended the Agricultural Research Policy Seminar held in the United States of America and visited the University of Reading, United Kingdom from 13 April to 3 May. Dr. Liyanage also attended the IRC '85 held in Malaysia from 14 October to 5 May.

Mr S. W. Karunaratne, Head of Rubber Chemistry Department attended a 4-day meeting convened by the International Atomic Energy Agency held in Indonesia from 6 to 9 May.

Dr (Mrs.) A. C. I. Samaranayake, Head of Plant Science Department attended the International Conference on Tissue Culture held in the United States of America from 17 October to 2 November.

Dr N. Yogaratnam, Head of Soils and Plant Nutrition Department attended the IRC '85 in Kuala Lumpur from 20 October to 5 November.

Dr N. E. M. Jayasekera Head of Genetics and Plant Breeding Department attended the IRC '85 held in Malaysia from 17 October to 5 November.

Dr P. A. J. Yapa, Head of Biochemistry Section who was on sabbatical leave returned to the Island on 8 April having completed a 6 months Research Fellowship at Okayama University, Japan. He also attended the meeting of the ISO/TC 45 meeting held in Germany from 31 October to 7 November.

Dr M. K. S. A. Samaraweera, Agricultural Chemist proceeded to Australia on sabbatical leave in October on an IAEA Fellowship and is due to return in 1986.

Dr A. Coomarasamy, Head of Polymer Chemistry Section who is on Sabbatical leave is doing a joint UNIDO/IRRDB Project in the United Kingdom from 25 April and is due to return to the Island shortly.

Dr L. M. K. Tillekeratne, Head of Specifications and Analysis Section attended an interview held in Malaysia on 21 May.

Dr W. S. E. Fernando, Head of Rubber Technology and Development Section attended the International Rubber Conference held in Malaysia from 20 October to 5 November.

Dr M. C. S. Perera, Asst. Rubber Chemist attended a course of training in Chemistry and Technology of Polymer Processing at the Australian National University, Australia and has returned to the Island in April.

Mr Asoka Nugawela, Assistant Botanist proceeded to the United Kingdom in October for one year to follow a course of training in Photosynthesis and Bio-productivity.

Miss G. P. W. P. Pushpika, Assistant Botanist followed a course of training in Tissue Culture for 2 months commencing 12 July in the United States of America.

Mr. T. L. G. Fernando, Assistant Development Officer attended the IRC '85 in Kuala Lumpur from 20 October to 5 November.

Mr. P. A. D. T. Vimalastri, Assistant Specifications Officer is following a course of training in Chemistry and Technology of Polymer Processing at the New South Wales, Australia for 15 months commencing March.

Mr. E. D. I. H. Perera Assistant Rubber Chemist followed a course of training in Chemical Engineering or Alternative Energies in the United Kingdom and returned to the Island in March.

Mr. C. K. Jayasinghe, Assistant Plant Pathologist followed a course of training on the use of Isotope and Radiation Techniques in Austria for 1 month and 25 days commencing May.

Mr M. D. R. J. Gunatilleke, Assistant Rubber Chemist is undergoing a course of training in Chemical Engineering with special reference to Tyre Technology at the University of Aston in Birmingham, in the United Kingdom.

Miss N. M. V. Kalyani, Assistant Rubber Chemist is undergoing a course of training in Latex Technology at London School of Polymer Science, London.

Mr. L. W. Amaratunge, Senior Technical Officer returned to the Island in May having followed a course of training in Photography and Audio Visual Aids at Bath in the United Kingdom for 7 months.

Mr. E. B. Ferando, Technical Officer is undergoing a course of training in South American leaf blight in Brazil for 6 months commencing September.

Mr. M. A. Mendis. Specification Assistant of the Rubber Chemistry Department is on 2 years no pay leave upto 3 June 1986 having accepted a contracted assignment in Saudi Arabia as a Labour Foreman.

Mrs. S. P. S. I. Yapa, Technical Officer of the Bio-Chemistry Section was away on 6 months no pay leave in Japan upto 7 April.

The salaried staff of the Institute at the end of the year (1985) was as follows:

Officers in Grade	I —	45
Officers in Grades	VII —	146
Officers in Grades	XVI —	90
		<hr/>
Total		281
		<hr/>

Director's Publications

The following publications were prepared by the Director with the assistance of the staff members named, for publication during the year:

- Peries, O.S. (1985). The Rubber Research Institute of Sri Lanka. *Report to the Ministry.*
- Peries, O.S. (1985). Diseases of economic importance on *Hevea brasiliensis* and their control. *Indian Phyto path. Soc. Ann. Rev.* invitation paper.
- Peries, O. S. and Liyanage, A. de S. (1984). The management of plant diseases with special reference to *Hevea*. *Jl Rub. Res. Inst, Sri Lanka*, 62 (in press)
- Peries, O. S. and Liyanage, A. de S. (1985). Biotechnology for increasing competitiveness of natural rubber *Rubpla Lanka*, 1985
- Peries, O. S. and Liyanage, A. de S. (1985). *Hevea* diseases of economic importance and integrated methods of control. *Int. Rub. Conf. RRIM*, 1985.
- Peries, O. S. and Liyanage, A. de S. (1985). Biological control of the diseases of the *Hevea* rubber tree *J.Natn. Sci. Coun, Sri Lanka*
- Peries, O.S. (1985). Director's Annual Review for 1984.
- Peries, O. S. and Liyanage, A. de s. (1985) Biological control of the diseases of the *Hevea* rubber tree. *Bull. Natural Res. Energy and Sc. Auth. of Sri Lanka* 8, 11—15.
- Peries, O. S. (1985). Strategies for the sale of Sri Lankan rubber. *Ceylon Daily News* (in press).
- Peries, O. S. (1986). Increasing income from rubber lands. *Ceylon Daily News* 69, 4.

VISITORS

Visitors to the Institute included:

- Dr R. Mead, University of Reading, England.
- Dr Richard Coe, University of Reading, England
- Mr R. N. Tyler, World Bank, Washington, D.C.
- Mr C. R. Warn, CDC, Kuala Lumpur, Malaysia.
- Mr Lesley Thom, Cambridge, U.K.
- Mr E. Keleta, Ethiopia, ICRA.

Miss A. Habiba, M.R.R. D.B.
Dr S. G. Reynolds, FAO, Rome.
Professor Chiko Haramaki, U.S.A.
Mr Kevin Wright, Singapore.
Professor David Reed, U.S.A.
Dr Alex Micke, FAO/IAEA.
Mr. Guy Evers, The Netherlands.
Mr Tim Kirway, The Netherlands.
Mr. Rafael Verar, South America.
Mr K. Ogino, Japan.
Mr. D. W. McAllister, England.
Mr T. R. G. Gray, University of Essex, U.K.
Groupe Arts Et Vie. France.
Mr A. J. McQuire, New Zealand.
Mr O. Homisch, World Bank, Washington, D.C.
Mr R. V. Ramakrishna, World Bank, Washington, D.C.
Mr R. J. Sopet, Canada

REVIEW OF THE PLANT SCIENCE DEPARTMENT

By

CHANDRA SAMARANAYAKE

SUMMARY

Studies on micropropagation of *Hevea* through shoot tip culture were started during the year. Problems in cleaning up of the explant and the browning of the tissue, hampered the progress of this project. However with improved techniques shoot tips from both budded plants and seedlings were successfully established in culture.

Puncture tapping of trees of different girth classes, ranging from 40.0—55.0 cm indicated no significant effect of girth on yield, whereas in conventional excision tapping there was almost a linear relationship between girth and yield.

Use of yield stimulants during high intensity tapping, failed to give any significant increases in yield.

The girthing and yield of clone PB 86 is not significantly affected upto 8 years from planting when planted at denser stands than the recommended density of planting, whereas in RRIC 101 and 103 there is a significant reduction in growth and yield.

DETAILED REVIEW

Staff

The Head of Department Dr (Mrs.) A. C. I. Samaranayake was on duty throughout the year. Mr A. Nugawela, Assistant Botanist was on duty until he left for Postgraduate studies at the University of Essex, England, on 27 October. Miss G. P. W. Priyani Pushpika, Assistant Botanist, was on duty throughout except for 2 months when she was away on training at the Beltsville Agricultural Research Centre, Maryland, U.S.A., from 11 July to 10 September.

Mr L. S. S. Pathiratne, Experimental Officer, Messrs R. B. Gunaratne and M. C. Perera, Senior Experimental Assistants, Mr. S. Wilbert, Experimental Assistant, Messrs. L. S. Kariyawasam, K. A. G. B. Amaratunga, R. P. Karunasena,

Miss C. W. Ranasinghe, Miss G. A. S. Wijesekera and Miss Renuka Aluthhewage Technical Officers were on duty throughout the year.

Mr A. H. R. Jayaratne, Experimental Officer was on duty until April when he was appointed an Assistant Plant Pathologist in the Plant Pathology Department. Mr R. B. Gunaratne was promoted Experimental Officer in June. Messrs A. G. Vidanapathirana and M. Samankumara were appointed Technical Officers in February and Messrs S. L. G. Ranjith and R. S. Wijesundera in April.

Miss I. G. Gunetilleka was appointed a Temporary Research Assistant in March. Miss Muditha S. Ranasinghe was appointed an Assistant Botanist with effect from 1 September.

Mr M. Samankumara, Technical Officer and Mrs Visaka Jayasundera, Clerk/Typist resigned their posts in September.

Mr N. D. Yawanis, Field Attendant passed away on 27 January.

Messrs U. K. D. Lewis, Experimental Assistant, J. D. Karunatilaka, Field Attendant and M. A. Gunadasa, Labourer, were transferred to the Plant Science Department from 1 December when the Intercropping Department was absorbed into the Plant Science Department.

Visits

Priyani Pushpika, was trained on Tissue Culture Techniques at the Tissue Culture and Molecular Biology Laboratory at the Beltsville, Agricultural Research Centre, United States Department of Agriculture, Maryland, U.S.A. from 11 July to 10 September. Muditha Ranasinghe, Assistant Botanist was trained on analytical techniques at the Ceylon Institute of Scientific and Industrial Research, from 1 October to 27 December.

Chandra Samaranayake attended the "Tissue Culture as a Plant Production System for Horticultural Crops" conference held at Beltsville Agricultural Research Centre, Maryland, U.S.A. and visited Tissue Culture Laboratories in Maryland from 18 October—3 November.

Department staff made advisory visits to plantations and made regular visits to experimental areas.

R. B. Gunaratne and U. S. Weerakoon assisted by S. L. G. Ranjith, R. S. Wijesundera and A. P. L. D. Michael inspected all nurseries supplying plants to the Smallholder Rubber Rehabilitation Project. They inspected stock seedling nurseries and budwood multiplication nurseries registered with the Rubber Control Department before permits are issued to sell planting material from them.

Meetings

The Head of the Department participated in the following seminars and conferences:

Sri Lanka State Plantation Corporation (SLSPC) Agricultural Advisor's Conference, Colombo.

Janatha Estates Development Board (JEDB) Agricultural Advisor's Conference, Kegalle.

Planters seminar, SLSPC Board IV, Galle.

Planters seminar, SLSPC Board III, Kalutara.

Tissue Culture Group meeting, Sri Lanka Tea Board, Colombo.

Training

An extensive training programme was conducted by the Department staff, to train budders of all State Plantations and private commercial nurseries on green budding technique. In addition, all Rubber Extension Assistants and Rubber Extension Officers of Advisory Services Department were trained on this technique to popularise green budding, among growers.

Department staff conducted lectures and practical demonstrations to trainees of the training courses organised by the Advisory Services Department and to the Assistant Rubber Controllers of the Rubber Control Department.

A course of lectures and practical demonstrations were conducted on "Nursery and Planting Technique and Exploitation of *Hevea*" for a group of planters following a course leading to the Diploma in Plantation Management, conducted by the National Institute of Plantation Management.

Publications

Samaranayake, Chandra, (1985). Puncture tapping of *Hevea brasiliensis* in comparison with conventional Excision tapping - Sri Lankan Experience. *International Rubber Conference*, 1985. Kuala Lumpur.

Wickramasinghe, W. N., Samaranayake, Chandra and Abayapala, R. A. P. (1985). On the estimation of leaf areas of some *Hevea* clones. *Jl. Rubb. Res. Inst Sri Lanka*, 62, (in press)

Reports

Samaranayake, Chandra (1985). Annual Review of the Plant Science Department.

General

Development of methods for micropropagation of *Hevea* was given high priority in the Research Programme of the Department and shoot tip culture of *Hevea* was started in March, Dr Freddi Hammerschlag, Research Plant Physiologist of the United States Department of Agriculture, Beltsville Agricultural Research Centre, Maryland, was with the Department from 25–28 March to advise us on this project. The tissue culture laboratory was equipped with the basic requirements for research on this subject,

Laboratory Investigations

Tissue Culture

Different methods of cleaning up of explants were tested and these methods were found to be inadequate to clean up explants, removed from field grown plants. This was overcome to some extent with plants grown in an enclosed environment. Techniques were improved and clonal shoot tips as well as seedling shoot tips were established in culture. Preliminary studies indicated that the hormonal requirements for seedling shoot tip culture may be different from that of clonal shoot tips. (Chandra Samaranayake, Priyani Pushpika, Iranganie Gunetilleka, Sunitha Wijesekera and A. G. Vidanapathirana)

Gas exchange studies

Gas exchange capacities and leaf diffusive resistance were monitored at different stages of development of leaves in some selected *Hevea* clones. Effect of extracting latex from young buddings on the gas exchange capacities of leaves was also studied. (A. Nugawela, and Renuka Aluthewage)

Field Experiments

Tapping

PB 86, 1963 replantation, Nivitigalakele (T / 75/3)

The aim of this experiment was to investigate the tappareability of PB 86 at higher frequencies of tapping than d/2, using half spiral cuts, and merits of controlled vs uncontrolled systems of recovery tapping. Yield and brown bast data for 1985 are summarised in Table 1.

Table 1. Yield (kg/ha/yr) and brown bast (%) in response to different tapping system (T/75/3)

Tapping system	Yield	Brown bast
$\frac{1}{2}$ S d/2	1362	17.5
$\frac{1}{2}$ S d/1	1725	35.0
$\frac{1}{2}$ S d/3	1440	17.0
$\frac{1}{2}$ S d/2 + Recovery tapping*	2032	17.5
$\frac{1}{2}$ S d/2 + Recovery tapping**	1697	17.0
LSD (0.5)	353	

* Recovery of lost tapping days by daily tapping

** Recovery tapping spaced, so that not more than six recovery tappings per month or two per week (controlled recovery tapping).

In treatments 4 and 5, 48 and 36 recovery tappings respectively were done during November 1984 to September 1985. Treatments with recovery tapping and daily tapping, have given significantly higher yields. Brown bast incidence has been very high in daily tapping. It should be noted that brown bast has not been taken into consideration in calculation of yields. (Chandra Samaranyake and S. Wilbert)

PB 86, 1974 replantation, Eladuwa (T/81/1)

This experiment was started in 1981 to compare puncture tapping (PT) with the conventional tapping (CT) under commercial conditions. After completion of 2 years, puncture tapping was discontinued and conventional tapping was started on all puncture tapped trees and which were tapped on the $\frac{1}{2}$ S d/2 system. Before the commencement of the experiment in 1981, girth of all trees was recorded. After introducing conventional tapping in 1983, 5 PT trees and 5 CT trees from each of the girth classes were selected and test tapped to study the effect of PT on future yield and growth of trees.

Results recorded in 1985 are summarised in Table 2.

Table 2. Mean yield (g/t/t) and girth increment (cm) in (T/81/1)

Treatment	Yield (g/t/t)	Girth (cm) increment
Less than 45.00 cm previously untapped	20.19	0.90
45.0 — 49.9 cm previously PT	22.15	1.50
45.0 — 49.9 cm " CT	18.82	3.04
50.0 — 54.9 cm " PT	22.89	5.18
50.0 — 54.9 cm " CT	17.74	3.80
Greater than 55 cm " PT	27.79	5.34
" " 55 cm " CT	26.89	6.16
Less than 45.0 cm " PT	16.05	1.86
LSD 0.5	4.79	1.04

There was a significantly higher yield from previously PT trees compared to CT trees, in 1984. In 1985, only the trees of girth class 50.0—54.9 gave a significantly higher yield with previously PT trees compared to CT trees. There was no significant difference in the girth increment between PT and CT trees. (Chandra Samaranyake and M. C. Perera)

PB 86, 1978 replantation, Urumiwela (T/84/3)

This experiment was set down to investigate whether economic yields could be obtained by starting tapping, at heights above the recommended level and, tapping higher panels upwards before normal base panels.

The treatments included are

1. $\frac{1}{2}$ S d/3
 - a. beginning at 105 cm height
 - b. beginning at 120 cm height
 - c. beginning at 135 cm height
2. $\frac{1}{2}$ S d/3 beginning at 105 cm height tapped upwards.

Results recorded for 1985 are summarised in Table 3.

Table 3. Mean Yield (g/t/t) of different heights of tapping (T/84/3)

Treatments	Yield (g/t/t)
1. a	30.94
1. b	30.90
1. c	28.29
2.	25.89
LSD 0.5	2.71

There was no significant difference in yield, in treatments where tapping was done downwards. There was a significant reduction in yield in upward tapping compared to downwards tapping. (Chandra Samaranyake and M. C. Perera)

RRIC 103, 1978 replantation, Pallegama (T/84/1)

This experiment was designed to compare several initial girths for commencement of tapping, for their effect on yield and subsequent girth increase. The following girth classes were included.

T ₁	— 40.0 — 44.9 cm girth
T ₂	— 45.0 — 49.9 cm "
T ₃	— 50.0 — 54.9 cm "
T ₄	— Greater than 55.0 cm girth

The system of tapping was $\frac{1}{2}$ S d/3

The results available so far indicate significantly higher yields with trees of greater girths. The increase in girth of trees, over 55.0 cm at the commencement of tapping, was significantly higher than the others. (Chandra Samaranayake and R. P. Karunasena)

PB 86, 1977 replantation, Dalketh (T/84/2)

This experiment was started to compare several initial girths for commencement of tapping on conventional (CT) and puncture tapping (PT) systems, for their effect on yield and subsequent girth increase. The following treatments were included.

Tapping system	— $\frac{1}{2}$ S d/2 6Pg/100 (0.5) d/2 + Ethrel Stimulation
Girth classes	— 40.0 — 44.9 cm girth 45.0 — 49.9 cm girth 50.0 — 54.9 cm girth Greater than 55 cm girth

In each girth class, CT has given significantly higher yields compared to PT. There is a significant increase in yield with increase in girth of trees in CT treatments. In PT, there is no significant difference in yield between different girth classes. There was no significant difference in girth increment between any of the treatments. (Chandra Samaranayake and S. Wilbert)

High intensity tapping during the last years of a plantation — Frocester (IS/84/1), (IS/84/2) Naktyadeniya (IS/84/3), (IS/84/4) and Ambadeniya (IS/84/5).

These experiments were laid down to investigate suitable systems of high intensity tapping with and without the use of yield stimulants, during the last few years of a replantation.

Following treatments were included in experiments (IS/84/1) and (IS/84/3):

T ₁	$\frac{1}{2}$ S + $\frac{1}{2}$ S*	(✓ /)	d/3
T ₂	$\frac{1}{2}$ S + V	(✓ /)	d/3
T ₃	$\frac{1}{2}$ S + $\frac{1}{2}$ S	(✓ /)	d/3
T ₄	$\frac{1}{2}$ S + $\frac{1}{2}$ S	(✓ /)	d/3

* Stimulated with 5% Ethrel four times a year

During the first year of high intensity tapping, the stimulated $\frac{1}{2}$ S cuts (T_1) gave significantly higher yields than the unstimulated control (T_4). $\frac{1}{2}$ S cuts tapped upwards (T_3) yielded more than V cuts (T_2). In the second year of tapping there was no significant difference in yield between different tapping systems.

The following treatments were compared in experiments: (IS/84/2), IS/84/4) and (IS/84/5):

T_1	V*	d/2 (↗)
T_2	$\frac{1}{2}$ S*	d/2 (↗)
T_3	$\frac{1}{2}$ S +	$\frac{1}{2}$ S d/2 (↙ ↗)
T_4	$\frac{1}{2}$ S +	PT** (↙ ↗)

* Stimulated with 5% Ethrel, four times a year

** Stimulated with 5% Ethrel, every two weeks

There was no significant difference in yield between different treatments in these experiments. (A. Nugawela, S. Wilbert and R. P. Karunasena)

Interaction of clones and tapping systems St. George (CT/77/3)

The purpose of this experiment was to ascertain the most effective tapping systems for different clones. The four tapping systems tested, on 15 clones, are as follows:

1. $\frac{1}{2}$ S d/3
2. $\frac{1}{2}$ S d/2
3. $\frac{1}{2}$ S d/2 with provision for changing over of panels for introducing extra cuts.
4. $\frac{1}{2}$ S d/2 for 8 months and Pg/100 (0.5) d/2 + E for 4 months.

The yield data for 1985 indicate no significant clone and tapping interaction. $\frac{1}{2}$ S d/3 tappings gave significantly higher yields per tapping, compared to $\frac{1}{2}$ S d/2. Puncture tapping yields were significantly lower than conventional tapping. (Chandra Samaranayake L. S. S. Pathiratne and Charlotte Ranasinghe)

Brown bast

RRIC 101, 1976 replantation, Eladuwa (BB/77/1)

The aim of this experiment was to see whether brown bast can be transmitted through the use of buds removed from brown bast affected trees. Experimental details are given in Ann. Rep. 1983. The incidence of brown bast recorded so far, does not give any indication that, brown bast in buddings originating from affected

trees, is higher than in normal bud grafts. (Chandra Samaranayake and R. P. Karunasena).

RRIC 101, 1976 replantation, Eladuwa (BB/77/2)

This experiment was started to see whether high yielding trees are more prone to brown bast and to see whether there is a definite pattern of spread of brown bast in a plantation. Individual tree yields, plugging indices and brown bast incidence were recorded. (Chandra Samaranayake and L. S. Kariyawasam)

Tree spacing and density

Tree spacing and density, Millewa (CD/77/1)

Clones RRIC 101, 103 and PB 86 were established at six spacings and densities on a factorial experiment with three replicates. Yield and girth data recorded in 1985 are summarised in Table 4.

Table 4. Mean yield (g/t/t) and girth increment (cm) spacing and density experiment (CD/77/1)

Spacing (cm)	Density trees/ha	Yield g/t/t	Girth cm	Girth increment cm
S ₁ 2.5 × 10.0	409	30.10	58.28	3.50
S ₂ 2.5 × 7.5	533	25.87	57.44	3.36
S ₃ 2.5 × 6.0	666	23.43	52.09	2.98
S ₄ 2.5 × 5.0	800	21.66	51.09	2.82
S ₅ 3.87 triangular	771	23.44	52.63	3.06
S ₆ 3.54 triangular	920	23.79	49.39	2.77
LSD 0.5		4.21	2.43	0.47

Girth increase of trees 8 years from planting showed that, in clone PB 86, there was no significant difference in growth due to different spacings and densities. In clones RRIC 101 and 103 there was a significant reduction in growth with increasing density, indicating that the optimum density may be S₁ or less than S₁.

Yield recorded so far, showed that PB 86 yields are not significantly affected by increasing the density of planting, whereas in clones RRIC 103 and 101, there was a significant reduction in yield with increasing density. (Chandra Samaranayake and L. S. S. Pathiratne).

Propagation

Stock-scion relationship

Stock-scion experiment, St. George (St. sc/75/4)

Clones RRIC 45, 52, PB 86 and Wagga 6278 have been budded on to clonal seedling rootstocks of the same four clones in a diallel design.

Yield and girth data recorded in 1985 did not indicate a significant rootstock effect on yield or growth. (Chandra Samaranayake, K.A. G. B. Amaratunga and L. S. Kariyawasam)

Stock-scion experiment, St. George (St. sc/80/6)

Clones RRIC 100, 101, 102, 103, 111 RRIC 52 and PB 86 have been budded on to seedling rootstocks of the same clone in a diallel design. Growth in girth, measured 5 years from planting, showed only a significant scion effect and no rootstock effect.

All RRIC clones were brought into tapping in 1985 whereas PB 86 could not be tapped as the trees of this clone, failed to reach tappable girth. (Chandra Samaranayake, R. B. Gunaratne and U. S. Weerakoon).

Stock-scion experiment, Moratoya (St. sc/81/7)

Clones RRIC 100, 101, 103, PB 86 and GT 1 have been budded on to seedling rootstocks of the same clone in a diallel design. Growth in girth at 4 years from planting, showed no significant rootstock effect. (Chandra Samaranayake and L. S. Kariyawasam)

Crown budding

Crown budding experiment St. George (CB/75/1)

The purpose of this experiment was to study the effect of different crowns on growth and yield of the trunk. The data collected so far indicate a significant influence of the crown on growth and yield of the trunk. (Chandra Samaranayake and K. A. G. B. Amaratunga)

Planting techniques

Stumped buddings, Neuchatel (RI/81/3)

Green buddings were compared with stumped buddings in this experiment. Experimental details are given in Ann. Rev. 1984. Green buddings were planted in

the field, 13 months ahead of stumped buddings which were planted in the field with 18 months of growth, from the nursery. Growth measurements recorded so far indicated that the growth of budded stumps was better than stumped buddings. (Chandra Samaranayake and K. A. G. B. Amaratunga)

Comparison of planting techniques, Peenkande (GB/79/2)

Several methods of field establishment were compared in this experiment. Experimental details are given in Ann. Rev. 1980. Growth of plants 5 years from planting continued to show the superiority of budding at stake in the field and seedling raised, budded, grown in polybags and transferred to the field, over bare root planting of budded stumps. (Chandra Samaranayake and L. S. Kariyawasam)

Green buddings in polybags and bare root stumps, Elston (PB/81/3)

Bare root green budded stumps which were planted in the field at the time of planting budded stumps in polybags, continued to show significantly better growth than the polybag grown plants which were transplanted in the field 6 months later. (Chandra Samaranayake and L. S. Kariyawasam)

Brown buddings in polybags Gallewatte (PB/81/4)

In this experiment budded stumps grown in polybags for 6 months and bare root budded stumps were transplanted in the field at the same time. Growth of plants after 4 years from planting showed that polybag grown plants were superior in growth to bare root plants, (Chandra Samaranayake and S. Wilbert)

Green buddings vs. brown buddings, Geektyanakande (PB/81/5)

The growth of green and brown bare root stumps and polybagged buddings were compared after transplanting in the field. The bare root plants which were transplanted in the field at the time of planting budded stumps in polybags, showed significantly better growth in the field than polybag grown plants transferred to the field 12 months later. (Chandra Samaranayake and K. A. G. B. Amaratunga)

Clone characters

Field observations, Eladuwa (CC/77/1)

The purpose of this study was to investigate a number of clones to see whether any criteria could be used in the early selection of clones. Experimental details are given in Ann. Rev. 1980. Recording of individual tree yields were continued in 1985. (Chandra Samaranayake and L. S. Kariyawasam)

REVIEW OF THE GENETICS AND PLANT BREEDING DEPARTMENT

by

N. E. M. JAYASEKERA

SUMMARY

RRIC 100 series continued to perform well in respect of vigour and yield. SALB resistant clone, RRIC 121, had shown very good early vigour in all small scale trials established since 1980. In two old small scale trials it has given very high yields of 178g and 87g per tree per tapping. In commercial estates RRIC 100 has given about 2200 kg per hectare per year in the seventh year of tapping. A new selection, 74-193 has been selected for future large scale testing. Attempts were made to study the growth of pollen tube in the stylar tissue. Two hand pollination methods were compared during the flowering season of 1986.

DETAILED REVIEW

Staff

Dr N. E. M. Jayasekera Head of the Department and Assistant Geneticists and Plant Breeders, Mrs S. C. Dharmaratne and Mr. D. P. S. T. G. Attanayake, were on duty throughout the year.

Experimental Officer, Mr K. B. Karunasekera, Senior Experimental Assistant, Mr B. M. S. G. Peiris, Experimental Assistant, Mr A. K. M. S. Senaratne and Technical Officers, Messrs K. W. Rupatunga, I. D. M. J. Sarath Kumara and R. A. S. K. Ranatunga were on duty throughout the year

Mr D. S. Gamage, Experimental Assistant retired from the service with effect from 2nd September, 1985.

Visits

The Department staff made regular visits to experimental areas.

Meetings and Conferences

Head of the Department attended the Visiting Agents' Conference of Sri Lanka State Plantation Corporation (SLSPC) held in Colombo on 14th August.

The Head of the Department addressed the following meetings on the Institute's recommendations on *Hevea* planting materials.

SLSPC Planters' meeting at Ratnapura on 8 October.

Agricultural Advisors' meeting of Janatha Estates Development Board (JEDB) at Kegalla on 9 October.

SLSPC Planters' meeting at Galle on 10 October

SLSPC Planters' meeting at Thebuwana Planters' Club on 12 November.

Head of the Department attended three Scientific Committee meetings held on 29 March, 28 June and 29 November.

N. E. M. Jayasekera attended the International Rubber Research and Development Board (IRRDB) Plant Breeders' meeting held in Kuala Lumpur, Malaysia on 18 October.

Head of Department also attended the International Rubber Conference 1985 held in Kuala Lumpur, Malaysia from 21 to 25 October and participated in a study tour programme of 10 days following the conference. The study tour was made possible by the Rubber Research Institute of Sri Lanka.

Extension and training

Head of the Department participated in the training programmes organized by the Training Centre of the Advisory Services Department for Rubber Extension, Officers and Assistant Rubber Controllers.

N. E. M. Jayasekera addressed the Planters who attended the training course in plantation management organized by the National Institute of Plantation Management.

Head of the Department also addressed the participants of the International Course for Development Oriented Research, organized by the Agrarian Research and Training Institute.

Publications

Attanayake, D. P. S. T. G, and Dharmaratne, Sumeda C. (1985). Preliminary observations on flowering, pollen germination and fruit-set of *Hevea*. *J. Rubb. Res. Inst.* 62, 41 - 46

Reports

Jayasekera. N. E. M. (1985), Annual Review of the Genetics and Plant Breeding Department, 1984.

General

Issues and receipts of budwood

The budwood nurseries at Kuruwita and Nivitigalakele Sub-stations issued a total of 2783 metres of budwood to estates and smallholders. Details are given in Table 1.

Table 1. Details of issues of budwood

Clone	Metres	
	Kuruwita	Nivitigalakele
RRIC 100	378	100
RRIC 102	20	15
RRIC 103	1043	70
RRIC 104	—	25
RRIC 110	50	15
RRIC 118	50	—
RRIC 121	537	450
RRIC 130	15	15
Total	2093	690

Laboratory Investigations

Floral biology of *Hevea* (FBH / 85 / 5)

Growth of the pollen tube in style

Hand pollinated *Hevea brasiliensis*, *Hevea nitida* and *Hevea spruceana* flowers were excised 2, 4, 24 and 48 hours after pollination and fixed in a mixture of equal parts of 95% ethanol and concentrated HCL acid for 2 to 1 hour. Flowers were then squashed in few drops of aceto-carmine to observe the growth of pollen tube in stylar tissue.

Longitudinal and cross sections of the pollinated and unpollinated female flowers of *H. brasiliensis* were made by using a microtome. Flowers were fixed in alcoholic formaline fixative after 19, 21, 24 and 48 hours from pollination. Fixed flowers were kept over night in the fixative and dehydration and wax in filtration sequence was followed for embedding. Embedded specimens were microtomed and sections were stained using aceto carmine after mounting on slides. Then they were observed for pollen tubes.

In both investigations pollen tubes could not be detected in the stylar tissue. It is hoped to repeat these investigations using pollen specific analine blue stain and flourescent microscope. (D. P. S. T. G. Attanayake and S. C. Dharmaratne)

Field Experiments

Breeding selection and clone evaluations

Hand pollination programme for 1985 (BST / 1 / HPS / 85 / 1)

The hand pollination programme for 1985 was carried out in the 1975 experimental area at Eladuwa State Plantation.

Due to continuous wet weather wintering was late and flowering of different clones was staggered. PB 86 and RRIC 102 wintered first, followed by GT 1. RRIC 104 and RRIC 107 did not winter at all and therefore these clones were not used in the crossing programme.

Using the flowers available from PB 86 and RRIC 102, the following two hand pollination methods were compared.

Method 1—Pollinations were done in the morning, 6 to 8 hours before the opening of female flowers, using the anther columns of male flowers due to open in the afternoon of the day of pollination (conventional method).

Method 2—Pollination of female flowers at the time (3 p.m.) of their opening, using the anthers of male flowers opened on the day of pollination.

The number of pollinations done in each method and number of fruits set are given in Table 2.

Table 2. *Details of comparison of two pollination methods.*

Cross	PB 86 x RRIC 52	
	Method 1	Method 2
No. of pollinations	450	450
No. of fruits-set	1	2

The data when analysed using chi-square test for homogeneity of binomial samples showed that fruit set from the pollinations done after the anthesis (method 2) was significantly (significant at 5%) higher than the fruit set from the pollinations, done before the anthesis. This study will be continued, in more detail, during 1986 flowering season.

In addition to the above hand pollinations a total of 5931 pollinations were done to obtain seedlings for future selection programme. The crosses attempted, number of pollinations done and the number of pods-obtained in each cross are given in Table 3. (N. E. M. Jayasekera, D. P. S. T. G. Attanayake and A. K. M. E. Senaratne)

Table 3. Details of the routine hand pollination programme (BST/1/HPS/85/1)

Cross	No. of pollinations	Pods
RRIC 102 x PB 86	933	1
RRIC 102 x GT 1	1593	Nil
RRIC 102 x RRIM 600	357	Nil
RRIC 100 x GT 1	328	3
GT 1 x RRIM 600	447	9
GT 1 x <i>H. nitida</i>	70	Nil
GT 1 x RRIC 103	530	12
RRIM 600 x RRIC 102	88	4
PB 86 x RRIC 102	1189	5
RRIC 102 x <i>H. nitida</i>	167	Nil
PB 86 x GT 1	186	1
GT 1 x RRIC 102	43	Nil
Total	5931	35

Selection of 1974, 1975 and 1978 H.P. seedlings (BST1 HPS/74 - 75/1), (BST 1/HPS/74, 75, 78/1)

Six small scale clone trials were established in 1980 and 1982. The trial at Dartonfield cannot be considered as there are missing plants due to an earthslip.

Annual girth measurements were collected from other 5 trials (for details see 1980, 1981 and 1982 Annual Reviews). Girth measurements of Aruppolakanda was not analysed as growth in this trial was generally poor due to very steep terrain and rocks in the field.

In other trials, out of four control clones RRIC 121 had the highest mean girth while RRIM 600 had the lowest mean girth.

In Moraliyoa trial where 52 clones are tested, ten new selections had higher mean girth values than the best control clone, RRIC 121 but non of them were significantly better than RRIC 121 as indicated by the result of non-significant t-tests.

In the trial established at Perth State Plantation there were four test clones with higher girth than RRIC 121. But only one of them had significantly better mean girth than RRIC 121.

At Yatadola trial there were 10 clones which exceeded the girth of the best control. But only one of them had significantly better growth than RRIC 121.

Morris-Mann test tapping data collected from Yatadola experiment were analysed. In this trial RRIC 103 had recorded the highest test tapping yield and

therefore its mean was compared with the mean yields of 12 test clones which had higher mean test tapping values than RRIC 103. Four of these test clones had significantly better test tapping yields than RRIC 103. One of these 4 clones 74-181 had also given significantly higher test-tapping yields than the best control (RRIC 121) in Moraliya trial (see 1984 Annual Review). These clones are being multiplied for large scale testing

In the small scale trial established in 1982 at Kuruwita Sub-station 11 test clones had better girth than the best control (RRIC 121) and 5 of them had significantly better girth than RRIC 121.

Morris-Mann test tapping data collected from Kuruwita trial were also analysed. Out of the control clones, RRIC 100 had the highest mean yield and there were four clones with higher means than RRIC 100. But only one clone, 74-193 had a significant difference, when compared with RRIC 100. This test clone also had a good mean girth (27.31 cm) when compared with RRIC 121 (27.57 cm). Therefore this clone (74-193) too will be tested in future large scale trials.

Three small scale trials established to evaluate 1975 H.P. selections were scored for girth. In two trials RRIC 121 was the best control while in the trial at Clyde State Plantation, RRIC 103 has the highest mean girth. In all these experiments non of the test clones had significant differences when compared with the best control.

In 1985 another small scale trial (BST 1/HPS/74, 75, 78/1) was established to evaluate remaining selection from 1974 and 1975 H.P. seedling populations. Selections from 1978 H.P. seedlings were also included in this trial. A randomized block design with four replications were used in this experiment which was planted at Paiyagala State Plantation. Five plants were included in each plot. RRIC 100, RRIC 102, RRIC 103 and RRIC 121 are included as control clones. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rupertunga, B. M. S. G. Peiris and R. A. S. K. Ranatunge)

1976 H.P. selections (BST 1/HPS/76/2)

Twenty-nine selections from 1976 H. P. seedling progeny have been established in 1985 in a small scale trials to evaluate them for their yield, vigour and disease resistance. A randomized block design with four replicates was used. Four plants were used in a plot. The experiment was established at Tempo Division of Hill-stream State Plantation. RRIC 100, RRIC 102, RRIC 103 and RRIC 121 were used as control clones in this trial. (N. E. M. Jayasekera, I. D. M. J. Sarath Kumara and K. W. Rupertunge)

1979 to 1981 HP seedling populations (BST 1/HPS 79/2, BST 1/HPS/80/1, BST 1/HPS/81/1)

Seedlings derived from hand pollination programmes in 1979, 1980 and 1981 were scored for their girth. It is hoped to test-tap the 1979 progeny during 1986. (N. E. M. Jayasekera, K. W. Rupatunge and K. B. Karunasekera)

Evaluation in Bibile Group (BST 1/V/67/20. BST 1 V/73/37)

The mean girth and mean yields of the clones tested are given in Tables 4 and 5.

Table 4. Mean yield and girth (BST 1/V/67/20)

(Tapped : S/2, d/2)

Clone	Trees tapped	Dry trees	Girth at 150 cm (cm)	Mean yield (g/t/t)	
				1984	1985
RRIC 103	50	5	79.7	58.3	57.8
RRIC 100	75	—	71.3	54.7	56.9
IAN 45/710	75	4	81.5	56.0	56.8
RRIC 101	75	15	67.6	50.4	46.2
RRIC 112	75	5	72.2	54.1	42.6
RRIC 45	75	6	75.2	40.9	35.7

In this trial IAN 45/710 showed the highest mean girth closely followed by RRIC 103. But the highest mean yield was recorded by RRIC 103 closely followed by RRIC 100 and IAN 45/710. Observed number of dry trees confirms that RRIC 101 is highly susceptible to brown bast.

Table 5: Mean girth and yield (BST 1/V/73/37)

(Tapped: S/2, d/3)

Clone	Trees tapped	Dry trees	Girth at 150 cm (cm)	Yield in g/t/t	
				1984	1985
RRIC 117	52	—	63.4	52.5	71.5
RRIC 110	116	3	65.8	49.8	61.8
RRIC 112	206	1	64.6	46.5	58.8
RRIC 103	166	5	66.3	51.2	56.3
1461	122	—	65.9	45.2	56.0
RRIC 102	146	2	62.6	51.2	53.2
506	84	—	57.2	22.0	51.4
RRIC 104	137	—	71.9	41.9	51.4
RRIC 105	67	1	65.6	20.8	48.6

RRIC 104 recorded the highest girth but RRIC 117 has given the highest mean yield in 1985 followed by RRIC 110. Yield in 1985 has considerably increased when compared with that of 1984. The highest increase is achieved by unregistered clone No. 506 followed by RRIC 105. (B. M. S. G. Peiris and R. A. S. K. Ranatunge)

Clone trials at Eladuwa State Plantation and Hedigalla State, Plantation (BST 1/VSM/69/29; BST 1/VSM | 69/30)

These two trials have the same experimental design but different clones yield and girth data collected from Hedigalla trial were analysed. Analysis of variance for the two characters are given in Table 6.

Table 6. *Analysis of variance (BST 1/VSM/69/29)*

a. Yield			
Source	D.F	M.S.	F value
Clones	5	3858.0	20.8***
Error	96	18559.0	
b. Girth			
Source	D.F	M.S.	F value
Clones	5	586.33	5.5***
Error	96	107.19	

Significance level *** <0.1%

Analysis showed highly significant differences between clones for both characters. Paired t-test was performed to find the test clones which performed significantly better than the control clone RRIC 45.

With respect to yield RRIC 102, RRIC 101 and RRIC 103 had significantly higher yields than RRIC 45. In the case of girth RRIC 100, RRIC 102, RRIC 103 and unregistered clone 1458 had significantly better growth.

Mean girth and yield of Eladuwa trial are presented in Table 7. (A. K. M. S. Senaratne and W. D. Armon)

Table 7. *Mean yield and girth (BST 1/VSM/69/30)*

Clone	Mean girth (cm)	Mean yield g/t/t
RRIC 100	60.6	23.7
RRIC 101	66.4	17.3
RRIC 103	81.2	66.7
RRIC 112	67.4	15.4
82	79.5	25.4
1458	60.3	17.6
RRIC 45	67.0	22.1

Large scale clone trial (BSC 1/LSC/85/3)

This was established in 1985 S. W. monsoon. The objective is to study the large scale performance of promising RRIC 100 series clones. In this trial RRIC 104, RRIC 110, RRIC 107, RRIC 121 and RRIC 131 were planted along with three control clones viz. RRIC 102, RRIC 103 and RRIM 600, A randomized block design was used with four replicates. The four replicates were planted on three estates as follows.

Clyde State Plantation — One replicate
Perth State Plantation — One replicate
Sorana State Plantation — Two replicates

An average plot size of 90 was used in the trial. (N. E. M. Jayasekera, D. P. S. T G. Attanayake and K. B. Karunasekera)

Evaluation of Ivory Coast Clones — Paiyagala State Plantation (BST 1/ICC/85/2)

This is a small scale trial to evaluate 10 clones received from Ivory Coast. Four RRIC clones, RRIC 100, RRIC 102, RRIC 103, and RRIC 121 have been included as controls. A randomized block design with four replicates was used in the experiment with 10 trees per plot. (N. E. M. Jayasekera, K. B. Karunasekera, and I. D. M. J. Sarath Kumara)

Clone trials at Kuruwita (Sub station) (BST 1/VSM/67/5, BST 1/VSM/68/21 and BST 1/VSM/69/28)

All these trials are small scale clone trials. Mean girth and yield of the clones in experiment No. BST 1/VSM/67/5 are given in Table 8.

Table 8. Mean girth and yield of clones BST 1/VSM/67/5
(Tapped: S/2, d/2)

Clone	Mean girth (cm)	Mean yield	
		1984	1985
RRIC 121	103.7	105.3	87.0
10570	93.8	93.3	54.4
7281	83.0	52.8	46.2
8794	90.2	64.4	42.1
RRIM 623	74.0	53.5	34.9
10727	72.2	56.3	33.5
RRIC 122	73.6	62.6	33.4
5682	82.8	47.3	31.6

RRIC 121 had the highest mean girth and yield in this trial. In 1985, the yield has gone down, in all the clones, when compared to 1984. This yield reduction is due to the change over of the tapping panel during 1985.

In the second trial eleven RRIC 100 series clones and two unregistered clones are tested using RRIC 45 as the control. RRIC 121 has given the highest yield of 178.4g per tree per tapping in this experiment. All the test clones have given higher yields than the control clone (Table 9).

Table 9. Mean girth and yield of clones (BST 1/VSM/68/21)

Clone	Parentage	Trees tapped	Girth at 150 cm (cm)	Yield (g/t/t)		Dry trees
				1984	1985	
RRIC 121	PB 28/59 x IAN 873	6	111.0	138.7	178.4	—
RRIC 123	IAN 710 x Ch 26	12	90.7	73.3	86.9	3
RRIC 131	PB 86 x F 1033	9	89.5	73.1	85.5	—
RRIC 110	LCB 1320 x RRIC 7	17	86.8	81.1	82.3	4
RRIC 130	IAN 710 x RRIC 52	16	77.2	78.0	78.6	3
RRIC 102	RRIC 52 x RRIC 7	18	85.9	71.2	75.9	5
7—541	RRIC 36 x RRIC 36	12	93.5	67.3	73.0	1
RRIC 133	IAN 710 x RRIC 45	8	109.9	80.9	72.3	2
RRIC 113	RRIC 52 x RRIC 36	7	87.1	68.4	68.0	1
RRIC 104	RRIC 52 x Tjir 1	11	102.5	68.8	60.0	4
7263	FX 3482 x RRIC 52	12	86.6	58.6	55.4	2
RRIC 120	RRIC 36 x FX 516	19	74.2	50.2	51.9	4
RRIC 112	RRIC 41 x Ch 26	17	79.9	41.6	47.8	1
RRIC 45	RRIC 8 x Tjir 1	17	72.9	44.2	37.9	5

In the third trial (BST 1/VSM/69/28) fifteen clones are evaluated and seven of them are unregistered clones. In 1985 the highest Mean girth (98.4 cm) and yield (100.2 g/t/t) were recorded by RRIC 126. (B. M. S. G. Peiris and R. A. S. K. Ranatunge)

Clone trial St. Jochim Estate TRI, Ratnapura (BST 1/CLT/80/2)

This experiment is a small scale clone trial where seven RRIC 100 series clones are evaluated along with RRIM 600 and IAN 45/710 and PB 86. The experiment was located at Tea Research Institute, Ratnapura, in a field not suitable for cultivation of tea. 1985 mean girth figures of clones included in this trial are presented in Table 10.

Table 10. Mean girth figures of clones in BST 1/CLT 80/2

Clone	Girth at 90 cm
RRIC 110	51.3
RRIC 121	49.4
RRIC 103	48.2
RRIC 100	44.9
RRIC 102	44.7
RRIC 101	44.4
RRIM 600	44.4
IAN 45/710	44.2
RRIC 130	41.9
PB 86	40.7

RRIC 110 had the best growth in this experiment. (N. E. M. Jayasekera and B. M. S. G. Peiris)

Miscellaneous clone trials

International clone trial — Hewagam estate (BST 1/ICT/78/2, BST 1/ICT/79 3)

This experiment has been planted in 2 years and the two areas are given two experimental numbers. Mean girth and percentage of tappable trees recorded in 1985 are given for the two clearings, separately in Tables 11 and 12.

Table 11. *International clone trial. Mean girth and percentage of tappable trees in 1978 area*

Clone	Mean girth (cm)	%Tappable trees
RRIC 103	48.9	51.65
PR 306	43.3	17.09
RRIC 110	52.5	63.78
RRIM 703	43.6	15.83
RRIC 100	46.9	37.83
RRIC 101	48.8	58.97
RRIM 600	41.7	4.55
RRIM 725	42.3	10.98
RRIC 105	43.1	33.33
RRIC 113	42.3	13.33

Table 12. *International clone trial. Mean girth and percentage of tappable trees in 1979 area*

Clone	Mean girth (cm)	% Tappable trees
RRIC 100	38.7	0.89
RRIC 101	38.3	3.64
RRIM 600	32.6	nil
RRIM 717	35.6	nil
BPM 24	32.9	nil
RRIC 118	34.1	4.92
RRIM 712	28.5	4.46
RRIC 107	37.7	nil
RRIC 121	38.1	1.09
RRIC 117	33.1	nil
BPM 22	38.9	3.23
BPM 3	32.0	1.39

In 1978 RRIC 110 had the highest mean girth and also the highest percentage of tappable trees (63.78%) followed by RRIC 101.

At the 1985 IRRDB Plant Breeders Conference it was decided to continue this experiment only for observational purposes, especially for disease resistance (N. E. M. Jayasekera and K. B. Karunasekera)

Rootstock-scion trial (SC /76/1)

The annual girth measurement was recorded in 1985. The two blocks of the experiment is planted on two estates, Ratmehera and Gasnawa. In 1985 six test tappings were recorded from Ratmehera area. The Gasnawa area will be test tapped during 1986. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rупatunge and I. D. M. J. Sarathkumara)

Testing of RRIC 100 series clones (BST/1/CET/79/1)

Eleven clones are tested in this experiment and it is planted on four estates. Mean girth recorded in 1985 is presented in Table 13.

Table 13. *Mean girth (cm) — BST 1/CET/79/1*

Clone	Eladuwa	Elston	Peenkande	Hathbawe	Clone mean
RRIC 100	49.4	57.1	53.0	53.7	53.3
RRIC 101	52.6	57.6	50.5	53.8	53.6
RRIC 102	54.1	57.9	52.6	57.9	55.6
RRIC 103	51.6	60.5	53.2	57.0	55.5
RRIC 104	56.4	60.5	55.3	58.7	57.7
RRIC 105	52.4	54.9	52.7	51.7	52.9
RRIC 107	53.2	61.7	56.8	57.4	57.2
RRIC 118	47.3	54.2	50.8	57.0	52.3
RRIM 600	45.2	49.3	44.4	49.6	47.1
PB 86	41.0	46.1	43.9	45.9	44.2
GT 1	44.8	52.1	41.6	50.4	47.2
Site mean	49.8	55.6	50.4	53.9	52.4

Tapping of this experiment commenced in 1985 and arrangements have been made to test-tap a random sample of trees from each clone in order to get individual tree yields. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rупatunge and I. D. M. J. Sarath Kumara)

Diallel progeny (GEN/78/1)

Seedling, approximately 20 from each of the 16 families derived by crossing RRIC 100, RRIC 101, RRIC 102 and RRIC 103 in all possible combination were cloned and polybaged plants were used to establish an experiment at Eladuwa State Plantation. A randomized block design with 4 replicates was used and a small plot size of 2 plants per plot had to be used as there was not enough material to increase the replicate size (N. E. M. Jayasekera, D. P. S. T. G. Attanayake, K. B. Karunasekera and A. K. M. S. Senaratne)

Genotype - environment interaction studies (GE/75/1)

A girth measurement was recorded in 1985 and mean girth of clones are given in Table 14.

The seven sites of this trial was test-tapped during 1985. Number of test tapping varies from site to site due to rain interference. The mean yeild of clones and the number of test tappings done in each site are given in Table 15.

Table 14. Mean girth (cm)--GE/75/1

Clone	Dens-worth	Miris-watta	Hunu-wella	Golinda	Bentota	Monrovia	Bibile	Clone mean
RRIC 36	64.4	57.5	55.7	57.0	64.5	63.8	58.54	60.20
RRIC 52	82.0	79.6	59.7	66.5	92.7	78.5	72.67	74.20
RRIC 100	61.2	61.4	65.3	57.1	64.4	61.2	56.62	61.03
RRIC 101	66.8	61.1	70.3	56.6	61.8	61.4	57.90	62.27
RRIC 102	66.3	62.5	53.9	54.1	66.0	62.5	59.63	60.84
RRIC 103	69.1	74.0	74.7	59.9	73.5	73.5	65.55	70.03
RRIM 600	67.7	64.8	64.2	64.1	71.0	66.3	60.65	65.53
RRIM 623	70.1	65.9	65.8	62.1	70.9	67.8	61.19	66.25
PB 86	64.7	64.5	60.8	65.4	62.7	62.6	55.96	62.38
IAN 45-710	68.1	71.8	66.9	63.7	70.0	64.8	62.55	67.07
Site mean	68.0	66.3	63.8	60.6	68.8	66.2	61.22	65.01

Table 15. Mean yield of clones (g / t / t) and number of test tapping done in each site

Clone	Dens- worth	Miris watta	Hunu- wella	Golinda	Bentota	Monrovia	Bibile	Clone mean
RRIC 36	39.7	27.4	23.25	30.3	31.2	39.8	37.63	32.75
RRIC 52	30.8	25.8	22.87	16.4	30.2	27.9	24.06	25.43
RRIC 100	42.5	35.6	23.89	22.9	35.6	41.0	36.09	33.94
RRIC 101	53.9	36.7	25.97	51.8	28.7	40.4	38.87	39.47
RRIC 102	43.5	37.4	30.30	24.1	39.6	44.6	37.71	36.74
RRIC 103	43.2	45.7	35.17	25.4	40.1	55.4	34.56	39.93
RRIM 600	47.5	42.2	34.70	36.3	40.8	48.3	43.59	41.91
RRIM 623	38.7	32.4	25.32	20.1	25.1	35.3	37.73	30.65
PB 86	32.4	34.6	25.96	31.5	21.8	34.9	28.43	29.94
IAN 45-710	38.6	49.4	28.50	28.3	38.3	36.4	37.29	36.68
Site mean	41.0	36.72	27.59	28.7	33.1	40.4	35.59	34.74
No. of test tappings	6	6	8	5	7	8	6	

It has been observed that bark consumption is very high in some areas and commencement of tapping on BO-2 panel is unavoidable. To have a uniformity we may have to start tapping panel BO-2 in all sites. (N. E. M. Jayasekera, K. B. Karunasekera, K. W. Rupatunge and I. D. M. J. Sarath Kumara)

IRRDB Germplasm Collection (GPC 18514)

Two trials were established at Kuruwita Sub-station to evaluate the 100 clones received from IRRDB germplasm collection.

Trial 1— In one trial 56 clones are evaluated in a randomized block design with 4 replicates. A plot size of 2 is used in this experiment. RRIC 102, RRIC 103, RRIC 121 and RRIM 600 have been used as controls,

Only 56 clones were used in this trial as there was no sufficient planting material from other clones due to poor budgrafting success after receiving from Malaysia.

Trial 2— In this the excess plants have been used in randomized block design with 4 replicates. But only one plant per plot was used. Two clones RO-PB2 3-449 and MT-C2 10-144 were lost due to poor grafting success. (N. E. M. Jayasekera, D. P. S. T. G. Attanayake, B. M. S. G. Peiris and R. A. S. K. Ranatunge)

REVIEW OF THE PLANT PATHOLOGY DEPARTMENT

By

A. de. S. LIYANAGE

SUMMARY

Wintering was protracted over a few months due to the wet weather conditions that prevailed during this period. Consequently, refoitation was also staggered and a mild attack of *Oidium* was evident in many areas, especially at higher elevations. The incidence of *Phytophthora* leaf fall and bark rot caused by the *Phytophthora meadii* was negligible except in some isolated pockets. The damage caused by *Colletotrichum gloeosporioides* to immature leaves of budded stumps and polybag plants was extensive particularly during the wet months of the year. *Corynespora* leaf disease caused by *Corynespora cassicola* was reported on *Hevea* for the first time in Sri Lanka, causing damage to leaves of budded stumps in polybagged plants. Reassessment of the incidence of white root disease indicated a lowering of the level of infection in estates compared to that recorded 6—7 years ago.

In the experiments which were carried out to find out the effect of fertilizer nitrogen on nodulation of cover crop, it was revealed that 3200 ppm $\text{NH}_4 \text{NO}_3$ was toxic to both *Desmodium* and *Pueraria*. Further it was noticed that around 200 ppm $\text{NH}_4 \text{NO}_3$ inhibited the nodule formation of *Mimosa*.

The estimated nitrogen fixation values for *Pueraria* in experimental sites were around 120 kg/ha/yr/ and only 10—30 kg/ha/yr in areas planted with natural rubber. It was found that *Mimosa* fixes around 45 kg/ha/yr under field conditions.

Studies on the effect of nitrogen on *Desmodium* in seedling agar, showed that around 256 ppm $\text{NH}_4 \text{NO}_3$ inhibited nodulation.

An experiment was conducted to find the effect of incubation time on acetylene reduction (AR) activity and it was noticed that there was a marked decrease in the expected AR value with time after the first hour of incubation.

Most mycorrhize spores were present in the surface layer of soil (0—10 cm depth) and there was a progressive decrease in spore numbers with increasing depth. Spores of *Glomus* spp., were abundant and *Acaulospora Gigaspora*, and *Sclerocystis* were found less abundantly.

It was observed that the greatest number of mycorrhizal spores were present in sites where the soil was disturbed.

Mycorrhizal plants inoculated with *Gigaspora margarita* were less susceptible to white root disease infection.

There was more litter under rain forest than under rubber trees. When the ground litter component was examined, grasses were the major species present but their litter contribution was small compared to mature rubber site. In young rubber, litter contributed by the *Pueraria* cover was comparable that of the mature rubber site. The maximum leaf area index was in the mature rubber site. In *Pinus* it was the lowest. When the water samples collected from different sites were analysed, a forest site had the highest potassium content in the through fall rain. A similar pattern was observed in relation to potassium in the stream flow and run off water samples of forest and mature rubber sites, respectively. Unfertilized smallholder sites had the highest number of fungal and bacterial colonies and also a higher rate of soil respiration. The commonest fungi isolated were *Penicillium citrinum*, *P. simplicissimum* and *Aspergillus flavus*.

DETAILED REVIEW

Staff

The Head of the Department and Deputy Director (Research), Dr A. de. S. Liyanage was on duty throughout the year. Mr C. K. Jayasinghe and Mrs N. I. S. Liyanage, Assistant Plant Pathologists, continued the work for the Ph.D Projects throughout the year. Mr A. H. R. Jayaratne, Experimental Officer, was promoted as Assistant Plant Pathologist on 1 April 1985 and was on duty throughout the year.

Mr Z. E. Irugalbandara Senior Technical Officer was transferred to the Rubber Chemistry Department on the 26 August 1985. Mr W. Amaratunga, Senior Technical Officer, returned to Sri Lanka after successfully completing the training course on Audio Visual Equipment and Aids Technique and Scientific Photography conducted by the City of Bath Technical College, England. He obtained distinctions in all four subjects offered for the examination. Senior Technical Officers Messrs A. Dharmaratne and W. A. D. D. S. Wettasinghe who was promoted on 24 July 1985, were on duty throughout the year. Mr B. Fernando who was also promoted to Senior Technical Officer on 24 July 1985 left to Brazil on 31 August to work on South American leaf blight on a Fellowship funded mainly by the International Rubber Research and Development Board (IRRDB) and the Rubber Research Board. Technical Officers Mr S. S. Warnapura, Mrs J. L. P. Wettasinghe and Mr E. A. T. Senadheera, Mrs Priyani Amarasakera, Clerk/Typist were on duty throughout the year.

Research students

Mr R. Weerasinghe who joined as a Temporary Research Assistant was recruited to the Institute as a Programmer Systems Analyst on 1 August 1985. Mr M. A. P.

K. Seneviratne and Mr V. Perera who joined the Department on the 1 February 1985, continued their post-graduate studies funded by the Rubber Research Institute and the National Resources Energy and Science Authority, respectively.

Misses Fiona Ferdinandes and Wasantha Pahalawattaarachchi, from the Ruhuna University worked for 6 months for their final year research projects entitled "A comparative population study of the *Endogonaceae*" and "An evaluation of the significance of VA mycorrhizae on root disease resistance of *Pueraria plants*", respectively under the supervision of A. de S. Liyanage and A. H. R. Jayaratne.

The following visits were undertaken by the staff of the Department.

Experimental	308
Advisory	39
Miscellaneous	<u>138</u>
Total	<u>485</u>

Meetings

A. de S. Liyanage attended the Agricultural Research policy Seminar held in Minneapolis, U.S.A., from April 15—25, 1985. It was sponsored by the ISNAR. He also attended the National Tissue Culture Symposium held at the University of Pertanian, Malaysia from October 15—17, 1985. First International Rubber Tissue Culture Workshop organised by the Rubber Research Institute of Malaysia (RRIM) for the IRRDB, Kuala Lumpur, on 17 October 1985. IRRDB Plant Breeders Meeting held at the RRIM from 17—18 October 1985 and the International Rubber Conference held in Kuala Lumpur, Malaysia from 21—25 October 1985. These visits were funded by the FAO. C. K. Jayasinghe, Assistant Plant Pathologist, attended a training course on the use of Isotopes and Radiation Techniques in Agriculture from 7 May—28 June, 1985 held in Vienna, Austria. It was sponsored by the FAO/IAEA,

A. de S. Liyanage and C. K. Jayasinghe presented a paper at a symposium organised by the Section D of the Sri Lanka Association for the Advancement of Science (SLAAS) on "Soil borne plant pathogens in rubber" and "Soil nitrogen fixation" respectively.

The Head of the Department served in the following committees.

Drafting Committee of Pesticides.

Pesticide Formulary Committee.

Board of study on Agricultural Biology at the University of Peradeniya.

Academic Syndicate of the Post-graduate Institute, University of Peradeniya.

Agriculture Group of the Atomic Energy Authority.

Scientific Committee of the Rubber Research Institute.

Training

The IRRDB has appointed A. de S. Liyanage as Liason Officer to co-ordinate the Plant Pathology Group of the member countries.

Mr Arief Budiman, Research Institute for Estate Crops, Sembawa, Sumatra Indonesia left on 16 April 1985 after completing a 6 month training course. Mr Agus Purwantara, Research Institute for Estate Crops, Bogor, Java, Indonesia left Sri Lanka on the 1 October after completing 4-month training course. Mr Pham Van Vinh, Rubber Research Institute, Vietnam, arrived on 3 July 1985 to undergo a training course for 1 year under a Fellowship awarded by the Food and Agriculture Organisation of the United Nations.

A. de S. Liyanage, C. K. Jayasinghe, Indrani Liyanage and A. H. R. Jayaratne were involved in training Superintendents and Assistant Superintendents of the Janatha Estate Development Board and the Sri Lanka State Plantation Corporation for the Diploma in Plantation Management, Assistant Rubber Controllers and Rubber Extension Officers.

A. de S. Liyanage, delivered 20 lectures in Plant Pathology to the M.Sc students of the Forestry Course conducted by the University of Sri Jayewardenepura.

Publications

Peries, O. S. and Liyanage, A. de S. (1985). *Hevea* diseases of economic importance and integrated methods of control. *Proc. Int. Rubb. Conf*, Kuala Lumpur, 1985 (in press).

Liyanage, A. de S., peries O. S., Dharmaratne, A., Fernando, B., Irugalbandara, Z. E., Wettasinghe, S. and Wettasinghe, P. C. (1985). Biology of *Oidium Hevea*, the powdery mildew fungus of *Hevea brasiliensis*. *Proc. Int. Rubb. Conf*. Kuala Lumpur, 1985 (in press).

Reports

Liyanage, A. de S. (1984). Annual Review of the Plant Pathology Department.

General

A mild attack of *Oidium* leaf fall was observed in most rubber growing areas. However, at higher elevations the incidence of *Oidium* leaf disease was severe in some estates in Ratnapura and Kegalle Districts. The damage caused by *Phytophthora* species was negligible except in some areas where *Oidium* infection was mild.

Corynespora leaf spot caused by *C. cassicola*, a new leaf disease in rubber, was detected in Dartonfield Estate, causing secondary leaf fall in polybagged plants. *Colletotrichum gloeosporioides* was also seen to affect immature leaves causing defoliation. These two diseases together could cause a severe set back to plant growth, under wet weather conditions or when exposed to factors that predispose the plants to heavy infection. The incidence of white root disease was low compared to the figures obtained in 1977—78.

Laboratory Investigations

Diseased specimens

The following specimens were sent to the Institute, for identification:

Identity of the disease	Number of specimens
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Fungi	6
Pests	1

Biology

Oidium hevea

Source of inoculum (0 / 76 / 2)

Spore germination increased substantially when senile spores were removed with 24 h. old inoculum being better than 48 h-old, irrespective of whether they were raised under field or laboratory conditions. (A. de S. Liyanage)

Effect of substrate (0 / 76 / 2)

Conidial germination was significantly better on host tissue than on inert surfaces. However, no differences were observed in germination of conidia on clones tolerant and susceptible to *Oidium*. (A. de S. Liyanage)

Effect of water (0 / 76 / 2)

Provision of water as a fine mist enhanced spore germination on inert surfaces compared to large droplets of water. Conidia immersed in water for 8h showed poor conidial germination. (A. de S. Liyanage)

Effect of temperature (0 / 76 / 2)

Exposure of conidia to high temperature reduced their viability appreciably while they remained turgid and viable at lower temperatures. Germination was best around 30°C while a slightly lower temperature of 25°C was better for germ tube growth and sporulation was also better at this temperature. (A. de S. Liyanage, A. Dharmaratne and P. C. Wettasinghe)

Effect of relative humidity (0 / 76 / 2)

Conidia formed at 25° C and 30° C at 90% relative humidity (RH) showed good germination compared to those formed at 40% relative humidity at the same temperatures. However, conidia formed at lower temperatures of 15° C and 20° C at 40% RH showed better germination than those exposed to 90% RH. Best germ tube growth was seen on conidia formed at room temperature under high humidity conditions. (A. de S. Liyanage and S. Wettasinghe)

Effect of light (0 / 76 / 2)

Spore germination was better under conditions of artificial light than in its absence. The sporulation was also better under conditions of light. Exposure to ultraviolet and sunlight for a short period of 1h inactivated the germination of spores. (A. de S. Liyanage and B. Fernando)

Effect of clones (0 / 76 / 2)

At the initial stages there was no growth difference between clones but 24h after inoculation better growth of the fungus was observed on a susceptible clone, PB 86 compared to RRIC 103 which was tolerant. A similar pattern was observed when sporulation was assessed. (A. de S. Liyanage and Z. E. Irugalbandara)

Phytophthora meadii

Survival on petioles of rubber in wet soil (P / 76 / 1)

Superficial sporangia were not observed at any time on the petioles 8 months after placing in soil with a 50% moisture holding capacity (MHC). When macerated and examined under the microscope fungal mycelium was seen in the cells up to about 3 weeks. They were mostly intra-cellular.

The fungal mycelium was seen to lyse from about the 14th day and by about the 44th day no mycelia were seen in the cells. From the 2nd week onwards Chlamydo-spores were formed in the cells. These were small and thin walled to begin with and increased in size with time. The number of chlamydo-spores also increased till about the 3rd month after which the chlamydo-spore wall began to thicken. The walls were at least 5—7 times thicker than those formed on artificial agar media. *P. meadii* generally produced less chlamydo-spores than *P. Palmivora* on artificial media, but on petioles, chlamydo-spores were produced in abundance. Usually one chlamydo-spore was seen per cell but occasionally two per cell.

Chlamydo-spores were observed in cells up to the 7 month, after which the Petioles started to decay gradually and only the outer epidermal area remained.

The pith has decayed fully at this stage. No sporangia were observed on Petioles at any time. Therefore, the propagules that survive in the petioles are primarily Chlamydo-spores.

With Soils that were held periodically as wet and dry soils, the succession of propagules was almost the same. The mycelium disintegrated completely in 30 days in dry soil and the number of chlamydo-spores was more compared to that of wet soil. The Chlamydo-spores formed on petioles were thick walled from about the 4th month and some were even thicker in dry than in moist soil. Chlamydo-spores were observed only up to about the 6th month. The petioles disintegrate faster than when held at 50% MHC

The above experiment was conducted at three temperature regimes; 28°C, 25°C and 20°C. There was hardly any difference in the number and size of chlamydo-spores formed at 28°C and 25°C. At 20°C the chlamydo-spores were more abundant but the size was smaller. The walls thickened with time in all treatments. Mycelial fragments were not observed after about the 44th day.

At any stage or under any condition oospores were not formed even though the infected petioles were placed in soil where *Trichoderma* species were present.

When macerated petioles were baited with tender petioles of rubber it was possible to re-isolate the fungus up to about 3-3½ months time. Macerated portions were mixed with PVPH medium and it was possible to re-isolate the fungus up to about 4-5 months. Baiting with cacao pods or pod discs had to be abandoned as it was not feasible to get a continuous supply of baiting material. (N. I. S. Liyanage)

Corynespora cassicola

Effect of temperature (C/85/1)

Germination of conidia was slow at low temperatures compared to high temperature of 30°C and 40°C. However, with the increase in incubation period to 12h germination increased remarkably at all temperatures except at 15°C. Highest germination was recorded at 30°C. (A. de S. Liyanage, A. H. R. Jayaratne and S. S. Warnapura)

Effect of relative humidity (C/85/1)

Conidia exposed to 100% RH germinated well and rapidly in 3h at 30°C. However at 50% RH none of the spores germinated. (A. de S. Liyanage, A. H. R. Jayaratne and S. S. warnapura)

Clonal susceptibility (C / 85 / 1)

A technique was developed using a standardized spore suspension to evaluate clonal resistance to *Corynespora* using a detached leaf technique, in the laboratory. Leaves of clones of RRIC 100, 103, 104, 110, 117, 121, 130 and PB 86 were tested so far. All the clones showed symptoms of the disease within 24h. Infection spread with time and typical symptoms of vein necrosis was observed in many clones. Use of inoculum as a dust did not give good results. (A. de S. Liyanage, N. I. S. Liyanage and A. Dharmaratne)

Epidemiology

Corynespora cassiicola

Spore distribution (C/85/1)

Spore distribution was studied with a Hirst spore trap. The release of spores began around 0600 h and reached a peak around 1000 h and tailed off about 1800 h. Spores were not usually released at night. (A. de S. Liyanage, A. H. R. Jayaratne and E. A. T. Senadheera)

Phytophthora meadii

Survival of spores (P / 76 / 1)

When infected petioles were placed in soil in a mature rubber plantation. (field condition), petioles disintegrated in 5-5½ months time. Propagules were only chlamydospores and no oospores were seen. Mycelial fragments were seen only up to 30 days. Chlamydospores thickened with time and the number and size are similar to that recorded under laboratory conditions. Re-isolation was possible up to 3½ months time (N. I. S. Liyanage)

Survival of propagules in naturally infected soil from (P / 76 / 1)

The soil was obtained from areas under infected trees and healthy trees. The fungus was isolated up to 2 months only by baiting with cacao pods. PVPH medium was used subsequently and the period could be extended to 3½ months. Cacao pod discs were not suitable due to frequent contamination. Under healthy trees *Phytophthora* fungus was not observed by baiting with cacao pods or by plating soil on agar. Soil plating was done instead of soil dilution method it proved to be a satisfactory method. (N. I. S. Liyanage)

Survival of mycelium in soil (P / 76 / 1)

When mycelial mats were placed on nylon mesh and placed in soil chlamydospores were formed rapidly. Mycelium started to disintegrate quickly and only

a very few sporangia were observed in the 1st week. These sporangia germinated indirectly giving rise to new sporangia. This was very frequently observed. Chlamydo-spores started forming from the 7th day onwards. In soil kept at 50% MHC decay of mycelium was slower than when placed in soil subjected to wet and dry condition. At 50% MHC viable mycelial fragments were observed upto about 30 days whereas in dry soil lysis of mycelia was faster and 100% lysis was observed in 14 days time. Very few of the chlamydo-spores formed were seen to germinate on the nylon mesh by producing several sporangia.

When pieces of nylon mesh containing mycelial fragments were placed on PVPH medium, it was possible to re-isolate the fungus up to 3 weeks only, in soil held at 50% MHC and for about 2 weeks under wet and dry condition. Many contaminations mainly by bacteria were noted. (N. I. S. Liyanage)

Host-parasite relationships

Corynespora cassiicola

Histopathology (C/85/1)

Naturally infected leaves of the clone RRIC 103 and 121 were fixed to examine the mode of penetration of the fungus. Leaflets of these clones were artificially inoculated to examine the different stages of entry of the fungus. (A. de S. Liyanage, N. I. S. Liyanage and P. C. Wettasinghe).

Control

Corynespora cassiicola

Efficacy of fungicides (C/85/1)

Thirteen fungicides and a water control were sprayed on to detached leaves at the concentration recommended by manufacturers to control similar diseases. Fungicides were tested in the laboratory *in vitro* and *in vivo*. Two methods of application were also tested. In these preliminary trials application of Antimucin Dithane M45, Captan and Benlate+Thiram were effective than the rest. (A. de S. Liyanage, C. K. Jayasinghe and Pham Van Vinh)

Field Experiments

Control

Phytophthora meadii

Efficacy of fungicides (P/84/1)

A new fungicide SAN 371 F4 PA 09 was tested in the field with the recommended fungicides Antimucin, Aliette, Difolatan and Ridomil. Virgin panels of naturally infected trees were selected for this experiment, to assess their curative and preventive effects. SAN 371 F4 PA 09, Difolatan at a high concentration of 1.6% and Antimucin have shown promising results both as preventive and Curative fungicides. This trial

is in progress and weekly applications of fungicide are being applied. (N. I. S. Liyanage and S. S. Warnapura)

Control

Rigidoporus lignosus

disease incidence

A survey was done to reassess the incidence of white root disease in 19, 10 and 10 estates in the Kalutara, Kegalle and Kelani Valley District, respectively (Table 1).

Table 1. *Extent infected with white root disease in different estates*

Estate	Infected hecterage (%)
Woodent	8.33
Udabage	5.17
Dewalakanda	4.62
Elston	2.28
Clunes	2.09
Salawa	1.86
Maha Oya	1.71
Udapola	1.27
Sunnycroft	1.09
Panawatta	0.96
St. George	4.43
Perth	3.91
Kiriwanaketiya	3.34
Culloden	2.99
Padukka	2.87
Eladuwa	1.92
Neuchatel	1.81
Yatadola	1.80
Delkeith	1.48
Mohamedi	1.44
Paiyagala	1.43
Geekiyanakande	1.38
Ambetenne	1.33

(Continued)

Millewa	1.15
Pimbura	0.99
Frocester	0.88
Mirishena	0.29
Ellakanda	0.20
Pallegama	2.33
Parambe	2.30
Yatideriya	0.84
Ambadeniya	0.76
Hatbawa	0.76
Higgoda	0.68
Eadella	0.33
Etana	0.25
Bidscar	0.21
Golinda	0.15

It was observed that there is a marked reduction in the extent of damages compared to the level of infection in these estates in 1977-78. (A. de S. Liyanage S. S. Warnapura and E. A. T. Senadheera)

Treatment of infected patches and disease incidence (F/76/4)

This experiment has now been in progress for 5 years at Stokesland and Panawatta Estates and four and a half years at Culloden, Yatadola, Elpitiya, Elston, Udabage Muwankanda and Pallegama Estates. Retention of infected roots in the field. Grubbing alone has not reduced infection. Removal of two rows of plants on the periphery of patches and application of sulphur gave a reduction of the disease incidence in most experimental locations (Table 2). This reemphasises the importance of proper methods of clearing infected roots and application of sulphur. (A. de S. Liyanage S. S. Warnapura and E. A. T. Senadheera)

Table 2. Cumulative infection of *R. Iignosus*

Estate	+G+S	+G-S	-G+S	-G-S
Culloden	0	1.9	1.0	3.0
Yatadola	0	0	0.7	2.8
Elpitya	0	4.5	2.1	13.4
Elston	0	0	0	0
Udabage	0	6.6	26.2	4.8
Muwankanda	0	18.7	5.8	13.0
Pallegama	2.0	12.2	0	4.4

+G+S = Roots grubbed and sulphur applied
+G-S = Roots grubbed and sulphur not applied
-G+S = Roots not grubbed and sulphur applied
-G-S = Roots not grubbed and sulphur not applied

Effect of nitrogenous fertilizers and sulphur (F / 81 / 12)

This experiment has been in progress for more than 3 years and the incidence of the disease in all experimental plots was negligible so that it is not possible to come to any conclusions. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Planting distance and disease incidence (F / 80 / 1)

Previous experiments have shown that the incidence of white root disease was generally high if replanting is done using the same spacing of the old stand. This trend was further emphasised (Table 3) in a trial laid down at Mapalagama Estate which as now in its fifth year. (A. de S. Liyanage, S. S. Warnapura and E. A. T. Senadheera)

Table 3. Cumulative loss of trees at different planting distance (F / 80 / 1)

Planting distance (m)	Cumulative loss (%)
4.6 x 4.9	2.3
3.7 x 6.1*	4.5
3.1 x 7.3	3.4
2.4 x 9.2	2.7

* Planting distance of the old stand

Nitrogen Fixation

Rhizobium spp.

The effect of fertilizer nitrogen on nitrogen fixing efficiency and construction of nitrogen response curves (NF / 84 / 1)

Experiments were carried out in Agalawatta soils. Basal nutrients without nitrogen were added on to soils and the effect of nitrogen on nodulation was observed using NH_4 NO_3 solutions equivalent to 0, 50, 100, 200, 400, 800, 1600, 3200 ppm NH_4 NO_3

The results were similar to those of previous experiments with *pueraria* and *Desmodium* and it was found that 3200 ppm NH_4 NO_3 was having a definite toxic effect on both crops.

Another experiment was carried out using *Mimosa invisa* as the host plant in Agalawatta soil series. Nitrogen was given as NH_4 NO_3 in eight concentrations viz 0, 50, 100, 200, 400, 800, 1600 and 3200 ppm and there were four replications of each treatment.

The results were obtained after 2½ months and nodule formation was inhibited around 200 ppm NH₄ NO₃. Further it was noticed that there was a great reduction in acetylene reduction activity at this concentration. The dry matter yield did not give the expected curve as *Desmodium* and *Pueraria*. (C. K. Jayasinghe, S. Wettasinghe and P. C. Wettasinghe)

Estimation on nitrogen fixation (NF/84/1)

Experiments were conducted to estimate the nitrogen fixation capacities of *Pueraria Phaseoloides* and *Mimosa invisa* in rubber growing areas and experimental sites. Here with acetylene reduction assay as described by Turner and Gibson 1980 was used for the estimations.

The estimated fixation value for *P. phaseoloides* in experimental fields was around 120 kg/ha/yr. But in natural fields under rubber the estimated values were around 45 kg/ha/yr for *Mimosa* and between 10-30 kg/ha/yr for *Pueraria*. This experiment was repeated at more sites and is in progress. (C. K. Jayasinghe, S. Wettasinghe and P. C. Wettasinghe)

Effect of N on nodulation of D. ovalifolium in seedling agar (NF/84/1)

Seedlings of *Pueraria* and *Desmodium* were introduced on to seedling agar in sterile large test tubes. NH₄ NO₃ was added in different concentration viz. 0, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048 and 4096 ppm in addition to the common basal nutrient mixture. One ml of *Rhizobium* cowpea complex strain CB 756 suspension was added to each test tube on the following day. Observations were made on nodulation and dry matter yields of the plants (Table 4).

Table 4. *The effect of fertilizer nitrogen on dry matter yield and nodulation of D. ovalifolium*

NH NO ₃ ppm	Dry matter yield (g)	Nodulation
0	0.0055	++++
2	0.0097	++++
4	0.0109	++++
8	0.0118	++++
16	0.0142	++++
32	0.0145	++++
64	0.0209	++++
128	0.0342	++++
256	0.0543	-----
512	0.06224	-----
1024	0.0341	-----
2048	whole plant was dried	-----
4096	whole plant was dried	-----

+ nodules were present; — nodules were absent

It was shown that around 256 ppm NH_4NO_3 inhibits the nodule formation in *Desmodium*. (C. K. Jayasinghe, S. Wettasinghe and P. C. Wettasinghe)

The effect of the incubation time on the acetylene reduction activity of P. phaseoloides (NF/84/1)

An experiment was carried out to find the effect of incubation time on the acetylene reduction activity (AR) of *Pueraria* (Table 5). Root systems were incubated upto 11 h and it was noticed that there was a marked decrease in expected AR value for each incubation hour from the first hour. (C. K. Jayasinghe, S. Wettasinghe and P. C. Wettasinghe)

Table 5. *Production of ethylene with different incubation times*
Sampling time (h)

Ethylene produced (μ moles)	1	2	3	4	5	6	7	9	11
	7.95	11.83	13.81	15.85	16.74	17.76	19.27	21.01	21.10
Rate of charge (per hour)	7.95	3.38	2.48	2.04	0.89	1.02	1.51	0.91	0.035

Studies on available nitrogen in fertilized soils (NF/84/1)

Soils were treated with NH_4NO_3 in different concentrations viz 0, 50, 100, 200, 400, 800, 1600 and 3200 ppm NH_4NO_3 . Available nitrogen (ammonium nitrogen and nitrate nitrogen) was determined (Table 6) using the KCl extraction method. (C. K. Jayasinghe, S. Wettasinghe and P. C. Wettasinghe)

Table 6. *Available nitrogen content in fertilized soils*

NH_4NO_3 (ppm)	Available N (ppm)
0	15.43
50	23.26
100	41.24
200	64.57
400	88.27
800	132.73
1600	247.46
3200	551.03

Cumulative acetylene reduction activity of P. phaseoloides (NF/84/1)

P. phaseoloides plants were established in 0.6 x 0.6 m plots which were lined with concrete slabs. The basal fertilizers were applied without nitrogen and the first assessment was made after one month. This experiment is in progress. (C. K. Jayasinghe, S. Wettasinghe and P. C. Wettasinghe).

Diurnal variation in AR activity of P. phaseoloides (NF/84/1)

Observations on AR activity, dry matter yield, and nodule dry weight were made hourly for 24 h in the field. Results are being processed. (C. K. Jayasinghe S. Wettasinghe and P. C. Wettasinghe).

Investigations on Mycorrhizae

Distribution and variation of VA mycorrhizal spores

An experiment is in progress to determine the distribution, abundance and seasonal variation of VA mycorrhizal spores in different rubber growing soil types. The wet sieving-decanting technique was used to isolate the VA mycorrhizal spores from the soil. So far two samplings have been done.

Soil samples collected every 3 months (two samples collected so far) revealed that the most number of spores were present in the 0—10 cm depth. A decrease in spore number was observed at 10—20 cm, 20—30 cm and 30—40 cm depths. At 50 cm depth the numbers were very low. *Glomus spp.*, were the most abundant type in all the sites so far examined. *Acaulospora*, *Gigaspora* and *Sclerocystis* were also found in much lesser frequencies. (A. H. R. Jayaratna, A. de S. Liyanage, P. C. Wettasinghe and Fiona Ferdinandes)

Population studies

In another study VA mycorrhizal population were compared between three rubber sites and a forest site. This experiment showed that the number of VA mycorrhizal population increased when the soil was disturbed. The immature rubber site which is the most disturbed area had the highest number of spores compared with the forest site. (A. H. R. Jayaratne, A. de S. Liyanage, P. C. Wettasinghe and Fiona Ferdinandes)

Effect of VA mycorrhizae on root disease incidence

A greenhouse pot experiment is in progress, to evaluate the role of VA mycorrhizae on white root disease and its spread on *Hevea* and on *Pueraria* plants.

Plants were grown in sterilized soil and the inoculations were done at three different times.

- (a) Both inoculum together.
- (b) Mycorrhizal inoculation, when plants have developed 50% infection with *R. lignosus*
- (c) Inoculation with *R. lignosus*, when the plants have developed over 50% infection with mycorrhizae.

The assessments done have shown that the mycorrhizal plants (inoculated with *Gigaspora margarita*) were significantly less susceptible to white root infection. This will be a very important observation if the mycorrhizal *Hevea* plants too show the same response to white root disease. (A. de S. Liyanage, A. R. Jayaratne and Wasantha Pahalawattaarachchi)

Storage of soil pellets (M/85/SP/1)

Another experiment is in progress to evaluate the production and storage of endomycorrhizal infected soil pellets to be used in large scale field experiments.

Soil pellets were prepared using clay and sand (inoculum obtained from pot cultures). These pellets were sown with *Pueraria* seeds at different time intervals to check the viability after this period. (A. H. R. Jayaratne).

Miscellaneous

Canopy litter (VP/85/1)

The canopy litter components were continued to be measured in all five sites and the nutrients of each component at every site is being calculated monthly. The litter fall in the rain forest site is more than that of the rubber sites and the *Pinus* site. There is a seasonal pattern of litter fall in the rubber sites and there is no correlation between rainfall and litter fall for the rubber sites. The mature rubber site (clone RRIC 103) showed continuous litter fall although the peak was at the beginning of the year. The smallholder site (clone RRIC 45) had a relatively low litter fall at the beginning of the year when compared to the mature rubber plantation. The *Pinus* site had a large contribution of non-*Pinus* litter as it was overgrown with other species. (V. Perera N. Gunatilleke, A de S. Liyanage and R. Munasinghe)

Ground litter (VP/85/2)

The ground litter components were measured in all five sites. Grasses occupied the major component in the mature rubber site, but the litter contribution by grasses was small, when compared to the rubber litter. In the young rubber site

the litter contribution of ground cover *Pueraria* is as large as rubber. The rubber litter in the young rubber site was relatively small. The *Pinus* site and the forest site had almost identical litter quality as the canopy traps unlike the tree rubber sites. The nutrient analysis of the components are being carried out monthly. (V. Perera, N. Gunatilleke, A. de S. Liyanage and R. Munasinghe)

Biomass (VP/85/3)

Growth measurements related to the biomass of the standing crop vegetation have been measured once in 5-6 months. Tree height in the rubber and *Pinus* sites have been calculated. The unbranched timber height and the height of the highest branch has been calculated.

The girth at breast height (GBH) has been calculated in all sites including the forest site. In this site 10, 10 x 10 m plots have been selected. All the plants from 0-5 cm have been classified according to the height classes upto 300 cm. In all the rubber and *Pinus* sites the basal girth has been calculated. There is no correlation between plant height and (1) Basal girth (2) (GBH) in all sites.

Growth measurements (VP/85/4)

Growth measurements related to biomass of the ground vegetation have been measured. The weeds in the mature rubber and smallholder sites, the ground cover/weeds in the young rubber sites have been measured for Leaf Area Index, Leaf Area ratio, Specific Leaf area and dry matter content. The highest LAI is among the rubber sites was the mature rubber site which was infested with grasses and lowest was in the young rubber site. The mixed ground vegetation of the smallholder had an intermediate value. In the *Pinus* site the dense mat of needles prevented weed growth, but wherever the tree crop stand was poor weed growth had set in. Therefore, the LAI of the *Pinus* site was the lowest among all sites.

Nutrients in water samples (VP/85/5)

Nutrient analysis has been carried out on water samples collected from throughfall, streamflow, run off in all sites. The forest site had the highest content of K while there was no significant difference between the Ca and Mg contents of the other sites of the throughfall water samples. Run off water samples from the mature rubber site had more K than the streamflow in the adjacent forest site on any given rainy day. The highest volume of throughfall water as a percent of precipitation was in the mature rubber site around (95%) while the *Pinus* site had about 80%. In the young rubber, smallholder and forest sites it ranged from about 65%—70%.

Microbial population and activity (VP/85/6)

The frequently occurring fungi and bacteria were isolated from soils of the five sites and the litter. The unfertilized smallholders site had a higher number of fungi and bacterial colonies and a higher rate of soil respiration than the fertilized mature rubber site.

Penicillium citrinum, *Penicillium simplissimum* and *Aspergillus flavus* were the commonest occurring fungi obtained by soil dilution plate method. (V. Perera, N. Gunatilleke, A. de S. Liyanage and R. Munasinghe)

REVIEW OF THE SOILS AND PLANT NUTRITION DEPARTMENT

By

N. YOGARATNAM

SUMMARY

The study of the responses of rubber trees factors affecting the supply of nutrients and water and to soil management practices has been the main concern of the department.

The currently recommended rates of fertilizer for immature rubber are considered sufficient for growth and latex production during the early mature period of replantings. In some instances, yield responses to application of K appeared to show differences between clones, suggesting that fertilizers to mature rubber may also have to be clone specific.

In the small holder sector where fertilizers may not have been applied for several years, it may be possible to obtain 23% yield increase with application of standard fertilizer mixtures and 50% increase with fertilizer on the basis of soil and leaf analysis, thus emphasising the importance of fertilizers to mature rubber on a discriminatory basis.

Dry matter production and nutrient uptake in both *Pueraria* and young rubber were found to increase with increases in the levels of soil moisture. Dead mulch was found to be superior to legumes and naturals in promoting girdling of immature rubber in the field.

Soil and foliar surveying programme continued to be popular in providing fertilizer recommendations to mature rubber in the estate sector. 11,333 hectares were surveyed this year. Anticipated savings on fertilizer bills would be approximately rupees two million and five hundred thousand in the estate sector.

Staff

The Head of the Department Dr N. Yogaratnam, the Agricultural Chemist, Dr M. K. S. A. Samaraweera and the Assistant Soils Chemist, Mrs Lalani Samarappuli were on duty. Mr D. M. A. P. Dissanayake joined the Department in July as an Assistant Soils Chemist. Mr Manitha Weerasureiya, Temporary Research Assistant, continued his studies for the M. Phil degree of the University of Peradeniya and his work was supervised by N. Yogaratnam.

The Experimental Officers Messrs W. C. Dayaratne, A. M. A. Perera and F. P. W. Silva and the Technical Officers Miss I. Denawake and Messrs. J. G. de Mel, C. K. Maheepala, S. N. Silva, P. Karunadasa, U. Mitrasena and C. J. Adikaram were on duty throughout the year.

Mr H. D. S. P. Perera joined as an Experimental Officer, Messrs Anusha Jayaweera and A. N. Yakandawala as Technical Officers and Luxmi Rupasinghe as temporary Stenographer. Miss H. V. K. Rodrigo was transferred to the Rubber Chemistry Department and Manel Mahanama was transferred to this Department from the Rubber Chemistry Department, Miss D. Udaratagedera resigned from the services of the Institute in September.

IAEA Fellowships

M. K. S. A. Samaraweera and Lalani Samarappuli were awarded fellowships under IAEA training programme, M. K. S. A. Samaraweera left for Australia in October for a 12-months Post-Doctoral study in mineral nutrition. Miss Lalani Samarappuli will leave for USA in late March 1985 for post-graduate studies at the University of California, Davis, on some aspects of soil-plant-water relations.

Research students

Research students from the Faculty of Agriculture, University of Peradeniya and Ruhuna worked on the following research projects in partial fulfilment of the requirements of the specialization course in soil science, under the supervision of N. Yogaratnam.

- | | |
|-----------------|--|
| De Soyza, Susil | - Variation in the N,P,K,Mg and Ca contents of soil, leaf and latex in <i>Hevea</i> plantations. |
| Liyanage, N. J. | - Effect of soil types and cultivars on leaf N,P,K, Ca and Mg concentrations. |

Mel, W. A. D. - Some aspects of micronutrients in the nutrition of *Hevea*.

Samaraweera, D. N. - Some aspects of soil moisture

Visits

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

N. Yogaratnam, attended the International Rubber Conference held in Kuala Lumpur, Malaysia, in October and presented a paper entitled "Micronutrients in the nutrition of *Hevea* under Sri Lankan conditions".

N. Yogaratnam was on a study tour in Malaysia and visited the Rubber Research Institute of Malaysia, Prang Besar Research Station, Asean Bitulu Fertilizer SDN BHD, Agricultural Research Station of Saime Darby, Bristol estate and RRIM field experimental sites.

Meetings

The research staff participated in the following:

Seminars and field days

SLSPC Agricultural advisors seminar. Colombo.

JEDB Kegalle region Agricultural advisors meeting, Kegalle.

SLSPC Ratnapura, Galle and Kalutara regions planters meetings.

Training Programmes

Rubber Extension Officers of the Advisory Services Department.

Rubber smallholders under the Smallholder Rubber Rehabilitation Project (SRRP).

Agricultural Officers of the Ceylon Fertilizer Corporation.

Working groups and Committees

Co-ordinating Committee on Fertilizer Supplies of the Ministry of Plan Implementation.

Technical Committee of the Tender Board of the Ceylon Fertilizer Corporation.

Technical Committee of the Sri Lanka Standards Institution.
Agriculture group of the Atomic Energy Authority.
Working group on experimental cultivation of Tea and Rubber in the Mahaweli area.

Publications

Yogaratnam, N. (1985). Micronutrients in *Hevea* nutrition under Sri Lankan conditions. *Proc. Int. Rub. Conf. Kuala Lumpur 1985*. (in press)

Reports

Yogaratnam, N. and Perera, A. M. A. (1985) Annual Review of the Soils and Plant Nutrition Department.

Laboratory Investigations

Analytical methods (AC/85/1 and 2)

Distribution of mineral ions in latex

Latex samples collected in replicates of four from twelve healthy trees of RRIC 100, RRIC 101 and PB 86 into vials kept in ice, were centrifuged at 12,000 rpm. Serum and lutoid fractions in two replicates were bigested using the selenium/sulphuric acid method while the other two were analyzed by the Trichloroacetic acid (TCA) method. Serum and lutoid fractions that remained in the centrifuged vials were transferred separately into two other plastic vials containing 2.5 ml of 5% TCA and 4 ml of 0.1% NH₄. The Technicon Autoanalyzer was used for the determination of N,P and K and the varian Techtron Atomic Absorption Spectrophotometer for Ca, Mg, and K and the Corning Colorimeter 253 to determine the sucrose content. This study will be repeated until consistant results are obtained. (M. K. S. A. Samaraweera, H. D. S. P. Perera, C. K. Maheepala and C. J. Adikaram)

Mineral and sucrose content of rubber trees

Latex samples from conventionally tapped ($\frac{1}{8}$ S, d/3) trees were collected from six points on tree trunk of clones RRIC 100, RRIC 101 and PB 86 into six centrifuge vials kept in ice and were centrifuged at 12,000. The lutoid fraction in each replicate was marked and the rubber and serum components were removed. Lutoid fractions that remained were analyzed for mineral ions and sucrose contents by the TCA method. Creamy rubber samples were removed from the centrifuged vials dried at 60°C and then analyzed for mineral ion contents by the dry ashing method. Sucrose contents of these components at different positions were also measured. This study will be repeated. (M. K. S. A. Samaraweera, H. D. S. P. Perera, C. K. Maheepala and C. J. Adikaram)

Soil-plant -water relations (SM/85/1 and 2, SM/83/2)

Moisture stress in Pueraria

The effects of moisture at five different depths of soil and two levels of fertilizer mixture N, P, K Mg on growth of *Pueraria phaseoloides* were studied in a pot trial in Dartonfield (SM/85/1). Conditions similar to field situation were simulated by maintaining dry surface soil and wet sub-soil.

Dry matter production was significantly influenced by different treatments. The highest dry matter production was recorded with sub-soil layer wet at 20 cm depth. There was also a significant linear positive effect of moisture levels on root development and root/shoot ratio (Table 1). Root length of *Pueraria* increased at the rate of 0.05 cm for an increase in moisture level by one unit. Applications of N,P,K fertilizer mixture had an overall advantage in increasing root/shoot ratio of *Pueraria* over the on fertilizer treatment. (L Samarappuli)

Table 1. *Effect of moisture at different depths on root/shoot ratio in Pueraria phaseoloides*

Depth (cm)	Root/shoot ratio
D ₀	0.8046
D ₂₀	0.8352
D ₄₀	0.8653
D ₆₀	0.9336
D ₈₀	1.4571

Moisture stress in immature rubber

The effects of four levels of moisture and 2 levels of fertilizer N, P, K, Mg on growth and nutrient uptake in immature rubber plants were studied in a pot experiment (SM/83/2). Soil water tension in the pots was maintained by tensiometers that were installed in each container.

Dry matter production was found to increase with a decrease in the soil water tension from 80 centibars to 5 centibars. It was also observed that higher available water increased stem diameter in immature rubber (Table 2).

Table 2. *Effects of moisture and fertilizers on stem diameters of young Hevea plants*

Treatments	Pre treatment stem diameter	Stem diameter after 12 months
	(cm)	(cm)
Tension 80 centibars, no fertilizer	0.87	1.43
Tension 55 " "	0.86	1.62
Tension 30 " "	0.91	2.13
Tension 5 " "	0.98	2.25
Tension 80 " with fertilizer	0.88	1.97
Tension 55 " "	0.83	2.11
Tension 30 " "	0.90	2.21
Tension 5 " "	0.91	2.91

Maintaining soil moisture status at 5 centibars was found to have an overall advantage in increasing the height of plants in comparison with the other moisture treatments. Increasing the availability of water also enhanced nutrient uptake. At both 5 and 30 centibar tension, uptake of N, P, K and Mg was higher than at 55 and 80 centibar tension. (L. Samarappuli, I. Denawake and U. Mitrasena)

Soil drying temperature on physico-chemical characteristics

The effect of oven drying at 40°C, 50°C, and 60°C was compared with air drying at ambient temperature (the normal practise at RRISL) on some physico chemical properties of soil in experiment SM/85/2. Moisture loss varied significantly between different soil series at different temperatures. Oven drying gave lower values for total N and also significantly different values for soil pH, and CEC. No differences were however observed on particle size distribution, organic carbon, exchangeable Mg, Ca and K and available P, suggesting that in chemical analytical work involving these parameters, oven drying of soil samples can be done as this would save time. (L. Samarappuli)

Nutrient deficiencies in sand culture

Study on nutrient deficiency symptoms done in 1980 was repeated to obtain more information. Rubber seeds from different clones were germinated in specially prepared nutrient free sand. Seedling of equal heights from this were transplanted in pots containing nutrient free sand in a green-house. Plants are being treated with specially prepared Hewitt's solution. There are eight treatments replicated five times making in all 40 plots. The nutrients tested include N, P, K, Ca, Mg and S. Girth and height measurements were recorded regularly and leaves were collected at different stages of deficiencies and analyzed for their chemical composition. (M. K. S. A. Samaraweera, H. D. S. P. Perera C. K. Maheepala)

Field Experiments

Response to fertilizers (F/76/1, 4, 5 and 8)

Experiment F/76/1, started at Pembroke State Plantation compared the effects of 5 levels, N, P, K and Mg on growth and yield of PB 86 growing in Boralu soils in a central composite second order design. Analysis of girth data indicates a significant 1st order term only. As the 2nd order and lack of fit terms are also relatively high, it appears that the expected homogeneity within blocks does not exist, thus resulting in inconsistent treatment effects over the past few years. This experiment is therefore being terminated. (N. Yogaratnam and F. P. W. Silva)

In experiment F/76/4 where the effects of 3 levels of N and K on growth and yield were compared in clones PB 86, RRIC 100, 101 and 102 there had been significant ($P < 0.01$) girth increases due to application of N at level 1 (normal recommended rate), and no further significant increase was observed with N_2 level of nitrogen (Table 3). Application K fertilizers however indicated significant ($P < 0.05$) K x clone interaction (Table 4).

Table 3. *Effect of three levels of N on growth of cultivars PB 86, RRIC 100 101 and 102*

Levels of nitrogen	Girth (cm)
N_0	54.78
N_1	56.89
N_2	57.55
LSD	1.21

Table 4. *Effect of 3 levels of K on growth of cultivars PB 86, RRIC 100, 101 and 102*

Cultivars	...	K_0	K_1	K_2
PB 86	...	46.36	55.4	56.15
RRIC 100	...	52.48	57.38	58.81
RRIC 101	...	54.88	58.56	58.83
RRIC 102	...	53.55	61.66	63.53
		LSD (for levels of K — 2.41		
		(for clones) — 8.252		

With regard to yield, there had been significant ($P < 0.05$) increases in yield with application of K at level 1 and further significant increase at level 2 (Table 5). A significant ($P > 0.05$) interaction between levels of N and clones in the field were also recorded in this experiment. These results seem to suggest

that the currently recommended level of N is sufficient for optimum growth of PB 86, RRIC 100, 101 and 102 but for optimum yield, the level of nitrogen may have to be changed depending on the cultivar planted. Potassium requirements on the other hand appear to differ between clones for growth but for yield the requirements of all the clones appear to be the same and would be much higher than the presently recommended rates. (N. Yogaratnam and J. G. de Mel)

Table 5, Effect of levels of K on yield in PB 86, RRIC 100, 101 and 102

Levels of K	Yield (kg/ha)	percentage increase over control
K ₀	1557	100
K ₁	1779	114
K ₂	1894	122

Experiment F/76/5 done at Eladuwa State Plantation to study the effects of three levels of K and tapping systems on the performance of clones PB 86 RRIC 100 and 101, showed significant interaction ($P < 0.05$) between levels of K and clones on girthing (Table 5). But the yield data showed significant interaction ($P > 0.05$) between K, clones and tapping systems suggesting a relationship between all three treatments on yield. Further analysis is being done to study this interaction.

Chemical analysis data showed significant decrease in leaf P and Mg with application of K at the first level ($P < 0.01$) and no further change was seen at the 2nd level. Leaf N and Ca were not influenced by applied K. Similar effect was observed for leaf K. Clones PB 86 RRIC 100 and 101 showed significant differences ($P < 0.01$) in leaf Mg content with RRIC 100 showing the highest value and RRIC 101 the lowest.

Latex K was increased significantly by application of K at the first level ($P < 0.001$) and no further increase was shown with increase in K level. On the other hand latex Mg showed a significant decline in concentration at the first level of applied K ($P < 0.01$). Latex Ca showed significant differences between clones, tapping systems and levels of K. Puncture tapping caused a reduction in the Ca content in the latex ($P < 0.05$) while significantly increasing the P^H value of the latex ($P < 0.05$) (N. Yogaratnam, M. Weerasuriya and J. G. de Mel)

In experiment F/76/8 the effects of 3 levels of N, P, K, Mg on rubber production is being studied on Agalawatta series soil, using clone RRIC 45, from a 1956 replanting at Raigam State Plantation. Girth data recorded at the end of 10 years after the commencement of fertilizer treatments indicates significant

($P < 0.001$) increase in girthing with application of nitrogen at level 1 and a further significant increase when nitrogen was increased to level 2, which is double the presently recommended rate (Table 6). A significant K x Mg interaction on girth indicating that Mg at the highest level with nil K can adversely affect girthing.

Table 6. *Effect of nitrogen on girthing of RRIC 45*

Levels of N	Girth (cm)	Percentage increase over control
N ₀	63.79	100
N ₁	66.38	104
N ₂	68.62	108
LSD	1.64	3

Significant increase ($P < 0.001$) in yield by 13% was also recorded from this experiment to application of N at level 1 and further increase (not significant) to 22% over control was observed at N₂ level (Table 7). As these results are consistent and have been recorded during the past few years, it appears that mature *Hevea* may require continuous application of nitrogen (urea was used in this experiment) at rates higher than the current recommendations. (N. Yogaratnam and A. M. A. Perera)

Table 7. *Effects of nitrogen on yield of RRIC 45*

Nitrogen	Yield (kg/ha)	Percentage increase over control
N ₀	1545	100
N ₁	1744**	113
N ₂	1880**	122
LSD	170.05	11

K and Mg nutrition (F/83/1 to 7 and F/84/1 and 2)

Ten field experiments which were started to study various aspects of K and Mg nutrition of immature and mature *Hevea* and associated ground covers were continued. Two pot experiments were also started this year to study the effects of different sources of N and Mg fertilizer and levels of K and Mg. Experiments F/83/1 to 7 were started at three sites replanted in 1981 which showed severe K and Mg deficiencies. The sites are located in Eduragalla State Plantation, Ingiriya, on Agalawatta series soil, Mirishena State Plantation, in Mahagama on Agalawatta series soil and Anhettigama State Plantation in Deraniyagala on Homagama series soil. In these experiments effects of three levels of K and Mg on growth and leaf nutrient content of *Hevea* are being studied in fully randomized designs using single tree plots

with 6 to 37 replicates. N and P were applied uniformly according to the normal RRI recommendations. Leaf samples were collected prior to the application of fertilizer treatments. Pre-treatment and quarterly girth measurements were also recorded. Leaf sampling was done in all three sites and are being analyzed for N, P, K, Ca and Mg contents. (M. Weerasuriya, N. Yogaratnam and A. M. A. Perera)

In experiment, F/84/1, the effects of some pre- and post-treatment practices on the performance of immature PB 86 was studied on six sites in a split plot confounded design. The main plot treatments are:

- T₁— Control without organic matter and fertilizer, prior to planting
- T₂— K and Mg before planting
- T₃— Rice straw twice a year
- T₄— Coir dust twice a year

Four levels of K and Mg were applied in the sub-plots. Girth measurements made 18 months after planting indicate a significant ($P < 0.05$) increase in girth to application of K at 200 g/year and no further effect was recorded to increase in K level to 300 g/year. This effect had been seen only in three sites viz. Padukka, Eladuwa and Panawatta. (M. K. S. A. Samaraweera, W. C. Dayaratne, S. N. Silva, C. K. Maheepala and C. J. Adikaram)

Experiment F/84/2 was started in 1984 at Eladuwa State Plantation, Paiyagala to study the effects of different sources of Mg namely commercial epsom salt, kieserite and dolomite and three levels of potassium on the performance of immature rubber. Diameter measurements were taken at 3 monthly intervals from 10 months after planting and leaf sampling was also done for chemical analysis. A significant ($P < 0.05$) decrease in leaf N content was recorded when Mg was applied at the second level. Leaf K showed a significant increase due to the application of K at the 1st level. Leaf Mg content was however decreased by the application of K at first level. A significant interaction between Mg and K was observed on the Mn content of leaves. (M. Weerasuriya, N. Yogaratnam and U. Mitrasena)

Pot experiments in the field (F/85/1 and 2)

Pot experiments that have been started in Dartonfield Estate, Agalawatta, investigate the effects of different forms of N and Mg fertilizers and levels of K on nutrient uptake and growth of clones, PB 86 and RRIC 100. Urea and ammonium sulphate and kieserite and dolomite are the sources of N and Mg respectively, that are being tested.

In another experiment effects of three levels of K and Mg (0, 1, and 2) on the performance of 4 clones, PC 86, RRIC 100, RRIC 103 and RRIC 121 is being studied. Pre-treatment and quarterly diameter and height measurements are being made. (M. Weerasuriya, N. Yogaratnam and A. Yakandawala).

Response to fertilizers in smallholdings (F/84/1)

Effects of fertilizers on rubber production in smallholdings was investigated on Boralu soils at Godigamuwa estate in Kalutara using clone PB 86 from a 1976 replanting. Fertilizer treatments consist of no fertilizer control, standard fertilizer mixture and fertilizer on the basis of soil and leaf analysis. First year's post treatment yield data showed significant ($P < 0.001$) increases in yield to application of fertilizers (Table 8). A yield increase of 23% was recorded with the standard fertilizer mixture and a further increase to 51% over control with fertilizers on the basis of soil and leaf analysis. (N. Yogaratnam and F. P. W. Silva)

Table 8

Treatment	Yield (kg/ha)	Percentage increase over control
Control	1027	100
Standard	1272***	123***
Soil & foliar analysis	1551***	151***
LSD	105.1	10

Efficiency of fertilizer utilization (F/76/17)

Experiment F/76/17 on the effects of different sources of nutrients on growth and yield of rubber was continued. Eppawela rock phosphate and imported rock phosphate each at 2 levels of P are being compared, using PB 86 growing in Boralu soils at Eladuwa State Plantation. Girth data recorded at the end of 10 years after the commencement of fertilizer treatments indicated application of phosphate to significantly ($P < 0.001$) increase girthing and among the sources tested, imported rock phosphate was significantly ($P < 0.01$) superior to Eppawela rock phosphate (Table 9). Although the yield data did not show a satisfactorily significant effect; yet application of phosphate was found to increase yield by 13 to 20% over no fertilizer plots.

Table 9. Effects of phosphate on girthing of PB 86

Treatments	Girth (cm)
Control	59.5
P	65.08***
Eppawela rock phosphate	62.18
Imported rock phosphate	65.98**

Covers and cover management (C/77/3 and C/77/6)

Studies on the effect of different leguminous cover species on growth and yield were continued in the Kalutara and Kurunegala Districts (C/77/3 and C/77/6 respectively). In the experiment in Kalutara District, there had been no significant differences between the cover species grown on both growth and yield. But in Muwankande Estate in Kurunegala District, rubber plants in the plots that were in legumes, except the plots in *Stylosanthus*, were found to be significantly ($P < 0.01$) superior to the plants under naturals. These results suggest that in the dry districts such as Kurunegala, *Stylosanthus* should not be used as a legume cover, but in the wet districts like Kalutara even *Stylosanthus* could be used. (N. Yogaratnam and J. G. de Mel)

Nutrition of covers (C/77/8)

Experiment C/77/8 which was started in 1977 to study the effects of K manuring of leguminous covers on the N status, growth and production of rubber in Boralu series soil, has been in progress at Lowment Division of St. George State Plantation in Kalutara. Tapping commenced last year. Chemical analytical data showed that leaf N was significantly influenced by K to rubber and K to cover with no K for cover. A significant drop in leaf N was however observed when K was applied to rubber only. Leaf P and Mg showed significant decline in their concentrations with applications of K to cover at the second level. Leaf K content however increased with increase in the level of applied K. N and Mg contents declined significantly ($P < 0.05$) with application of K at the first level to cover and rubber but the latex P, K, and Ca were unaffected. (M. Weerasuriya, N. Yogaratnam, J. G. de Mel)

Soil plant water relations (SM /82/6, SM 83/1 and 3)

Water stress in relation to management practices

This experiment was started to study the effects of different soil management practices on water stress in immature rubber plantations (SM/83/6). The ground cover treatments were:

- a. bare (clean weeded)
- b. natural cover
- c. mixed legumes
- d. dead mulch

Plots in dead mulch exhibited the highest soil moisture storage capacity in comparison with other management practices. Similar results were observed with leaf water potential, relative water content of leaves and leaf water deficit.

In general growth of trees in dead mulch plots was superior to the trees in other plots. Rate of girthing had also been high under dead mulch in comparison with other three management practices. (Table 10).

Table 10. *Effect of ground cover treatments on growth of immature rubber*

Treatment	Girth (cm)
Bare	27.54
Naturals	23.39
Mixed legumes	23.95
Dead mulch	29.76

Bulk density measurements did not indicate any differences due to experimental treatments, but it changed significantly with time. (L. Samarappuli, P. Karunadasa and I. Denawake)

Water stress on nutrient uptake

In this experiment the (SM/83/1) the effect of water stress on nutrient uptake by immature rubber plants was studied in a 33 factorial design with three levels of N,P, and K. Soil moisture content, leaf water potential, girth measurement and chemical composition of leaves and soil were made. It is too early to make any conclusions from this study. (L. Samarappuli, P. Karunadasa, U. Mitrasena)

Water stress on latex production

Effects of water stress on latex production is being studied in experiment SM/83/3. Neutron moisture meter readings were made and yield measurement were also made. Field calibration are being made by obtaining moisture meter readings in duplicate at appropriate depths. Soil samples for determining moisture content and bulk density were also collected by digging a pit around the access tubes. (L. Samarappuli, P. Karunadasa and U. Mitrasena)

Rubber cultivation in Mahaweli area

Cultivation of rubber in the Mahaweli area on an experimental basis under irrigation has been planned. Initially this will be confined to the system 'C' area only and will be done in collaboration of the Tea Research Institute. RRI will cultivate 10 acres, 8 acres out of which would be cultivated exclusively with rubber and the balance 2 acres will be a mixed cultivation of tea and rubber. A 10 acre plot has been marked out and a detailed soil map of the area was prepared. Poly-bagged plants of clones RRIC 100, 102, 104, 110 and 121 would be planted in this area in October 1986. (N. Yogaratnam, A. Dissanayake, F. P. W. Silva)

Use of Organic Manures

Investigations were started on the use of organic manures. A suitable site was selected at Elston Estate, Puwakpitiya and pre-treatment organic matter status of the experimental area was monitored. Treatments will be applied in 1986. (N. Yogaratnam and F. P. W. Silva)

Extension

Soil and foliar survey for discriminatory fertilizer recommendations

All rubber plantations managed by the SLSPC and JEDB are now fertilized on the basis of soil and leaf analysis. The foliar survey programme for 1985 commenced in July and 11,333 hectares were covered this year. Computerised fertilizer programme for the next 3 years (1986, 1987 and 1988) based on this survey were sent to all the estates concerned before the end of December. Urea was the only source of nitrogen recommended. Implementation of this programme would result in a saving of Rs. 2,500,000/- (rupees two million and five hundred thousand) to the rubber industry in 1986. (N. Yogaratnam, M. Weerasuriya, F. P. W. Silva, A. M. A. Perera, Mamei Mahanama, Anusha Jayaweera and Ahamedeen in collaboration with Ruwan Weerasinghe, of the Biometry Section)

Nutrient deficiencies

Nutrient deficiencies, in particular Mg deficiency in commercial plantations, were investigated. It had been found that in most cases Mg fertilizers have not been applied prior to planting and during the early post-planting period. It was possible to control mild deficiencies with immediate application of kieserite followed by regular applications of dolomite as recommended by this Institute. But under very advanced stages of this deficiency, dolomite applications may not help as the Ca. content of leaves were also found to be high, possibly due to an imbalance. Therefore, under advanced stages of deficiency, it had been recommended that application of kieserite should be continued throughout the immature period and that dolomite should not be applied to such plants. (N. Yogaratnam, F. P. W. Silva and A. M. A. Perera)

Chemical analysis

Routine chemical analyses of soil and leaf samples from survey, experimental and advisory work of the Department were done. Requests from other Research Departments of the Institute, other Research Organisations, Universities, JEDB, CFC, Sri Lanka Standards Institute, Pelawatta Sugar Corporation were also considered. (A. M. A. Perera, H. V. K. Rodrigo, Anusha Jayaweera, M. Mahanama, A. Yakandawela, and T. M. Ahamedeen)

REVIEW OF THE RUBBER CHEMISTRY DEPARTMENT

By

S. W. KARUNARATNE

SUMMARY

During 1985 the Rubber Chemistry Department continued its research into all aspects of natural rubber processing, to develop new forms of rubber, to promote the use of natural rubber in existing and new applications and to provide advisory services to all sections of the industry.

Research into the biomodification of natural rubber continued with confirmation on earlier observations on the changes effected by proteolytic enzymes and a new method to produce low nitrogen natural rubber has been perfected.

Improved efficiency of grafting methacrylate to natural rubber has been achieved by reducing the barrier effect of proteins surrounding the rubber particles.

Tread compounds used for retreading based on improved formulations, gave superior tread wear characteristics.

The Rubber Chemistry Department played a useful role in the dissemination of information on natural rubber to the industry. Several seminars and training programmes were held during the year to achieve this objective.

The Department continued to function as the central TSR testing authority. The production of TSR showed a decline during 1985 due to the non availability of sufficient quantities of field grades and due to other economic reasons.

The development of a water soluble bleaching agent for the manufacture of pale crepe was reported in the 1984 Review. This development won for Dr L. M. K. Tillekeratne the prestigious Gold Medal awarded by the Institute of Chemistry for the best scientific achievement during the year 1985.

The Department played a major role in the functioning of the RUBPLA LANKA International Conference which was organised by the PRI (Sri Lanka Section).

DETAILED REVIEW

Staff

Mr S. W. Karunaratne Head, Rubber Chemistry Department was on 3 months sabbatical leave from 1985.07.22 to undertake a UNIDO assignment in the country and resumed duties on 1985.10.21. Dr. P. A. J. Yapa, Head Biochemistry Section, served as Acting Head of the Department in Mr Karunaratne's absence.

P. A. J. Yapa, Head, Biochemistry Section, returned after 6 months sabbatical leave in Japan in April, 1985. He was away on a Research Fellowship at Okayama University, Japan.

P. A. J. Yapa, Head, Biochemistry Section, attended the ISO—TC/45 meeting held in West Berlin during October/November, 1985.

Dr W. S. E. Fernando Head, Rubber Technology and Development Section, attended the International Rubber Conference in Malaysia and undertook a 10-day study tour in Malaysia in October, 1985.

Dr A. Coomarasamy Head, Polymer Chemistry Section was on sabbatical leave in United Kingdom since April, 1985. He is attached to MRPRA on a UNIDO assignment. Assistant Rubber Chemists Messrs Ranjan Goonatillake, P. A. D. T. Wimalasiri and Miss. N. M. V. Kalyani continued their post graduate studies abroad.

Dr M. C. S. Perera, Rubber Chemist, returned from Australia in April 1985 after successfully completing his Ph.D. at the Australian National University.

Mr E. D. I. H. Perera, Assistant Rubber Chemist returned from United Kingdom in April 1985, after successfully completing a 12 months MSc. course on 'Alternative Energy for developing countries' and after spending a period of 6 months at Reading as part fulfilment of a Ph.D. project on rubber seed oil. He will continue his studies here and proceed to Reading later to complete his Ph.D.

Dr (Mrs) Karnika de Silva was appointed as Assistant Rubber Chemist with effect from 1985.04.01.

Mr T. L. G. Fernando, Assistant Rubber Chemist attended the International Rubber Conference in Malaysia in October, 1985.

Dr L. M. K. Tillekeratne, Head, Specifications and Analysis Section Mr. L. B. K. Silva, Research Assistant Mr. G. Seneviratne, Assistant Rubber Chemist, Mrs.

S. Wickramasinghe, Assistant Biochemist and Miss P. Sirimanne, Assistant Development Officer were on duty throughout the year.

Mr G. Seneviratne and Miss P. Sirimanne attended a 5 day training workshop on spectroscopy at the University of Peradeniya in July, 1985.

Mr L. B. K. Silva, continued to follow an afternoon course of studies in Electronics at the Institute of Technological studies, Colombo

Mr U. L. M. Perera, Assistant Rubber Chemist resigned from his post in May 1985.

Messrs K. A. R. M. Perera, and S. Kasinathan, Experimental Officers resigned from their posts in May, 1985.

Messrs A. S. Dekumpitiya and S. L. Weerasinghe both Senior Technical Officers were promoted as Experimental Officers in June, 1985.

Mr Z. E. Irugalbandara Senior Technical Officer formerly in the Plant Pathology Department was transferred to the Rubber Chemistry Department with effect from 1985.08.26.

Experimental Officers Messrs P. P. Jayasinghe, H. N. K. K. Chandralal, W. W. D. Y. Jayasinghe, A. S. Dekumpitiya and S. L. Weerasinghe were on duty throughout the year.

Mr D. D. Medagama, Senior Technical Officer, was on duty throughout the year. Messrs W. D. Dharmasena, K. M. U. Mithrananda P. H. Sarath Kumara, M. D. C. Seneviratne, T. A. S. Siriwardena and Mrs. Manel Neelaweera, Nanda Baduge Sriyanthie Weeraman, Chitra Kuruppu, Leela Wanigathunga and Miss Mangalika de Costa, Technical Officers were on duty throughout the year Mrs Sriyani Yapa, Technical Officer was on 6 mths no pay leave and resumed duties in April, 1985. Mrs Manel Wickramapala, Technical Officer of the Specifications and Analysis Section of the Department was transferred to the Soils and Plant Nutrition Department on 1985.10.16. Miss W. Rodrigo, Technical Officer formerly of the Soils and Plant Nutrition Department, was transferred to the Specifications and Analysis Section of the Department in 1985.10.16.

Mr C. Senanayake, was appointed as Technical Officer Rubber Chemistry Department, with effect from 1985.07.22.

Mr T. A. S. Siriwardena, Specification Assistant was promoted as Technical Officer on 1985.07.27.

Mr C. N. Wickramasinghe was appointed as a Specification Assistant on 1985.01.01. Messrs W. A. S. Wijesekera, G. Wanigathunga, R. Wickramaratne, K. K. Austin, W. Nandasena, B. Gunasiri and P. D. J. Rodrigo Specification Assistants were on duty throughout the year.

Mr G. R. S. S. Gamlath, Instrument Technician, resigned from his post on 1985.01.01. Miss Chitrani Dissanayake, Instrument Technician, completed an 8 months course in Electronics at the Tea Research Institute, Talawakele.

Mr P. Lelwala, Instrument Technician was on duty throughout the year.

The duration of training of Miss Astrid Furlong, N. A. B. Trainee was extended for a further period of 3 months with effect from 1985.10.01.

The Clerk/Typists Mrs Anusha Paranavitane, Thilaka Danthanarayana, Miss. Indrani Wijesinghe and the Stores Assistant, Mrs L. Rukmanie were on duty throughout the year.

Mr W. A. D. Fonseka, Laboratory Labourer, who assumed duties on 1985.10.01 vacated his post as from 1985.11.05.

Miss Nishadee Kulatillake, Temporary Research Assistant, continued her studies on biological control of pollution in rubber plantations.

Meetings

The Department gave the fullest co-operation and participated actively in the Rubber Lanka International Conference organised by the Plastics and Rubber Institute of Sri Lanka at the BMICH in October, 1985. Dr W. S. E. Fernando, Head of Rubber Technology and Development Section, was the Chairman of the organising Committee of the Conference and did an outstanding job, showing that he had profited by the experience gained in organising the Institute's conference.

The Head of the Department, Mr S. W. Karunaratne, attended a meeting organised by the IAEA held in May 1985 at the Centre for Atomic Energy in Indonesia to review the progress in radiation vulcanization.

The Head of the Department served in the following committees:

Chairman drafting Committee of Sri Lanka Standards Institute (SLSI) on NR specifications.

Member of the Advisory Committee on rubber and rubber products set up by the SLSI.

Member of the Chemicals Divisional Committee set up by the SLSI.

Member of the Advisory Committee on rubber for the Export Development Board (EDB) appointed by the Hon. Minister of Trade and Shipping.

Member of the Technical Committee on specifications for coagulating pans set up by EDB

Member of the Committee of the Plastics and Rubber Institute

Director of Co-operative Industries Union from July, 1985.

Member of the Scientific Committee of the Rubber Research Institute.

Member of the Steering Committee of Rubpla Lanka International Conference and exhibition.

Member of the Technical Evaluation Committee of Tea and Rubber Factory machinery set up by the State Plantations Corporation (SPC)

The Head of the Department moderated the following seminars conducted in the auditorium of the Rubber Chemistry Department.

Energy saving and new methods of drying NR including vacuum drying held on 1985.09.02.

The Natural Rubber scene and prospects for the future held on 1985.12.03.

The Head of the Biochemistry Section, Dr P. A. J. Yapa, served as a member of the Committee for Popularization of Science of the Sri Lanka Association for the Advancement of Science

The Head of the Specifications and Analysis Section L. M. K. Tillekeratne served in the H. P. de Silva Commission on "RSS auctions"

The Head of the Rubber Technology and Development Section, W. S. E. Fernando chaired a special session on tyre rebuilding at the Sri Lanka Transportation Forum held at Moratuwa University sponsored by Bandag Corporation of USA.

T. L. G. Fernando served as Director of the Sri Lanka Energy Management Association and participated at several Board meetings

The Head of the Department, Mr S. W. Karunaratne gave 20, 2 hour lectures on Rubber Technology to N.D.T. second year students at the University of Moratuwa.

L. M. K. Tillekeratne conducted 50 lectures on physical testing to N.D.T. second year students at the University of Moratuwa. He also delivered 12 lectures to the MSc students at the Sri Jayawardenapura University (SJU)

M. C. S. Perera delivered 18 lectures to the MSc students at the SJU on the physical chemistry of polymers.

Mrs Karnika de Silva delivered 10 lectures to the MSc students at the SJU on Industrial polymers.

L. B. K. Silva conducted 40 lectures on rubber physics to N.D.T. second year students at the University of Moratuwa.

S. W. Karunaratne gave a 2 hour lecture to students participating in the International Course for Development oriented Research in Agriculture organised by the Agricultural Research and Training Institute (ARTI).

S. W. Karunaratne conducted a lecture/demonstration in the use of analytical methods in the rubber industry for the Curriculum Development Centre in November, 1985.

S. W. Karunaratne gave a lecture on radiation vulcanization of latex to a limited audience. This was organised by the Atomic Energy Authority (AEA), in November 1985 and all trainees who participated in the programme including Mr H. N. K. K. Chandralal, Experimental Officer, joined in the discussion that followed.

L. M. K. Tillekeratne delivered the Gold Medal lecture at the Institute of Chemistry annual sessions in July, 1985.

T. L. G. Fernando participated in a seminar on 'Energy Planning' conducted at the Mount Lavinia Hotel in November, 1985.

Training in rubber processing, grading and marketing

The Head of the Department, the Heads of sections P. A. J. Yapa and L. M. K. Tillekeratne, M. C. S. Perera, Gunaruwan Fernando and Sunil Weerasinghe were involved in the training of Rubber Extension Staff of the Advisory Services Department, Rubber Control Department staff and Co-operative Inspectors and Managers in the processing grading and marketing of raw rubber.

Special projects

The Head of the Department, S. W. Karunaratne was given a special project of 3 months duration by the Foreign Investment Advisory Committee (FIAC) of the Ministry of Finance under the sponsorship of UNDP/UNIDO. The task was to identify rubber products suitable for promotion as joint ventures with foreign collaboration. This task was successfully completed and a booklet was printed and distributed at the end of the assignment.

S. W. Karunaratne and E. D. I. H. Perera, also assisted in another UNIDO project in collection, processing and potential of rubber seed.

Miscellaneous

Electronics Repair Unit

Mr T. Abeyratne, Electronics Engineer from University of Moratuwa, continued to visit the Electronics Repair Unit on a part time basis to carry out repairs to instruments and to train the staff on electronic repairs. Of the regular staff L. B. K. Silva is undergoing a 1 year Diploma course in Electronics on a part time basis and Miss Chitrani Dissanayake was trained at the TRI on maintenance and repair of electronic equipment.

Repairs

The following instruments were repaired at the electronics repair unit during the year.

- (1). Packard Model 437 Gas Chromatograph —
Plant Pathology Department
- (2). Packard Model 428 Gas Chromatograph —
Plant Science Department
- (3). Perkin Elmer Model F-17 Gas Chromatograph —
Rubber Chemistry Department
- (4). Instron Materials Tester —
Rubber Chemistry Department
- (5). Perkin Elmer Model 577 Infra Red Spectrophotometer —
Rubber Chemistry Department

Exhibitions

The Rubber Chemistry Department participated at the following exhibitions in addition to giving assistance at several school exhibitions.

- (1). Institute of Chemistry exhibition held during its annual sessions.
- (2). Exhibition on Science and Technology organised by NARESA
- (3). RUBPLA LANKA exhibition.

Publications

- Bradbury, J. H. and Perera, M. C. S. (1985). Epoxidation of NR studied by NMR spectroscopy. *J. Appl. Polym. Sci*, 30, p. 3347.
- Bradbury, J. H. and Perera M. C. S. (1986). Dichlorocorbene modified NR. *Brit. Polym. J.* (in press)
- Coomarasamy, A., Seneviratne, G. and Kuruppu, C. (1985). The use of polymeric antioxidants derived from styrene maleic anhydride copolymers in NR and nitrile rubbers. *Conference preprints, 6-13 Rubpla Lanka International Conference*, October 1985, Colombo, Sri Lanka.
- Fernando, T. L. G. and Kulasekera, S. (1985). New electricity tariffs and the crepe industry. *Bull. Rubb. Res. Inst. Sri Lanka*, (in press)
- ප්‍රනාන්දු, ටී. එල්. ජී. (1984) ත්‍රෝප් රබර් කර්මාන්තයේ බලශක්ති ඉල්ලුම් කරනය රබර් ප්‍රමාණ
- Fernando, W. S. E., Perera E. D. I. H. and Perera, K. A. R. M (1985), Carbonyl reactive antioxidant for natural rubber. *RRIM Conference IRC '85, Kuala Lumpur, Malaysia*.
- Fernando, W. S. E, Yapa, P, A. J and Jayasinghe, P. P. (1985). Preparation and properties of low nitrogen natural rubber. *Kautschuk & Gummi, Kunststoffe 38 (11) 1010-1011*.
- Jayasinghe, P. P. (1985). Non-black fillers for the rubber industry. *Bull. Rubb. Res. Inst. Sri Lanka* (in press)
- Karunaratne, S. W. (1985) Growth of the polymer industry in Sri Lanka and the role of the PRI. *Conference preprints, 86-96. Rubpla Lanka International Conference*, October 1985, Colombo, Sri Lanka.
- Perera, M. C. S., Bradbury, J. H. and Elix, J. A. (1985) Modified NR studied by NMR, *Polymer Conference*. February 1981, Melbourne, Australia.
- Perera, E. D. I. H. and Dunn. P. D. (1985). Rubber seed oil as a diesel fuel substitute, *3rd European Bio-Mass Conference*. March 1985. Venice.
- Walpita, M and Fernando, T. L. G. (1985). Combustion efficiency of a fire woodfed boiler in a crepe drying system. *Bull. Rubb. Res. Inst. Sri Lanka*. (in press)

Yapa, P. A. J., Kawasaki T. and Matsumoto, H. (1986) "Changes of some membrane associated enzyme activities and degradation of membrane phospholipids in cucumber roots due to Ca^{2+} starvation. *Plant and Cell Physiology* (in press)

Yapa, P. A. J., Fernando, W. S. E., Jayasinghe, W. W. D. Y. and Yapa, S. I. (1985) Low nitrogen natural rubber, *Conference preprints*, 289-291, *Rubpla Lanka International Conference* October, Sri Lanka.

Editorial

Fernando, W. S. E. Editor, Conference Proceedings Rubpla Lanka International Conference '85. The Plastics & Rubber Institute of Sri Lanka 1985.

Fernando, W. S. E. Editor. Rubpla Lanka Souvenir. The Plastics and Rubber institute of Sri Lanka, 1985.

Abstracts

Tillekeratne, L. M. K. (1985). Accuracy of the metrofac to estimate DRC of latex *Proceedings of the forty first annual sessions of the SLASS*, December Part 1, 107.

Reports

Fernando, T. L. G. and Silva, L. B. K. (1985). Survey report on electricity consumption for lighting and ventilation at RRISL buildings, Ratmalana.

Fernando, T. L. G. and Bandara, S. M. J. (1985). Firewood consumption in latex industry, FAO Report.

Karunaratne, S. W. (1984). Annual Review of the Rubber Chemistry Department.

Karunaratne, S. W. and Abeysekera, H. (1985). Potential for foreign investment in rubber products manufacture, Foreign Investment Advisory Committee Ministry of Finance and Planning.

Karunaratne, S. W. (1985). Feasibility report on production of TSR for the JEDB.

Karunaratne, S. W. Tillekeratne, L. M. K. and Fernando, T. L. G. (1985). Natural rubber scene and prospects for the future.

Yapa, P. A. J. (1984). Role of calcium on function of membrane of cucumber roots. MIF Fellowship Research Report, Japan, 367-383.

Yapa, P. A. J. Report on the 33rd meeting of the ISO/TC/45 meeting held in West Berlin, Nov. 1985.

The following articles were submitted for publication in the Daily news-papers:

De, Silva, K. G. K. Modified rubbers for expanding the uses of NR in Sri Lanka.

Fernando, W. S. E. Rubpla Lanka 85

Karunaratne, S. W. Natural rubber and the synthetics

Karunaratne, S. W. Milestones in the development of the rubber industry

Karunaratne, S. W. Pale crepe, the purest grade of natural rubber

Karunaratne, S. W. Chemical analysis in the rubber industry

Tillekeratne, L. M. K. Improvement of the presentation of raw rubber from Sri Lanka.

Yapa, P. A. J. Uniformity in properties, novel uses and challenges ahead of natural rubber

Patents

De Silva, K. G. K. and Fernando, W. S. E. (1985). A method for the preparation of NR latex for improved graft copolymerisation of vinyl monomers. Sri Lanka Patent No. 9547.

Yapa, P. A. J. and Fernando W. S. E. Low nitrogen natural rubber. Sri Lanka Patent No. 9574.

POLYMER CHEMISTRY

1. Antioxidant Studies

(i) *Antioxidants based on maleic anhydride derivatives*

Two polymer antioxidants namely N-4 (Anilino phenyl) maleimide-styrene 1:1 copolymer and Di (3,5 ditert. butyl 4 hydroxy benzyl) maleate-styrene 1:1 copolymer were synthesised using the procedures developed in the laboratory. Being polymeric in nature having high molecular weights, these antioxidants are expected to be more resistant to losses by extraction, leaching and volatilization when compared to the low molecular weight antioxidants.

The use of these two polymeric antioxidants and a simple maleimide antioxidant 4-anilino phenyl maleimide, was evaluated in natural rubber and nitrile rubber compounds. The polymeric antioxidants were found to be more compatible with nitrile rubber than with natural rubber and showed good antioxidant properties in nitrile rubber compounds. The

simple antioxidant was found to be equally effective in both types of rubber. A paper on this work was presented at the Rubpla Lanka 1985 Conference organised by the PRI Sri Lanka and held in Colombo. (A. Coomarasamy, G. Seniviratne, S. Kasinathan, H. N. K. K. Chandralal and Chitra Kuruppu)

Cashew nut shell liquid based antioxidants

Mannich based of tetra hydro cardanol and dimethyl amine was synthesised using the procedure reported by us earlier. The corresponding dithiocarbamate was also synthesised by treating the Mannich base with carbon disulphide. NMR analysis of the reaction mixture revealed that the conversion of the Mannich base to dithiocarbamate was poor. Experiments are being planned to improve the yield of this reaction.

Effort is also being made to carry out large scale trials on the use of Mannich base produced from cardanal, dimethyl amine and formaldehyde as this compound showed very good antioxidant activity in laboratory tests. (A. Coomarasamy, G. Seniviratne, S. Kasinathan, H. N. K. K. Chandralal and Chitra Kuruppu)

Preparation of superior processing rubber

Overseas inquiries indicated that there is a small market for SP rubbers especially for heat resistant applications and small scale experiments on prevulcanization of NR latex using a conventional SP rubber formulation a room temperatuer curing formulation and three different formulations compounded for heat resistant properties, were carried out. The Properties including the ageing behaviour of the SP rubber samples prepared from the various prevulcanised latices were evaluated. The formulation which gave the best set of results was selected and used for the large scale preparation of PA 80 SP rubber masterbatch at Mawanella block rubber factory. A sample from this large batch was sent to Weber and Schaer, West Germany for their evaluations. (A. Coomarasamy, Pushpa Sirimanne, Karnika de Silva, H. N. K. K. Chandralal and Mangalika de Costa)

Heat resistant tellurium rubbers

The work carried out at the University of Aston during 1981 - 1984 shows that tellurium compounds could act as accelerators, antioxidants as well as crosslinking agents *in situ* in the absence of any added sulphur. The preliminary trials carried out in the RRISL laboratories during the period under review show that natural rubber latex could also be prevulcanized with tellurium compounds. The prevulcanised latex so prepared is blended with fresh field latex and used in the preparation of heat resistant superior processing rubber.

The samples were tested in our laboratories as well as elsewhere, Mr Hoffmann of Weber and Schaer in West Germany has reported on the excellent heat ageing resistance of tellurium rubbers. A firm order for 1000 kg of this rubber has been placed by Weber and Schaer through Associated Traders. A trade name is given to this rubber as Neorub 80 PA-T.

The die-swell, stress relaxation, and other physical properties were tested and they show tremendous potential as heat resistant SP rubber (Karnika de Silva, Pushpa Sirimanne, Mangalika de Costa, K. M. U. Mithrananda).

Preparation of graft copolymers of NR and vinyl monomers:-

Pilot plant trials on the preparation of MG 49 and MG 30 rubbers and latices were carried out in the stainless steel reactor of 10 litre capacity at Ratmalana Laboratories using NR latices stabilized with different systems with a view to find the most suitable type of latex for the preparation of graft copolymers. Experiments were performed at Dartonfield with fresh latex. The results obtained reveal that for the preparation of MG rubber in dry form, the fresh latex is preferred to matured, stabilized latex as the coagulation of grafted latex obtained from fresh latex could be effected quite easily. If MG rubber in latex form is required, it is advisable to use matured, stabilized latex. (A. Coomarasamy, L. Perera, H. N. K. K. Chandralal, Manel Nilaweera, Chitra Kuruppu).

Experiments were also performed with papain treated latex. The MG latex prepared from papain treated latex could be easily coagulated and milled. (Karnika de Silva, W. S. E. Fernando and A. Coomarasamy). The latex was treated with papain in the presence of a suitable stabilizer to reduce the protein content. The latex so treated reacted readily with vinyl monomers in the presence of free radical initiators to form graft copolymers. These reactions have shorter induction periods and produced grafted rubbers with high grafting efficiency. The film properties of the MG 30 and 49 obtained by this method have been found to be superior to the samples prepared from normal latex. Techniques which have been used for the experiments with other latices were used in this study. (Karnika de Silva, Manel Nilaweera).

It was noted that the oil resistant properties of the MG rubbers increase with the percentage of MMA in the product, therefore a successful attempt was made to prepare MG 75 rubber in powder form to be used as a filler for both plastics and rubber in order to increase their resistance to oil. The problems experienced in the production of MG 75 were solved. The testing for oil resistance is in progress. (Karnika de Silva, Manel Nilaweera, K. K. D. P. Senanayake).

Preparation of NR composites and blends

Dr A. Coomasamy, Head of Polymer Chemistry Section carried out some aspects of the work on this project at the MRPRA Laboratories in U.K. for the UNIDO sponsored IRRDB project on NR composites.

- (i). His work was mainly concerned with fibre and polymeric reinforcement of NR for the preparation of NR/fabric laminates for engineering applications. High performance fabric materials such as Kevlar fabric (Kevlar is a Poly-aramid manufactured by Dupont), and glass fabric (Marglass) were selected for this work to replace steel plate, as these materials have the required strength properties. Another prime requirement is that these fabric materials should be satisfactorily bonded to NR. The peel strength of such bond should be above the minimum value of 5.2 KN/m.

A detailed investigation on bonding of glass fabric and Kevlar fabric to NR was undertaken during this study and the following three practicable adhesive systems have been developed for bonding these fabrics to NR.

- (a). Resorcinol - formaldehyde — MG 30 latex based RFL systems. This was prepared using the same procedure used for the preparation of RFL based on vinyl pyridine latex. This system gave peel load values in the range of 5.5—6.5 KN/m for both Kevlar/NR & glass fabric to NR bonds.

- (b). Chemlok 402 Adhesive system

Though the above adhesive is a proprietary material, attempts to use this adhesive with recommended primer did not give satisfactory bonding. However the use of this adhesive at about 15—20% pick up (on the wt of fabric) on epoxy subcoated Kevlar fabric and glass fabric (with size) gave peel load values in the range of 15—20 KN/m.

- (c). Dry bonding system

Use of dry bonding ingredients such as RF resin (Penacolite B-185) and a methylene donor (Hexamine, Cyrez 964) at 3-5 phr and adhesion promoters such as silica at 15phr, in rubber compounds gave peel load values in the range of 7—10 KN/m for NR/glass fabric bonds. But further improvements could be possible.

Durability tests in 2% NaCl solution have been carried out for 0-3 month period using samples prepared with the first two types of adhesive systems. The results obtained have been quite satisfactory.

Protection of adhesive bonds could also be effected by the use of suitable sealants. Satisfactory results were obtained by the use of Silastic RTV 734 self curing silicone sealants.

Valuable information on the possibility of using RFL based on MG 30 latex as an adhesive for the preparation of laminates for engineering applications was obtained by quadruple shear tests. The tests carried out clearly indicated that these adhesives can withstand heavy stresses without undergoing any failure and are therefore suitable for use as adhesives for the construction of bridge bearings and similar products.

- (ii). Reinforcement NR with coir and coir pads was also studied. The test data obtained revealed that the NR/coir pad laminates could withstand moderate comprehensive stresses (in the region of 50 kn for 100 sq cm/ laminate) without any drastic failure. This is very encouraging and shows promise for possible application of the NR/ coir fabric pad laminates for load bearing mounts for machinery and other light structures. Information has also been obtained on the morphological structure of the fibre as well as its physical properties. Reinforcement of rubber with loose fibre too was studied.
- (iii). The investigation on the use of 4-anilino phenyl maleimide as an antioxidant in Thermoplastic Natural/rubber/Poly propylene (GWN 101) 60:40 blends.

A series of samples of natural rubber (SMR CV 60) poly propylene (GWM 101) 60:40 TPNR blends were prepared in a laboratory banbury using the procedure developed by the MRPRA, using Irgonox 1010, Hostanox 03 and 4 anilino phenyl maleimide as antioxidants with and without light Stabilizer Tinuvin 770 and crosslinking agent HVA-2. From the Melt flow index measurements on the TPNR samples prepared, it was found that 4-anilino phenyl maleimide acted as a good antioxidant for the TPNR. The physical properties of the TPNR blends containing the maleimide compound were also found to be good. This work was done with the assistance of other officers working on the TPNR project at MRPRA.

Preparation of superior quality natural rubber by enzyme treatment

This study was undertaken at the early part of the year under review, as it was found necessary to carry out some work for improving the manufacturing procedure for the preparation of papain coagulated rubber.

Trials were conducted at the Dartonfield factory using the following four procedures:

- (a). Field latex was stabilized with 0.15% ammonia and treated with diammonium hydrogen phosphate at 0.1% and allowed to stand overnight. The sludge formed was removed and the latex after dilution with two volumes of water, was treated with papain at 0.075% (on undiluted latex) for deproteinization and coagulation. The following day the coagulum was washed, milled into lace, washed and dried (DPNR - No. 1)
- (b). Field latex was stabilized with 0.15% ammonia and diluted with equal volume of water containing Nonidet T at 0.1% on latex and treated with papain at 0.025% in latex overnight. Diammonium hydrogen phosphate at 0.1% on latex was added as 13% solution and allowed to stand over night followed by the removal of the sludge formed. Treated latex was then coagulated with 2% formic acid, milled and washed the following day and dried — (DPNR No. 2).
- (c) Field latex stabilized with ammonia was treated with diammonium hydrogen phosphate and subsequently centrifuged. The centrifuged latex was treated with papain to effect coagulation and digestion of proteins. The following day the coagulum obtained was milled, washed and dried (DPNR No. 3)
- (d). Field latex was diluted and treated with papain to effect coagulation and digestion of proteins. Subsequently washed and milled into lace and dried in a drying tower. (DPNR 4). This work has led to the improved process for treating latex to obtain superior quality DPNR.

Raw Rubber properties obtained for these four samples are given in Table 1.

Table 1. Raw rubber properties.

Sample No.	N	Ash	Dirt	Po	PRI
DPNR No. 1	0.12	0.13	—	45	38
DPNR No. 2	0.10	0.07	—	—	Poor
DPNR No. 3	0.05	0.07	0.023	51	41
DPNR No. 4	0.06	0.03	0.019	49	65

These results clearly indicate that deproteinised natural rubber with N and ash values as low as 0.06 could be prepared easily. Samples of DPNR No. 3 and No. 4 were sent to a foreign buyer, and they were extremely satisfied with both the samples,

but preferred the sample No 4 as its PRI was high. Further trials were conducted using Nonited T as well as Texofor FN 30 and in the absence of any soap. These trials confirmed the finding that DPNR rubber with N and ash contents in the range of 0.06 could be prepared easily in a crepe factory. Compounding studies have been carried out with all the four samples of DPNR at the MRPRA laboratories for evaluation of their properties in selected formulations for engineering applications. These results will be presented elsewhere. (A. Coomasamy, S. Kasinathan, K. A. R. M. Perera, G. Seniviratne, C. Jayasekera and Karnika de Silva was also involved in later trials)

Preparation of positively charged latex and its uses

Two cationic soaps were used in the preparation of positex. Most of the work was carried out using Cetyl trimethyl Ammonium bromide (Centrimide)

The positive charge carried by the positex latex particle was determined by a direct and indirect method, namely electro deposition of positex and the deposition on wool fibres. It has been found that rubber particles in positex (used as a very dilute solution) get absorbed to the surface of the wool fibres leaving a clear serum, whereas with normal latex the rubber particles are not absorbed to wool fibres in this manner.

Positex appears promising for several applications. It has potential as an adhesive for textile industry and as positex — bitumen mixtures for road surfacing. The potential of positex will be further evaluated.

Creaming of positex and vulcanization studies have been initiated and testing is in progress.

A trial sample of positex was sent to West Germany. (Mr Hoffmann, Weber and Schaer) for evaluation. (Pushpa Sirimanne A. Coomasamy, Mangalika de Costa, Manel Nilaweera)

Cyclised rubber

It was found that low nitrogen latex is a good substrate for the manufacture of cyclised rubber. The method by using conc sulphuric acid in the presence of a stabilizer such as texofore FN 170 gave a dark purple powdery material at room temperature. This dark coloured powder when added into cold water gave an off-white product.

Cyclised rubber prepared from positex by the same procedure was difficult to isolate and further work on this project is in progress. (Karnika de Silva, Pushpa Sirimanne, Mangalika de Costa, Manel Nilaweera)

Radical grafting by organic halide initiation.

An attempt was made to introduce dichloro cyclo propane rings on to the natural rubber chain by treating NR latex with chloroform and sodium hydroxide *in situ* in the presence of a phase transfer catalyst at 50°C.

A white coagulum was obtained after 3 hours of the reaction. This Rubber is expected to show better oil resistant properties. The product is being further analysed for chlorine content. (Karnika de Silva, Manel Nilaweera, Mangalika de Costa)

Solubility, migration and loss of antioxidants

In this study the synthesis of a variety of antioxidant structure is undertaken containing the same functionally active group but with varying molecular shapes and sizes in order to assess the importance of the shape/size factor on the migration of the additives in the polymer and loss of both initial additives and derived products from the polymer surface. (M. D. R. J. Goonatilake)

RUBBER TECHNOLOGY AND DEVELOPMENT

Compounding

Tyre retreading

Evaluation of a suitable secondary accelerator for MBTS for use in the retreading industry is now completed. It was observed that the MBTS/ZDC system is superior to the MBTS/TMTD system currently used in Sri Lanka in the following aspects, when a higher dosage of stearic acid as activator (3.5 phr) is used;

- (i) Safer compounds due to enhanced scorch safety.
- (ii) MBTS/ZDC system responds better to higher dosages of stearic acid than MBST/TMTED resulting in enhanced reversion resistance at vulcanizing temperatures.
- (iii) The MBTS/ZDC system gave vulcanizates of higher abrasion resistance and lower heat build up, Road trials conducted, showed higher wear resistance of MBTS/ZDC retreads.

Non tyre applications

- (i) General moulding compounds.

The use of MBTS/ZDC vulcanization system was recommended for hard compounds reinforced with the histyrene resin and china clay. This resulted in improved flow properties and safer compounds giving better surface finish and less rejects. This system is now used in a commercial moulding formulation, in conjunction with the antiblooming agent recommended by the Rubber Technology Section.

(ii) Transparent vulcanizates

Compound evaluation studies are in progress to obtain transparent vulcanizates suitable for general purpose as well as special applications, such as bottle teats.

(iii) Resilient vulcanizates

The use of LNNR is evaluated for applications where highly resilient material is required containing substantial quantities of silica fillers. (W. S. E. Fernando, P. P. Jayasinghe, H. N. K. K. Chandralal and Manel Nilaweera)

Low nitrogen natural rubber

A paper on preparation and properties of low nitrogen natural rubber was presented at the International Rubber Conference held in Stuttgart, West Germany. This paper was published in the *Kautschuk Gummi, Kunststoffe* Vol. 38 (1985)

The effect of stearic acid and a curative system on the dynamic properties are being evaluated on the LNNR made by maturation techniques. (W. S. E. Fernando, P. A. J. Yapa, P. P. Jayasinghe, D. D. Medagama, and K. M. U. Mithrananda)

Bound antioxidant system

A paper entitled carbonyl reactive antioxidants for natural rubber was presented at the RRIM International Conference held in Kuala Lumpur, Malaysia, in October, 1985.

A carbonyl reactive, functionalised phenolic antioxidants was found to react with natural rubber when dispersed in latex, to give approximately 0.7% bound system. (W. S. E. Fernando, E. D. I. H. Perera, and K. R. R. M. Perera)

Chlorinated natural rubber

Use of latex as a starting material for chlorination was investigated. Initial experiments indicate that a high dosage of non-ionic stabilizer is necessary for proper stabilization of latex during chlorination. However, splitting of chlorine has been a recurrent problem. These experiments are in progress. (W. M. G. Seneviratne, W. S. E. Fernando, S. W. Karunaratne and K. M. U. Mitrananda)

Latex technology

Effect of hydrophilic polymer on the properties of N.R. latex

Water soluble polymers with different degrees of hydrophilicity were synthesised by solution polymerisation of methacrylic acid (MAA), hydroxyl ethyl methacrylate (HEMA) and 2-ethyl hexyl acrylate (EHA).

The effect of the addition of sodium salts of these polymers upon certain properties of NR latex such as mechanical stability, viscosity, zinc oxide, thickening, heat sensitivity and creaming have been studied.

In general all these polymers increase the mechanical stability and viscosity of NR latex. The more hydrophilic polymers are less effective in enhancing the mechanical stability but are more effective in enhancing the viscosity.

The effect of some of the copolymers upon heat sensitization of NR latex by the zinc amine system are quite significant. The cross linked copolymers of 20% EHA and 80% MAA gave an appreciable increase in heat sensitization of NR latex by the zinc amine system.

Some of the copolymers increase the creaming of latex. The effect is dependent on the molecular weight and the composition of added polymer. (N. M. V. Kalyani)

Incorporation of carbon black into rubber at the latex stage

Carbon black masterbatches prepared by incorporating carbon black at the latex stage is less energy consuming but the efficiency has to be improved before commercial acceptance of the process. With low structure HAF Black the efficiency of incorporation could be improved when the PH is increased to a point and also when the temperature of coagulation is increased. The efficiency is judged by the percentage of carbon black retained in the coagulum, after it is squeezed by pressing a number of times, through rollers.

Amounts up to 50% carbon black were added to latex in the form of a slurry but the percentage retention could be optimised only within a level of incorporation of up to 30%. Within this limit the efficiency of incorporation can be increased to 95%, still a 5% wastage is unavoidable. Further experiments are being planned to optimise the efficiency of incorporation and the effect of variables such as particle size, structure and surface properties of carbon black (several types) would be studied. (S. W. Karunaratne, Pushpa Sirimanne, A. S. Dekumpitiya, P. Sarath Kumara and Mangalika de Costa).

Industrial extension

Technical assistance was given to the following organisations for products mentioned below:—

- (1) Polymer Products, Panadura
- (2) State Engineering Corporation
- (3) Hettiarachchi and Company Limited
- (4) C. W. Mackie and Company Limited
- (5) Carson Cumberbatch and Company Limited
- (6) Associated Motorways Limited
- (7) G-Rio Unircraft International Company Limited
- (8) Chemanex Limited

Products

Foam backing of coconut fibre matting, various types of moulded rubber goods resilient play balls, PVC/Nitrile, Nitrile/NR blends, tyre retreading compounds, tyre repair compounds, histyrene/rubber-blends, low ammonia SPP latex, cyclised, rubber manufacture from latex.

Water proofing of concrete roofs

- (a) Work has been undertaken to lay a latex bitumen mix at the Plantations Ministry Head Office. The water proofing mix was made using low ammonia field latex in place of formaldehyde stabilised latex as described in an earlier patent granted to RRISL due to technical difficulties observed with the latter.
- (b) A quotation was submitted to the Maintenance Department of the People's Bank at their request, for water proofing of its Headquarters. The area under consideration is approx 2000 sq. metres and the sum involved is over Rs. 1 Million.

Other activities

- (1) Coastal conservation using rubberised fibre composite is under investigation for coastal conservation and sea erosion.
- (2) Pressed slabs prepared from cement waste, paper pulp and latex mix is under investigation for various applications in the building construction industry.
- (3) Two project proposals were submitted to the Army Engineering Services and Engineer Command. (W. S. E. Fernando, P. P. Jayasinghe, H. N. K. K. Chandralal, W D. Dharmasena, D. D. Medagama and K. M. U. Mithrananda).

RAW RUBBER DEVELOPMENT

The Head of the Department, the officer in charge of the Raw Rubber Development Section Dr. M. C. S. Ferera and the rest of the staff in the Section undertook several factory visits on requests made by Superintendents to upgrade their manufacturing methods.

The Raw Rubber Development Section organised a seminar for the factory officers in the Kegalle region and a seminar on energy for the Superintendents and Regional Officers of both SLSPC and JEDB.

M. C. S. Perera and T. L. G. Fernando spoke at Planters' Conferences in Kalutara, Ratnapura, Kegalle and Galle Region on conventional drying systems and electricity tariffs. The vacuum dryer fabricated by Industrial Engineers Limited was evaluated and alternative methods such as fire wood and solar energy were suggested to reduce the cost of drying.

Factory Development Programme

Factory Subsidy Scheme

The factory subsidy has been withdrawn from estate factories in the 1984 budget but during the year 1985 several earlier programmes were evaluated and reports on 12 factories were submitted to the Rubber Controller. Two of them were TSR factories and the rest were pale/sole crepe factories. (M. C. S. Perera and S Weerasinghe)

Manufacturing advice

Twenty factories were visited during the year as requested by the estate management. The problems encountered by these factories were carefully studied and remedies were suggested. (M. C. S. Perera, T. L. G. Fernando and S. Weerasinghe).

Drying towers

Several requests were received from factories that their drying towers do not function efficiently. Five factories were visited and suitable modifications were suggested.

Three more factories were visited to check and report on their new drying towers.

These drying towers are being constructed by Colombo Commercial Company and several defects in the original construction and drying elements were highlighted. A full study will be carried out when the construction is over and a report will be submitted with recommendations.

During the investigations on drying towers, we have felt that the present conventional boiler radiator system could be further modified and improved. It was also

found that the construction of drying towers could be done more scientifically to increase its efficiency. Therefore it was felt that recommendations specifying tower dimensions, boiler capacity and the number of radiators to be used should be given on the basis of scientific studies on drying efficiency. (T. L. G. Fernando, M. C. S. Perera, S. Weerasinghe, C. Senanayake)

Re-sitting of mills and tanks

Re-sitting of mills and tanks were suggested in Opatha State Plantation, Peen-kande State Plantation and Bentota State Plantation factories. (M. C. S. Perera and S. Weerasinghe)

New electricity tariffs

It was found that a reduction in power consumption of about 30% could be achieved if the rubber factories adopt the new electricity tariff system introduced by the Ceylon Electricity Board (CEB). The feasibility of adopting this system was tested in Nakiadeniya State Plantation and Sorana State Plantation. (T. L. G. Fernando, M. C. S. Perera and S. Weerasinghe)

Solar project

Experiments carried out so far have proved that the normal drying tower should be sufficiently modified to retain the temperature for efficient drying. The temperature of the hot air carried to the drying tower reached an optimum of 60°C in sunny weather with 8 flat bed solar collectors the dimensions of each being 1.5 x 5.0m.

Further modifications and improvements are being carried out with a view to get more hot air in circulation inside the drying tower, specially when it is opened for movement of wet laces. (T. L. G. Fernando and M. C. S. Perera).

Private factory survey

It was required to collect some information regarding private rubber factories in order to work out a Medium Term Investment Programme (MTIP) for the private factories. Therefore a survey was initiated in collaboration with the Plantation Industries Ministry. A total of about 50 factories were visited and a report was submitted. (M. C. S. Perera, T. L. G. Fernando, S. Weerasinghe and C. Senanayake)

Epoxidised natural rubber (ENR)

The work on this project was reinitiated during this year was higher than the most economical method for the manufacture of ENR should be worked out

for commercial scale production. Therefore, more information would be required with regard to the epoxidation process specially in coagulation and drying steps. At the same time it was brought to our attention that MRPRA has patented a process for production of ENR in Sri Lanka. Therefore, it was decided to request them to come to a licensing agreement.

Attention was also focussed on finding an alternative method to prepare ENR. At a preliminary trial, promising results were obtained but a severe drop in P.R.I. was noticed as happened earlier with the latex method. An NMR study is being carried out.

Work is also in progress to prepare concentrated ENR latex. (M. C. S. Perera and Chitra Kuruppu)

Air dried sheets (ADS)

The furnace and the drying system constructed at Ratmalana premises were tested and a maximum temperature of 47°C was achieved inside the tower. A more systematic method of loading the firewood resulted in a maximum temperature of 49°C achieved within 6h. Therefore, a modification to the ducting system inside the tower appears necessary.

Five estates were selected in the five regions: Kegalle, Galle, Avissawella, Kalutara and Ratnapura to prepare small scale samples of ADS using the crepe drying towers. Initial trials were carried out at Urumewala Estate, Kegalle, Halwatura State Plantations, Kalutara and Mapalagama State Plantations, Galle. A few samples prepared at Urumewala Estate were sent to West Germany and U.K. for evaluation.

Samples prepared at Dartonfield were sent to two rubber products manufacturing firms in Sri Lanka. Work is in progress to prepare ADS with high Mooney viscosity. Preparation of ADS using different clones such as PB 86 and RRIM 623 did not result in products with significant differences. (M. C. S. Perera, S. Weerasinghe and C. Senanayake)

Discolouration of crepe rubber

Studies on the discolouration of crepe rubber revealed the following facts:

- (a). Dilution of latex reduces enzymatic discolouration.
- (b). Delay in coagulation enhances enzymatic discolouration.
- (c). A new acid referred to as Catalyst A gave a lighter colour than formic acid and it also suppressed enzymatic action.
- (d). Impurities in the bleaching agent can cause discolouration. Colour retention also suffers as a result of batch to batch variation of the bleaching agent.

(e) Some of the non rubber ingredients could suppress enzymatic discoloration as removal of these causes darkening to occur. (S. W. Karunaratne and K. Jayasinghe)

RAW RUBBER SPECIFICATIONS AND ANALYSIS

TSR production

During the year under review the following block rubber samples were tested.

Code	Producer	No. of samples
AA	Sri Lanka Rubber Manufacturing Company Limited, Natural Rubber Complex, Mannanella	1051
AB	Cenat Block Rubber Factory, Paiyagala	817
AC	Ceymac Rubber Company Limited Colombo and Horana	3262
AD	Statcon Block Rubber Factory, Getahetta	2155
AE	Sherman Sons tory, Ingiriya	2013
AH	Lanka Star Rubber Works Limited, Parakaduwa	567
AI	Associated Traders, Colombo 13	200

Analysis of miscellaneous samples

567, miscellaneous rubber samples and 196 latex samples were analysed during the year. 80 samples of rubber chemicals and 36 rubber products were also tested.

Inspection visits

The Head Specifications and Analysis Section, inspected all TSR factories on a regular basis. Activity in TSR production dropped during the second half of the year and most factories virtually stopped production. With the withdrawal of the cash grant of Rs. 1/- per kg given by the EDB manufacturers of TSR found it difficult to produce TSR at a profit.

Control of mould growth in raw rubber

Protein and sugars added to RSS has no influence on the moisture absorption. It is believed that certain functional groups in the rubber molecule are capable of bonding water molecules to rubber. An attempt is made to identify these functional groups. (L. M. K. Tillekeratne, H. P. Sarath Kumara and Sriyanthie Weeraman)

Effect of Mineral oil and Thiols on storage of crepe rubber

The main experiment done under this project was the study of the concentration of polyvalent metal ions in all types of bleaching agents available in the market using the atomic absorption spectrophotometer. It has been found that the variation of metal ions which cause discolouration in the bleaching agents vary with the brand but it is less in the sodium salt of tolyl mercaptan. Work is in progress to identify all causes of storage discolouration of crepe rubber under this project. (L. M. K. Tillekeratne and Manel Mahanama)

Constant viscosity RSS

This study was continued during 1985. In order to activate the action of hydroxyl amine and sodium paratoluene thiophenate on rubber, the sheets made by incorporating the above chemicals were passed through the TSR dryer for 10 minutes for final drying. The product obtained this way was very satisfactory and large scale trials will be carried out soon. (L. M. K. Tillekeratne and H. P. Sarath Kumara)

Fusion reaction gas chromatography of polyurethanes

polyurethanes are among the most versatile of all polymer systems with extensive commercial applications in such areas as flexible and rigid foams, elastomers, coating, adhesives and plastics.

In this work, attempts have been made to develop rapid analytical procedures for representative series of polyurethane polymers.

The procedures developed were cleavage of the polymer using fusion reactions and the subsequent identification of fragments produced. Suitable fusion reagents were chosen and fusion conditions were optimized so that rapid hydrolysis of the polymer is achieved in a fraction of a time required for the hydrolysis using aqueous conditions as previously reported. The hydrolysis fragments were analysed by gas chromatography (GC), high performance liquid chromatography (HPLC), size exclusion liquid chromatography (SEC) and gas chromatography mass spectrometry (GCMS).

Initial work concerned the analysis of polyether - based polyurethane foams.

The procedures used include the cleavage of polymer by alkali fusion and the subsequent analysis of diamine and polyether fragments by GC and SEC respectively after separation using liquid /liquid extraction procedure. polyether fragments were further cleaved using mixed anhydride reagent and the resulting polyol acetate fragment were also analysed by GC.

The procedure was modified and applied successfully to polyether-based polyurethane elastomer analysis. Samples examined included thermoplastic elastomers, commonly used in medical applications.

The procedure was further extended to the analysis of polyester-based polyurethane elastomers crosslinked with both diamines and diols. Although diamines and diol fragments could be examined directly using GC, dicarboxylic acid fragment had to be converted into volatile methyl ester derivatives before the GC analysis.

The procedure was further successfully, applied to co-polyamides, which are condensation products of diisocyanate and dicarboxylic acids. Although these materials are very much resistant to hydrolysis and generally exhibit high temperature and chemical and chemical resistance, successful analysis was conducted on recently introduced polymers using the developed alkali fusion procedure. (P. A. D. T. Wimalasiri, *et al*)

BIOCHEMISTRY SECTION

Biomodification of latex

Studies on this project were continued during the year, with a view to reducing the ash and nitrogen levels and as a result a new method was developed to produce a rubber with a considerably lower ash and nitrogen contents than before. This new method involves the maturation of coagulum, for more than 24h. The resulting rubber has a nitrogen content of less than 0.10% and an ash content around 0.10% and the other typical properties are given in Table 1.

Table 1 *Typical properties of low protein rubber prepared by the new method*

	Acid control	Papain treatment (conventional)	Papain treatment (new method)
Ash % wt.	0.15	0.19	0.12
Nitrogen % wt.	0.34	0.13	0.098
Volatile matter % wt.	0.45	0.45	0.38
Po	40	42	40
PRI	88	90	87
Mooney viscosity	69	71	71
Colour	1.5	2.0	2.0

Samples of this new low nitrogen rubber (LNNR) were sent abroad for evaluation and it has been found to be better than the LNNR produced by the previous

method *i.e.* normal papain treatment of latex without maturation. Several tonnes of new LNNR have been already sold to overseas customers. The Head of the Biochemistry Section had the opportunity of meeting some of the customers of LNNR during his visit to West Germany, towards the end of the year. A detailed programme for testing LNNR for various technological and dynamic properties to be carried out at a reputed German Institute was agreed upon during this visit. With the results of these tests, it is planned to promote this grade overseas and an increase in the demand for LNNR is anticipated in 1986. A definite price formula for LNNR is also to be worked out.

Genotype - Environment Interaction

Studies on the effect of genotype-environment interaction on raw rubber properties were continued during the year. Two sets of samples from the seven experimental areas with 10 different clones were collected for further testing, during the year. The results of tests carried out in the first year of this trial is being analysed in the statistics section. (P. A. J. Yapa, M. D. C. Seneviratne, Sriyani Yapa, P. D. J. Rodrigo in collaboration with Head, Genetics and Plant Breeding Department)

Effluent treatment and disposal

Studies on the biological control of pollution caused by rubber factory effluents were continued during the year under review. Several green house trials were carried out to see the effect of water hyacinth on reducing the BOD and COD levels and the results are now being analysed. Preliminary studies gave satisfactory results with regard to reducing the pollutant levels. Uptake of various cations by water hyacinth was also studied and the results are being analysed.

Several complaints were received from a number of estates about pollution problems caused by rubber factory effluents. The officers of the Section visited some of these estates to assess the extent of pollution and make suitable recommendations. (P. A. J. Yapa, Nishadee Kulatillake, M. D. C. Seneviratne and Sriyani Yapa)

Studies on brown bast

Protein patterns in the A—serum of brown bast affected and healthy trees were studied using polyacrylamide gel electrophoresis. These studies confirmed the disappearance of some of the bands, observed in preliminary trials. This would be extended to some of the widely grown clones of the RRIC series.

Studies on proline content of brown bast affected trees were continued. A fresh set of bark samples was collected from both brown bast affected and healthy trees from Eladuwa State Plantation, during the early part of the year. These

samples were analysed for proline content and the results showed some significant differences, between healthy and brown bast affected trees.

In another experiment proline determination was extended to leaves and latex as well. Both bark and latex samples gave some interesting results compared to leaf samples. Further work is in progress. (Seetha Wickremasinghe, P. A. J. Yapa and Sriyani Yapa)

Non Rubber Resources

Collection of rubber seed

During the period from April to December, 1985, statistical and economic data with regard to rubber seed collection and processing was carried out. Results obtained from about 30 estates and a number of smallholders are being analysed. In general the seed fall for the year 1985 has been considerably low throughout the country. Quantity of rubber seed oil produced by leading rubber seed millers was as low as 50 tonnes. (E. D. I. H. Perera)

Rubber seed oil as a diesel fuel substitute

Rubber seed oil has a much greater viscosity and is much less volatile than petroleum based diesel oil, Hence problems have arisen when rubber seed oil was used as a diesel fuel substitute. One promising solution to this problem, is to due to fatty esters that can be obtained from vegetable oil, by transesterification. An attempt was made to establish the ideal conditions for the process of transesterification of rubber seed oil with methanol using a GLC.

It was found that the rate of the reaction is low when sodium methoxide is used as the catalyst although it is quite possible to achieve a conversion of 90% with other vegetable oils. This may be due to the high free fatty acid content in rubber seed oil.

Arrangements are in hand to carry out engine performance tests on a single cylinder, four stroke diesel engine at the University of Moratuwa. Also Messrs 'Amalgamated Manure Works' agreed to allow us to carry out a survey on energy requirements in the process of rubber seed milling. (E. D. I. H. Perera)

REVIEW OF THE BIOMETRY SECTION

By

W. N. WICKREMASINGHE

SUMMARY

This year was a significant one, with the section's capacity to analyse experimental data increasing considerably with the introduction of a BBC micro computer to the section, along with the statistical package INSTAT. The training received by 2 Technical Officers of the section, on statistical computing, also contributed to this positively.

A considerable portion of the routine service was involved with the analyses of temporary research assistants and students attached to various Departments. About 100 different data sets of this kind, from various designs and projects, were analysed and interpreted during the year.

The studies on the leaf area estimation of *Hevea* clones showed that the simple linear equation $A = 0.677 (L \times B)$ where A = leaf area, L = leaf length and B = maximum leaf breadth, was superior to any existing ones of the same kind.

The Biometrician, also assisted as a co-worker in several projects carried out by other research officers of the Institute.

DETAILED REVIEW

Staff

The Assistant Biometrician, Mr W. N. Wickremasinghe was promoted to the post of Biometrician, during the first quarter, and was on duty throughout. Senior Technical Officer, Mr L. T. Pieries, Technical Officers, Mr R. A. P. Abayapala and Miss J. D. Nandanie were also on duty, throughout.

Mr Ruvan Weerasinghe was appointed as Programmer System Analyst and was in charge of the computer work of the section since 1st August, 1985.

Publications

Wickramasinghe, W. N. Samaranayake, Chandra, and Abayapala, R. A. P. (1985).
On the estimation of Leaf Areas of some selected *Hevea* clones *J. Rubb. Res. Inst. Sri Lanka*, 62, (in press)

Nugawela, A. Wickremasinghe, W. N. and Aluthhewage, R. (1985). Studies on the Variation Involved in Field Measurements of Transpiration Rates and Stomatal Diffusive Resistance of *Hevea* clones and the Relationship of the Latter with Net Photosynthetic Rate *J. Rubb. Res. Inst. Sri Lanka*, 62 (in press)

Wickremasinghe, W. N. (1985). Statistics: It's Importance and Relevance to our Life *Bull. Rubb. Res. Inst. Sri Lanka*, 19. (in press)

Reports

Wickramasinghe, W. N. (1985). Annual Review of Biometry Section.

A review of the work of the section is given below under several headings.

Routine Statistical Service

This consists of assistance in planning and designing of field and laboratory experiments, and analysis and interpretation of results. Usually, during the first and last few weeks of the year, the section gets flooded out with experimental data from all the research Departments, for analysis for the Annual Review. The former, being for last year's review, while the latter is for the current year's. This year too, was no exception. In between these two busy ends, our staff spent some considerable time on analyses for publication of other Research Departments, projects involved with post-graduate studies and also projects of under-graduates temporarily attached to Research Departments.

Some of the significant work of this kind is listed below.

- a. Regression analyses for the comparison of several methods to estimate dry matter from volume of latex of some *Hevea* clones. (Genetics & plant Breeding Department)
- b. Various types of analyses (including Nested ANOVA) for studies on photosynthesis and relevant topics of some *Hevea* clones. (Plant Science Department)
- c. Regression analysis with emphasis on linear calibration (Soils & Plant Nutrition Department)

The statistical services rendered to temporary research assistants and research students are summarized below.

Biochemistry section

Two separate data sets, each having eight different characteristics for analysis, of a research assistant working on a Master's degree under the title "Role of Aquatic Plants in Effluent Treatment system in Rubber Plantations", were analysed and interpreted. There were six treatments, three replicates and five times of sampling, in a split-plot design where sub-treatments are times of sampling.

Since the treatments were equispaced concentrations, Treatment x Time interaction was analysed in detail to study the response to time and how this response varies with the increasing level of treatment

Plant Pathology Department.

A large number of data sets received continuously from a research assistant working on a project under the title "Some Comparative Biological Aspects of Nutrient Cycling in Rubber Plantations, a Pinus Plantation and a Rain Forest" were analysed and interpreted. These data were obtained from five different sites. Analyses included simple means, Coefficients of Variation, Confidence Intervals, Standard Errors, Simple Correlations, t - tests, Chi-square tests, and Analysis of Variance. Data transformations were also done before analysis, where appropriate.

Assistance was provided in the analysis and interpretation of data of two research students, one working on a project titled "A comparative Population Study on the *Endogonacae*" and the other working on a project titled "Effect of VA Mycorrhiza in *Hevea* and in Leguminous Cover Crops on the Incidence of White Root Disease of Rubber". Analyses involved were simple means coefficient of variation, correlation and analysis of variance of a fully randomized design with factorial structure of treatments. Altogether, there were 11 different data sets for analysis.

Soils & Plant Nutrition Department

Assistance was provided in the analysis and interpretation of data of four temporary research students. The following are the titles of the relevant projects.

- a. Some Aspects of Micronutrients in the Nutrition of *Hevea*.
- b. Effect of Soil Types and Cultivars on Leaf N,P,K, Ca and Mg concentration.
- c. Some Aspects of Soil Moisture.
- d. Variations in the N,P,K, Mg and Ca Content of Soil Leaf and Latex in *Hevea* Plantation.

Altogether there were 61 different data sets of different parameters for analysis. Designs involved were split-plot, fully randomized and randomized block. While the analyses involved were, ANOVA. Regression and Correlation Analysis and Multiple Range Tests Transformation of data and missing plot evaluation were also done where appropriate and necessary.

Biometrical Research

The studies carried out on the estimation of leaf area of rubber, resulted in the establishment of a common simple linear equation, $A = 0.677 (L \times B)$ where A = Leaf Area, L = Leaf Length and B = Maximum Leaf Breadth, for the 10 clones, PB 96, GT 1, RRIC 45, IRCI 2, RRIC 101, RRIC 52, RRIC 88, RRIM 600.

LCB 870 and RRIC 100. This equation was found to be superior to the existing ones of the same kind. (W. N. Wickremasinghe, C. Samaranayake and R. A. P. Abayapala)

In addition to the above the Biometrician assisted in the following projects as a co-worker:

- a. Studies on the variations involved in field measurements of Transpiration rates and Stomatal Diffusive Resistance of *Hevea* clones and the relationship of the latter with Net Photosynthetic rate (A. Nugawala and R. Aluthewage)
- b. Studies to assess the minimum number of days a rubber tree has to be tapped to obtain a representative value of the yield potential of that tree. (A. de S. Liyanage)

Computing

The current year was a significant one with respect to statistical computing of the section. The first major step was the introduction of a BBC micro computer to the section, under the Reading - Colombo - R.R.I. link arrangements which also included a small but efficient, unfinished version of the new commercial statistical package INSTAT.

Arrival of this package along with the training that one of the Technical Officers of our section (Mr. R. A. P. Abayapala) received during a course on Statistics in Agriculture, jointly conducted by the Universities of Reading (U.K.) & Colombo, had steadily increased the capacity of the Section to computerize more analyses and complete them faster and more accurately than previous years. However, analyses involved with more complicated designs have still to be done manually, as INSTAT is still in its infancy and has not yet got sufficient capability to handle more complex ones. It is hoped that in future, opportunities will be opened up for a total switch over from manual operation to computers.

Most of the routine work as well as independent research of biometrical nature were done using this package INSTAT, wherever possible. Various specific purpose and utility programs were developed during the year to help in the related data analysis. Soft ware was also developed on the IBM - PC computer belonging to the Soils & Plant Nutrition Department, for storing and retrieving soil and foliar analysis data. The efficiency of the Section in the analysis of experimental data using INSTAT was further increased when another Technical Officer of the section (Miss J. D. Nandani) received a training on statistical computing, during a 1 - month course, entitled "Statistics and Computer application in Agriculture", towards the end of the year.

Meteorology

The routine collection of weather data from the Dartonfield weather station and Nakiadeniya Oil Palm State Plantation, was continued without interruption. Software have been developed to store and retrieve these data. The graph of rainfall, temperature and sunshine duration at Dartonfield is shown in Fig 1.

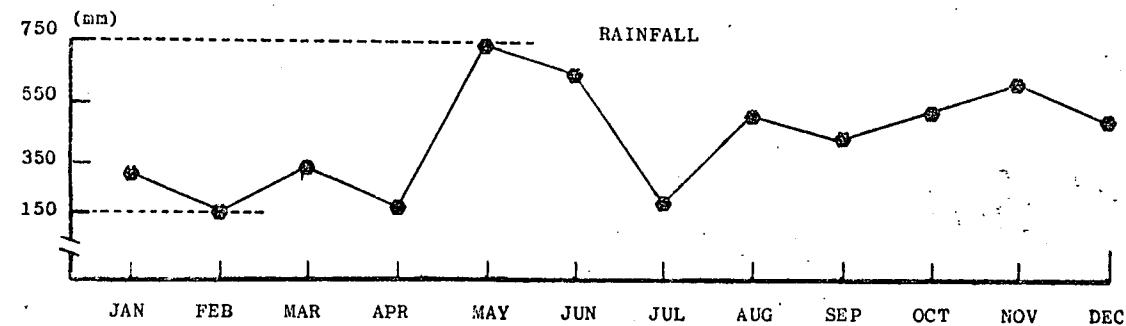
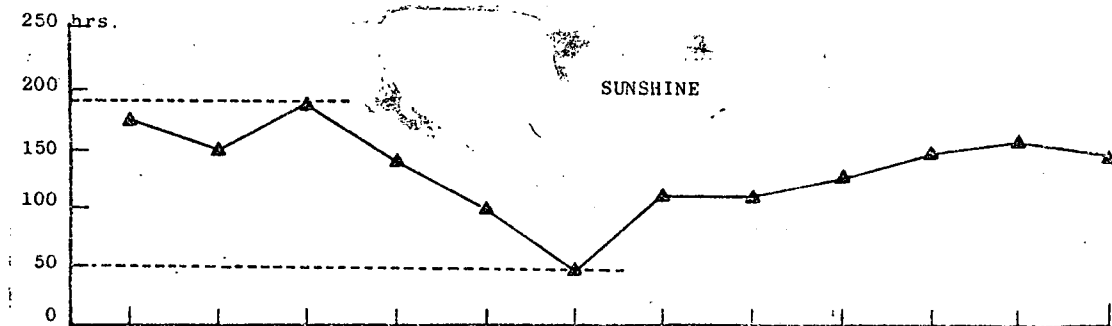
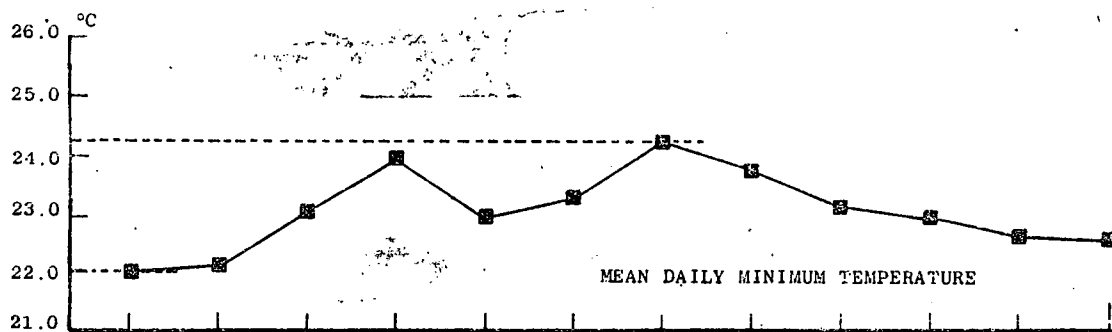
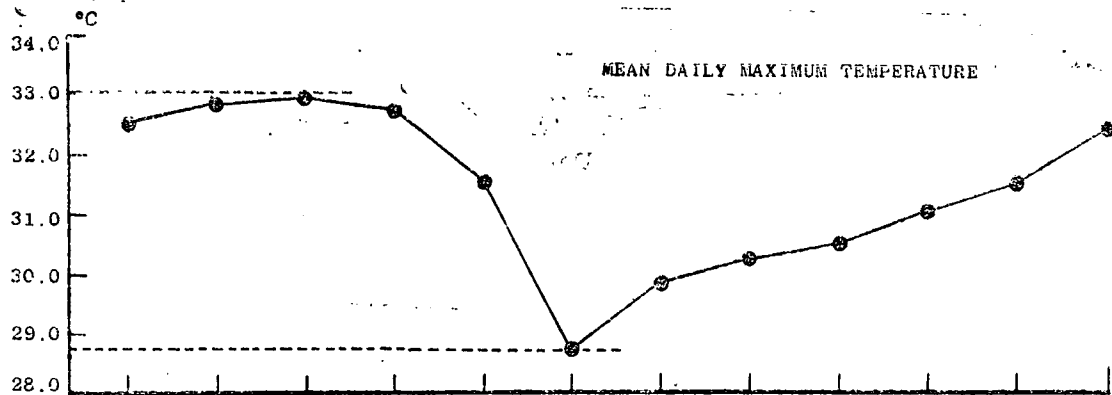


Fig. 1. Rainfall, duration of sunshine and temperature at D'field

REVIEW OF THE LIBRARY AND PUBLICATIONS SECTION

By

VIJITHA JAYARATNE

SUMMARY

The Library and Publications Section was able to maintain the processing and publishing of the Institute's regular publications and collecting and disseminating of information on all aspects of natural rubber (NR) throughout the year.

The current scientific information relevant to research was obtained without much delay through the Agricultural Information Network (AGRINET) and the National Information System for Agricultural Science, (AGRIS).

DETAILED REVIEW

Staff

Mrs V. S. Jayaratne, Librarian and Publications Officer, Mr D. C. Thambawita Library Assistant and Assistant Publications Officer and Miss Ramani Mahakumara Clerk/Typist, were on duty throughout the year. Miss L. T. Ramanaden, Library Assistant and Assistant Publications Officer attached to the Coombo Office Library, returned in December 1984 after a year's no pay leave and went on a further 3 months no pay leave in Jan

Miss Ramani Mahakumara Clerk/Typist attached to the Library sat for the preliminary examination in Library Science in November 1985.

Acquisitions

To enable to maintain the subscription for essential periodicals which are of more use to the Research Staff, the number of text books to be ordered for this year too had to be curtailed. Back copies of 300 titles of Journals were bound and added to the existing 3500 bound copies.

Two hundred and thirty four titles of current periodicals including abstracting and indexing periodicals were obtained this year too.

	Local	Overseas
On subscription	—	87
On exchange/gratis	32	115

Inter library loans

Inter library loans scheme has helped us in obtaining reprints of articles from other research libraries without much delay. With the wake of increasing subscription rates most of the libraries find it difficult to obtain all research journals that are essential in their own libraries. Therefore this scheme is a very successful scheme which benefits all libraries in obtaining urgent research articles which are not available in their own libraries. Through this scheme we were able to send 35 copies of articles to other libraries and receive 16 copies of articles from other libraries on request.

Publications

All Institute publications were published and circulated without any delay. The Annual Review was published by June 1985. The International Rubber Conference Proceedings which are in 3 volumes are in the final proof stage.

The book titled "A Practical guide to rubber planting and processing" edited by Drs. A. de S. Liyanage and O. S. Peries, was very popular among the rubber growers throughout the world, and as requests for more copies were received daily, 1000 more copies are been printed and will be available for distribution by end of January 1986.

The following publications were printed during the year.

Publications	Volume
Annual Review	1984
Journal	62
Bulletin	19 20 and 21
Rubber Puwath	12

Information services

Disseminations of information

Selecting and disseminating of information required by the Institute's scientific staff as well as the staff of other research Institutes, Universities etc., were carried out regularly. By circulating contents pages of current scientific journals among the Institute's scientific staff we were able to help them in selecting the required articles. We were able to help the Scientific Officers of Other Institutes in obtaining relevant articles of their interest; by sending photocopies of requested articles.

Agricultural Information Network (AGRINET)

The work of the AGRINET with the initiative of the National Resources Energy and Science Authority of Sri Lanka (NARESA) was maintained throughout

the year. A user survey was carried out to enable the newly appointed Research Officers of the AGRINET Member Institutes to participate in the Selective Dissemination of Contents Pages programme (SDCP). A "Directory of Agricultural Information Users 1985" was published and released by NARESA, which lists Scientists and Technologists who are actively engaged in research in agriculture and allied subjects. As our Library and Publications Section is an active member of the AGRINET the names of Institute's Research Officers who participated in the user survey were included in this Directory.

National AGRIS Project

Some of the Research Officers were able to obtain SDI (Selective Dissemination of Information) and retrospective searches done on subjects of their interest through the National AGRIS project.

The AGRIS Sri Lanka has published a bibliography on Agriculture which gives information on agricultural publications. This will be published annually and all agricultural publications will be included. The Institute's publications are sent to the Central Library to be used as inputs to the bibliography of AGRIS Sri Lanka and the International data base (AGRIS).

REVIEW OF THE ESTATE DEPARTMENT

By

H. E. S. DON PETER

SUMMARY

The estate belonging to the Research Institute at Dartonfield & Gallewatta Divisions in Agalawatta and Nivitigalakele Division in Matugama known as Dartonfield Group consisting of 333.79 ha. The planted area is 277.80 ha of which 213.34 ha were in bearing during the year.

The rainfall recorded this year was higher than that in 1984. Heavy downpours prevailed during the cropping months contributing to heavy shortfall in crop.

Wintering was early this year. No symptoms of *Oidium* leaf disease noticeable except on the later wintering clones which suffered slight leaf fall such as the 1971 PB 28/59 areas. A few scattered bark rot trees found in Nivitigalakele and *Rigidoporus* affected trees in Gallewatta Divisions were treated. The incidence of *Phytophthora* leaf disease was negligible this year.

Budwood of clones of the RRIC 100, 103 and 121 continued to be in demand and issues to all Estates of Sri Lanka State Plantations Corporation and Janatha Estates Development Board and Smallholders were made accordingly.

All agricultural operations were carried out in mature and immature areas and nurseries of the Group.

The estate made a profit of -/45 cts. per kilo during this season.

DETAILED REVIEW

Staff

The writer assumed duties as Estate Superintendent, Dartonfield Group, with effect from 01 February 1985.

Mr W. D. Sugathadasa, Tractor Driver left the Estate on 10 July 1985 to join the Works Section of the Rubber Research Institute as a Driver.

Mr S. K. S. de Silva, Field Officer of Nivitigalakele Division was under interdiction since 02 August 1985 to 24 October, 1985 on disciplinary grounds. Mr W. D. D. Senanayake Field Supervisor of Gallewatta Division was transferred to

Nivitigalakele Division temporarily to over look the work during this period.

Mr T. Somaratne Field Supervisor of Dartonfield Division was transferred to Gallewatta Division with effect from 01 October, 1985 while transferring the daily paid Supervisor Mr A. K. D. A. Wickramasinghe from Gallewatta Division to Dartonfield Division.

Mr D. C. C. Jayasekara resigned from the post of Factory Officer to join the Sri Lanka State Plantations Corporation on 30 November, 1985.

Mr H. W. Amaradasa was appointed as Tractor Driver with effect from 1 October, 1985.

Mr A. A. Ariyaratne, Chief Clerk, Mr K. K. P. Gunawardana (Acting Senior Assistant Clerk, Mr K. D. Sumanasena, Junior Assistant Clerk, Mr D. S. K. Ranaweera, Assistant Factory officer, Messrs N. L. D. Piyadasa, A. K. D. Hemapala and H. M. Jayantha Premlal, Field Officers, Messrs J. A. Wimalasena and A. K. D. M. Wickremasinghe Assistant Field Officers, Messrs T. Somaratne, S. R. Vadivel and W. D. D. Senanayake. Field Supervisors and Miss C. H. Hettiarachchi Creche Attendant were on duty throughout the year.

The Dartonfield Group cadre stood at 16 at the close of the year made up as follows:

Senior Staff	01
Assistant Staff	13
Minor Staff	02
	—
Total	16

Agricultural adviser

Mr R. C. Peries, Director JEDB No. 1 the Agricultural Adviser visited the property twice during the year and reports on these visits were submitted to the Robber Research Board.

Hectareage

A summary of the hectareage is given in Table 1.

Table 1. Land distribution in Dartonfield Group

	Dartonfield	Gallewatta	Nivitigalakele	Total
Mature area	27.70	141.72	43.92	213.34
Immature	15.47	35.16	—	50.63
Nurseries	3.42	1.80	8.61	13.83
	46.59	178.68	52.53	277.80
Paddy fields	—	1.25	—	1.25
Abandoned area	—	—	8.06	8.06
Swamps	—	—	1.21	1.21
Buildings	16.23	6.00	7.79	30.02
Roads	2.67	.50	.32	3.49
Streams/reservation	.03	—	—	.03
Jungle	—	—	.71	.71
Uncultivated rocky and earthslipped areas	7.36	1.34	2.62	11.22
Grand total	72.78	187.77	73.24	333.79

Weather

Rainfall figures (mm) for 1985 and 1984 are given in Table 2.

Table 2. *Rainfall distribution for 1984 and 1985 in Dartonfield Group*

	Dartonfield		Gallewatta		Nivitigalakele	
	1985	1984	1985	1984	1985	1984
January	275.5	327.5	296.6	340.1	371.1	324.4
February	169.9	296.1	169.4	377.9	135.0	312.4
March	320.4	361.0	339.0	319.5	241.2	265.5
April	187.0	643.7	219.2	607.0	238.2	522.3
May	731.6	1070.5	607.9	832.1	704.7	891.0
June	631.1	375.3	700.7	397.5	820.4	405.7
July	199.4	432.8	207.8	424.1	219.1	630.4
August	494.5	33.4	663.2	30.0	235.9	30.0
September	416.6	273.1	409.7	308.6	260.5	185.0
October	503.4	256.1	531.6	309.6	280.6	159.2
November	594.9	493.0	549.1	425.7	325.0	235.0
December	477.6	275.8	436.3	310.9	130.5	145.3
	5001.9	4838.3	5130.6	4683.0	3962.2	4006.2
Total wet days	242	227	252	203	145	148

The season had begun with a wet January and February too was wetter than usual. May and June proved to be the wettest months. Weather from August onwards was unusual recording heavier downpours than last year.

Crop

The yield data for the last 5 years are given in Table 3.

Table 3. *Yield records from 1981 - 1985 (kg/ha)*

	1985	1984	1983	1982	1981
Dartonfield	825	865	838	772	818
Gallewatta	635	781	804	875	1233
Nivitigalakele	741	924	667	684	953
Total	730	884	779	858	1105
Estimated	913	889	1052	1124	1064
Tapping (ha)	213	197	205	209	187

The crop for the year was 155721 kg, which fell short of the estimate by 39147 kg. However 80% of the estimated crop was harvested in spite of the heavy and uneven distribution of rainfall during the cropping months which caused the drop in crop

126 days tapping were lost due to unfavourable weather conditions and recovery tapping was done on 56 days.

Tapping cuts were marked with appropriate guide lines for bark consumption according to the systems of tapping adopted.

The tapping panels were treated with fungicides.

Manufacture

A summary of manufacture records during the year is given in Table 4.

Table 4. *Details of manufactured crop in Dartonfield*

Latex grade	Total crop	
	(kg)	(%)
Pale crepe No. 1	150491	82
Pale crepe No. 2	450	—
Pale crepe No. 3	7909	4
Scrap crepe No. 1	5578	3
Scrap crepe No. 2	3078	2
Scrap crepe No. 3	458	—
Smoked sheet No. 1	7739	4
Smoked sheet No. 3	61	—
Air dried sheet No. 1	8231	5
Total crop manufactured (inclusive of 28274 kg of bought latex	183995	100

Ten thousand (10000) kg of thin crepe was contracted for and supplied.

Twenty three thousand four hundred (23400) kg of De-protinized natural rubber, eight thousand one hundred and thirty three (8133 kg of air dried sheets and twenty five (25) kg of constant viscosity crepe rubber were manufactured and supplied on a special request made by Messrs Associated Traders.

The estate continued buying latex from the small-holders of the neighbourhood and the total bought latex manufactured at the end of the year was 28274 kg. The small-holders were paid a price almost on par with net sales average.

Factory machinery

All machinery were in good order.

Agricultural operations

All the routine agricultural operations were carried out as required to maintain a good standard of accepted agricultural practice.

Wind damage

The loss of trees due to wind damage were as follows:

	Dartonfield	Gallewatta	Nivitigalakele
Wind damaged trees	37	239	44

Nurseries

Nurseries were established in Nivitigalakele and Dartonfield Divisions for 1985/86 replantings and to supply budwood for the smallholders were maintained during the season.

Field and factory experiments

The Research Departments were given the necessary assistance in carrying out their field and technological experiments.

Soil conservation measures

A retaining wall (400 ft. in length) was constructed on the lip of the earth slip area and two drains — 2' x 2' x 2' (525 ft and 650 ft. long) were also constructed on either side of the retaining wall to drain excess run-off water. This work was inspected by Prof. P. W. Vithanage of Department of Geology Peradeniya who visited Dartonfield on two occasions and expressed satisfaction in the manner in which this work had been completed.

Approach road to RRI

The main approach road to RRI which was buried with 25 ft earth after the earth slip was repaired and made available for normal traffic.

Labour and health

The health of the entire estate population was satisfactory during the year.

Repairs to line rooms and drinking wells in Dartonfield Division were attended to during the season.

The CARE Sri Lanka branch continued to provide "Thriposha" free of charge under the medically selective programme for infants and to natal and lactating mothers of the estate.

All non-working resident children over 01 year of age below 13 years continued to be issued with $\frac{1}{4}$ lb. of bread per day per head. In addition fortnightly cash payments were made in lieu of half cream milk to resident non-lactating mothers with infants under 01 year of age.

Wages were paid during the year in accordance with the Wages Board Ordinance in force, festival advances were paid as required. Incentive bonus and the annual holiday pay wages were paid to the labour in accordance with the Ordinance.

Accounts

The final accounts for the year 1985 is in progress.

Estimates

Estimates for Capital and Revenue Expenditure for 1996 in respect of Dartonfield Group were submitted to the Rubber Research Board and were approved.