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Cover: Wintering has commenced in rubber plantations

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Technology and Preparation Studies at the Institut De Recherches Sur Le Caoutchouc En Afrique (IRCA)*

M J Leveque

nstitut Francais du Caoutchouc/ Institut de Recherches sur le Caoutchouc en Afrique
42, Rue Scheffer, 75016 Paris

The first granulated rubber factory was set up in the Ivory Coast in 1956. Accordingly it was an innovation due, for a great part, to the studies carried out in the Research Institutes in Cambodia and Viet-Nam.

The general line of this preparation included a coagulation in circular rolls after continuous filtration on a self-cleaning filter, an unrolling of coagulums on saws, in order to get sheets whose serum should not be pressed out by roll pressure, a granulation of sheets on rotary cutters, a drying on a continuously working band-drier then weighing, baling and packing with detection of metal particles by an appropriate device.

At that time this process was quite modern and gave rubbers with high rates of cure and a 100% elongation modulus between 7 and 8 kg/cm². The french manufacturers who were regular purchasers of this rubber, wished to receive this type of rubber which had the high mechanical properties and high cure rates required in manufacturing firms.

Preparation

I. R. C. A. set out its own pilot-factory in 1968 to try new preparation systems, particularly using hammer mills and vibrating driers. The latter were disappointing for natural rubber because of its stickiness, but hammer mills were improved by fitting of sharpened knives instead of hammers, generally at a 90° angle, which resulted in a 30% decrease of the energy consumption of the hammer mill and in an increase of production rising to nearly 2 tons/hour for a 35 CV apparatus.

The polyvalency of the hammer mill was thus demonstrated, as it was a better rubber cleaner with flat hammers and an excellent granulator with sharpened hammers.

The hammer mill, considering of course a device with fixed hammers which in spite of more important energy peaks are superior to flying hammers, has the following advantage: a single apparatus is sufficient for preparing and granulating and this type of apparatus is particularly strong. For instance, after five years' use, the hammer mill of the pilot factory did not need any repair relating to motors, bearings, etc.

The hammer mill must be fed with creped sheet. The creping may be summary for rubbers from coagulated latex: one or two passes or an eight-pass creping for lower grade rubbers.

Thus, the firm include now a delivery and storage area for lower grade rubber and latex, a creping stage, a hammermilling stage, a deep bed dryer built locally and replacing the vibrating drier, a weighting and pressing divice which also never failed for five years.

The aim of this factory is to stand for what the new factories set up in the Ivory Coast might be as the production increases.

It is clear that the studies aimed at simplifying the preparation material and at increasing the yield. Both objects were attained.

Some studies were devoted to the development of a special processing system for cumulative tapping rubber. This system, called polybag was invented by Southorn in Malaysia and used on an industrial scale in large areas with success, since a plantation fitted with polybag allows the preparation of 95% of the production under the single form, which is of advantage and polybag might constitute in Africa one of the possible types of a future standard natural rubber.

The preparation of polybag is similar to the preparation of lower grade rubber for it is necessary to homogenize carefully the rubbers from different clones so as to get a satisfactory evenness in colour and PRI.

As an indication, polybag rubbers possess the average following properties:

—Impurities..........	0.20 – 0.25
—Volatile matters....	0.35
—Ashes...............	0.35

* Paper presented at the International Rubber Research and Development Board Scientific Symposium, Cochin 26-28, September 1974.

—Nitrogen.	0.25
—Po	42
—PRI	60 + 5
—Colour	between the colour of latex rubber and the colour of cup lump rubber.

The dynamometric properties of these rubbers are quite the same as those of latex rubbers. But the dynamic properties are slightly superior to the latter, because of the hydrolysis of some proteins during the storage within water for about one month. This gives a material whose rubber hydro-carbon content is slightly higher.

Polybag rubber preparation techniques including six passes in creping machine and one in hammer mill have now reached a high stage of development. It is to be noticed that the drying of this rubber is less easy than for latex rubber because of its closed structure and its greater stickiness.

Technological Studies

Natural rubber technical specification has been for several years the main object of the service of technology. It consisted first in checking off the quality of all the Ivory Coast products and then in setting in place a centralized testing service enabling to check the productions of each factory for each quality in a statistically safe way.

The most commonly used procedures are those of ISO, as well as the specification grades. As a matter of fact, we thought it was normal to adopt at once those defined by the manufacturers who are the users of this rubber.

It is to be noticed that in addition to the usual specifications: impurities, ashes, volatile matters, nitrogen, Po, PRI and Lovibond colour, all the rubbers are submitted to a cure rate test in a cured compound ACS n° 1, with the exception of a few lower grade rubbers. The whole Ivory Coast production have high or very high cure rates, between 7 and 8 kg/cm² for 100% elongation.

Thus, 90% of the Ivory Coast production is sold according to a technical classification, in the shape of small granulated reagglomerated rubber bales. 10% of the Ivory Coast production is sold according to the Green Book descriptions. This 10% includes, for a great part; TC Rubbers, for which cure rates are given. These figures show that the Ivory Coast production is extremely up-to-date though its amount is still small.

Very intensive technological studies on cumulative tapping rubbers enabled to know their characteristics: as said before, they showed to be equal or slightly superior to those of the best RSS.

I. R. C. A. is now trying, on a laboratory scale, to increase the evenness of the colour of polybag rubbers as well as of their PRI. Economic studies pointed out the availability of the process for the Ivory Coast and the Cameroons, for in this country, polybag is the most commonly produced.

A testing centre of I. R. C. A. is located in the Western Cameroons. It is nearly the same as the one in the Ivory Coast. It gives technical specifications to the productions of the main planters in the Cameroons, which are sold principally under the shape of reagglomerated granulates in 33,33 kg. bales.

I. R. C. A. tries also to Value basic raw materials which might be mixed with rubber, thus giving to manufacturers the possibility of local supply without using carbon black for instance, while getting excellent properties. Thus red clay reinforced masterbatches and masterbatches reinforced with local proteins from fishery scraps which would be unused otherwise have been developed.

Rubbers with stabilized viscosity are also under study as far as some manufacturers are interested.

I. R. C. A. also gives advice locally to a certain number of rubber manufacturers who rely on its laboratory results to improve their production.

Another aspect of the activities of I. R. C. A. is to deliver a quality label for certain products, such as latex foam from unfilled natural latex which has much better properties than foams marketed in Europe which are most often made from synthetic rubber.

The efficiency of I. R. C. A. in the Ivory Coast and the Cameroons is now well-known, not only in Africa where regular contacts exist with other producer countries, but also in Asia where I. R. C. A. sent specialists to help a certain number of producer countries.

Rubb Board bull. 13, 1; 1976; 3—4.

Phytophthora nicotianae var parasitica (Dastur) Water house on Hevea brasiliensis in South India

Thomson T Edathil and **M K George**
Rubber Research Institute of India, Kottayam-686 009

Abstract

Phytophthora infected petioles and fruits of *Hevea brasiliensis* were collected from an isolated rubber estate during the *Phytophthora* disease season of July 1971. *P. nicotianae* var *parasitica* was isolated from the infected petioles and fruits of rubber. The isolate, when artificially inoculated on healthy twigs of the clone RRIM 701, produced typical symptoms of abnormal leaf fall disease of rubber under controlled conditions in the laboratory. The pathogen was reisolated from artificially inoculated and infected plant parts.

Phytophthora causes a number of diseases in rubber. Among the various diseases caused by the pathogen in rubber, the abnormal leaf fall disease, resulting in premature leaf fall and die back of tender shoots, causing considerable loss of crop, is the most serious disease of rubber. Two species, *P. palmivora* (Butl) Butl. and *P. meadii* (Mc Rae) are reported to cause abnormal leaf fall disease of rubber in India (2). No reports are available on *P. nicotianae* var *parasitica* causing any disease in *Hevea*. This is the first report of this pathogen causing abnormal leaf fall disease in *Hevea*.

Materials and Method

During the *Phytophthora* disease season in July 1971, infected petioles and fruits of rubber were collected from an isolated rubber estate situated at an elevation of about 915 meters M. S. L. at Vandiperiyar, Kerala State, India. The pathogen was isolated by tissue culturing of the infected materials on potato-dextrose agar and identified as *P. nicotianae* var *parasitica* by the Commonwealth Mycological Institute, Surrey, England (IMI No. 165733). The fungus was grown on different media to study its morphology and reproduction. The isolate was observed to produce sporangia in Lima-bean agar, Rubber leaf-extract agar and soil-extract agar. Healthy twigs of rubber plants (RRIM 701) were inoculated with a sporangial suspension of the fungus by the methods described by pillai and Chee (1). The sporangial suspension was prepared by blending an eight day old lima-bean agar culture of the isolate in a waring blender. The twigs were inoculated on the petioles with sterile cotton swabs, dipped in sporangial suspension. Inoculated twigs were thoroughly sprayed with water and enclosed inside polythene bags, the inside of which were also sprayed with water and incubated at 22±2°C and 100% relative humidity for 72 hrs.

Results and Discussions

Inoculated leaves produced typical black lesions on the petioles with a drop of latex coagulated, in the centre. Lesions were noticed on the leaf lamina also. In the artificial inoculation studies, 90% of the inoculated leaves took infection and they abscised and dropped off from the twigs, when taken out of the polythene bags. The pathogen was re-isolated from the infected petioles and compared with the original isolate. Hyphae of the fungus were fairly uniform in diameter, measuring 8.33μ with frequent hyphal swellings. Chlamydospores were produced in rubber leaf-extract agar medium and they measured 35.15μ

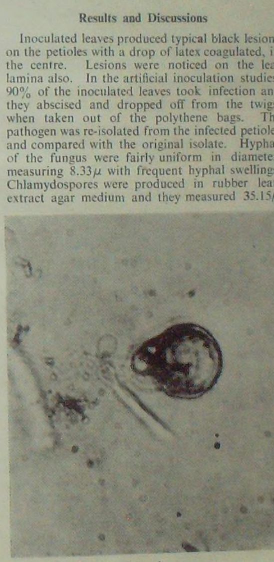

Fig. 1

Fig. 2

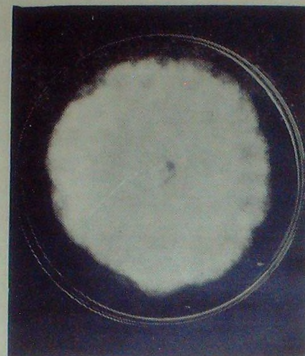

Fig. 3

forming rather tardily (after 2 weeks), intercalry, becoming yellowish brown with age. Sporangia were broadly ovoid, with spherical basal portions and not noticeably narrowed in the apical part, papillate, measured $42.73\mu \times 32.40\mu$ on an average (Fig. 1). Sporangia got detached with a very short pedicel. Oospores were not produced in single culture, but were readily formed when paired with *P. meadii* and measured 24.99μ, antheridia spherical (Fig. 2). Culture was irregularly fluffy in an irregular rosette pattern (Fig. 3).

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Rubb Board bull. 13, 1 ; 1976 ; 5—10.

Processing and service properties of oil extended natural rubber prepared from Latex

E V Thomas, K S Gopalakrishnan and K Kochappan Nair
Rubber Research Institute of India, Kottayam 686 009

Introduction:

Oil extension was started in natural rubber as a step to improve its competitive position with the general purpose synthetic rubbers. Most of the general purpose synthetic rubbers are available in oil extended forms and have definite advantages in the manufacturing operations. The earliest attempt at extension of natural rubber was by using pine tar (3). Subsequently various process oils have become popular as rubber extenders and plasticisers. In the studies conducted by Van Amerongen (10), mixing of oil with natural rubber was done in the dry stage by mastication in open mills. Grosch (4), has later compared the service properties of the treads prepared from oil extended natural rubber with that of OESBR. Simultaneously attempts were made by the various Rubber Research Institutes for the preparation of oil extended natural rubber from latex (7, 8, 9) (OENR—L).

The difficulties encountered during the earlier stages of preparation of OENR—L were its decrease in physical properties and the cold flow characteristics. These defects were mainly due to the attack of the rubber hydrocarbon by the oil molecules (6). So attempts were made to carry out oil extension after treating the latex with cross linking agents or after addition of carbon black (1). Lat r with the intrcduction of modern processing methods Chin Pen Sung and O'conell (2), have reported that oil extension of latex can be done with success if undiluted field latex is used for the work. They have also found that the physical properties of OENR—L are comparable to those of the dry oil mixed (OENR—D) stocks. Karunarathne (5) in an earlier work has reported that the service properties of the treads prepared from OENR—L are inferior to those of the treads from OENR—D.

So the present work was undertaken with the following objectives (i) to examine the possibility or eliminating peptiser in the banbury mixing of OENR—L and low viscosity rubber containing 10 phr oil. (ii) to arrive at satisfactory levels of oil content for the preparation of oil extended and low viscosity rubbers. (iii) to assess the road wearing qualities of tread rubber prepared from OENR—L. (iv) to assess the storage hardening properties of OENR—L. (v) to compare the physical properties of natural rubber loaded with different levels of aromatic and naphthenic oils.

Materials and Methods:

Two types of process oils viz. Rubber Oil A (aromatic) and Flex on—542 (naphthenic) supplied by M/s. Esso Standard, Eastern Ltd., were used in the study.

Preparation of oil emulsion:

Oil emulsion was prepared by heating oil with the required amount of stearic acid (4% on weight of oil for aromatic and 1·5% for naphthenic) and pouring the hot solution into equal weight of water containing a little ammonia under vigorous stirring. The rate of addition during the initial stages should be controlled so as to obtain uniform mixing. A stable emulsion which mixed well with latex was thus obtained.

Preparation of OENR—L and OENR—D:

Undiluted field latex, of predetermined d. r. c. and free from tendency for pre-coagulation, is mixed with calculated amount of oil emulsion, so as to obtain the required amount of oil in rubber. This mixture is then properly blended and coagulated with acetic acid. The sheets so obtained were smoke dried and used for the evaluations. The drying was over in about five to seven days. When the oil content was above 10 Phr, there was difficulty in getting perfectly dry sheets. But sheets up to 10 Phr oil content could be smoke dried in five days without any difficulty. Sheet rubbers with 5, 10, 20 and 30 Phr oil content were prepared using the two grades of oil. In dry mixing, the corresponding levels of these oils were incorporated with sheet rubber at the time of compounding.

Compounding and testing:

The sheets were examined for their Mooney Viscosity before and after a storage period of four months. The formulation used for assessment is given below:

Rubber	—	100.0
Oil	—	(variable)
HAF Black	—	50.0
ZnO	—	5.0
St. Acid	—	2.0
HBS	—	0.85
S .	—	2.25

Compounding of sheet rubbers containing different levels of the two oils was carried out in 12″ laboratory mill according to ASTM procedure. Simultaneously dry rubber sheets were also compounded in the same formulation with addition of corresponding levels of oil, in each, as present in the respective OENR—L. The samples were cured at the optimum cure time (from Viscurometer data) for the determination of various physical properties and physical tests were carried out on the cured samples.

Large scale mixing studies to assess the processing characteristics:

Large scale mixing studies were carried out in a size 3A banbury. These studies were conducted using sheet rubbers extended in the latex stage with 22.5 and 10 Phr aromatic oil. Dry sheet rubbers were prepared from the same lot of latex and oil mixing in the dry stage was carried out for assessing the time for compounding. The formulations and the schedule of mixing used are given below:

Rubber	—	100
Oil	—	(Variable)
Peptiser	—	(As required)
HAF. Black	—	50
ZnO	—	5
St. acid	—	2
PBN	—	2
HBS	—	0.6
Vulcatard A	—	0.5
Sulphur	—	2.0

The details of the compounding are given below:

Batch I — OENR—L with 22.5 phr aromatic oil. No peptiser.

Batch II — Dry sheet rubber blended with 22.5 phr aromatic oil in banbury (OENR–D) Peptiser 0.2 phr.

Batch III — Sheet rubber extended in the latex stage with 10 phr aromatic oil. No peptiser (low viscosity).

Batch IV — Dry sheet rubber blended with 10 phr aromatic oil in banbury (Peptiser 0.2 phr).

Schedule of mixing:

Batch I		Batch II	
Time in minutes	*Order of addition*	*Time in minutes*	*Order of addition*
0	load OENR–L	0	Load rubber + peptiser
½	Zinc oxide	1	Zinc oxide
1½	Stearic acid + ¾ black	2	Stearic acid + ¾ black
3	¼th Black	4	¼ Black + oil.
4th Minute Dump.		5th Minute Dump.	

Sulphur, accelerator and other ingredients were mixed by a second stage of mixing after cooling the stock overnight. The same mixing cycle was used for Batches III and IV. In the case of Batch III, peptiser was not required in the first stage of mixing even though there was no reduction in mixing time. The dump temperatures of the banbury while mixing the OENR–L stocks were found to be lower than those for the dry mixing operations.

Preparation of tread and evaluation of Service properties:

The compounded stocks obtained from batch I and II were used for the production of tread rubber. The stocks were homogenised in mixing mill and extruded through a factory extruder, so as to obtain standard treads for jeep tyres. Cushion backing was also given on the extruded treads at the time of extrusion. Smooth extrusion was possible in both cases and the extruded stocks were free from defects. The treads were used for retreading the jeep tyres of the Rubber Research Institute of India. In all cases, where the service testing was carried out, care was taken to see that the load on the experimental tyres was identical during actual service. This was ensured by fixing the tyres retreaded with dry and latex extended treads on either side of the back wheel of the jeep. The position of the tyres was inter-changed periodically.

Results and discussion:

Table I gives the change in Mooney Viscosity of the OENR–L during a storage period of four months. Table II gives a comparison of the physical properties of rubbers extended with different levels of naphthenic oil in the dry and latex stages, while Table III gives the corresponding values for aromatic oil. These results are further explained in the histograms I, II and III.

From Table I it can be seen that the storage hardening in OENR–L decreases as the oil content increases. But the hardening observed for low oil concentrations is almost comparable to that for ordinary sheet rubber. An examination of the data in table II and III and the three histograms will show that the physical properties of oil extended rubber prepared in the dry and latex stage are comparable. From the histograms it can also be seen that the percentage retention in physical properties after aging is in general superior for aromatic oil. The abrasion resistance of the stocks with 30 phr aromatic oil is found to decrease to a considerable extent. Because of these two reasons in the large scale studies, aromatic oil is used and the level fixed for OENR-L was 22.5 phr. From Tables II and III it may also be seen that there is no appreciable drop in any of the mechanical properties at an oil loading of 10 phr. But sheet rubbers with this level of oil can give a reasonable reduction in Mooney viscosity. So in the large scale studies 10 phr oil level is selected for the preparation of low viscosity sheet.

Under large scale mixing studies it was explained that the OENR-L with 22.5 phr aromatic oil could be masticated and compounded in the banbury without the use of peptiser. Further it is also observed that the mixing of black and other ingredients with OENR-L could be carried out, one minute earlier than that with the dry oil mixed lot. These observations clearly show that use of oil extended rubber will help in reducing the cost of compounding and in increasing the through put of the basic mixing units. It is further seen that the sheets with 10 phr oil also do not required peptiser for mastication. But the storage hardening of the sheets with low levels of oil is appreciable, and so it is doubtful as to whether these grades can give the same performance after a storage period of six months as the fresh sheets.

In the studies conducted by Karunarathne (loc-cit) it is reported that the wearing qualities of treads prepared from OENR-L is inferior to that from OENR-D. But in the present study, there was no indication of excessive wearing loss in the case of treads obtained from OENR-L. Further, the retreaded treads do not show any tendency for tread separation, oil migration or groove cracking. The treads with this high level of oil could complete satisfactory running for 16000 Kms. In all these aspects the tyres retreaded using OENR-L and OENR-D gave comparable performance.

It may be seen from the tables II and III that there is a drop in physical properties of the valcanisates as the oil content increases. This observation is in agreement with that of the previous workers (Van Amerongen-loc-cit). Thus at high oil loadings, properties like hardness and abrasion resistance are appreciably lowered. But it may be remembered that OENR or OESBR is generally used for light duty applications like that for the production of passenger car treads. For such applications the magnitude of the physical properties retained in OENR is enough for rendering satisfactory service properties.

Conclusions:

(i) Use of OENR-L will help in reducing the mixing time and in eliminating the cost of peptiser (ii) The service properties of the tread prepared from OENR-L and OENR-D are comparable. (iii) Storage hardening of raw rubber with high levels of oil is not appreciable. (iv) Low viscosity rubbers also do not require peptiser in banbury mixing provided there is no much time lag between its preparation and compounding.

Acknowledgements:

The authors are grateful to the Director of Research for his keen interest in this study. The preliminary work carried out by Dr. N. H. Sivaramakrishnan and Dr. P. John Jacob formerly Dy. Directors of R. R. I. I., in the standardisation of procedure for preparation of OENR-L is gratefully acknowledged. The large scale mixing studies in size 3A banuury was carried out at M/s. MRF, Vadavathoor and the extrusion of tread was carried out at M/s. General rubbers, Industrial Estate, Ettumanoor. The moulding part of the work was done at M/s. Premier Tyres, Kalamassery. The valuable assistance and co-operation provided by these Factories are also remembered with thanks.

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Oil	—	(variable)
HAF Black	—	50.0
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Compounding of sheet rubbers containing different levels of the two oils was carried out in 12″ laboratory mill according to ASTM procedure. Simultaneously dry rubber sheets were also compounded in the same formulation with addition of corresponding levels of oil, in each, as present in the respective OENR—L. The samples were cured at the optimum cure time (from Viscurometer data) for the determination of various physical properties and physical tests were carried out on the cured samples.

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Batch IV Dry sheet rubber blended with 10 phr aromatic oil in banbury (Peptiser 0.2 phr).

Schedule of mixing:

Batch I		Batch II	
Time in minutes	*Order of addition*	*Time in minutes*	*Order of addition*
0	load OENR-L	0	Load rubber + peptiser
$\frac{1}{2}$	Zinc oxide	1	Zinc oxide
$1\frac{1}{2}$	Stearic acid $+\frac{3}{4}$ black	2	Stearic acid $+\frac{3}{4}$ black
3	$\frac{1}{4}$th Black	4	$\frac{1}{4}$ Black+oil.
4th Minute Dump.		5th Minute Dump.	

Sulphur, accelerator and other ingredients were mixed by a second stage of mixing after cooling the stock overnight. The same mixing cycle was used for Batches III and IV. In the case of Batch III, peptiser was not required in the first stage of mixing even though there was no reduction in mixing time. The dump temperatures of the banbury while mixing the OENR-L stocks were found to be lower than those for the dry mixing operations.

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Under large scale mixing studies it was explained that the OENR-L with 22.5 phr aromatic oil could be masticated and compounded in the banbury without the use of peptiser. Further it is also observed that the mixing of black and other ingredients with OENR-L could be carried out, one minute earlier than that with the dry oil mixed lot. These observations clearly show that use of oil extended rubber will help in reducing the cost of compounding and in increasing the through put of the basic mixing units. It is further seen that the sheets with 10 phr oil also do not required peptiser for mastication. But the storage hardening of the sheets with low levels of oil is appreciable, and so it is doubtful as to whether these grades can give the same performance after a storage period of six months as the fresh sheets.

In the studies conducted by Karunarathne (loc-cit) it is reported that the wearing qualities of treads prepared from OENR-L is inferior to that from OENR-D. But in the present study, there was no indication of excessive wearing loss in the case of treads obtained from OENR-L. Further, the retreaded treads do not show any tendency for tread separation, oil migration or groove cracking. The treads with this high level of oil could complete satisfactory running for 16000 Kms. In all these aspects the tyres retreaded using OENR-L and OENR-D gave comparable performance.

It may be seen from the tables II and III that there is a drop in physical properties of the valcanisates as the oil content increases. This observation is in agreement with that of the previous workers (Van Amerongen-loc-cit). Thus at high oil loadings, properties like hardness and abrasion resistance are appreciably lowered. But it may be remembered that OENR or OESBR is generally used for light duty applications like that for the production of passenger car treads. For such applications the magnitude of the physical properties retained in OENR is enough for rendering satisfactory service properties.

Conclusions:

(i) Use of OENR-L will help in reducing the mixing time and in eliminating the cost of peptiser (ii) The service properties of the tread prepared from OENR-L and OENR-D are comparable. (iii) Storage hardening of raw rubber with high levels of oil is not appreciable. (iv) Low viscosity rubbers also do not require peptiser in banbury mixing provided there is no much time lag between its preparation and compounding.

Acknowledgements:

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TABLE I

Type and amount of oil	ML (1 + 4) 100°C	
	19-2-'73	13-6-'73
Blank	83	95
Naphthenic Oil 7.5 Phr	70	88
Naphthenic Oil 25 Phr	49	57
Aromatic Oil 7.5 Phr	73	88
Aromatic Oil 25 Phr	52	58

TABLE II

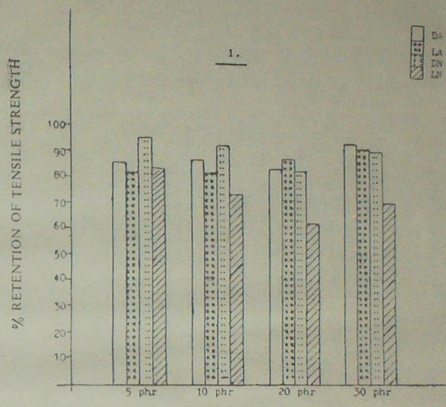
Physical Properties	LN 5 Phr	LN 10 Phr	LN 20 Phr	LN 30 Phr	DN 5 Phr	DN 10 Phr	DN 20 Phr	DN 30 Phr
Modulus 300% Kg/cm²								
BA	209.5	172.3	166.1	150.4	188.0	210.7	141.3	126.3
AA	219.3	189.2	174.4	158.7	232.1	222.3	157.9	156.1
Tensile strength Kg/cm²								
BA	279.3	273.9	297.5	323.1	279.2	322.9	278.2	286.5
AA	230.7	202.8	186.1	230.4	266.6	297.6	229.4	259.8
Elongation at break%								
BA	380	420	450	490	384	406	490	490
AA	315	318	320	396	342	378	390	412
Hardness Shore A	58	54	49	45	56	50	47	42
Resilience %	64.0	61.5	60.0	61.0	66.5	64.1	64.1	62.5
Abrasion loss cc/hr.	0.2649	0.3207	0.3146	0.3548	0.2468	0.2470	0.3454	0.6612

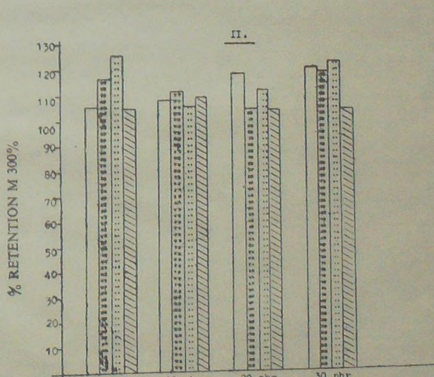
LN Latex extended with naphthenic oil.
DN Dry extended with naphthenic oil.
BA Before ageing.
AA After ageing for 96 hours at 70 ± 1°C.

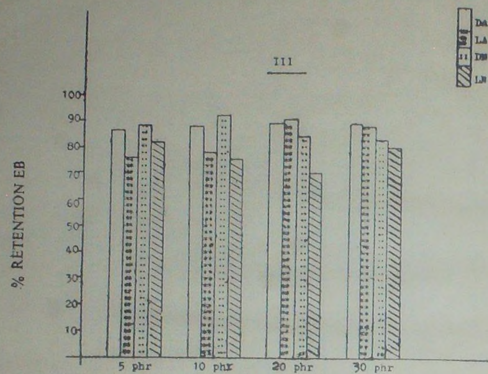
TABLE III

Physical properties	LA 5 Phr.	LA 10 Phr.	LA 20 Phr.	LA 30 Phr.	DA 5 Phr.	DA 10 Phr.	DA 20 Phr.	DA 30 Phr.
Modulus 300% Kg/cm²								
BA	183.5	182.2	152.4	112.1	229.8	189.2	133.3	105.9
AA	214.6	204.0	161.6	134.6	242.7	205.6	157.5	128.8
Tensile strength Kg/cm²								
BA	283.5	283.6	280.3	252.7	320.0	332.6	268.1	249.9
AA	231.8	234.3	242.4	233.2	279.4	288.6	225.3	235.6
Elongation at break%								
BA	416	430	444	500	392	454	456	496
AA	326	340	410	445	345	406	412	446
Hardness Shore A	59	55	51	45	55	55	49	45
Resilience%	62.0	61.0	59.5	59.0	63.1	61.0	60.0	59.0
Abrasion loss cc/hr.	0.2384	0.2336	0.2686	0.4592	0.2632	0.2857	0.3725	0.5916

LA Latex extended with aromatic oil
DA Dry extended with aromatic oil
BA Before ageing.
AA After ageing for 96 hours at 70 ± 1°C.


I.
DA
LA
DN
LN
% RETENTION OF TENSILE STRENGTH
100
90
80
70
60
50
40
30
20
10
5 phr
10 phr
20 phr
30 phr


II.
% RETENTION M 300%
130
120
110
100
90
80
70
60
50
40
30
20
10
5 phr
10 phr
20 phr
30 phr


III
% RETENTION EB
100
90
80
70
60
50
40
30
20
10
5 phr
10 phr
20 phr
30 phr
DA
LA
DB
LB

Rubb Board bull. 13, 1; 1976; 11—13.

A study on the Relative Efficiency of some Nitrogenous Fertilizers on the Growth of Rubber Seedlings in the Nursery

K I Punnoose, M Abdul Kalam and **S Narayanan Potty**
Rubber Research Institute of India, Kottayam-686 009

Abstract

In order to study the comparative efficiency of five nitrogenous fertilizers, viz; ammonium sulphate, urea, ammonium sulphate nitrate, calcium ammonium nitrate and Chilean nitrate on the growth of rubber seedlings, a bilocational trial was conducted during the period from 1969 to 1972 in two nurseries of the Rubber Board. A uniform dose of nitrogen at the rate of 250 kg/ha was supplied through the different fertilizers. It was observed from all these trials that there was no significant difference among the three fertilizers viz; ammonium sulphate, urea and ammonium sulphate nitrate. Chilean nitrate was found to be inferior to all the other forms.

The beneficial effects of nitrogenous fertilizers on the growth of rubber seedlings have been well established. Exhaustive experiments were done in these lines by Middleton and Chin Tet Tsoy (1964) and Saleh (1965) in Malaysia and by the Rubber Research Institute of Ceylon (Anon. 1966 and 1968). But no experimental evidence is at present available to prove what form of nitrogenous fertiliser would be most efficient and economic for rubber seedlings under the soil and climatic conditions of the rubber growing tracts of South India. Hence with this object in view, the present investigation was taken up in which five forms of nitrogenous fertilizers commonly available in the market viz; ammonium sulphate, urea, ammonium sulphate nitrate, calcium ammonium nitrate and Chilean nitrate were included.

Experimental

A bilocational trial was conducted in the RRII nursery and in the Central Nursery of the Rubber Board in 1969–70. The trial was repeated in 1970–71 and 1971–72 in the Central Nursery. For the repetition of the trial, new areas were selected every year. The following were the treatments included in the trial:

- T1 — Urea
- T2 — Ammonium sulphate nitrate
- T3 — Chilean nitrate
- T4 — Calcium ammonium nitrate
- T5 — Ammonium sulphate
- T6 — No nitrogen application

Nursery beds of four feet width were prepared and germinated Tjir-1 monoclonal seeds planted at a spacing of 30 × 30 cm during August/September. The plot size was 3 × 1.2 m with 40 seedlings. A uniform dose of nitrogen at 250 kg/ha was applied in the different forms as per the treatments, in two equal split doses at 8 and 16 weeks after planting. Phosphorus at 300 kg P_2O_5/ha, potash at 250 kg K_2O/ha and magnesium at 80 kg MgO/ha were uniformly applied in all the plots in two equal split doses along with the first and second applications of nitrogen. The fertilizers were applied in between rows of plants and forked into the top 2–3 cm of soil using a mammatty fork. The beds were mulched with dry leaves after fertilizer application. The final height and diameter of individual seedlings in the net plot area of each plot consisting of 16 seedlings were recorded during June-July every year.

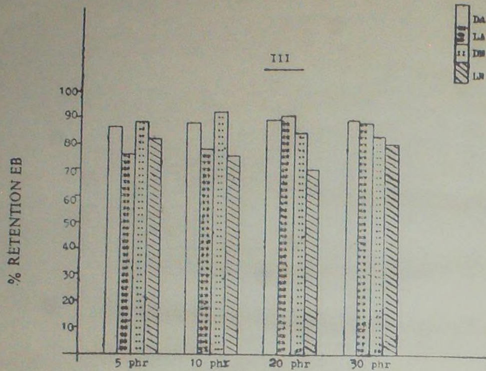
The height of the seedling was measured from the collar region of the stem to the apical growing point and the diameter at the collar region. Seedlings in the net plot with diameter 18 mm and above at the collar region were considered as buddable and the percentage of buddable seedlings was worked out.

The data on height, diameter and percentage of buddable seedlings were statistically analysed and the means given in the Table. The values of percentages being not normally distributed were transformed to angles and then analysed. For convenience of comparison, the percentage figures are also furnished along with the transformed angles in the body of the Table. The values of S. E. and C. D. are also given in cases of significance for comparison of means.

Results and Discussion

With regard to the height of seedlings, no significant difference in response was noticed among the various forms of nitrogen at the RRII Experiment Station during 1969–70 season. The average effect of nitrogenous fertilizers was significantly superior to that of no nitrogen treatment. The highest mean values were obtained for urea and ammonium sulphate nitrate, followed by ammonium sulphate.

Similar results were obtained for the diameter of seedlings also. Ammonium sulphate nitrate


III
DA
LA
DB
LB
% RETENTION EB
100
90
80
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5 phr
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20 phr
30 phr

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Similar results were obtained for the diameter of seedlings also. Ammonium sulphate nitrate gave the maximum diameter followed by urea and ammonium sulphate.

Significant differences among the treatments were noticed in the percentage of buddable seedlings. Ammonium sulphate nitrate and urea were significantly better than calcium ammonium nitrate. The highest mean values were obtained for the treatments of ammonium sulphate nitrate urea and ammonium sulphate. No significant difference in responses was noticed among ammonium sulphate nitrate, urea, ammonium sulphate and Chilean nitrate. The average effect of nitrogenous fertilizers also was significant.

No significant difference was noticed among the different forms of nitrogen for mean heights, diameter and percentages of buddable seedlings in the experiment conducted at the Central Nursery during 1969–70 season. However, the highest mean values were obtained for the treatments of urea and ammonium sulphate in all the three cases. The average effect of nitrogenous fertilizers was significant.

Regarding the height of seedlings, significant differences were noticed among the treatments in 1970–71 trial at the Central Nursery. Ammonium sulphate and calcium ammonium nitrate gave significantly better heights over that given by Chilean nitrate. The maximum mean height was obtained for ammonium sulphate followed by calcium ammonium nitrate and urea. The average effect of nitrogen application was significantly better than the no nitrogen treatment.

With regard to the diameter of seedlings also significant differences were noticed among the treatments. Ammonium sulphate and calcium ammonium nitrate gave significantly increased diameter than Chilean nitrate. No significant difference was noticed among the treatments of ammonium sulphate, calcium ammonium nitrate, urea and ammonium sulphate nitrate. The highest mean diameter was given by ammonium sulphate followed by calcium ammonium nitrate and urea. The average effect of nitrogenous fertilizers also was significant.

In the case of percentage of buddable seedlings, no significant difference was noticed among the different forms of nitrogenous fertilisers. The heighest percentages were obtained for the treatments of ammonium sulphate nitrate and ammonium sulphate. The average effect of nitrogenous fertilizers was significant.

In the Central Nursery, during the 1971–72 season no significant difference was noticed among the treatments either for the mean heights or diameters. In both cases heighest mean values were recorded for urea.

Mean tables for height, diameter and percentage of buddable seedlings.

	Treatments	Mean height in cm				Mean diameter in mm				Mean angles/percentages		
		RRII	Central Nursery			RRII	Central Nursery			RRII	Central Nursery	
		1969-70	69-70	70-71	71-72	69-70	69-70	70-71	71-72	1969-70	69-70	1970-71
T1	Urea	104.1	160.2	142.4	115.3	12.21	16.15	14.65	12.07	17.6 (10.7)*	45.1 (50.6)	35.5 (33.9)
T2	Ammonium sulphate nitrate	104.1	157.0	141.1	103.6	12.26	15.66	14.53	10.90	18.3 (11.6)	41.3 (43.8)	37.8 (37.9)
T3	Chilean nitrate	95.2	155.2	137.8	110.6	11.73	15.72	14.08	11.30	12.7 (8.1)	44.2 (48.6)	34.9 (33.5)
T4	Calcium ammonium nitrate	99.9	152.7	147.6	112.3	11.72	15.48	15.37	11.75	10.7 (6.7)	41.7 (44.3)	36.5 (35.7)
T5	Ammonium sulphate	101.0	158.4	148.7	112.0	12.10	15.86	15.49	12.01	13.4 (10.9)	45.3 (50.5)	37.8 (37.9)
T6	No nitrogen	91.2	140.2	120.8	112.6	11.30	14.10	12.46	11.92	7.5 (3.8)	31.4 (20.7)	21.0 (15.3)
	S. E.	3.30	4.31	3.18	3.55	0.31	0.44	0.36	0.38	2.27	3.2	2.93
	C. D. (5%)	—	12.4	9.1	—	—	1.3	1.1	—	6.5	9.2	8.3

*Percentages given in brackets.

A general evaluation of the effect of the various fertilizers on the three parameters studied would indicate that there is no difference among ammonium sulphate, urea and ammonium sulphate nitrate. Calcium ammonium nitrate comes only next to these fertilizers and Chilean nitrate is the least effective among the lot. Similar results were obtained by Saleh (1965) for urea and ammonium sulphate in rubber seedling nursery. The results obtained by the Rubber Research Institute of Ceylon (1966 and 1968) on immature rubber are also in support of these findings. The whole of nitrogen in ammonium sulphate, the majority of it in ammonium sulphate nitrate and the half of it in calcium ammonium nitrate are in the form of NH^4 ions which immediately after application, are retained by the soil for long time through cation-exchange reactions and thus become easily available to the plants (Agarwal, 1965). Urea also, after application, hydrolyses to give NH^4 ions (Tisdale and Nelson, 1966). This may be the probable reason for the general superiority of these four nitrogenous fertilizers over Chilean nitrate.

The poor response of Chilean nitrate noticed in this trial also is in agreement with the results obtained by Middleton and Chin Tet Tsoy (1964). This can be attributed to the fact that the whole of nitrogen in Chilean nitrate being in the form of NO_3 ions, is liable to leaching loss (Vickar *et al*, 1963).

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Microhelices in Hevea Latex : their Isolation and Electron Microscopy*

J B Gomez and Esah Yip
Rubber Research Institute of Malaysia, Kula Lumpur

Summary

In *Hevea brasiliensis* latex there are lysosome-like organelles known as lutoids. In some cases mature lutoids contain minute inclusions with an open helical configuration, which we designate *microhelices* : these are distinct from the *microfibrils* found in young lutoids. Microhelices can be obtained in quantity by suitable treatments of B serum, the fluid from within lutoids. The structure of the microhelices, as observed by electron microscopy, is discribed and their possible significance is discussed. They appear to be largely composed of a basic protein.

The latex in the vessels of *Hevea brasiliensis* has been shown to be a specialized cytoplasm containing several cytoplasmic organelles other than rubber particles (2,6,14,8). Of these particle types, the lutoids have attracted great attention in recent years due to their probable involvement in the mechanism of latex flow and plugging (15). Lutoids can be considered as vacuoles (7, 13) and as lysosomes (11, 12); these two concepts are not contradictory: matile (9) has presented evidence for the equivalence of vacuoles and lysosomes in plant cells in general.

Lutoids in latex vessels from young tissues contain microfibrils, each with the structure of a tightly coiled helix (2, 7). These microfibrils have been well characterized by Dickenson and others (3, 4, 5).

Dickenson (2) observed a second type of microfibril in centifuged suspensions from mature trees. This had a zig-zag configuration. Southorn and Yip (16) encountered similar structures during an investigation of the action of dialyzed B serum on rubber particles *in vitro*. Tata (17), at the last IRRDB symposium, mentioned a structural component of mature lutoids detected by electron microscopy. The present paper is concerned with these structures, which we designate *microhelices*.

Materials and methods

Tissue sections were prepared by removing plugs of bark from the trunks of mature *Hevea* trees of the clone Tjir 1. Samples were taken from bark treated for 18 months with the yield stimulant 2-chloroethyl phosphonic acid (1) as well as from untreated control trees. The plugs were subsectioned under 2% osmium tetroxide fixative prepared in phosphate buffer pH 7.0 containing 0.3 M sucrose. After 24 hours of fixation in osium tetroxide the tissue was washed and dehydrated in a graded ethanol series before embedding in Epon 812 for final sectioning with a Porter-Blum microtome. Latex vessels from the inner, soft bark were studied by this method.

For a study of isolated lutoids in section, latex of clones RRIM 600 and Tjir 1 was collected under chilled conditions after tapping the trees. Both control trees and trees stimulated with 2-chloroethyl phosphonic acid were used. The latex was centrifuged at 0–5°C in a Spinco model L centrifuge essentially as described by Moir (10). This gave the three main fractions mentioned above, with the bottom fraction showing several 'zones' as also described by Moir. The plastic tubes were pierced to drain off the C serum, then cut to obtain the bottom fraction. The fluffy white material at the top of this ('zone 6') was scraped off and discarded and a sample of the central mass of the bottom fraction ('zone 8') was scooped up for fixation. Fixation and embedding were carried out as for tissue sections except that the fixation time was 2 hours inst ad of 21 hours.

To prepare B serum, bottom fraction was made in the same way, except that zone 6 was usually removed by rinsing with 0.4 M mannitol. Bottom fractions from several tubes were then pooled and subjected to alernate freezing and thawing using dry ice/alcohol mixture. The product was then centrifuged at 12,000 r. p. m. (= 11,00 g maz) for 30 minutes in a Martin Christ centrifuge. The supernatant serum thus obtained was decanted from the sediment, consisting of debris from ruptured lutoid membranes etc., and filted.

Dialysis of B serum against distilled water for 24 hours produced a precipitate. This was collected by centrifugation and negatively stained with 1% phosphotungstic acid at pH 6.0 or pH 7.0 and observed under the electron microscope.

All the electron micrographs were taken with a Philips EM 100 B electron microscope.

* Paper presented at the International Rubber Research and Development Board Scientific Symposium, Cochin 26-28, September 1974.

Results

Figure 1 shows a lutoid in a tissue section from a tree (clone Tjir 1) stimulated with 2-chloroethyl phosphonic acid. Numerous microhelices are visible, both longitudinal and tangential profiles being frequent. The individual microhelices are mostly more than 1 um in length with a diameter of about 300° A. The fibre width is of the order of 50° A and the pitch of the helix is approximately 200° A. The axis of he helix is hollow.

No inclusions of microhelical material have been seen in lutoids in tissue from untreated trees. They show clear spaces with an occasional osmiophilic particle inside (Figure 2).

Figure 3 shows isolated lutoids from the bottom fraction of centrifuged latex from control trees of clone RRIM 600 and *Figure 4* shows those from stimulated RRIM 600 trees. The stimulated sample shows microhelices in the lutoids although they are not as numerous as in Figure 1. The control sample shows no microhelices.

Figure 5 shows sections of isolated lutoids from the bottom fraction of latex from control trees of clone Tjir 1. In this instance, there is evidence of the presence of microhelices in some of the lutoids in the preparation. They are, however, more numerous in some sections of isolated lutoids from the latex of the corresponding stimulated Tjir 1 trees (*Figure 6*).

Figure 7 is a preparation, negatively stained with PTA, of the precipitate formed on dialyzing B serum from latex of clone RRIM 600 (untreated trees). Microhelices are present in quantity in the preparation, accompanied by some apparently amorphous material. The diameter of the microhelices is somewhat larger than observed in osmium tetroxide preparations of whole lutoids: about 450° A. The difference may be explained by the lack of shrinkage in PTA-stained preparations as compared to those fixed with osmium tetroxide and embedded in Epon. In some samples from B serum individual microhelices appear to be associated laterally into bundles (*Figure 8*); occasionally single microhelices are observed (*Figure 9*).

Microhelices are also numerous in the precipitate obtained by dialysing B serum from the latex of untreated trees of clone Tjir 1.

Dilution of B serum with distilled water (without dialysis) also produces a precipitate in which microhelices are readily detected after negative staining with PTA.

Discussion

The microhelices described above are clearly distinct in appearance and dimensions from the microfibrils present in young lutoids and well characterized by Dickenson and Audley(2, 3, 4, 5). Each of these microfibrils is a continuous tightly coiled helix with a hollow axis. After negative staining with phosphotungstic acid the diameter of the helix is 125° A. The pitch of the coils is 100° A, the diameter of the hollow axis 30° A and the wall of the helix is about 50° A thick. These microfibrils are absent from the lutoids of latex from mature tissue; they have been shown to consist of an acidic protein (i. e. one of low isoelectric point) with possibly a small amount of carbohydrate (3, 4, 5).

Our microhelices do resemble the 'second type of microfibril' with a zig-zag structure detected by Dickenson (2) in latex from mature trees. This structure was apparently observed sporadically and therefore not fully characterised. The published electron micrographs (2) suggest some differences in dimensions from our microhelices, though the general form is very similar. The question of identity cannot be resolved at present.

The appearance of microhelices in large numbers in the precipitate from the dialysis or dilution of B serum implies the presence, in solution in B serum, of a precursor material which precipitates in the ordered form of microhelices when the ionic strength is lowered. Since microhelices are readily obtained from B serum from untreated trees, the presence of the precursor material is not an artefact of yield stimulation with 2-chloroethyl phosphonic acid. However, such treatment does appear to be responsible for the presence of microhelices in large numbers within lutoids *in vivo*, since they have not so far been observed in tissue sections from untreated trees. In isolated lutoids also microhelices seem to be more frequent and more numerous with material from stimulated trees.

The presence of microhelices in lutoids in trees stimulated with 2-chloroethyl phosphonic acid was observed after 18 months of repeated treatments at two-monthly intervals and may reflect some cumulative effect of the stimulant. This may be a change in the ionic concentration within lutoid particles; some such changes are already known to occur: there is a fall in the concentration of calcium and magnesium within lutoids, i. e. in B-serum, in trees treated with 2-chloroethyl phosphonic acid (19). The presence of microhelices in lutoids isolated from latex collected by tapping unstimulated trees may be due to the dilution of latex that occurs after tapping.

The very striking appearance of the microhelices invites speculation on their chemical composition and function. Preliminary tests suggest that they are largely composed of a basic protein (18); further work on their chemistry is in progress in our laboratories.

Those basic proteins of B serum which remain in solution after dialysis are known to flocculate rubber particles *in vitro*, and this reaction is thought to play a part in the 'plugging' of latex vessels which ultimately terminates latex flow after tapping (15). It is of interest to determine whether the microhelices are important in this process, especially since microhelices were earlier observed connecting some of the individual rubber particles in suspensions flocculated by dialyzed B serum (16). It has been found (19) that the microhelical precipitate from dialyzed B serum, when redissolved in sodium chloride solution, can flocculate rubber particles. However, dialyzed B serum from which the microhelical precipitate has been removed by centrifugation also flocculates rubber suspensions strongly, so it seems unlikely at present that the microhelic material is essential to the process.

Further work will be necessary to determine the function of these intra-lysosomal structures.

Acknowledgement

The authors wish to thank Miss Ho Lai Har, Messers Yee Shin Meng and Chew Mian Seng for skilled technical assistance and Mr. G. F. J. Moir for assistance in preparing the text.

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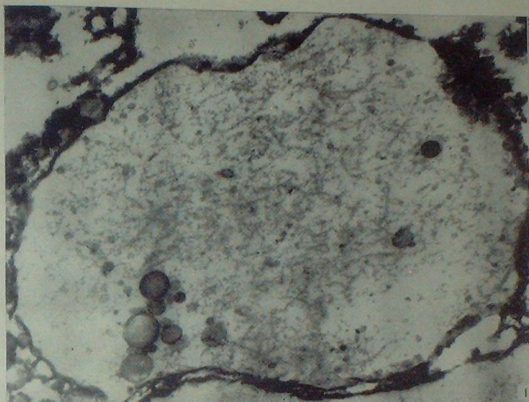


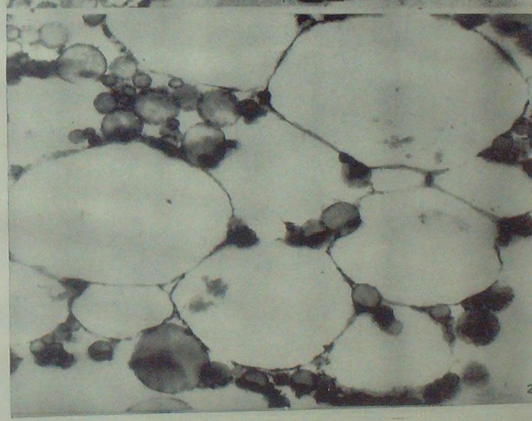
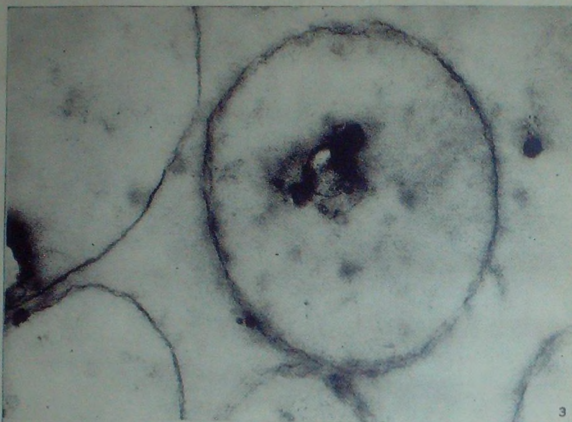


FIGURE 1. Ultrathin section of tissue from a tree stimulated with 2-chloroethyl phosphonic acid, showing a portion of a lutoid containing numerous microhelices. × 35,000.

FIGURE 2. Ultrathin section of tissue from a control tree showing several lutoids. Microhelices are not present. The smaller osmiophilic particles are rubber particles. × 35,000.



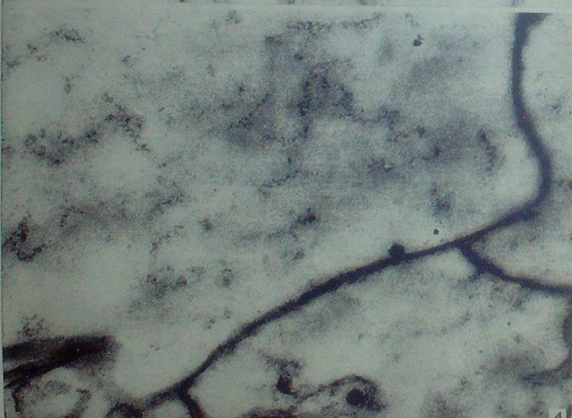
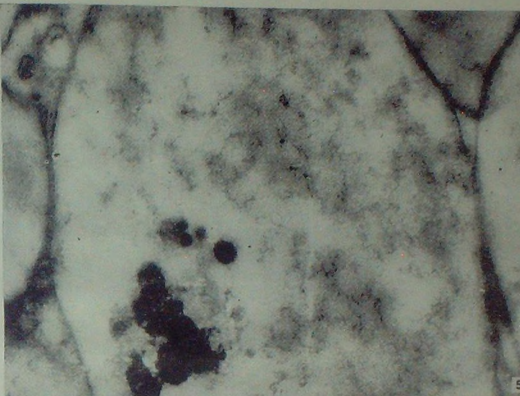


FIGURE 3. Section through isolated lutoids from latex of RRIM 600 trees (untreated trees). No microhelices are visible. × 50,000.

FIGURE 4. Section through isolated lutoids from latex of stimulated RRIM 600 trees. Some microhelics are visible. × 60,000.



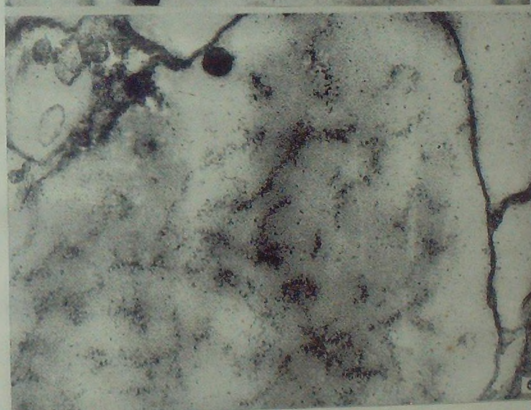


FIGURE 5. Section through isolated lutoids from latex of Tjir 1 trees (untreated controls). Some microhelical material is present. × 60,000.

FIGURE 6. Section through isolated lutoids from latex of stimulated Tjir 1 trees. Microhelices are profuse. × 60,000.

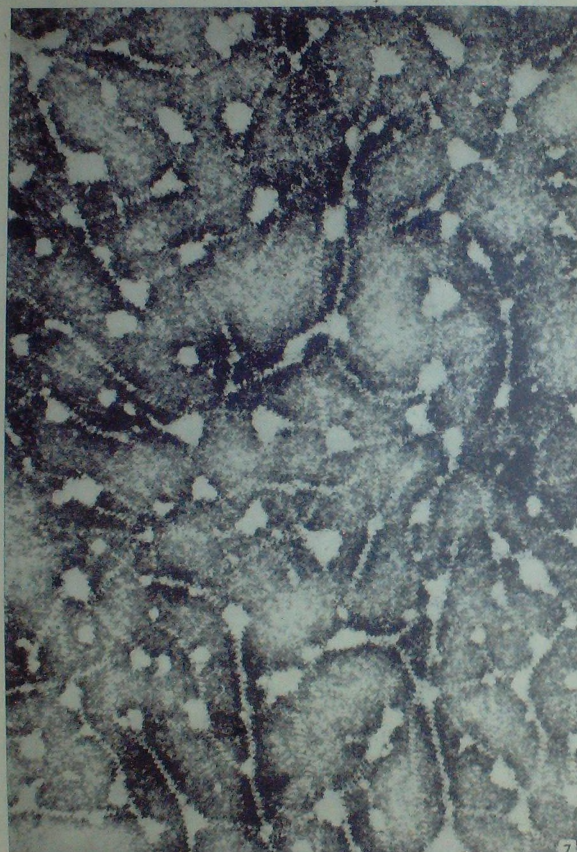
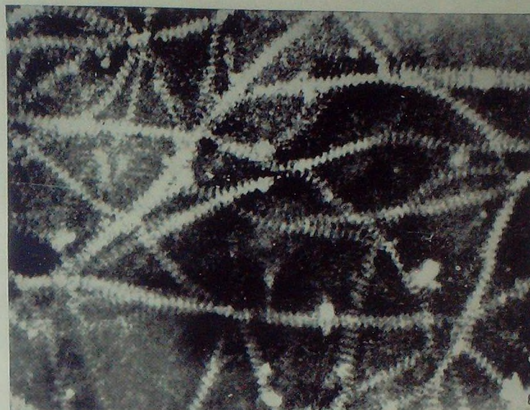


FIGURE 7. Microhelices from dialyzed B serum (Clone RRIM 600). × 50,000.



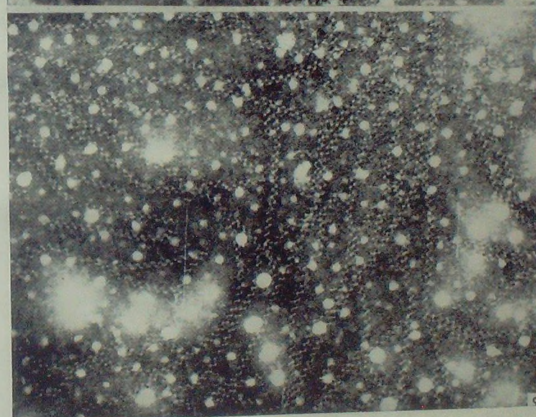


FIGURE 8. Bundles of microhelices from dialyzed B serum (Clone RRIM 600). × 80,000.

FIGURE 9. Single microhelices from dialyzed B serum (Clone RRIM 600). × 80,000.

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Studies on a Stabilising Substance Derived from a Destabilising Factor in B-serum of Hevea Brasilinesis Latex*

A M Hahn and **A Koesdarminta**
Research Institute for Estate Crops, Bogor, Indonesia

A basic protein compound of B-serum of Hevea brasiliensis latex with strong flocculating action on dilute suspensions of white fraction latex, was further investigated with regard to properties and structure. From this protein a stabilising substance was obtained by an immunological assay technique. Its ability to neutralize the flocculating effect of the above mentioned protein compound in suspensions of rubber particles and diluted latex was studied in vitro.

Introduction

A major basic protein compound of B-serum with strong flocculating effect on suspensions of rubber particles, has been isolated at the R. R. I M. (7) by DEAE cellulose column chromatography of dialysed B-serum at pH 9.5 and also by Archer (1) by ammonium sulphate precipitation from B-serum.

These research workers obtained two proteins in the isolates and Archer has named these 'Heveamines'.

As already described previously, we also obtained two components of this destabilising protein by DEAE cellulose chromatography of dialysed B-serum at pH 10 (2).

The two components were investigated further by high voltage electrophoresis combined with paper chromatography after enzymatic hydrolysation with respectively papain and trypsin. In this way the so-called fingerprints have been obtained.

To obtain a higher yield, the earlier mentioned protein has been precipitated first from dialysed B-serum by ammonium sulphate, and then separated by DEAE-cellulose column chromatography at pH 10.

In accordance with the results obtained by Tata and Archer, electrophoresis in polyacrylamide gels showed two bands.

The mixture of the two 'Heveamines' was used as an antigen and injected into a sheep to obtain an antibody by means of an immunological assay.

After isolation from the blood-serum and purification, a substance was obtained which could neutralize the strong flocculating effect of the 'Heveamines' on a suspension of rubber particles. The coagulating and neutralizing effect of respectively the 'Heveamines' and the anti-destabiliser were also studied.

Experimental

For the isolation of the basic protein the dialysed B-serum was first precipitated by 40–60% (saturation) ammonium sulphate, then dialysed against water, freeze dried and separated by means of DEAE cellulose column chromatography at pH 10.

The optical density of each fraction was measured with a Zeiss-Spectrophotometer at a wavelength of 280 n. m. and when plotted, a graph with two peaks was obtained. The fractions of each 'peak' were collected and freeze dried. The isoelectric points of both components were measured by paper chromatography at pH 6.5 and pH 8.6. In the same previous paper we already described that both components showed nearly the same flocculation time on the suspension of rubber particles, which were obtained from the top white rubber fraction after high speed centrifugation. The two components were further investigated by high voltage electrophoresis applied at 3 K. V., with a current strength of 150–270 m. A., in combination with paper chromatography to obtain the so-called fingerprints. Paper chromatography was performed with n-Butanol-acetic acid-pyridine-water 1 : 3 : 10 : 12 as eluent. The paper was dyed with ninhydrin and specific colouring methods for determining the amino acids Histidine, Alanine, Tyrosine, and Tryptophane.

To obtain a 'three dimensional picture' the freeze dried hydrolysate was applied on a Sephadex G–25 column of 150 × 1 cm and eluted with 0.2 M. acetic acid. Each traction was examined by paper chromatography with the above mentioned elution mixture of n-Butanol-acetic acid-pyridine-water.

* Paper presented at the International Rubber Research and Development Board Scientific Symposium, Cochin, 26-28, September 1974.

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* Paper presented at the International Rubber Research and Development Board Scientific Symposium, Cochin, 26-28, September 1974.

Immunization. A solution of 2 mg of the mixture of the 'Heveamines' and 3 mg alhydrogel per ml in saline, was injected subcutaneously into a sheep at two days interval during two weeks.

Each week the presence of antibody was analysed by gel precipitation test. The maximum quantity of the active component (antibody) was normally reached after about one month after the first injection, 250 cc blood was then taken from the sheep, which provided about 100 cc serum.

Antibody purification. The antibody was first precipitated by 45% (saturation) ammonium sulphate and after dialysis against water, separated on a Sephadex G-200 column with 0, 1 M Tris-HCl buffer in 1 M saline (pH 8) as eluent.

The optical density of each fraction was measured with a Zeiss Spectrophotometer at 280 n. m. and from these values a figure was obtained with 3 peaks. The fractions of each peak were collected, dialysed against water, and freeze dried.

By means of the agar gel precipitation test, the active component against 'Heveamine' was determined and further used as anti-destabiliser.

Assay for antibody avidity. This was performed by quantitative flocculation test of the destablising protein and the anti-destabilising substance. The stabilising substance was then tested against a 2% dispersion of rubber particles in water and also against latex which was diluted with a solution of Mannitol.

Results and Discussion

The isoelectric point of components I and II measured by paper chromatography at pH 6.5 and 8.6 were respectively 11.6 and 10.3.

The fingerprints obtained after enzymatic hydrolyzation of the two protein components with papain showed the same prints, but the ones after hydrolysation with trypsin differ in five peptides.

The gel precipitation test of the three components of the antibody showed that only one of the three components (peak 2) was active.

The results of quantitative precipitation test of the destabiliser and stabiliser, which are given in table 1 indicated that at the equivalent point the concentration of the stabiliser (tube number 7) is thirty times the concentration of the destabiliser.

The results of the influence of the anti-destabilising protein on the flocculation time of the destabiliser on a suspension of rubber particles and on latex diluted with Mannitol are given in respectively table 2 and 3.

The graph plotted on the basis of the values of table 3 indicated that the coagulation period obtained in the experiments 1 D and 4 D were in accordance with the period of experiment 1A, because in these two experiments the concentration of the stabiliser and destabiliser must neutralize each other, which is in accordance with the neutralization point on the abseissa of the graph.

By the addition of only stabiliser, the coagulation period of (diluted) latex of 15 hours and thirty minutes was prolonged with 3 hours and reached a maximum of about 18 hours and 30 minutes which was further constant and means that in (diluted) latex the factors which were responsible for the natural coagulation of latex, were influenced for only 20% of the time by the derived stabilising substance.

As the stabilising substance is specific in the neutralization of the destabiliser, probably we can draw the conclusion that the destabilising factor, released by the lutoids, under normal conditions does not play a dominant role in the natural coagulation process of latex and is only important for the termination of latex flow on the tapping-region (5).

TABLE 1

Quantitative precipitation test between the destabiliser (0,2 mg per ml) and the anti-destabiliser (2,0 mg per ml)

Tube number	1	2	3	4	5	6	7	8	9	10
Anti-destabiliser (2 mg/ml) in ml.	0,125	0,250	0,500	0,750	1,00	1,25	1,50	1,75	2,0	2,5
Destabilising protein (0.2 mg/ml) in ml.	0,500	0,500	0,500	0,500	0,500	0,500	0,500	0,500	0,500	0,500
Precipitation period in minutes	186	120	75	73	58	51	42	65	70	102

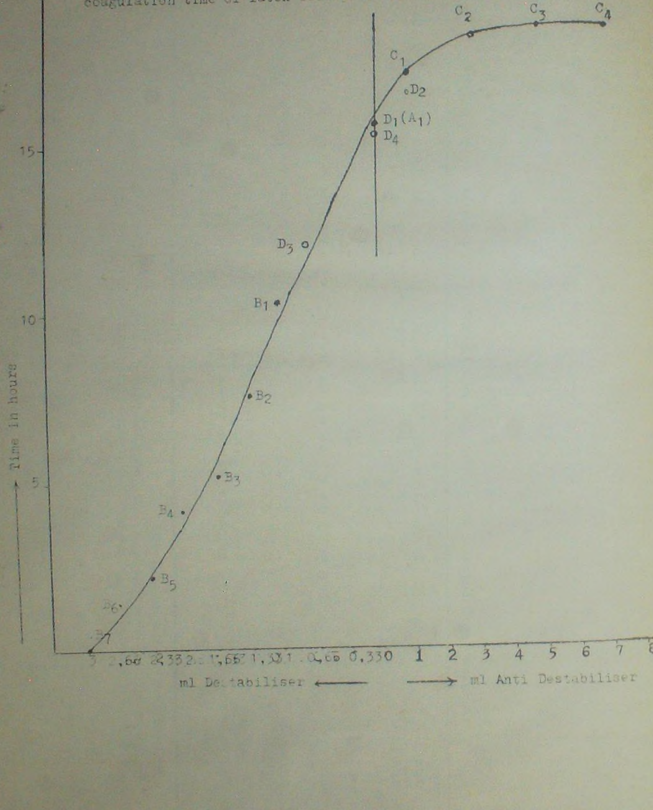
From this table it is apparent, that tube number seven showed a specific flocculation zone.

TABLE 2

The influence of the destabiliser and anti-destabiliser on the flocculation of a suspension of rubber particles.

Experiment		A		B										C										D
Tube number		1a	2a	1b	2b	3b	4b	5b	6b	7b	8b	9b	10b	1c	2c	3c	4c	5c	6c	7c	8c	9c	10c	1d
Rubber suspension (2%) in ml.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Aqua dest		–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Destabiliser (1 mg/cc) in ml.		–	–	0,1	0,1	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	–
Anti-destabiliser (10 mg/cc) in ml.		–	–	–	–	–	–	–	–	–	–	–	–	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Floccu-	minutes	–	–	14	6	4	3	2	2	2	2	2	2	–	–	–	–	–	–	–	–	–	–	–
lation	seconds	–	–	3	20	38	42	50	28	21	14	10	7	–	–	–	–	–	–	–	–	–	–	–
period	hours	22	22	–	–	–	–	–	–	–	–	–	–	25	25	26	24	22	20	18	17	15	6	39
	minutes	–	–	–	–	–	–	–	–	–	–	–	–	47	39	3	56	40	2	52	23	12	7	6

The experiments were carried out at pH 5.2
From these values we learned that the equivalent point was obtained in experiment 3 C, where the concentration of the stabiliser is thirty times the concentration of the destabiliser.



The influence of the destabiliser and anti-destabiliser on the coagulation time of latex diluted with Mannitol (Table 3)

TABLE 3

The influence of the destabiliser and anti-destabiliser on the coagulation time of latex diluted with Mannitol

Experiment	A	B							C				D			
Tube number	1	1	2	3	4	5	6	7	1	2	3	4	1	2	3	4
Latex (ten times diluted with Mannitol 0,4 M) in ml.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Destabiliser (1 mg/1 ml) in ml	–	1,0	1,33	1,66	2	2,33	2,66	3	–	–	–	–	0,33	0,33	1	2
Anti-Destabiliser (10 mg/ml) in ml	–	–	–	–	–	–	–	–	1	3	5	7	1	2	1	6
Coagulation period — Hours	15	10	7	5	4	2	1	0	17	18	18	18	15	16	12	15
Coagulation period — Minutes	30	23	35	14	8	9	26	2	12	25	32	32	33	42	7	26

Acknowledgement

The experiments were performed by Mr. Chandra Asparton, student in Chemistry at Padjadjaran State University in Bandung.

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Rubb Board bull. 13, 2; 1976; 28—29

Relationship of Seed Weight and Seedling Vigour in Hevea

C K Saraswathy Amma and V K Bhaskaran Nair
Rubber Research Institute of India, Kottayam 686 009

Seeds constitute the basis of agricultural production and the quality of seed planted has been universally recognised as one of the principal factors having profound influence on the yielding capacity of a crop. The yield and qualities of all crops in the final analysis are mere reflection of the genetical composition of the seed and its capacity to develop into a productive crop in the environment to which it is adapted.

When seed is used as a planting material, its quality is an important factor to be looked into. In Hevea, selected seedlings are used directly as planting materials or used as a better stock for bud-grafting. The quality of seeds is dependent on various factors namely its genetic and physical characters. In rubber, when seeds are used for planting, planters discard, light seeds with the concept that they are of inferior quality. But no scientific study has been done so far to find out the correlation between seed weight and seedling vigour. With this object in view, the present study was initiated.

Materials and Methods

Fresh monoclonal (Tjir 1) and polyclonal seeds were used for the study. Based on the weight of each seed they were categorised into Heavy, Medium and Light. Seeds weighing 5 gms and above were classified as Heavy, below 5 gms but above 4 gms as Medium and 4 gms and below as light. The seeds thus sorted out were kept for germination in germination beds, made with a layer of river sand about 5 cms in depth on the top. Watering was done daily. Germination of the seeds were recorded from the 8th day of sowing. The germinated seeds were planted in the nursery in a randomized block design with 4 replications. Regular monthly height measurements were taken and the diameter of the seedlings was recorded at the age of 10 months after planting.

Results and Discussion

Data on germination percentage of monoclonal as well as polyclonal seeds are presented in Table 1. Data show that the heavy monoclonal seeds gave more percentage of germination than medium and light. Within 26 days all the heavy seeds kept for germination germinated Also the heavy seeds germinated earlier compared to the medium and light ones Up to 16th day the germination percentage of Heavy, Medium and Light seeds were 94, 70 and 56 respectively. Similar trend of germination was noted in the case of polyclonal seeds also. The percentage of germination of heavy, medium and light seeds were 96, 89 and 67 respectively. In the case of heavy seeds more seeds germinated earlier than the medium and light.

Statistical analysis of the data on height (Table II) and diameter also revealed significant differences at 1% level. Heavy seeds were significantly better than light and medium seeds which among themselves fared equally. Polyclone seeds were significantly better than Tjir 1 seeds. Regarding the diameter (Table III) heavy seeds were significantly better than light and medium seeds. Medium seeds were significantly better than light seeds.

The speed of germination is one of the concept of seedling vigour. Kittock and William (4) found in Castor a significant correlation between seed weight and germination. The germination of heavy seeds was quicker and the percentage of seeds germinated higher compared to the medium and light categories of seed. The superiority of heavy seeds may be eredited to the better development of endosperm and embryo. Bavappa and Abraham (1) found that in Arecanut the seedlings raised from heavier nuts were much more vigorous than the seedlings raised from medium and light nuts. Nuts with heavy and medium weight had significantly higher percentage of germination than lighter nuts. The seed weight has a marked influence on growth. The superiority of heavy seeds can be attributed to more test weight where more reserved food materials stored in the grain and good early initiation. Similar results have been reported by Harper and Obeid (3).

Seedlings raised from heavy seeds in Hevea have a distinct advantage since these seedlings attain buddable girth earlier. Early germination is associated with heavy seeds. The vigorous seedlings also serve as better stocks for budgrafting. The vigour of the seedlings root system is a particularly important factor in determining the size, and indirectly the yield, of the scion, in *Hevea* (2).

The results of the study elucidates that the heavy seeds are superior in germination and vigour than medium and light. Hence in order to produce vigorous seedlings heavy seeds are more suitable. Medium seeds are better than the light seeds. Therefore, proper seed processing to remove light seeds will enable to improve germination and vigour of the seedlings.

Acknowledgement

The authors are grateful to Dr. C. K. N. Nair, Director, Rubber Research Institute of India for his valuable guidance in this study. They are also thankful to Sri. C. M. George, Deputy Director (Agronomy) for his suggestions in connection with the study. We are also thankful to Sri. G. Subbarayalu, Asst. Statistician for the analysis of the data and to Sri. V. K. Chithrangathan, Junior Field Officer, Rubber Board for his assistance in the study. We also thank the officers of the Botany Division for the help rendered.

TABLE 1

Germination Percentage of seeds

Day of observation	Mono-clonal Heavy (330)	Mono-clonal Medium (1200)	Mono-clonal Light (790)	Poly-clonal Heavy (690)	Poly-clonal Medium (900)	Poly-clonal Light (345)
8th day	16	5	2	3	3	3
11th day	23	10	7	17	14	7
14th day	38	35	33	50	47	34
16th day	17	20	14	18	15	12
18th day	2	12	6	4	5	5
21st day	2	7	5	2	2	3
26th day	2	6	7	2	2	2
28th day	—	1	4	—	1	1
30th day	—	0.2	0.8	—	—	0.3
upto 16th day	94	70	56	88	79	56
Total	100	96.2	78.8	96	89	67.3

* Total number of seeds, under each category is given in the bracket.

TABLE 2

Mean Height

C \ S	S1	S2	S3	Mean S. E. 5.78 C. D. 17.4
C1	104.5	123.0	152.0	126.5
C2	142.7	147.3	176.1	155.3
Mean S.E. 7.88 C.D. 21.3	123.6	135.2	164.0	140.9

For means in the body of the table S. E.—10.01 C. D. —

TABLE 3

Mean Diameter

C \ S	S1	S2	S3	Mean S. E. 0.32 C. D. 0.96
C1	9.94	11.60	14.22	11.92
C2	12.01	13.75	16.00	13.92
Mean S.E. 0.39 C.D. 1.17	10.98	12.67	15.11	

For means in the body of the table S. E.—0.55 C. D.— —

S1 —Light
S2 — Medium
S3 — Heavy
C1—Monoclonal
C2 – Polyclonal

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Relationship of Seed Weight and Seedling Vigour in Hevea

C K Saraswathy Amma and V K Bhaskaran Nair
Rubber Research Institute of India, Kottayam 686 009

Seeds constitute the basis of agricultural production and the quality of seed planted has been universally recognised as one of the principal factors having profound influence on the yielding capacity of a crop. The yield and qualities of all crops in the final analysis are mere reflection of the genetical composition of the seed and its capacity to develop into a productive crop in the environment to which it is adapted.

When seed is used as a planting material, its quality is an important factor to be looked into. In Hevea, selected seedlings are used directly as planting materials or used as a better stock for bud-grafting. The quality of seeds is dependent on various factors namely its genetic and physical characters. In rubber, when seeds are used for planting, planters discard, light seeds with the concept that they are of inferior quality. But no scientific study has been done so far to find out the correlation between seed weight and seedling vigour. With this object in view, the present study was initiated.

Materials and Methods

Fresh monoclonal (Tjir 1) and polyclonal seeds were used for the study. Based on the weight of each seed they were categorised into Heavy, Medium and Light. Seeds weighing 5 gms and above were classified as Heavy, below 5 gms but above 4 gms as Medium and 4 gms and below as light. The seeds thus sorted out were kept for germination in germination beds, made with a layer of river sand about 5 cms in depth on the top. Watering was done daily. Germination of the seeds were recorded from the 8th day of sowing. The germinated seeds were planted in the nursery in a randomized block design with 4 replications. Regular monthly height measurements were taken and the diameter of the seedlings was recorded at the age of 10 months after planting.

Results and Discussion

Data on germination percentage of monoclonal as well as polyclonal seeds are presented in Table I. Data show that the heavy monoclonal seeds gave more percentage of germination than medium and light. Within 26 days all the heavy seeds kept for germination germinated. Also the heavy seeds germinated earlier compared to the medium and light ones. Up to 16th day the germination percentage of Heavy, Medium and Light seeds were 94, 70 and 56 respectively. Similar trend of germination was noted in the case of polyclonal seeds also. The percentage of germination of heavy, medium and light seeds were 96, 89 and 67 respectively. In the case of heavy seeds more seeds germinated earlier than the medium and light.

Statistical analysis of the data on height (Table II) and diameter also revealed significant differences at 1% level. Heavy seeds were significantly better than light and medium seeds which among themselves fared equally. Polyclone seeds were significantly better than Tjir 1 seeds. Regarding the diameter (Table III) heavy seeds were significantly better than light and medium seeds. Medium seeds were significantly better than light seeds.

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TABLE 1

Germination Percentage of seeds

	Mono-clonal			Poly-clonal		
Day of observation	Heavy (330)	Medium (1200)	Light (790)	Heavy (690)	Medium (900)	Light (345)
8th day	16	5	2	3	3	3
11th day	23	10	7	17	14	7
14th day	38	35	33	50	47	34
16th day	17	20	14	18	15	12
18th day	2	12	6	4	5	5
21st day	2	7	5	2	2	3
26th day	2	6	7	2	2	2
28th day	—	1	4	—	1	1
30th day	—	0.2	0.8	—	—	0.3
upto 16th day	94	70	56	88	79	56
Total	100	96.2	78.8	96	89	67.3

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Rubb Board bull. 13, 2; 1976; 30—32.

A Study on the Effect of some Trace Elements on the Growth of Rubber Seedlings in Nursery

S Narayanan Potty, K I Punnoose and M Abdul Kalam
Rubber Research Institute of India, Kottayam-686 009

Abstract

A field trial conducted in rubber seedling nursery in two locations for three seasons to study the response to five trace elements viz. boron, copper, manganese, zinc and molybdenum did not reveal any favourable effect on the growth of seedlings. During one season a depressing effect on the growth of seedlings due to boron application was noticed. The nursery beds were regularly being supplied with vegetable mulch every year resulting in a continuous supply of organic matter and thereby micronutrients also.

Response to application of trace elements was observed for rubber seedlings by workers both in Malaya and Ceylon (4, 3, 2). Cases of deficiency are exhibited by foliar symptoms (5). The deficiency may either be due to the nonavailability of the nutrient as a result of some soil reaction or due to their scarcity in the soil (2).

This paper presents the results of a field trial conducted to study the response of nursery seedlings to application of the trace elements viz., boron, copper, manganese, zinc and molybdenum.

Materials and Methods

The experiment was conducted in the RRII nursery during 1969-70 season and in the Central Nursery, Karikattoor during the three seasons from 1969 to 1972. At Karikattoor a new area was selected, every year, for the repetition of the trial. The treatments consisted of all possible combinations of two levels each of the five trace elements viz. boron, copper, manganese, zinc and molybdenum. The doses were as follows;

Trace element	Material used	Dose per ha of the material	Notation used
Boron (A)	Boric Acid	4.940 kg	a_1
		no boron	a_0
Copper (B)	Copper sulphate	9.880 kg	b_1
		no copper	b_0
Manganese (C)	Manganese sulphate	17.290 kg	c_1
		no manganese	c_0
Zinc (D)	Zinc sulphate	7.410 kg	d_1
		no zinc	d_0
Molybdenum (E)	Ammonium molybdate	2.470 kg	e_1
		no molybdenum	e_0

Four feet wide nursery beds were prepared and germinated Tjir-1 seeds planted at a spacing of 30×30 cm during August/September. The plot size was 3×1.2 m with 40 seedlings. A uniform dose of nitrogen at 250kg/ha phosphorus at 300kg P_2O_5/ha, potash at 250 kg K_2O/ha and magnesium at 80 kg MgO/ha were applied in all the plots in two equal split doses six and twelve weeks after planting. The trace element carriers were applied as a single dose as per the treatments, along with the first dose of fertilizers. The fertilizers and trace elements were applied in between the rows of plants and forked into the top 2-3 cm of soil using a mammatty fork. The beds were mulched with dry leaves after fertilizer application. The final height and diameter of individual seedling in the net plot area of each plot consisting of 16 seedlings were recorded during June-July every year.

The height of the seedling was measured from the collar region of the stem to the apical growing point and the diameter at the collar region. Seedlings in the net plot with diameter 18 mm and above at the collar region were considered as buddable and the percentage of buddable seedlings was worked out.

The data on height, diameter and percentage of buddable seedlings were statistically analysed and the means given in tables. The values of percentages being not normally distributed, were transformed to angles and then analysed. For convenience of comparison, the percentage figures are also furnished in the tables together with the transformed angles. The values of S. E. and C. D. are also given in the table in cases of statistical significance for comparison of means.

Results and Discussion

At RRII farm during 1969-70 season the main effects of none of the trace elements came out significant for the three characters analysed viz. height, diameter and percentage of buddable seedlings. But the interaction ABD, ABE and ABDE were significant at 5% level for the percentage of buddable seedlings. Among the combinations of A, B, D and E, a_0 b_0 e, gave the highest mean, followed by the combinations of a_0 b_0 d_1 and a_0 b_1 d_0.

TABLE I

Mean Table (ABD) for Percentage of Buddable Seedlings. RRII 1969–'70

	bo		bl		
	do	dl	do	dl	Mean
ao	24.9	27.8	27.8	21.8	25.6
	(19.0)	(24.1)	(22.9)	(16.0)	(20.5)
al	25.3	18.5	24.3	27.1	23.8
	(19.5)	(13.6)	(18.7)	(22.6)	(18.6)
Mean	25.1	23.1	26.1	24.4	24.7
	(19.3)	(18.8)	(20.8)	(19.3)	(19.5)

For means in the body of the table S.E : 2.88
C.D : 8.2

TABLE II

Mean Table (ABE) for Percentage of Buddable Seedlings RRII 1969–'70

	bo		bl		
	eo	el	eo	el	Mean
ao	22 6	30.1	24.3	25.3	25.6
	(17.1)	(26.0)	(19.1)	(19.8)	(20.5)
al	25.8	17.9	24.3	27.1	23.8
	(20.9)	(12.2)	(18.4)	(22.9)	(18.6)
Mean	24.2	24.0	24.3	26.2	24.7
	(19.0)	(19,1)	(18.7)	(21.4)	(19.5)

For means in the body of the table S. E. : 2.88
C. D. : 8.2

In the case of the diameter of seedlings the interactions ABD and ABE were significant at 5% level. The best combinations were a_0 b_1 d_0 and a_1 b_1 c_1.

TABLE III

Mean Table (ABD) for Diameters RRII 1969–'70

	bo		bl		
	do	dl	do	dl	Mean
ao	13.21	13.31	13.79	12.70	13.25
al	13.42	12.88	13 02	13.49	13.20
Mean	13.31	13.09	13.40	13.10	13.23

For means in the body of the table S. E. : 0.37
C. D. : 1.05

TABLE IV

Mean Table (ABE) for Diameter RRII 1969–'70

	bo		bl		
	eo	el	eo	el	Mean
ao	13.02	13.50	13.09	13.40	13.25
al	13.66	12.64	12.80	13.72	13.20
Mean	13.34	13.07	12.94	13.56	13.23

For means in the body of the table S. E. : 0 37
C. D. : 1.05

At Karikattoor during 1969–70 season the main effect of boron was significant and negative for all the three characters analysed. The height and diameter were significant at 5% level while the percentage at 1% level.

TABLE V

Mean Table (AB) for Height of Seedlings, Karikattoor 1969–'70

		bo	bl	Mean
ao		161.1	162 4	161.8
al		154.5	157.2	155.8
Mean SE:	1.68	157.8	159.8	158 8
CD:	—			

For means of A S. E. : 1.68
C. D. : 4.8

TABLE VI

Mean Table (AB) for Diameter of Seedlings Karikattoor, 1969–'70

	bo	bl	Mean
ao	16.15	16.21	16.18
al	15.17	15.51	15.34
S. E: 0.16			
C. D: — Mean	15 66	15.86	15.76

For means of A S. E: 0.16
C. D: 0.45

TABLE VII

Mean Table (AB) for Percentage of Buddable Seedlings Karikattoor 1969–'70

	bo	bl	Mean
ao	45.2	45 0	45 1
	(50.2)	(50.2)	(50.2)
al	39 3	40 8	40.1
	(40.4)	(43.2)	(41.8)
S. E: 1.06	42.3	42.9	42.6
C. D: — Mean	(45 3)	(46 7)	(46 0)

For means of A S. E: 1.06
C. D: 0.45

Interaction ABDE was significant at 5% level for diameter. In all the combinations of ABDE the depressing effect of boron was noticed.

During the 1970-71 season no significance was noticed either for the main effect or interactions in the case of all the three characters analysed, at Karikattoor. During the 1971-72 season also no significant difference was obtained either for the main effects or interactions when the height and percentage of buddable seedlings were analysed. In the case of the diameter of seedlings also none of the main effects was significant. But the effect of BC interaction was significant. The heighest diameter was obtained for the combination $b_0 c_0$.

TABLE VIII

Mean Table (BC) for Diameter of Seedlings, Karikattoor 1971-'72

	co	cl	Mean
bo	12.92	12.54	12.73
bl	12.31	12.86	12.59
S. E: 0.16			
C. D: —	Mean 12 61	12.70	12.66

For means in the body of the table S. E: 0.23
C. D: 0.65

Note: In tables showing percentage of buddable seedlings the figures given in brackets are the percentages. The S. E. and C. D. given are for transformed figures (angles) only.

From the results it may be concluded that addition of the trace elements boron, copper, manganese, zinc and molybdenum had no favourable effect on the growth of rubber seedlings. This may be because these trace elements were sufficient in the soil, as a result of the high status of organic matter maintained due to the continued supply of vegetable mulch every year. This result is in agreement with the findings of Varley (6).

The depressing tendency of boron on the growth of seedlings noticed in this trial is in conformity with the findings of Varley (6).

In the growing of rubber only in the seedling nursery stage there is intensive cultivation where heavy applications of fertilizers are made annually and where the crop is removed completely every year. Even in this case there was no need for supplimentary trace elements, as evidenced from this experiment. Therefore the chance for getting a response to applied trace elements is still remote in the main field, both during the immature and mature phase, where the fertilizer consumption is small compared to seedling nursery and where through the growing of grouned cover and annual leaf fall, the organic matter content of the soil is maintained at a higher level.

Acknowledgement

The authors make grateful acknowledgement to Dr. C. K. N. Nair, Director of the Rubber Research Institute of India for his valuable guidance in the preparation of this paper. They are thankful to Shri. C. M. George, Deputy Director (Agronomy) for his critical review of the manuscript and valuable suggestions. Thanks are also due to Shri. G. Subbarayalu, Assistant Statistician for the statistical analysis of the data and the staff of the Agronomy Division for the assistance rendered by them at various stages of this work. The authors are also thaukful to the officers and staff of the Central Nursery, Karikattoor and the RRII Experiment Station who gave necessary facilities and cooperation in conducting this experiment.

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Available Phosphorus and Potassium status of rubber growing soils in relation to manuring of leguminous Ground Covers

M Karthikakutty Amma, M V Balan and **C M George**
Rubber Research Institute of India, Kottayam-686 009

Abstract

Data on analytical results of soil samples collected from rubber estates and holdings located in the important agro-climatic Rubber growing regions in South India, indicate that rubber soils in general are deficient in available Phosphorus and variable with regard to available Potassium and soil reaction. Since it is known that Phosphorus is one of the principal plant nutrients required by the leguminous cover crop, there is need for manuring the legumes with Phosphates for its early establishment. The highly acidic nature of the soils in the rubber tract as indicated by the summary of the soil test data suggest that Rock Phosphate which is the cheapest source of Phosphatic fertilizer is well suited for cover crop manuring.

Introduction

Rubber cultivation in India is mainly confined to a narrow belt extending from Kanyakumari District of Madras State in the South, to Coorg District of Mysore State in the north and lying almost parallel to the Western Ghats for about 400 Kilometers. This rubber tract consists mostly of hills and slopes which are covered with well-drained and highly porous laterite or lateritic soils. Climate in this tract is severe with a conspicuous wet season with very high intensity rains and a dry season with an ideal temperature range for intense soil microbial activity. These conditions enhance the degradation of soils through erosion, leaching and progressive depletion of humus. Hence for the successful cultivation of Rubber, it is essential to adopt measures for conserving the soils and maintaining soil fertility. Establishment and maintenance of a good leguminous ground cover along with rubber is the proper cultivation practice that can conserve the soil and improve and maintain soil fertility (7). The successful establishment of leguminous ground covers depend on the fertility status of the soil in which it is grown. Hence the fertility status of the rubber growing soils in different agro-climatic regions is assessed on the basis of available soil analysis data for understanding the nutritional requirement of leguminous covers.

Experimental

For advisory purposes large number of soil samples collected from rubber estates and holdings located in the different agro-climatic regions of the rubber tract have been analysed for available phosphorus, available potassium and soil reaction. A summary of these analytical data is presented with a view to obtaining an indication regarding the fertility status of the rubber growing soils. The soil samples included in the study were all composite soil samples collected from immature rubber areas. The depth of sampling in all the cases was 30 cm.

Soil reaction was determined using a glass electrode in a soil water ratio of 1: 2 5. The pH values were rated as slightly acidic (pH 6–7). Moderately acidic (pH5–5.9) and highly acidic (pH4–4.9) Available Phosphorus was determined by extracting the soil with Bray No:2 extractant (O. 1N HCl +O.O3N NH_4F) using a soil extractant ratio of 1:10 and a shaking time of 5 minutes in a reciprocating shaker. Phosphorus in the extract was determined colorimetrically as molybdenum blue complex (1). Available Potassium was determined using Morgan's reagent as the extractant with a soil extractant ratio of 1:5 and a shaking time of 5 minutes in a reciprocating shaker. Potassium in the extract was determined by means of a flame photometer.

The available Phosphorus and available Potassium values were then rated as low, medium and high levels. The critical levels of available Phosphorus and available Potassium contents in the soils are as shown in Table I.

TABLE 1

Levels of available Phosphorus and available Potassium values in soil samples.

Range/ Level	Available P in the soil expressed as mg/100g of air dried soil	Available K in the soil expressed as mg/100 gm. of air dried soil
Low	Below 1.0	Below 5.0
Medium	1.0—2.5	5 —12.5
High	Above 2·5	Above 12.5

Results and Discussion

The summary of the data on the available Phosphorus, available Potassium and pH values

TABLE II

Regions	No. of Estate/ holdings sampled	Total No. of samples analysed	% frequency of Av.P content			% frequency of Av.K content			% frequency of pH value		
			% of samples containing low Av. P	% of samples containing medium Av. P	% of samples containing high Av P	% of samples containing low Av. K	% of samples containing medium Av. K	% of samples containing high Av. K	% of samples containing high pH	% of samples containing medium pH	% of samples having slight pH
1. Kanyakumari Region	12	59	79.66	11.86	8.48	22.03	57.63	20.34	30.51	61.02	8.47
2. Trivandrum & Quilon Region	27	86	97.69	1.16	1.16	55.81	34.89	9.30	45.35	54.65	—
3. Kottayam, Ernakulam & Trichur Part	56	162	93.2	3.08	3.70	40.74	43.83	15.43	25.93	70.37	3.70
4. Palghat Region	15	61	93.44	4.42	1.64	1.64	31.15	67.21	—	68.85	31.15
5. Kozhikode & Cannanore Region	33	172	98.25	1.75	—	38.95	45.93	15.12	18 60	76.75	4.65

of the soil collected from the five major agro-climatic regions which constitute 95% of the total area under rubber are presented in Table II.

From the table it can be seen that the soils in all the five agro-climatic rubber growing regions represented by the soil samples under study are moderate to highly acidic and are deficient in available Phosphorus and variable with regard to available Potassium. The soil samples from Trivandrum, Quilon, Kottayam, Ernakulam, Kozhikode and Cannanore regions contain mostly low to medium levels and the soil samples collected from Kanyakumari, Palghat and Trichur contain mostly medium to high levels of available Potassium. Though the samples collected and examined from each region cannot be considered as representative of the entire rubber growing areas in South India, the results presented give an indication regarding the soil reaction and available Phosphorus and Potassium status of the soil in the major agro-climatic rubber growing regions in the country.

It is well known that Phosphorus is the principal plant nutrient required by leguminous ground covers for satisfactory growth. The finding that the application of Phosphorus to legume crops results in a higher yield of green matter containing higher percentage of Nitrogen and Phosphorus, supports this fact (5). Phosphorus requirements of legumes are much higher than ordinary crops and abundant application of Phosphorus leads to a higher fixation of Nitrogen (2). In Malaysia where the soils are deficient in available Phosphorus (4), leguminous cover plants show a marked response to Phosphatic fertilizer applications particularly in the early stages of cover plant establishment (8). Hence broadcast dressings of Rock Phosphate at the rate of 1–2 cwt. per acre in the year of establishment and thereafter at regular intervals are recommended for legume covers in Malaysia (6). Since the rubber growing soils are deficient in available Phosphorus, application of Rock Phosphate as a routine dressing for cover crop establishment in plantations in India, is essential. The fact that the rubber growing soils in general are moderate to highly acidic suggests that phosphate if applied in the soluble form to these soils may be fixed as insoluble iron and aluminium phosphate from which the phosphate may not get relased for plant up-take (3). Therefore it is desirable to apply phosphate in the form of Rock Phosphate to leguminous ground covers.

Summary and Recommendation

The soil analytical data of the different Rubber growing Regions indicate that these soils in general are deficient in available Phosphorus content and variable with regard to available Potassium and soil reaction. Since phosphorus is highly essential for satisfactory growth of legume covers, application of 100 kg. of Rock phosphate per hectare during the year of establishment of the cover crop will be beneficial. In areas where the soils are known to be deficient in available Potassium application of 50 kg/hectare muriate of potash will be beneficial for the cover crop establishment. If both available phosphorus and available potassium are low application of a 2:1 mixture of Rock phosphate and muriate of Potash at the rate of 150 kg/hectare is recommended for cover crop establishment. The acidic condition of the soils also favour the choice of Rock Phosphate as the phosphatic fertilizer.

Bibliographical References

1 JACKSON (ML). Soil chemical analysis. NJ, Prentice Hall. 1958.

2 KHARE (NK) and RAI (MM). Effect of phosphorus on symbiotic fixation of nitrogen by leguminous crops. J, Ind Soc Soil Sci. 16: 1968; 111–4.

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TABLE II

Regions	No. of Estate/ holdings sampled	Total No. of samples analysed	% frequency of Av.P content			% frequency of Av.K content			% frequency of pH value		
			% of samples containing low Av. P	% of samples containing medium Av. P	% of samples containing high Av P	% of samples containing low Av. K	% of samples containing medium Av. K	% of samples containing high Av. K	% of samples containing high pH	% of samples containing medium pH	% of samples having slight pH
1. Kanyakumari Region	12	59	79.66	11.86	8.48	22.03	57.63	20.34	30.51	61.02	8.47
2. Trivandrum & Quilon Region	27	86	97.69	1.16	1.16	55.81	34.89	9.30	45.35	54.65	—
3. Kottayam, Ernakulam & Trichur Part	56	162	93.2	3.08	3.70	40.74	43.83	15.43	25.93	70.37	3.70
4. Palghat Region	15	61	93.44	4.42	1.64	1 64	31.15	67.21	—	68.85	31.15
5. Kozhikode & Cannanore Region	33	172	98.25	1.75	—	38.95	45.93	15.12	18 60	76.75	4.65

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Effect of Slashing Cover Crop (Mucuna species) on Soil Moisture During Summer

M V Pushpadas, M Mathew and **K G Mohanan**
Rubber Research Institute of India, Kottayam 686 009

Rubber (*Hevea brasiliensis*) is usually grown in association with a leguminous ground cover, which persists during the immature phase of the trees, and perishes as and when the canopy closes. A cover crop has a dual effect on the moisture content of the soil. On the one hand, it serves as a mulch and reduces evaporation from the soil, and on the other hand, it depletes available moisture from the soil through transpiration. The net effect on soil moisture, thus, depends on which of the two factors is dominant.

Unlike Malaysia, the important rubber growing tract in India viz. Kerala has a pronounced dry season covering a period of three to five months, and soil moisture stress during this period is one of the important factors limiting the growth of rubber and extending the period of immaturity. Any attempt to improve the moisture regime of the soil during summer is therefore, of practical significance. The present paper reports the results of a study on the effect of slashing the cover crop on soil moisture status during the dry period.

Experimental

The experiment was laid out in a field attached to the Rubber Research Institute of India, with typical laterite soil, the laterite bed being at a depth of 52 cm. A broad leaved creeper legume of *Mucuna* species was established in 7×24 metre area which was divided into two equal halves. In the first week of December, gypsum blocks were installed at depths of 15, 30 and 52 cm. at the centre of each of the two halves and also in a clean-weeded area three metres away from one half of the cover-croped area meant for subsequent slashing. Care was taken to see that the hole augered for installing the blocks was refilled, replacing the soil in the original order. With the aid of a Bouyoucos moisture meter, available soil moisture was recorded at the three depths in all the three plots on all working days from the second week of December 1973, till the end of April, 1974. Daily rainfall data for the period from 1-1-1974 to 30-4-1974 were also collected. On 3-12-1973, when the moisture readings on the three plots were near about 100%, the cover crop in one half of the area was slashed completely, and the slashing left as such on the surface of the soil to serve as a mulch.

Results and Discussion

Weekly average of available moisture percentage in the three plots during the summer period are presented in Table-1. Data relating to the earlier part of December and the period beyond the first half of April are not presented, since in all the plots moisture percentage during these periods was found to be near about 100, as a result of rainfall. Data on total number of recorded days on which the soil moisture was maintained at different levels are furnished in Table-2. Table-3 gives the rainfall data for the period from January to April, 1974.

The data presented in Tables 1 and 2 clearly show that, during the dry period, the moisture percentages in the slashed plot were maintained at higher levels and also for a longer duration, as compared to those of the unslashed plot. Comparison between slashed and clean weeded plot shows that moisture levels at 15 cm. depth were higher in slashed plot eventhough similar trend was not evident at the other two depths. In Ceylon, Joachim and Holland (1927) and Joachim and Kandia (1930), using *Centrosema pubescens*, a creeping legume, found that during the first two years, the greatest total moisture in the top 18 inches was found under the bare soil, as compared to the soil under cover. However, during the second two years more moisture was found at all levels down to 24 inches under the cover than under the bare surface, evidently as a result of the dominant influence of the enhanced mulching effect over transpirational effect during the later period. It can be seen from the average moisture percentage from 10th week onwards (Table-1) that the moisture at 52 cm. depth is much lower in the unslashed plot in comparison to the levels for corresponding depth of the slashed and bare plots. This result is in agreement with the finding of Hopkinson (1971) that movement of rain water down the profile was much slower in cover-cropped than in bare area.

TABLE 1

Weekly average of available soil moisture % from the week preceding slashing of the cover (1st week) to 15th April, 1974 (16th week)

Treat-ment	Depth in cm.	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
U	15	97	75	41	22	<20	<20	<20	<20	<20	94	91	51	20	36	82	95
S	15	93	89	88	85	76	55	32	23	<20	88	90	85	51	30	80	90
B	15	100	91	68	47	33	26	21	<20	<20	83	96	70	37	26	95	<100
U	30	96	25	<20	<20	<20	<20	<20	<20	<20	80	96	82	38	24	95	100
S	30	98	95	86	69	47	34	27	24	<20	81	98	97	67	33	89	98
B	30	>100	99	95	87	70	52	41	33	22	74	98	89	67	44	62	<100
U	52	100	87	45	<20	<20	<20	<20	<20	<20	42	66	54	32	20	29	80
S	52	>100	98	96	89	68	43	24	20	<20	75	92	93	86	68	66	97
B	52	>100	100	96	89	71	52	37	28	21	68	99	93	75	53	43	90

U—Unslashed area; S—Slashed area; B—Bare area.

TABLE 2

No. of recorded days during the period from 4-1-1974 to 15-4-1974 on which soil moisture was maintained at different levels.

Available Moisture %	Number of recorded days: 15 cm. Depth			30 cm. Depth			52 cm. Depth		
	U	S	B	U	S	B	U	S	B
>100	—	—	1	—	—	1	—	—	1
91—100	12	—	14	17	24	22	2	24	21
81—90	3	35	7	2	7	7	2	12	8
71—80	5	6	2	1	4	6	2	6	5
61—70	5	5	3	1	4	5	7	6	9
51—60	—	2	5	1	2	8	4	5	4
41—50	3	5	5	1	5	8	7	2	6
31—40	5	4	7	2	9	7	4	2	8
21—30	8	8	15	12	10	3	10	4	5
<21	29	5	11	33	5	3	32	9	3

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TABLE 3

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27-2-1974	32.8
1-3-1974	63.0
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4-3-1974	2.4
27-3-1974	14.0
2-4-1974	40.0
6-4-1974	41.0
7-4-1974	12.0
9-4-1974	7.0
10-4-1974	8.0
11-4-1974	62.0
12-4-1974	19.2
15-4-1974	25.0

Eventhough, the slashing of the cover crop is found to improve the moisture regime of the soil during the dry period, further work is required for establishing the beneficial effect of this operation on the growth of young rubber, as the influence of other factors such as nitrogen fixation, mineralisation and leaching of nutrients vis-a-vis slashing of the cover has also to be taken into consideration.

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U	52	100	87	45	<20	<20	<20	<20	<20	<20	42	66	54	32	20	29	80
S	52	>100	98	96	89	68	43	24	20	<20	75	92	93	86	68	66	97
B	52	>100	100	96	89	71	52	37	28	21	68	99	93	75	53	43	90

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No. of recorded days during the period from 4-1-1974 to 15-4-1974 on which soil moisture was maintained at different levels.

Available Moisture %	Number of recorded days: 15 cm. Depth U	S	B	30 cm. Depth U	S	B	52 cm. Depth U	S	B
>100	—	—	1	—	—	1	—	—	1
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81—90	3	35	7	2	7	7	2	12	8
71—80	5	6	2	1	4	6	2	6	5
61—70	5	5	3	1	4	5	7	6	9
51—60	—	2	5	1	2	8	4	5	4
41—50	3	5	5	1	5	8	7	2	6
31—40	5	4	7	2	9	7	4	2	8
21—30	8	8	15	12	10	3	10	4	5
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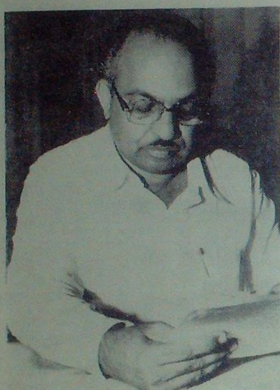
News and Notes

The term of Prof. Chandy extended

The Government of India have extended the term of office of Prof. K. M. Chandy, Chairman, Rubber Board for a further period of 3 years in



recognition of his valuable contributions to the rubber plantation industry, especially the small rubber growers during the last four and half years. Prof. Chandy who joined the Rubber Board as its Chairman on 14th March 1972 was to have relinquished charge on 13th March 1977. The extention ordered now, 6 months prior to the expiry of the present term of office testifies the desire of the Government that the continued services of Prof. Chandy are essential to the rubber plantation industry. He will now continue as Chairman upto August 1979. This is the first time that a person is being asked to hold this office for a period beyond 5 years.

Rubber Board Meetings

The 84th and 85th meetings of the Rubber Board were held on 1st July 1976 and 28th September 1976 respectively at Kottayam. Prof. K. M. Chandy, Chairman presided over these meetings. The 85th meeting of the Board reconstituted ten sub committees namely Executive Committee, Research and Training Committee, Economic Research Committee, Development and Extension Committee, Planting Committee, Technical Specifications Committee, Statistics and Import/Export Committee, Marketing and Co-operation Committee, Labour Welfare Committee and Staff affairs Committee.

UPASI Rubber Conference

A "Rubber Conference" was held at Willingdon Island, Cochin on 8th December 1976 under the auspices of the United Planters' Association of South India (UPASI). Prof. K. M. Chandy, Chairman, Rubber Board who inaugurated the

conference appealed to the planting community to make use of the new technology to produce more rubber at less cost.

Dr. B. C. Sekhar, Chairman of the Malaysian Rubber Research and Development Board who spoke at the conference as a special invitee struck an optimistic note on the bright future in store for natural rubber. Dr. Sekhar held that unless elaborate preparations are begun right now, the planting interests of the world may not be able to meet the growing demand for natural rubber which has been doubling every ten years in the past.

Dr. L. Mullins, Director of Research, Malaysian Rubber Producers Research Association located at London, talked on the new uses of natural rubber.

Dr. C. K. N. Nair, Director, Rubber Research Institute of India, who presented the paper on "Recent Developments in Natural Rubber Research" discussed in detail the gains made by the different divisions of the Institute since its inception.

M/s K. M. Philip, V. I. Chacko, G. Arumugham and John Mathew are the other authors who put up papers at the conference.

Mr. D. W. Mc Cririck, Chairman of the UPASI Rubber Products Committee, presided over the technical sessions of the conference.

Mr. KB Somanna, Chairman, UPASI welcomed the guests and Mr. George John Ancheril, Chairman, Association of Planters of Kerala extended vote of thanks.

Jacob Thomas Vice Chairman

Shri Jacob Thomas has been unanimously elected Vice-Chairman of the Board for another term of one year. Shri Thomas who represents the large growers in the Board is one of the leading planters of Kerala. He is also the Managing Director of the Vaniampara Rubber Estates.

Shri Jacob Thomas

Seminars

One day seminars of rubber growers were held at Teekoy, Kalloor, Charumood, Kaliyar, Mallappally, Ranni, Parathode, Kattappana, Adimali and Chadayamangalam.

To popularise the replanting subsidy scheme of the Board an intensive persuasive campaign was held at 103 centres. About 5000 rubber growers were contacted at these mass contact meetings.

Visits

Shri V. P. Singh, Hon'ble Deputy Minister, Govt. of India, Shri B. B. Shalam, Minister for Developments, Meghalaya and Soviet friendship delegation led by Shri H. A. Aristhan Bokov visited the Rubber Board and Rubber Research Institute of India in January 1976.

Dr. V. A. Seyid Mohammed, Hon'ble Minister of State for Law, Justice and Company affairs, Govt. of India visited the Rubber Board on 13th February 1976. He was accorded a warm welcome on his arrival.

The Lok Sabha Committee on petitions under the leadership of Shri S. N. Singh visited the Rubber Board on 20th February 1976. The Committee held discussions with the Chairman, and senior officers of the Rubber Board and visited plantation areas.

rubber board bulletin

Cover: Damage to the roots of rubber plants due to Cockchafer Grubs

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Asst. Editor: KA Aravindakshan Nair

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Natural Rubber Processing and Environmental Pollution

R Kothandaraman and **MK Balagopalan Nair**
Rubber Research Institute of India, Kottayam 686 009

Environmental pollution due to the growth of modern industries is a world wide problem. This problem is a very serious one in developed countries and is assuming importance in developing countries. Newer inventions in the agro-based industries also play a major role in aggravating the environmental pollution problems.

Unlike other agricultural crops natural rubber is harvested in liquid form called latex. In latex rubber is only 30—40% and the rest is water containing organic and inorganic constituents. Proteins, Carbohydrates, Fats, Lipids and minerals and organic acids are the constituents. Latex is processed as preserved concentrated latex, ribbed smoke sheets different forms of crepe and crumb. Considerable quantity of water is used at various stages in all rubber processing factories. Water phase of the latex with its organic and inorganic constituents and water used for washing rubber and equipments constitute the effluent in natural rubber processing factories. Little quantity of preservatives and other chemicals also add to the pollution. The quantity and chemical composition of effluent vary considerably depending upon the type of processing, quantity of rubber produced and the season. Continuous and regular discharge of waste water containing organic materials suitable for bacterial multiplication is found to increase pollution problem. The problem becomes more serious due to the introduction of centralised processing in large factories.

Biochemical oxygen demand (BOD) the indicator of organic load of the effluent varies from 720 to 7600 ppm. variation with respect to pH was also observed.

Origin of effluents from different rubber processing factories

1. Ribbed smoke sheets making factory

A major portion of latex is processed as sheets. Fresh water is used for dilution of latex to the desired dry rubber content, for washing while sheeting the coagulum, and for dipping the sheets in tanks containing antimicrobial compounds. Periodical washings of tanks, containers and floor are additional source of effluent. Acids like formic and acetic are used for coagulation and hence the pH of the waste is about 5.2. Besides the organic and inorganic constituents present originally in the latex the effluent contains the organic acids, sodium bisulphite, santobrite etc. storing such effluent for a couple of days lead to the emination of a foul smelling gas hydrogen sulphide. If the effluent is not properly disposed the foul odour can cause extreme discomfort for people even from long distance. In bigger plantation factories this problem is very serious.

2. Modern solid block rubber

This is a technically specified natural rubber in block form and its production has started in India only recently. These units have an estimated output of about 6 tons/day. The quantity of effluent produced is about 120,000 litres/day at the rate of 20 litres/Kg. of rubber processed. Starting materials are either field latex or different forms of field coagulum. Water is used mainly for washing the coagulum during maceration, creping and hammer milling and also for soaking and blending of rubber at various stages. pH of the samples are just below neutral when the scrap is used and below 5 when latex is used as starting materials. In both the cases of starting materials besides the organic constituents of the latex, the effluent contains traces of grease, castor oil and phosphatic acid if the last one is used to improve the technological properties of rubber. When the scrap is used bark tissues are present in large quantities and increase the total solids in the effluent. Traces of rubber is also present and is trapped in settling tanks. The settable solids settle in the sedimentation tanks and produce methane gas in plenty. Since large quantity of water is used in this type of processing of NR the problem of water pollution is much more when compared to other types of NR processing. Foul smell production in the scrap soaking tanks is also observed if the water is not changed frequently. Similar effluent also originate from the crepe processing factories.

3. Latex concentration factory

Latex concentration is mainly carried out by centrifuging the ammoniated field latex. Skim latex containing 5–10% dry rubber and ammonia about 0.2–0.4% is collected. Rubber in skim latex is generally removed by coagulation with dilute sulphuric acid or by spontaneous coogulation. Because of the addition of sulphuric acid the effluent is highly acidic and no bacteria can survive in it. But when the effluent is diluted in the course of disposal or neutralised the bacteria grow well and pollution problem will be very serious. Biochemical oxygen demand is very high for lack of dilution and high percentage of non rubber constituents compared to field latex. Ammonia in the skim is converted to ammonium sulphate which goes into the serum along with other non-rubber constituents. The sludge removed from the bulking tanks and the centrifuging bouls contains mainly rubber and magnesium ammonium phosphate. All these ingred ents increase the BOD level to a maximum of 7600 ppm.

Pollution problems caused by effluent from natural rubber processing factories

Since polluted water is the effluent coming out of natural rubber processing factories pollution of natural sources of water with the effluent is the major aspect of this problem. Most of the rubber processing factories are located near the natural streams and on river banks, where from adequate water supply is available for the processing purpose. At present the effluent coming out of the factory is conveniently discharged into water-ways by many NR processing factories. Water-ways become extremely important as source of potable water as well as means of transportation in many parts of Kerala State. Streams also become the centre of domestic activities such as bathing, washing, animal watering and the waste disposal. The dicharge of effluents with high organic loading into waterage is a threat to public health and aquatic life. In biological terms a normal stream supports a teeming population of micro organisms, plants and animals dependent on each other for food and drawing oxygen for existance from the stream water. An adequate dissolved oxygen content is usually maintained in stream water by natural process of gaseous exchange taking place through the water surface. Under normal condition this process is able to replace all the oxygen lost due to life activity of living organisms. Addition of effluent stimulate microbial growth and the supply of dissolved oxygen in the water is rapidly exhausted in its capacity to assimilate organic wastes. In extreme cases like increased output of the effluent or the low water flow in streams during summer months vegetation and fish may be destroyed and the polluted stream is just like an open sewer. In the absence of oxygen, hydrogen sulphide is produced from the proteinaceous materials and the inorganic chemicals like sodium bisulphite. Hydrogen sulphide itself is toxic to animals and plants under extreme cases. Methane gas is also produced from crumb factory wastes. This may also affect the aquatic life.

Preliminary studies on effluent treatment

Studies on treatment of effluent from different kinds of natural rubber processing factories were started. In the initial stage methods for preventing foul gas production from the effluent and *Chlorella* culturing in the effluent were given importance. *Chlorella* grow well in effluent from crumb rubber factory and ribbed smoke sheets making factories and foul smell was not at all present in the treated effluent. Biochemical oxygen demand was also very low in the treated effluent. However it is very difficult to treat the effluent from latex centrifuging factories because of its high concentration of ammonium sulphate. Studies also initiated to treat the effluents by the activated sludge process followed by *Chlorella* cultivation if necessary for the latex centrifuging factory affluent. A detailed study on the various methods of effluent treatment with emphasis on the economical aspects should be carried out. Possibilities of getting some return by way of *Chlorella* harvest and extracting some energy through biogas production in large scale should also be looked into.

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Induction of off-season flowering in Hevea brasiliensis

D Premakumari, and **VK Bhaskaran Nair**
Rubber Research Institute of India, Kottayam-686 009

One of the major problems in Hevea breeding in our country is the very poor fruit set due to severe oidium attack during the flowering season (January–February) and heavy loss of hand pollinated fruits due to pot rot infection during the months of June–July. Altering the flowering season by any artificial means will be helpful for escaping oidium infection and there by increasing the fruit set. Pod rot infection can also be avoided by advancing the time of flowering and fruit collection.

Materials and methods

In the present study ring barking and foliar application of different chemicals alone and in combinations, had been tried on the clone GI–1 to study their effect in altering the flowering time.

1. Ring barking + foliar application of TIBA at 600 ppm.
2. Ring barking + foliar application of potassium gibberellate at 20 ppm.
3. Ring barking + foliar spray with 10^{-4} M solution of catechol.
4. Ring barking + foliar application of water.
5. Foliar application of TIBA at 600 ppm without ring barking.
6. Foliar application of Potassium gibberellate at 20 ppm without ring barking.
7. Foliar application of 10^{-4} M solution of catechol without ring barking.
8. Spraying the foliage with water without ring barking.
9. Ring barking without spraying.

Aqueous solutions of the chemicals were used for spraying. Ring barking was done on branches, *about 8 cm. circumference*, at a distance of *about 5 cm.* from the branch union and 1½ *cm.* bark was removed all around the branch.

For each treatment 3 trees were chosen and the treatments were employed on 5 selected branches on each tree. Ring barking and spraying were done during the *first half of August* 1972. The time of flower initiation and the number of branches flowered under each treatment were recorded at weekly intervals.

Results

The table shows time of flower initiation with regard to each treatment and number of branches flowered out of the 15 branches treated, 2–3 months earlier than the general flowering time.

No.	Treatments	Time of flower initiation	Branches with off-season flower	
1.	Ring barking + spraying with TIBA	October 4th week 1972	8	53.3%
2.	Ring barking + spraying with potassium gibberellate	November 1st week 1972	9	60.0%
3.	Ring barking + spraying with Catechol	November 3rd week 1972	4	26.7%
4.	Ring barking + spraying with water	January 1st week 1973		
5.	Spraying with TIBA without ringing	January 3rd week 1973		
6.	Spraying with Potassium gibberellate without ring barking	—do—		
7.	Spraying with Catechol without ring barking	—do—		
8.	Spraying with water without ring barking	—do—		
9.	Ring barking without spraying	December 4th week 1972		
10.	Normal flowering time	January 3rd week 1973		

Flowering was obtained 3–4 months after treatment for ring barking + spraying chemical and that was 2–3 months earlier than the general flowering time. TIBA at 600 ppm and Potassium gibberellate at 20 ppm were more effective where more than 50 percent of the treated branches flowered by the end of November 1972. The untreated branches flowered only by the end of January 1973.

For ring barking without hormone spray, flowering was obtained 2–3 weeks earlier, while application of chemicals without ring barking had no effect on flowering time.

It was noticed that the leaves on the ring barked branches turned thick and showed a little chlorotic nature. The flowers were normal and healthy and heavy fruit set was obtained.

Discussion

Completion of the juvenile phase and stimulation of flowering is associated with slakening of the stem growth rate. Such treatments as ringing, tying the branches into a down-ward pointing direction or pinching of the terminal buds of shoots have all been employed by horticulturists to encourage earliness in fruit trees. Ringing the bark of fruit trees retards translocation of sap out of the branch resulting in both the retardation of growth and accumulation of nutrients and growth substances in the branches so treated (6).

There are experimental evidences that certain growth hormones induce or inhibit flower production or influence the time of flower formation in plants depending on the concentration used (5), (10), (3). These flower inducing chemical treatments are also associated with an overall inhibition of vegetative growth (4), (7), (9). Earlier reports show that induction of flowering on 1 or 2 year old Hevea grafts have been achieved by mechanical treatments like bending (2), ring barking and ring barking in combination with spraying TIBA at different combinations (2), (8).

Results of the present study indicates that in Hevea induction of off season flowring could be achieved by ring barking rather than application of chemicals alone. However ring barking incombination with application of chemicals had an added effect.

Off season flowering could be used successfully in breeding programmes for increasing the percentage fruit set. The difference in flowering time of the parental clones could also be solved to some extent by adjusting the flowering time by artificial means.

Summary

Aqueous solutions of TIBA, Potassium gibberellate and Catechol at 600 ppm, and 10^4 M concentrations respectively were applied on braches of Hevea brasiliensis Mull. Arg. clone Gl-1, with and without ring barking, for advancing the flowering time. It was observed that flowering could be advanced for 2–3 months by ring barking + foliar application of any of the growth hormones mentioned above, of which the first two were more effective than with the third one. By ring barking alone flowering could be advanced for 2–3 weeks while application of the hormones alone had no effect.

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Use of Tetramethyl Thiuram Disulphide (Thiride) for the Control of Pink Disease of Rubber

Thomson T Edathil and **Radhakrishna Pillai, PN**
Rubber Research Institute of India, Kottayam 686 009

Introduction

Pink disease of rubber caused by the fungus *Corticium salmonicolor* (Berk & Br.) (*Pellicularia salmonicolor*) (Berk & Br.) Dastur is prevalent in all rubber growing countries.

Several fungicides are effective in controlling this disease among which those based on copper, especially Bordeaux mixture and Bordeaux paste, are observed to be very widely used. This disease incidence occurs during the rainy season and any fungicide applied is likely to be washed off. Hence repeated fungicide applications often become necessary for the control of this disease. The use of copper fungicides is not favoured for the treatment of this disease on trees under tapping due to the risk of copper contamination of latex. Hence for the control of this disease a fungicide formulation not based on copper, which will not be easily washed off and give satisfactory protection in a single application, will be the ideal. With these objects in view several fungicides were subjected to laboratory and field tests against *C. salmonicolor*.

Materials and Methods

Modified paper disk bioassay method was employed for laboratory screening of different fungicides (2). Paper disks measuring 12 mm were soaked in different concentrations of the test fungicide by putting two drops each to a paper disk. Soaked paper disks were transferred to potato dextrose agar plates. Culture bits of the pathogen, measuring 9 mm removed from the periphery of eight days old culture of *C. salmonicolor* on potato dextrose agar were placed on each paper disk. The inoculated culture plates were incubated at laborytory temperature (28°C ± 2°C) and the results recorded as positive or negative (+ or –), based on the presence of growth or inhibition of the pathogen, after 144 hours.

The fungicide selected on the basis of growth inhibition of the pathogen in culture plates was again screened by putting two drops of the fungicide mixture on the centre of the paper disks and by placing culture bits on them after incorporating the fungicide in petroleum products like rubberkote, treseal and mahathotex wax, which are highly rainfast. These petroleum products alone were also screened in the laboratory.

For field application, the petroleum compound was heated to a liquid stage (90°C), cooled and the fungicide added before solidifying (40°C), stirring the mixture vigorously to produce a homogenous suspension. This mixture was allowed to cool and was thinly applied with a brush all around the Pink disease affected portion upto 30 cm above and below the infected region. Monthly observations were taken and the results recorded. At the end of the disease incidence season effect of treatments was assessed on the basis of either recovery or drying up of the treated plant parts.

After preliminary field trials the selected fungicide in three concentrations—1500 ppm, 2000 ppm and 2500 ppm—incorporated in rubberkote was applied on 90 affected four year old plants each in three locations. Each concentration of the fungicide was applied on 30 plants in each location. Bordeaux paste was applied as control on the same number of plants. The fungicide was painted on the affected portion without scraping the bark. Before the imposition of the treatment the affected plants were classified into three groups as follows.

(x) Initial stage (Cobweb mycelial stage).

(y) Medium stage (latex oozing out from the infected region).

(z) Advanced stage (death and decay of the bark in patches already occured).

Results and discussion

Among the various fungicides evaluated in the laboratory, as detailed in table 1, tetramethyl thiuram disulphide (thiride) showed complete growth inhibition of the pathogen at a concentration of 1000 ppm and above (Fig. 1), when tested alone and in combination with the petroleum compounds (Fig. 2). Growth inhibition of the pathogen was also obtained with aretan and ceresan at 2000 ppm concentration.

Merculine inhibited the growth of the pathogen at 1500 ppm concentration; fytolan (copper oxychloride), hexaferb (ferric dimethyl dithiocarbamate) and dithane M–45 (zinc ion manganese ethylene bisdithiocarbamate) at 2500 ppm concentration inhibited the growth of the pathogen. Cuprous oxide and ziride did not inhibit the growth of the pathogen even at 2500 ppm concentration. None of the petroleum products tried inhibited the growth of the pathogen, in the laboratory bioassay tests, when used alone (Fig. 3).

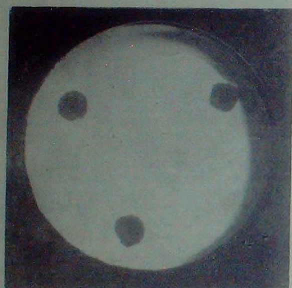

Fig. 1

TABLE 1

Various concentrations of fungicide tested and the results obtained in the laboratory

Sl. No.	Fungicides tested	Concentrations tested in ppm & results 250	500	1000	1500	2000	2500
1.	Aretan	+	+	+	+	—	—
2.	Ceresan	+	+	+	+	—	—
3.	Merculine	+	+	+	—	—	—
4.	Cuprous oxide	+	+	+	+	+	+
5.	Fytolan	+	+	+	+	+	—
6.	Hexaferb	+	+	+	+	+	—
7.	Ziride	+	+	+	+	+	+
8.	Thiride	+	+	—	—	—	—
9.	Dithane M 45	+	+	+	+	+	—
10.	Thiride + Rubberkote	+	+	—	—	—	—
11.	Thiride + Mahathotex wax	+	+	—	—	—	—
12.	Thiride + Treseal	+	+	—	—	—	—
13.	Rubberkote	+	+	+	+	+	+
14.	Mahathotex wax	+	+	+	+	+	+
15.	Treseal	+	+	+	+	+	+

Based on the fungicidal properties of different chemicals at lower concentrations and other desired properties, tetramethyl thiruam disulphide (thiride) was selected for field trials against pink disease of rubber. This fungicide is comparatively cheaper, is being manufactured in the country and also is of low mammalian toxicity.

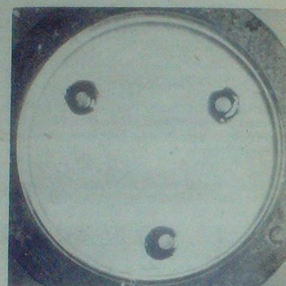

Fig. 2

During the 1969 disease incidence season few affected plants at the RRII Experiment Station were treated with 1500 ppm thiride, incorporated in rubberkote. All the treated plants recovered from the disease. Encouraged by the results of the preliminary trial, during the 1970 season, three concentrations of thiride—1500 ppm, 2000 ppm and 2500 ppm—incorporated in

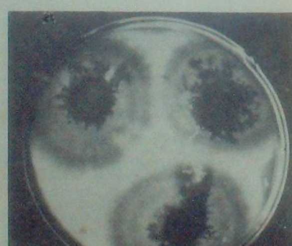

Fig. 3

rubberkote were tried against pink disease of rubber in the field. The effect of various treatments was assessed at the end of the disease incidence season and is presented in table 2.

TABLE 2
Results of field trials

Treatments	Plants treated			Plants recovered & percentage of recovery in each group			Total plants treated	Total plants recovered	Percentage of total recovery
	X	Y	Z	X	Y	Z			
Thiride 1550 ppm	27	38	25	25 (*93%)	33 (*87%)	19 (*76%)	90	77	86%
Thiride 2000 ppm	32	34	24	29 (*91%)	30 (*88%)	19 (*79%)	90	78	87%
Thiride 2500 ppm	33	29	28	26 (*79%)	28 (*97%)	18 (*64%)	90	72	80%
Bordeaux paste	27	34	29	19 (*70%)	23 (*68%)	12 (*41%)	90	54	60%

X Initial stage. Y Medium stage. Z Advanced stage.
* Percentage of recovery in each group.

Application of two concentrations of thiride—1500 ppm and 2000 ppm—incorporated in rubberkote resulted in 86 and 87% recovery of the treated plants, respectively, whereas in the control, treated with Bordeaux paste, only 60% of the treated plants recovered. Only 80% recovery was obtained in the case of treatment with 2500 ppm concentration of thiride. The lower percentage of recovery in the case of high concentration of thiride treatment could be explained to be due to the possible effect of double maximum curve of toxicity of thiride (1). This trend is clearly seen in the percentage of recovery of the plants treated with 2500 ppm concentration of thiride in all the three locations.

Percentage of recovery in each treatment at each location

Treatments	Location		
	Shaliacary Estate, Punalur.	T R & T Estate, Mundakayam.	Kottamala Estate, Kanhangad
Bordeaux paste	70%	73%	37%
Thiride 1500 ppm	97%	83%	77%
Thiride 2000 ppm	97%	90%	73%
Thiride 2500 ppm	83%	87%	70%

Eventhough growth inhibition of the pathogen was noticed with 1000 ppm concentration of thiride in the laboratory bioassay tests, higher concentrations of the fungicide was preferred for field application in view of possible heavy weathering action generally encountered under open field conditions, especially during the rainy season. Hence 2000 ppm thiride is recommended for field application.

As the petroleum product used in this study (rubberkote) was black in colour, possible bark damages due to sun scorch cannot be ruled out in exposed areas. So white washing over such black surfaces or the use of other petroleum products like mahathotex wax (yellow colour) may have to be adopted.

Summary

Several fungicides were subjected to laboratory tests employing paper disk bioassay method against *Corticium salmonicolor* causing pink disease of rubber. Complete growth inhibition of the pathogen was obtained with thiride at 1000 ppm concentration, alone and incorporated in petroleum products. Petroleum products alone did not inhibit the growth of the pathogen in the laboratory test. Three concentrations of thiride—1500 ppm, 2000 ppm and 2500 ppm–incorporated in rubberkote, were painted around the affected portions of the infected plants in the field. Only one application was made without scraping the infected bark. Application of thiride at 1500 and 2000 ppm concentrations incorporated in rubberkote resulted in 86 and 87% recovery, respectively. In the control treated with bordeaux paste only 60% recovery was obtained. Based on the results, 2000 ppm concentration of thiride incorporated in rubberkote or any other petroleum product is recommended for the control of pink disease of rubber.

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Response of Hevea to Fertilizer Application in Relation to Soil Fertility Characteristics*

S Narayanan Potty, M Abdul Kalam, KI Punnoose and **CM George**
Rubber Research Institute of India, Kottayam 686 009.

Abstract

The results of a 3^3 NPK factorial experiment carried out on rubber (*Hevea brasiliensis*) in four different regions having marked variations in soil fertility characteristics are discussed. The response on yeild of rubber to different fertilizer treatments in relation to soil analysis data are also discussed. The results indicated that the effect of applied fertilizers for rubber were very much related to the available nutrient contents of the soil and therefore a fair prediction of the fertilizer responses based on soil analysis data is possible in the case of mature rubber. The results further point to the necessity for region-wise recommendations, taking into consideration the marked variations in soil fertility for those plantations where only the general recommendations for manuring mature rubber are jollowed.

Introduction

Application of fertilizers to *Hevea* adopting generalised recommendations does not give profitable returns in some cases (11) mainly because of an imbalance in the applied nutrients in relation to the inherent soil nutrient status of the location. Results of experiments conducted by Pushparajah and Guha (8) showed different patterns of response to fertilizers in the major rubber growing soils of West Malaysia. From recent fertiliser experiments in different series of soils in Malaysia, Chan (3) reported that general fertilizer recommendations do not always provide the best growth and yield of rubber, which was reflected by the variability of responses observed in fertilizer trials. Case studies on fertilizer applications in different estates in India also revealed variations in response to applied nutrients according to the difference in the soil fertility status. This paper based on the results obtained from fertilizer experiments in different areas of varying soil fertility, explains the differences in respontse to applied fertilizers in relation to soil fertiliy levels and discusses the usefulness of soil analysis data for determining the nutrient requirements of rubber.

Experimental

3^3 NPK factorial experiments were laid out in 1956 in four different locations viz. Kulasekharam, Mundakayam, Thodupuzha and Palapilly representing the four major rubber growing regions of South India, with varying soil fertility characteristics.

The levels of nutrients tried were as follows:

N as Ammonium sulphate nitrate	:	N_0 :	0 kg/ha
	:	N_1 :	34 ,,
		N_2 :	68 ,,
P_2O_5 as Rock phosphate	:	P_0 :	0 ,,
		P_1 :	45 ,,
		P_2 :	90 ,,
K_2O as Muriate of potash	:	K_0 :	0 ,,
		K_1 :	45 ,,
		K_2 :	90 ,,

Further details of the experiment had been reported by Ananth *et al* (1).

The year of commencement of tapping of the trees in the different locations was as follows:

Kulasekharam	:	September 1963
Mundakayam	:	March 1964
Thodupuzha	:	September 1962
Palapilly	:	September 1965

Fertilizer applications were made in two split doses in all the treatments during April-May and September-October every year. Yield recording was undertaken by cup-coagulation technique on a normal tapping day, at approximately one month intervals till March 1969 and thereafter on two consecutive normal tapping days every month.

The mean yield per tree per tap was calculated for each year and statistically analysed. The difference in the mean yield figures between the first and the last year of recording for each location was subjected to covariance analysis also, giving due adjustments for regression for girth at initiation of tapping.

Results and Discussion

The annual mean yield figures are presented in Table 1. (a, b, c, d) The soil nutrient status and the leaf nutrient contents of the control plots ($N_0 P_0 K_0$) in the four locations are given in Tables 2 and 3 respectively. The soil fertility standards and critical leaf nutrient contents for the normal rubber growing tracts of South India are given in Tables 4 and 5 respectively.

* Paper presented at the International Rubber Research and Development Board Scientific Symposium, Cochin 26-28, September 1974.

TABLE 1 (a)

Main effects of nitrogen, phosphorus and potassium on mean yield of dry rubber per tree per tap (g)

Treatments	Kulasekharam				
	1966—67	1967—68	1968—69	1969—70	1970—71
N_0	29.4	41.1	38.5	49.9	45.8
N_1	29.5	40.7	40.6	50.2	49.0
N_2	32.7	43.5	44.3	51.5	47.6
P_0	29.1	41.5	40.1	49.0	45.6
P_1	30.8	40.6	40.6	50.8	47.5
P_2	31.7	43.2	42.7	51.8	49.3
K_0	30.7	42.2	41.3	50.8	48.5
K_1	31.0	42.3	41.9	50.9	46.4
K_2	30.0	40.8	42.2	49.9	47.5
SE	1.01	1.37	1.76	1.51	2.00

TABLE 1 (b)

Main effects of nitrogen, phosphorus and potassium on mean yield of dry rubber per tree per tap (g)

Treatments	Mundakayam				
	1966 - 67	1967—68	1968—69	1969—70	1970—71
N_0	25.3	30.5	36.2	33.8	32.2
N_1	29.0	32.8	39.3	37.2	35.4
N_2	25.1	30.6	34.7	33.2	31.5
P_0	25.4	30.1	35.5	34.1	32.7
P_1	26.8	31.6	37.7	34.1	33.5
P_2	27.2	32.2	37.0	36.0	33.0
K_0	26.8	31.1	37.5	35.0	33.9
K_1	26.8	32.4	37.0	35.7	33.7
K_2	25.9	30.3	35.7	33.6	31.6
SE	0.82	0.76	1.20	1.26	1.17
CD at 5% level	2.40		3.50		
CD at 1% level	3.30		4.80		

TABLE 1 (c)

Main effects of nitrogen, phosphorus and potassium on mean yield of dry rubber per tree per tap (g)

Treatments	Thodupuzha			
	1966—67	1967—68	1969—70	1970—71
N_0	24.5**	24.5**	27.7**	27.8**
N_1	25.5	27.8	28.2	32.0
N_2	24.8	27.0	27.8	32.2
P_0	23.0	22.6	25.7	29.5
P_1	25.6*	26.5*	27.0*	30.8*
P_2	26.3*	30.2*	31.0*	31.6*
K_0	26.4*	28.2*	27.4*	28.7*
K_1	27.0*	28.4*	30.7*	32.6*
K_2	21.4	22.8	25.7	30.6
SE for comparison of figures with '*'	1.68	2.56	1.80	1.68
SE for comparison of figures with '**'	1.76	2.68	1.89	1.76
SE for comparison of other other (with no '*')	1.61	2.45	1.72	1.62
CD (at 5% level) for comparison of figures with '*' and no '*'	4.80			
CD (at 1% level) for comparison of figures with '*' and no '*'	6.60			

TABLE 1 (d)

Main effects of nitrogen, phosphorus and potassium on mean yield of dry rubber per tree per tap (g)

Treatments	Palapilly			
	1967—68	1968—69	1969—70	1970—71
N_0	22.3	22.5	22.4	26.1
N_1	22.9	23.7	23.6	28.2
N_2	23.8	23.3	23.4	28.9
P_0	23.1	23.6	23.2	27.9
P_1	23.0	23.1	23.3	28.0
P_2	23.0	22.8	22.7	27.4
K_0	23.5	24.0	23.9	28.5
K_1	22.7	23.1	23.0	27.9
K_2	22.8	22.4	22.4	26.9
SE	0.51	0.49	0.44	0.70
CD at 5% level				2.04
CD at 1% level				2.77

TABLE 2

*Results of analysis of soil samples from control (N_0 P_0 K_0) plots**

Location	Depth in cm	Organic carbon %	Nitrogen %	Available nutrients in mg/100 g soil				
				P	K	Mg	Ca	pH
Kulasekharam	0–15	1.60	0.13	2.4	10.0	13.1	50.8	5.4
	15–30	1.27	0.12	1.4	7.5	9.4	39.8	5.6
Mundakayam	0–15	1.43	0.13	0.3	6.3	1.8	13.2	5.1
	15–30	1.43	0.14	0.3	8.4	1.4	14.7	5.3
Thodupuzha	0–15	1.80	0.18	0.2	5.7	2.2	16.4	5.5
	15–30	1.87	0.18	Trace	7.5	4.2	24.7	5.1
Palapilly	0–15	2.70	0.28	4.6	9.5	3.6	43.6	5.7
	15–30	2.32	0.22	3.6	9.3	2.0	30.6	5.6

* Pushpadas *et al.* (1974)

TABLE 3

*Results of analysis of leaf samples from control (N_0 P_0 K_0) plots (% on dry matter)**

Location	N	P	K	Mg	Ca
Kulasekharam	NA	NA	NA	NA	NA
Mundakayam	3.87	0.25	2.22	0.32	1.23
Thodupuzha	3.68	0.18	0.82	0.42	1.08
Palapilly	3.90	0.34	2.10	0.33	0.71

NA : Not available. * Pushpadas *et al.* (1974)

TABLE 4

Fertility Standards of soil being adopted by the RRII

Nutrient	Low	Medium	High
Organic carbon %* (used as a measure of availability of nitrogen)	<0.5	0.5 —0.75	>0.75
Av. phosphorus (mg/100 g soil)	<1.0	1.0 —2.5	>2.5
Av. potassium (mg/100 g soil)	<5.0	5.0 —12.5	>12.5

**Muhr et al.* 1966

TABLE 5

Critical leaf nutrient contents of rubber

Nutrient	Low	Medium	High
Nitrogen %	<3.0	3.0 —3.2	>3.2
Phosphorus %	<0.20	0.2 —0.25	>0.25
Potassium %	<1.00	1.00—1.20	>1.20

The inherent soil fertility evaluation of all the locations for phosphorus and potassium was done by using the soil fertility standards fixed by the Rubber Research Institute of India. Pending fixation of standards for nitrogen, the standards followed by the soil testing laboratories in India (6) for organic carbon were considerd for assessing the soil nitrogen status. Considering these standards, the nitrogen status in all the locations was high; phosphorus low at Mundakayam and Thodupuzha, medium at Kulasekharam and high at Palapilly; potassium, medium in all the locations.

The analysis of girth data recorded every year during the immaturity period in all these locations had shown (1) a general trend of suppression of girth at the highest level of nitrogen in Thodupuzha and Palapilly. Response to nitrogen as measured by girth increase was generally evident upto 4½ years from planting / budding. Later falling off of response and in certain cases negative responses were also noticed.

Significant response to phosphorus on annual girth had been obtained during the entire immaturity period at Kulasekharam, Thodupuzha and Mundakayam; but with regard to the annual girth increases, a definite cessation of response to applied phosphate after 5½ years from planting / budding at Kulasekharam and Thoduduzha and 4½ years at Mundakayam had been noticed. At Palapilly, no response to applied phosphate had been obtained. The main effect due to potassium had not registered any significant response at Kulasekharam, Mundakayam and Palapilly. However at Thodupuzha, the growth response to applied potassium had been negative.

The response to nitrogen, phosphorus and potassium on the yield of the trees for five years (1966–1971) at Kulasekharam and Mundakayam and for four years at Thodupuzha and Palapilly in relation to the response of the trees in their immaturity phase to these nutrients as already reported by Ananth *et al* (1) are discussed here.

Nitorgen

The mean yield was not found to be significantly affected by application of nitrogen in Kulasekharam and Thodupuzha, in any of the years. In these locations covariance analysis of mean yield for five and four years respectively, adjusted for regression for girth also, did not show any significant effect. At Mundakayam, however, significant reduction in yield was noticed, at the N_2 level in 1966–67 and 1968–69 in the mean annual yield analysis. Also, depressive effect for nitrogen was indicated at the higher level in the remaining three years. Highly significant yield depression at the N_2 level was shown in the analysis of covariance of mean yield for five years, adjusted for girth. The data are presented in Table 6.

TABLE 6

Effect of nitrogen on mean yield per tree per tap (g) during 1966—1971 *at Mundakayam*

Treatment	N_0	N_1	N_2
Mean yield	31.9	34.5	30.7

	at 5% level	*at 1% level*
CD for comparison of means N_0 and N_1	2.60	3.54
CD for comparison of means N_0 and N_2	2.72	3.71
CD for comparison of means N_1 and N_2	2.50	3.40

At Palapilly, in the annual mean yield analysis, response to nitrogen application was observed giving a significantly higher yield at the N_2 level in 1970—71; but the yield was not found influenced in any of the previous years. In the covariance analysis for mean yield for four years also, significance was recorded for the N_2 level. The data are presented in Table 7 below.

TABLE 7

Effect of nitrogen on mean yield per tree per tap (g) during 1967—1971 *at Palapilly*

Treatment	N_0	N_1	N_2
Mean yield	23.4	24.6	26.0

CD at 5% level — 1.79
CD at 1% level — 2.43

A fairly high soil and leaf nitrogen status explains the reasons for non-response to nitrogen application at Thodupuzha and Kulasekharam and a significant yield depression at N_2 level at Mundakayam. In this connection it has to be pointed out that the growth response as measured by the annual girth increase in these locations was significant only upto the first 4½ years of immaturity and afterwards the response at the N_2 level was negative in some cases and less than N_1 level in others (1). A very good leguminous cover management system adopted in these locations might also have played a prominent role in slowly making available the organic nitrogen into mineralised forms during the initial few years of the maturity phase. The significant yield increase recorded at the N_2 level at Palapilly could be attributed to the high available soil phosphorus and magnesium and a fair available soil potassium in that location. The higher level of applied nitrogen with the high soil status in the other nutrients mentioned might have resulted in a balanced nutrition and consequently higher yield. These results therefore point to the necessity for considering the nutritional requirements of rubber in terms of balanced applications.

Phosphorus

The annual mean yield showed an increasing trend at the P_2 level at Mundakayam and Thodupuzha, where the soil phosphorus was low and at Kulasekharam where it was medium. In Palapilly, wherr the soil phosphorus was high, no response was indicated. The leaf analysis values also showed a low to medium leaf phosphorus in all the locations except Palapilly. The significant response to phosphorus application on mean annual girth observed during the immaturity phase in the low to medium phosphorus areas viz. Mundakayam, Thodupuzha and Kulasekharam is worth mentioning in this context. These results on growth during the immaturity phase and yield during the maturity phase therefore reveal that *Hevea* would respond to phosphorus applications in soils were the phosphorus status is low. The Rubber Research Institute of Malaysia (10) reported responses to phosphate applications in cases where low phosphate was indicated in the soil and leaf analysis data. The studies of Guha and Pushparajah (4) also showed good response to phosphorus in Red and Yellow Latosols of Malaysia, where phosphorus status was low. According to Owen (7) and Bolton (2) response to phosphate should be obtained at levels of available phosphate in the soil below 25 ppm. Chan (3) also indicated response for phosphorus in certain types of soils of Malaysia, where most of the leaf values of phosphorus were low.

Potassium

In the analysis of mean annual yield data, response to potassium was not indicated in any of the locations except Thodupuzha, where significantly negative response was recorded in 1966—67 season. In the analysis of covariance of mean annual yield for four years, significantly negative response was observed at both the levels of potassium at Palapilly. The results are shown in Table 8 below.

TABLE 8

Effect of potassium on mean yield per tree per tap (g) during 1966—1971 at Palapilly

Treatment	K_0	K_1	K_2
Mean yield	26.10	24.20	23.60

	at 5% level	*at 1% level*
CD for comparison of means K_0 and K_1	1.87	2.55
CD for comparison of means K_0 and K_2	1.87	2.55
CD for comparison of means K_1 and K_2	1.79	2.43

The soils in all the locations as could be seen from the data were fairly well supplied with available potassium. However, at Thodupuzha and Palapilly comparatively better potassium availability could normally be expected, owing to the specific soil features of the area viz. micaceous nature at Thodupuzha and fine texture and good depth at Palapilly. Therefore further application of potassium in these soils might have caused a nutritional imbalance resulting in depression of yield, which attained significance at Thodupuzha and Palapilly. Consistantly suppressing effect on the annual mean girth increase at K_2 level had also been observed in these locations during the immaturity phase (1). Though significant effect owing to potassium application was reported by John (5) even at medium soil potassium levels no positive response was indicated in any of the locations in the present experiments. However, the non-response to potassium application in soils with high potassium was reported by Chan (3).

Interactions

The NK interaction on the mean yield for the four year period was significant in the case of Palapilly. The data are given in Table 9.

TABLE 9

Effect of NK interaction on mean yield per tree per tap (g) at Palapilly

Treatment	N_2K_0	N_2K_1	N_2K_2
Mean yield	29.8	24.0	24.1

	at 5% level	*at 1% level*
CD for comparison of means N_2K_0 and N_2K_1	1.79	2.43
CD for comparison of means N_2K_0 and and N_2K_2	1.87	2.55
CD for comparison of means N_2K_1 and N_2K_2	1.78	2.43

The treatment N_2K_0 gave the highest yield, but significant yield depression was observed in the N_2K_1 and N_2K_2 levels. The reason for obtaining the highest yield in the N_2K_0 treatment could be attributed to the better nutrient balance resulted from the application of high levels of nitrogen in a situation where the soils were well supplied with phosphorus, magnesium calcium and potassium. This is evidenced by the significant positive response obtained on yield at the N_2 levels. The significant depression in yield at the N_2K_1 and N_2K_2 levels, may be attributed to the excess potassium resulted by the potassium applications in relation to nitrogen.

Conclusions

On the basis of the results obtained for five years during the maturity phase of a 3^3 NPK factorial experiment conducted at four different locations of varying soil fertility levels and with the back ground information on the nutrient response of the trees during their immaturity phase in these locations the following conclusions could be drawn:

1. The response to nitrogen in yield could depend not only on the soil and leaf nitrogen status, but also on the other plant nutrient status of the trees, thus indicating the importance of balanced nutrition for high yield.
2. In areas where a good cover management had been practised during the immaturity phase and a proper balance is maintained between other nutrients, response to nitrogen is unlikely during the initial years of tapping.
3. Wherever high soil and leaf phosphorus are indicated resulting from a continued application of rock phosphate during the immaturity phase, application of phosphorus may not give significant response on yield during the initial years of the maturity phase.
4. It may be possible in most cases to predict the possibility of getting responses to applied fertilizers in a specific location provided sufficient information on the soil fertility status is available in respect of that location.
5. Generalised fertilizer recommendation for mature rubber may have many limitations.. Therefore, there is a clear need for recommendations for specific regions based on the soil fertility levels. A soil and leaf fertility survey would give a broad basis for such an approach.
6. A unilateral approach in fertilizer recommendations considering each nutrient as an independent factor for yield of rubber would not give correct solutions to the nutritional problems in all cases. The need for investigations on nutrient-antagonisms and balanced ratios between nutrients cannot therefore be over emphasised, for giving proper fertilizer recommendations for rubber.

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Cyclisation of Natural Rubber using P-Toluene Sulphonic Acid

Baby Kuriakose, KS Gopalakrishnan and **EV Thomas**
Rubber Research Institute of India, Kottayam 686 009, India

Synopsis

Cyclisation of natural rubber was effected by treating smoked sheets with p-toluene sulphonic acid. Effects of variations in the quantity of p-toluene sulphonic acid, precipitated silica, time and temperature of heating, on the extent of cyclisation of natural rubbers were studied. The use of cyclised natural rubber in soling compound was evaluated and compared with that from SBR 1941 X.

Introduction

Cyclised natural is a resinous material, obtained by treating natural rubber with acidic reagents. It is found to have increased softening point, density and refractive index than natural rubber. Cyclisation of natural rubber could be effected by proton acids like sulphuric acid, p-toluene sulphonic acid, and also by Lewis acids like $SnCl_4$ $TiCl_4$, BF_3 and $FeCl_3$. The cyclisation reaction, in natural rubber could be done in the solid, solution or the latex stage. Fisher (1) observed that when natural rubber was mixed with sulphuric acid, p-toluene sulphonic acid or p-toluene sulphonyl chloride, in the mixing mill and the resulting mix heated, an exothermic reaction took place with the transformation of natural rubber into a hard thermoplastic material. Rubber isomers were prepared by Bruson, Sebrell and Calvert (2), by treating natural rubber with Antimony trichloride, Stannic chloride, Ferric chloride and Titanium tetrachloride, in an inert atmosphere of nitrogen. The preparation of cyclised rubber latex on a commercial scale was also well established as early as 1947 (3) (4).

Out of the several methods available for the cyclisation of natural rubber, treatment of rubber with halides of amphoteric metals, with acidic reagents and with concentrated sulphuric acid in the latex stage, were of commercial interest. In the present study the effects of variation in the amounts of p-toluene sulphonic acid, of precipitated silica and time and temperature of heating, on the extent of cyclisation of natural rubber were evaluated, with a view to arriving at the optimum levels of these variables for the preparation of fully cyclised natural rubber. The use of cyclised natural rubber in microcecellular soling compounds was also evaluated.

Materials and Methods

Natural rubber in the sheet form (RSS 3 quality) was used for the study. Rubber was first plasticised in a 12" laboratory mixing mill and mixed with p-toluene sulphonic acid and precipitated silica. The mix was then sheeted out in ½ inch thickness and heated in air ovens at fixed temperatures for specified periods of time. The four factors namely, amount of p-toluene sulphonic acid A, temperature of heating B, time of heating C and amount of precipitated silica D, were varied at three levels as given below.

Factor	*Levels*
P-toluene sulphonic Acid (A).	5, 10 and 15 parts per 100 parts rubber (a_0, a_1 & a_2).
Temperature of heating (B).	100, 120 & 140°C (b_0, b_1 & b_2).
Time of heating (C).	2, 4 and 6 hours. (c_0, c_1 & c_2).
Precipitated silica (D).	2.5; 5.0 and 7.5 parts per 100 parts rubber. (d_0, d_1 & d_2).

The iodine value of the resulting products were determined by the perbenzonic acid method (5). The experiment was laid down on a statistical basis and 3^4 confounded factorial design confounding certain components of higher order interactions, with plots arranged in randomised incomplete blocks in single replication was used for the study. Cyclised natural rubber for which the lowest iodine value was obtained (24% retention of unsaturation) was used for the preparation of microcellular solings. Microcellular solings containing high styrene resin-SBR 1941 X—was taken as the control. The cyclised rubber could be mixed with natural rubber in the mixing mill either in the powder form (200 mesh size) or by mixing at high temperature (95°C). The compounding recipes used for the preparation of microcellular compounds are given below.

Ingredients	Mix I	Mix II
Natural rubber	65.0	65.0
Cyclised natural rubber	35.0	—
SBR 1941 X	—	35.0
Zinc oxide	3.5	3.5
Stearic acid	4.0	4.0
Vulcafor F	1.25	1.25
Anti oxidant SP	1.0	1.0

Ingredients	Mix I	Mix II
Sulphur	2.5	2.0
Nitrogen Blowing Agent DPT	4.0	4.0
Magnesium oxide	2.0	—
Paraffin wax	1.0	1.0
Ethylene Glycol	2.0	2.0
Titanium dioxide	10.0	10.0
Naphthenic oil—Flexon 542	15.0	15.0
China clay	150.0	150.0
Cure time at 150°C (Minutes)	10	10

The following properties of the solings were evaluated as per the I. S. test methods (6).

1. Relative Density.
2. Hardness.
3. Change in hardness after ageing at 100 ± 1°C for 24 hrs.
4. Split tear strength (using tensile testing machine with a rate of traverse of 40 mm per minute).
5. Heat shrinkage.

The percentage expansion of the compounds was also studied.

Results and Discussions

The data on the statistical analysis of the results of iodine values with the variables A, and D are given in Tables I to V. Statistical analysis of the results indicated that the effects of A, B, C and D on the cyclisation of natural rubber were significant at 1% level. A, B and C had interacted significantly between themselves at 1% level.

At 5 phr level of A, the iodine value was the same irrespective of the temperature of heating. At 10 and 15 phr levels of A, significant difference in iodine values among the temperatures were found, the lowest iodine value was obtained for the sample heated at 140°C and the highest at 100°C.

At 5 phr level of A, 4 hours heating gave significantly lower iodine value than 6 hours heating. At 10 phr level of A, 4 hours heating gave significantly lower iodine value than 2 and 6 hours heating.

While at 120°C, iodine value was the same irrespective of the time of heating, significant difference in iodine value was obtained at 100°C with the time of heating. 4 hours heating at 100°C gave the lowest iodine value than 2 and 6 hours heating and the sample heated for 2 hours was having lower iodine value than that heated for 6 hours. But at 140°C, lowest iodine value was obtained for the sample heated for 6 hours.

At 100°C irrespective of the time of heating, the iodine value of the sample with 15 phr of A, was lower than that for 5 and 10 phr levels. For all other combinations of temperature and time of heating, the iodine value for the sample containing 15 phr of A was the lowest when compared with that for 5 and 10 phr levels. The iodine value of the fully cyclised sample was 90.14 which is equivalent to a percentage retention of unsaturation of 24.13. This is in agreement with the results of Wallenberger (7) and Turorskii (8) et al and the structure of the cyclised material might be mostly fused tricyclic rings (9).

On the average, the iodine value got for the sample with 5 and 7.5 phr of D was lower than that for 2.5 phr.

The test results on the microcellular solings indicated that the relative density, hardness, change in hardness and split tear strength of the soling using cyclised rubber were comparable with that from the high styrene resin. The microcellular soling with cyclised rubber had lower heat shrinkage even though the percentage expansion of the compound was slightly lower when compared with that from the SBR 1941 X compound.

Conclusions

P-toluene sulphonic acid was found to be an effective cyclising agent for natural rubber. The compound containing 15 phr of P-toluene sulphonic acid and 7.5 phr of precipitated silica when heated at 140°C for 6 hours gave fully cyclised natural rubber. The cyclised rubber prepared by this method, when used for the preparation of microcellular solings, gave products with properties comparable with those from SBR 1941 X.

TABLE 1—*Mean Iodine Values*

	b_0	b_1	b_2	Mean S.E. 1.95 CD. 5084* 8.04**
a_0	326.8	331.6	326.5	328.3
a_1	317.6	298.3	262.8	292.9
a_2	286.4	224.6	128.6	213.2
Mean S.E. 1.95 C.D. 5.84** 8.04**	310.3	284.8	239.3	278.1

For means in the body of the table S. E. 3.37, C. D. 10.12* 13.93**

TABLE II—*Mean Iodine Values*

	c_0	c_1	c_2	Mean S.E. 1.95 C.D. 5.84* 8.04**
a_0	328.9	320.6	335.3	328.3
a_1	300.1	382.0	296.7	292.9
a_2	221.2	216.0	202.4	213.2
Mean S.E. 1.95 C.D. 5.84* 8.04**	283.4	272.9	278,2	278.1

For means in the body of the table S. E. 3.37, C. D. 10.12* 13.93**

TABLE III—*Mean Iodine Values*

	c_0	c_1	c_2	Mean S.E. 1.95 C.D. 5.84* 8.04**
b_0	313.5	289.3	328.0	310.3
b_1	285.3	284.0	285.2	284.8
b_2	251.4	245.3	221.2	239.3
Mean S.E. 1.95 C.D. 5.84* 8.04**	283.4	272.9	278.2	278.1

For means in the body of tye table S. E. 3.37, C. D. 10.12* 13.93**

TABLE IV—Mean Iodine Values

	c_0			c_1			c_2			Mean
	b_0	b_1	b_2	b_0	b_1	b_2	b_0	b_1	b_2	S. E. 1.95 C. D. 84* 8.04**
a_0	325.2	339.3	322.1	309.3	320.7	331.9	345.8	334.7	325.4	328.3
a_1	321.0	298.9	280.4	297.0	288.9	260.1	334.9	307.2	248.0	292.9
a_2	294.2	217.6	151.7	261.6	242.4	144.0	303.3	213.8	90.1	213.2
Mean SE 1.95 CD 5.84* 8.04**	313.5	285.3	251.4	289.3	284.0	245.3	328.0	285.2	201.2	278.1

For means in the body of the table S. E. 5.84, C. D. 17.52*, 24.13**
* —Sig. at 5% level.
**—Sig. at 1% level.

TABLE V—*Properties of Microcellular solings*

Tests	Mix I	Mix II
Relative Density at 27°C	0.7046	0.6834
Hardness (Shore A)	48.0	47.0
Change in hardness after aging at 100 ± 1°C for 24 hours	+18	+18
Split tear strength (kg)	5.67	5.50
Heat shrinkage at 100±1°C for one hour (%).	3.508	5.143
Expansion (%)	73.0	80.0

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Preservation of Concentrated Natural Rubber Latex with Methylamine

NM Mathew, Leelamma Varghese, R Kothandaraman and **EV Thomas**
Rubber Research Institute of India, Kottayam 686 009

Introduction

Preservation of natural rubber latex is for the maintenance or improvement of its colloidal character. This is achieved by the addition of chemicals which prevent bacterial activity. The usual practice in plantations is to preserve the latex using ammonia at a concentration of 0.7% by weight of latex. This treatment effectively preserves the latex and maintains it in a stable colloidal condition almost indefinitely. Also, during storage the higher fatty acid esters present in the latex get hydrolysed into ammonium soaps, thereby improving the mechanical stability of the latex considerably.

The presence of the high level of ammonia in preserved concentrated latex has been considered undesirable by the latex products manufacturing industry. Apart from handling difficulties it presents problems in some manufacturing processes. Also the high concentration of ammonia aggravates the inherent tendency of some serum constituents to get hydrolysed and broken down into a variety of compounds including simple salts and soaps. This results in a progressive loss of zinc oxide stability of latex.

Because of the disadvantages associated with the use of ammonia, rubber producers and their research institutes have long been trying to find out alternative preservatives for natural rubber latex. Mc Gavac (7) reviewed the use of chemicals like tetrahydro naphthalene, alkyl mercury chlorides, arseneous oxide, acetaldehyde, nitrophenols and other organic nitro compounds, moroholine, formaldehyde, etc. as secondary or tertiary preservatives. Rhodes (10) studeid in details the use of sodium pentachlorophenate as secondary preservative. Use of ammonium pentachlorophenate, zinc dialkyl dithiocarbamates, aminophenols, EDTA and boric acid was described by Philpott (9). Angove (1) studied the use of 8-hydroxyquinoline and its various halogen and metal derivatives as secondary preservatives in low ammonia natural rubber latex concentrate. Evaluation of miscellaneous rubber accelerators as secondary and tertiary preservatives was also carried out by Angove (2). Zinc oxide ,which is known to be a good enzyme poison, has been tried for the inhibition of volatile fatty acids formation in field latex (11). But most of these materials were not helpful to lower the ammonia content to harmless levels although many of them were proved to be successful as secondary preservatives.

In spite of its various drawbacks, ammonia is still the most widely used preservative for NR latex probably because of its high volatility, high alkalinity and good bactericidal properties,. Monomethylamine also is highly alkaline in reaction and is having bactericidal properties. It is now being manufactured in India and is available at a reasonable price. Therefore a study was undertaken to evaluate the usefulness of this chemical as a primary preservative for NR latex concentrate.

Materials and Methods

Monomethylamine solution (40% w/v) used in the study was supplied by M/s. Fertilizer Corporation of India (Trombay Unit)

Preliminary experiments were carried out with fresh field latex collected from the RRII Experiment Station. 200 ml batches of the latex were treated with methylamine at concentrations 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, and 0.7% , with 0.7% ammonia as control. The samples were observed over a period of two months. Based on the observations studies on the long term preservation of concentrated latex was started.

200 litres of fresh field latex, collected from the RRII Experiment Station was divided into two parts. One part (150 litres) was treated with 0.3% methylamine and the other part (50 litres) was treated with 0.3% ammonia. Both were separately centrifuged on the same day using an Alfa Lavel 410/70 A/AM centrifuge. The methylamine/ammonia content of the concentrates were estimated. The methylamine treated latex concentrate was subdivided into 5 batches of 15 litres each and transferred to 5 different polythene containers and the concentrations of methylamine was adjusted at 0.3%, 0.4%, 0.5%, 0.6% and 0.7%. The ammonia treated concentrate was also transferred to a polythene container and the concentration of ammonia in the latex was raised to 0.7%.

After bottling the following tests were carried out on the latex samples.

1. T. S, D. R. C, Alkalinity.
2. Volatile fatty acid number—V. F. A.
3. pH
4. Mechanical stability time—M. S. T.
5. Magnesium content.
6. Sludge content.
7. Coagulum content.

pH, alkalinity, MST, VFA and Magnesium estimations were repeated at various time intervals upto a period of 6 months. Indian Standard test methods (8) were followed in the above estimations.

Bactericidal properties of methylamine and ammonia were compared in a separate experiment. Fresh field latex collected from the RRII Experiment Station was divided into six 300 ml batches. Five batches were treated with methylamine at 0.3%, 0.4%, 0.5%, 0.6% and 0.7% concentrations and the sixth batch was treated with 0.7% ammonia as control. The viable bacterial count per ml of latex was made on all the batches using the dilution plate technique with sterile water. The medium used was modified Kliglers iron agar medium (13).

After six months storage zinc oxide stability, gelling time and gelling pH of the preserved concentrated latex samples were determined. These tests were carried out according to the methods suggested by Madge (6).

Latex products like dipped goods and foam were prepared from the latices. Dipping was carried out using the coagulant dipping technique with glass formers. The following formulation was used for dipping.

Latex compounds for dipping

Latex 60% ..	167
KOH 10% ..	1
Sulphur 50% ..	4
ZnO 50% ..	4
ZDC 50% ..	2
Antioxidant SP 50%	2
Coagulant: Ca $(NO_3)_2$	20
Water ..	20
Rectified spirit ..	60

Latex foam products were made from the samples using a plannetary mixer. The following formulations were used.

Latex compounds for foam

	I	II
Latex 60% (0.7% NH_3)	167	—
Latex 60% (0.4% CH_3NH_2)	—	167
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Potassium oleate 20%	5	5
Sulphur 50%	4	4
ZDC 50%	2	2
ZnO 50%	6	6
Sodium silicofluoride 20%	10	7.5

Results and discussion

In the preliminary experiments with field latex a concentration of 0.2% methylamine was found ineffective as the latex underwent coagulation in two days. The latex preserved with 0.3% methylamine thickened after a week's storage and finally coagulated after 10 days. All the other samples remained unchanged even after two months storage. As the non-rubber content of centrifugally concentrated NR latex is less than that in field latex, it was thought that even a concentration of 0.3% methylamine could be tried for the preservation of concentrated latex. Therefore in the long term preservation experiments with centrifuged latex, methylamine was used at concentrations ranging from 0.3% to 0.7%.

Changes on storage

The changes in pH, alkalinity, VFA No, MST and magnesium content during storage are graphically shown in figures I to V. Methylamine is a stronger alkali than ammonia and that is why the pH of methylamine preserved latex is higher than that of ammonia preserved latex of the same concentration. The higher pH of the methylamine preserved latices might be one of the reasons for their better bactericidal properties. Alkalinity is found to decrease at a slower rate during storage in the case of methylamine preserved latices. This may be owing to the lower volatility of methylamine.

VFA No. is a direct index of bacterial activity in latex (5). From Figure III it is evident that methylamine even at a concentration of 0.3% is better than ammonia in inhibiting VFA formation, a concentration of 0.4% being optimum. Mechanical stability of methylamine preserved latices remains almost constant throughout the storage period. But mechanical stability of the samples could be boosted by adding ammonium laurate as in the case of ammonia preserved latex. Effect of adding ammonium laurate on the mechanical stability of methylamine preserved latices is given in Table I.

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Preservation of Concentrated Natural Rubber Latex with Methylamine

NM Mathew, Leelamma Varghese, R Kothandaraman and **EV Thomas**
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TABLE I

Effect of adding am. laurate on the MST of CH_3NH_2 preserved latices

Concentration of am. laurate: 0.02% by weight of latex

Concentration of CH_3NH_2 %	MST Seconds	
	Without ammonium laurate	With ammonium laurate
0.3	160	596
0.4	245	579
0.5	111	370
0.6	103	190
0.7	72	124

MST of the samples preserved with 0.3% and 0.4% methylamine could be enhanced beyond the specification limit of 475 seconds (12) by the addition of 0.02% ammonium laurate. But as the concentration of methylamine in latex is increased, the enhancement in MST brought about by ammonium laurate is not considerable. A higher dosage of ammonium laurate might be required in those cases.

As magnesium was not removed from the field latex by adding diammonium hydrogen phosphate before centrifuging the initial concentration of magnesium in the latex samples was high. But in the case of ammonia preserved latex a considerable part of the magnesium was removed during storage. This may be as a result of the formation of phosphate ions from the phopholipids present in the latex. A proportionate removal of mangnesium was not observed in methylamine preserved samples. The absence of ammonium ions in the latex does not favour the formation of insoluable magnesium ammonium phosphate, if at all any phosphate ions are formed.

Viable bacterial count

Changes in the viable bacterial count during storage of field latex treated with 0.7% NH_3 and different concentrations of methylamine are given in Table II.

TABLE II

Viable bacterial count per ml of latex

Initial count of untreated latex—31×10^5 per ml.

Treatment	Count per ml of latex				
	1st day	2nd day	3rd day	5th day	15th day
CH_3NH_2 0.3%	49×10^4	25×10^3	38×10^3	10.5×10^3	Coagulated
,, 0.4%	12×10^4	86×10	23×10	25×10	25×10
,, 0.5%	19×10^3	25×10	17×10	19×10	18×10
,, 0.6%	36×10^2	25×10	15×10	17×10	15×10
,, 0.7%	20×10^2	25×10	16×10	14×10	8×10
NH_3 0.7%	25×10^4	21×10	14×10	13×10	10×10

The results indicate that methylamine is very effective in preventing bacterial growth in latex. No acid producing bacteria was observed in all the samples except in the sample preserved with 0.3% methylamine, which eventually coagulated. But the concentrated latex preserved with 0.3% methylamine remained stable throughout the storage period of six months. As pointed out earlier, the higher non-rubber content of field latex might be responsible for the higher bacterial activity in it.

Processing characteristics

Zinc oxide stability of the latex samples are given in Table III.

TABLE III

Zinc oxide stability

Treatment	MST Seconds	ZST Seconds
NH_3 0.7%	734	91
CH_3NH_2 0.3%	596	436
,, 0.4%	579	564
,, 0.5%	370	276
,, 0.6%	190	202
,, 0.7%	124	220

In the above experiment mechanical stability of the methylamine preserved latex samples was boosted by the addition of 0.02% ammonium laurate before testing zinc oxide stability. The results indicate that the mechanical stability of latices preserved with methylamine is not affected to any considerable extent by the addition of zinc oxide. The addition of potassium oleate in the zinc oxide stability determination makes ZST higher than MST at least in the last two cases. NH_4^+ ions are required for zinc oxide thickening (4). Absence of NH_4^+ ions in methylamine preserved latices accounts for the low zinc oxide thickening in them.

Gelling with sodium silicofluoride is faster with the methylamine preserved latices as may be seen from Table IV. It is also observed from the table that gelling pH increases with increase in the concentration of methylamine. In experiments 5 and 6 there was difficulty in getting firm gel probably owing to the high gelling pH. Gelling time could be adjusted by varying the concentration of gelling agent as may be seen from Table V.

TABLE IV

Gelling pH and gelling time

Volume of latex —100 ml.

Sl. No.	Treatment		Vol. of 50% ZnO dispersion ml	Vol. of 20% sod. silico fluoride dispersion ml	Gelling pH	Gelling time
1.	NH_3	0.7%	1.5	3.5	8.2	6'
2.	CH_3NH_2	0.3%	1.5	1.5	7.9	4'
3.	,,	0.4%	1.5	2.0	8.1	1'50"
4.	,,	0.5%	1.5	2.0	8.3	1'30"
5.	,,	0.6%	1.5	2.5	8.8	1'30"
6.	,,	0.7%	1.5	2.5	9.3	1'45"

TABLE V

Effect of conc. of gelling agent on gelling time

Concentration of CH_3NH_2 —0.4%

Volume of latex — 100 ml.

Sl. No.	Volume of 20% sodium silico-fluoride disperion ml	Gelling time
1.	1.0	5'30"
2.	1.5	2'30"
3.	2.0	1'50"
4.	2.5	1'20"
5.	3.0	55,,

Only pasty gels could be obtained with 1.0 ml and 1.5 ml of the gelling agent. 2.0 ml seems to be the minimum concentration of the gelling agent required to get a firm gel. But with 2.0 ml the gelling time is too short to be of any practical value. But gelling time could be increased at will by adding potassium chloride. Addition of soaps also increases gelling time, as may be seen from Table VI.

CABLE VI

Effect of soap, ZnO, Zinc ammines and KCl on gelling

Concentration of methylamine—0.4%

Sl. No.	Vol. latex	Vol of 20% sod. silico-gluoride dispersion	Vol. of 20% pot. oleate solution	Vol. of 5% ZnO dis-persion	Vol. of 10% $(NH_4)_4SO_2$ solution	Vol. of 10% KCl solution	Gelling time
	ml	ml	ml	ml	ml	ml	
1	100	2.0	—	—	—	—	1'50"
2	100	2.0	5	—	—	—	5'
3	100	2.0	5	1.5	—	—	5'
4	100	2.0	5	1.5	4	—	5'
5	100	2.0	5	1.5	4	4	14'

From the results it can also be assumed that zinc oxide or zinc ammines are not involved in the gelling mechanism. The mechanism of gelling of methylamine preserved latices might be different from that of ammonia preserved latex, where the combined effect of zinc soap formation, adsorption of latex stabilisers on to the preceipitated silica particles and the mechanical entrapment of the latex particles in the gelatinous silica bring about gelation of latex (3).

Production of dipped goods and latex foam

Dipped articles and latex foam were made from the methylamine preserved latex, containing 0.4% CH_3NH_2. A slightly more yellow colour was noticed in the case of dipped goods from methylamine preserved latex. But the products vulcanised in boiling water instead of in hot air did not have any such discolouration. Pick up was slightly less than that in the case of ammonia preserved latex when compared under

FIG.1

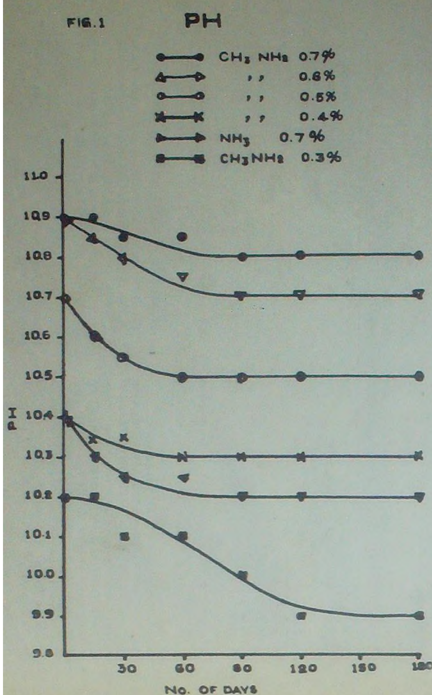

PH
CH_3NH_2 0.7%
,, 0.6%
,, 0.5%
,, 0.4%
NH_3 0.7%
CH_3NH_2 0.3%
PH
11.0
10.9
10.8
10.7
10.6
10.5
10.4
10.3
10.2
10.1
10.0
9.9
9.8
30
60
90
120
150
180
No. OF DAYS

FIG.2

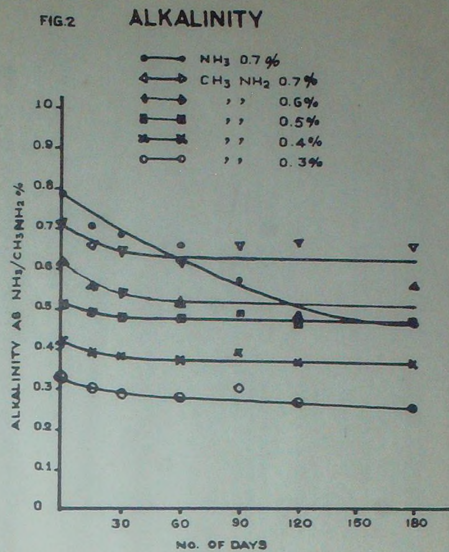

ALKALINITY
NH_3 0.7%
CH_3NH_2 0.7%
,, 0.6%
,, 0.5%
,, 0.4%
,, 0.3%
ALKALINITY AS NH_3/CH_3NH_2 %
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
30
60
90
120
150
180
NO. OF DAYS

FIG. 3

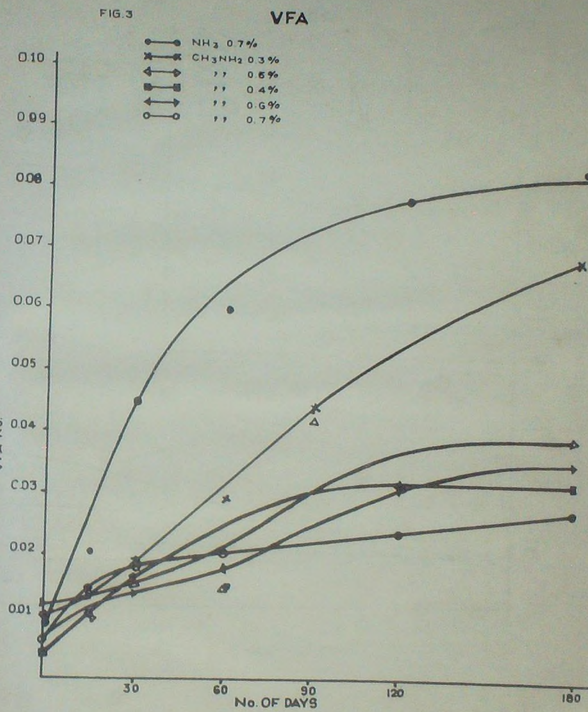

VFA
NH₃ 0.7%
CH₃NH₂ 0.3%
,, 0.5%
,, 0.4%
,, 0.6%
,, 0.7%
VFA No.
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
30
60
90
120
180
No. OF DAYS

FIG.1 **PH**

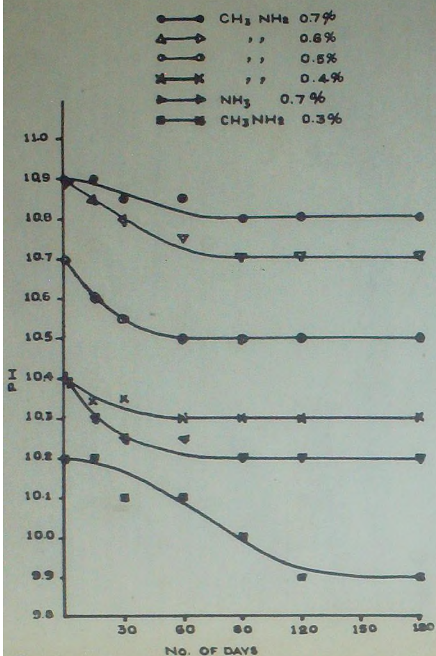


FIG.2 **ALKALINITY**

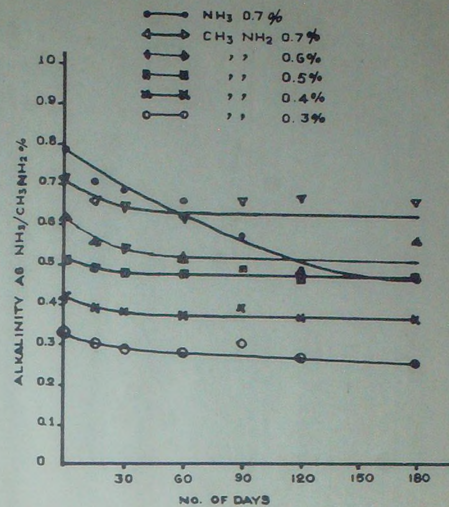


FIG. 3

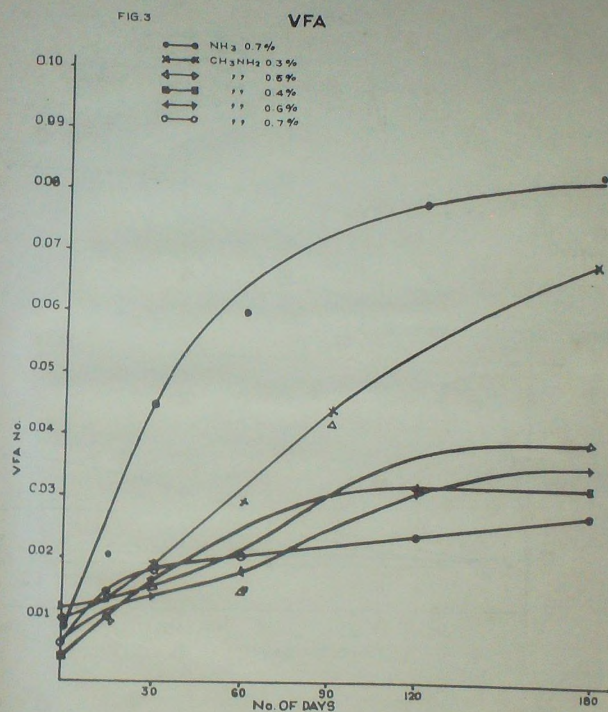

VFA
NH3 0.7%
CH3NH2 0.3%
,, 0.5%
,, 0.4%
,, 0.6%
,, 0.7%
VFA No.
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
30
60
90
120
180
No. OF DAYS

FIG. 4

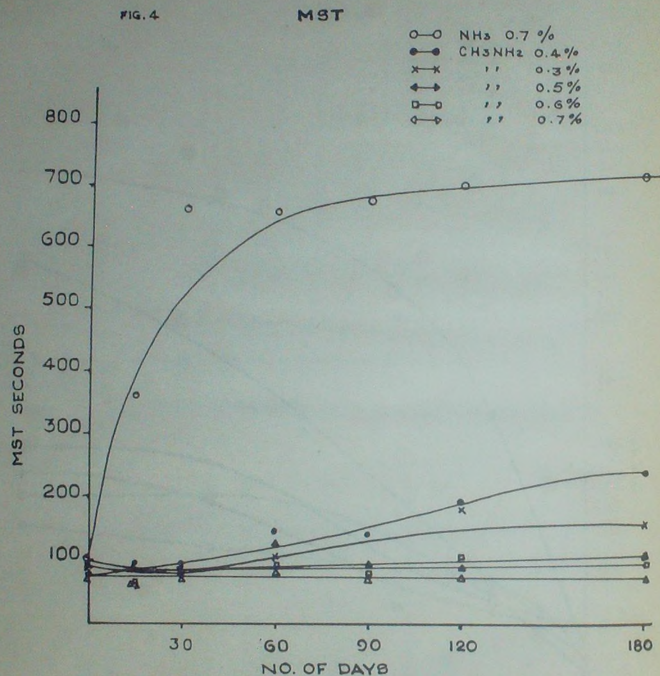
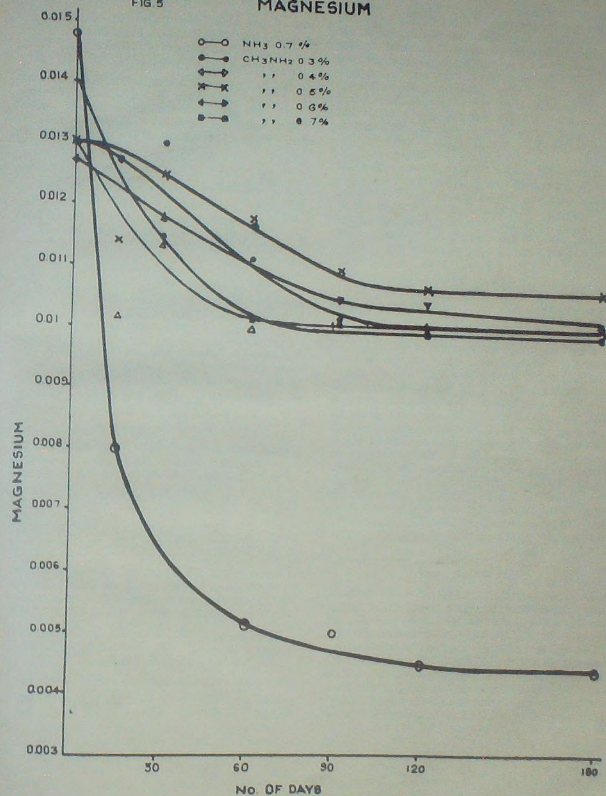

MST
NH3 0.7 %
CH3NH2 0.4 %
,, 0.3 %
,, 0.5%
,, 0.6%
,, 0.7%
800
700
600
500
400
300
200
100
MST SECONDS
30
60
90
120
180
NO. OF DAYS

FIG. 5


MAGNESIUM
NH3 0.7 %
CH3NH2 0 3 %
,, 0 4 %
,, 0 5 %
,, 0 6 %
,, 0 7 %
0.015
0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
MAGNESIUM
30
60
90
120
180
No. OF DAYS

identical conditions. But by adding thickening agents like carboxymethyl cellulose pick up could be increased. An important observation made during the dipping experiment was that surface skin formation was practically absent in the case of methylamine preserved latex. As a considerable part of the wastage in small scale latex goods manufacturing units is due to surface skin formation, it is expected that a significant saving can be achieved by using methylamine preserved latex.

Latex foam cushions were made both from methylamine preserved latex and from ammonia preserved latex. No difficulty was experienced in processing methylamine preserved latex. Only a slightly lower quantity of gelling agent was required for methylamine preserved latex. The products were comparable in appearance.

Summary and conclusions

Monomethylamine at concentrations ranging from 0.3% to 0.7% was tried as preservative for NR latex concentrate in comparison with the conventional preservative ammonia at 0.7% concentration. Methylamine was found to be more effective in preventing bacterial activity and a concentration of 0.4% by weight of latex was found to be optimum. Removal of magnesium was not as efficient as in ammonia preserved latex. The low MST of methylamine preserved latex could be enhanced by the addition of ammonnium laurate. No difficulty was obscrbved in the production of dipped goods and latex foam from methylamine preserved latex and the products were found to be comparable in appearance to those from ammonia preserved latex. Surface skin formation was negligible in the case of methylamine preserved latex compound.

Acknowledgement

The authors are grateful to Dr. C. K. N. Nair, Director, Rubber Research Institute of India, for this keen interest in the study. Thanks are also due to M/s. Fertilizer Corporation of India for supplying us with samples of monomethylamine, to M/s. Meenachil Rubber Growers Marketing and Processing cooperative Society for giving us facilities for centrifuging the latex and to our colleagues in the Chemistry/Rubber Technology Division for their valuable suggestions.

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Carbon Black—Natural Rubber Latex Masterbatch*

KS Gopalakrishnan, Baby Kuriakose and **EV Thomas**
Rubber Research Institute of India, Kottayam-686 009

Abstract

Carbon Black-Natural Rubber Latex Master batches were prepared by three methods and the properties evaluated in comparison with the mill mixed sample. The results of the studies indicate that the latex masterbatches are having properties comparable to the mill mixed sample. There was reduction in mixing time for the masterbatches. Dispersion of black in rubber was poor when black in powder form was added directly to latex for the preparation of the masterbatch.

In the course of rubber goods manufacture, various combinations of vulcanising, protective, processing and reinforcing materials are incorporated into rubber and conventional methods employ powerful masticating equipments like banbury mixer or mixing mills for this purpose. Incorporation of ingredients like reinforcing blacks with dry rubber presented serious problems like maintenance of cleanliness in the factory and huge power consumption. Attempts were made to mix the ingredients with latex before flocculating it so that a premix which may be processed with much less difficulties could result.

Reinforcement of natural rubber by dispersion of extremely small particles of carbon black became established in 1920. Attempts soon were made to mix black with natural rubber in the latex stage and two patents were inssued to Peterson (5) and Cohen (1) as early as 1922 and 1933 respectively. Masterbatching was then carried out by mixing carbon black which had been previously dispersed in a suitable liquid medium with latex and coprecipitating the black-rubber mixture. Some of the earlier patents claimed that the dried black-latex masterbatch can produce reinforced rubber articles without high shear mixing whereas it is now known that such a product is not at all comparable in strength to the dry mixed compound. The black-latex masterbatch can deliver to the masticating equipment a premix which can give a shorter mixing cycle and still result in a well dispersed compound.

Dannenberg et al (2) held the view that direct addition of black to latex was not practicable because it might lead to partial coagulation of a tex and also result in poor dispersion of black in rubber. Samuels (7) described the attempts made at the research laboratories of Huber Corporation in the development of a process for the preparation of dispersant-free masterbatch where in dry black was added directly to the latex without making it a dispersion. In spite of the advantages claimed for masterbatching black with natural rubber latex, commercialisation of the process has not been successful so far. The most important reason for this may be the large distance between the countries producing natural rubber latex and carbon black necessitating transport of either black or latex over a large distance. In the case of synthetic latex none of these disadvantages exists and synthetic rubber-black masterbatches are produced in large quantities. India, being a country producing natural rubber latex and carbon black, commercial exploitation of the masterbatching process is a proposition worthwhile looking into.

The present study was aimed at developing a process for the preparation of latex-carbon black masterbatches using indigenously available materials.

Materials and Methods

Masterbatches of the composition, Rubber: Black: Oil as 100: 50: 7.5, were prepared by three methods. Dispersant-free masterbatch (A) was prepared by adding to field latex containing oil emulsion (Aromatic oil— Esso Rubber oil A 50% aqueous emulsion prepared using ammonium stearate as the emulsifier) HAF black under high speed stirring (3000 rpm) and after 45 seconds stirring, coagulating the mix with 2.5 % acetic acid. Dispersant type masterbatches B and S were prepared by two methods: (B) by mixing field latex containing Rubber oil A emulsion with carbon black dispersion (HAF black dispersed to 17% aqueous dispersion by ball milling for 18 hours with 1 part dispersol LN/100 parts black) under high speed stirring for 45 seconds and coagulating the mix with acetic acid; and (S) by grinding the black in a pug mill for half an hour with water containing dispersol LN/ (1 part per hundred parts black) to 17% aqueous dispersion of black. The amount of water used for grinding black was so adjusted that a paste of black resulted after grinding and this was subsequently diluted with water to a 17% dispersion. This dispersion was added to latex containing oil emulsion under stirring and the mix coagulated with acetic acid. In all cases coagula were processed as sheets and smoke dried. Practically no loss of black was noticed during the machining of the coagula. Drying time for the masterbatches was five to six days as against four to five days for ribbed smoked sheets. The dried sheets were having moisture content of 1% or less.

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TABLE I

STUDIES ON LATEX CARBON BLACK MASTERBATCHES

Treat-ment.	Modulus 300% kg/cm² B Mean SE: 4.15 CD:—	Modulus 300% kg/cm² A Mean SE: 5.23 CD:—	Elongation at break % B Mean SE: 11.4 CD:—	Elongation at break % A Mean SE: 9.4 CD:—	Tensile strength kg/cm² B Mean SE: 3.35 CD: 9.88+ 13.48++	Tensile strength kg/cm² A Mean SE: 7.57 C:D—	Tear strength lb/in. Mean SE: 28.73 CD:—	Hardness shore A Mean SE: 0.7 CD:—	Resilience % Mean SE: 0.58 CD:	Abrasion loss cc/hr Mean SE: 0.1334 CD:	Compre--ssion set % Mean SE: 2.23 CD:
A	138.0	169.7	503.7	439.	262.5	254.0	476.5	59	61.0	1.1878	34.2
B	127.9	152.2	526.7	459	280.9	259.4	497.6	57	60.9	1.1118	36.9
C	135.0	170.9	515.7	451	275.2	270.3	544.7	59	59.2	1.1568	34.1
D	134.3	159.6	513.3	460	272.9	268.8	481.9	59	60.3	1.0393	36.2
G.Mean	133.8	163.1	514.8	452	272.9	263.1	500.2	59	60.3	1.1239	35.3

A — Direct mix
B — Black dispersion
C — Mill mix
D — Black slurry

+ Significant at 5% level.
++ Significant at 1% level.

Dried sheets were compounded in a 12" laboratory mixing mill. ASTM D 15–72 method was followed in the compounding of the samples. The formulation of the compound was Rubber 100, Zinc oxide 5, Stearic acid 2, Morpholinothio benzothiozole 0.8, Phenyl β-naphthyl amine 1, Sulphur 2.5, HAF black 50, Rubber oil A 7.5. Cure characteristics of all the samples were evaluated using viscurometer (Scott GSV) at 150°C. The samples were cured and the physical properties namely, tensile Strength, Modulus at 300% EB, Elongation at Break, Tear Strength, Hardness, Resilience, Abrasion Resistance and Compression Set, were assessed.

The entire study was based on completely randomised design with six replications. Vulcanised samples were taken and the dispersion of black was evaluated.

Results and Discussion

The mean properties for the various mixings are summarised in Table 1. From the table, it is evident that the treatments are not significant with respect to any of the above properties except tensile strength before aging.

Tensile strength before aging of dispersant type masterbatches and mill mixed sample is equal in performance and all are significantly better than that of dispersant-free masterbatch.

According to Dannenberg et al (2) the quality of black masterbatch depends strongly on the methods used for the mixing and coagulating steps. Studies of Swart and his group have shown that 'shock' coagulation gave a better product compared with the procedure of salt creaming followed by acid coagulation. In this study also, latex after mixing with carbon black was subjected to quick coagulation so as to obtain a uniform masterbatch.

It was observed that the time taken for the complete mixing of black masterbatch sample was less than that for the mill mixed sample. This is in line with observations of Janssen (3) and LaPorte (4) who claim that with masterbatches mixing cycles are shorter and less power is used.

The importance of attaining adequate, if not complete, dispersion of black in rubber need not be overemphasised. Work of Sweitzer (8) shows that with increase in the percentage of dispersion of black, tensile strength and resistance to abrasion (wear) are better. Carbon black dispersion rating of the masterbatches and mill mixed sample were obtained and the photographs of the same are shown in Figures I, II, III and IV. From the photographs, it is clear that sample A (Figure I) is giving poor dispersion in accordance with its low tensile strength. Though the dispersion of black in sample S (Figure IV) is not as good as that in samples B and C, tensile strength of S has not been adversely affected indicating somewhat adequate dispersion has been achieved.

Dispersion of black in rubber when used alone is inadequate for correlating the quality of carbon black incorporation with the physical properties of a masterbatch. Studies of Prestridge (6) revealed that at least three terms must be employed to evaluate the result of black incorporation and to determine its effect on the physical properties of the vulcanisate. These factors have been described by him as dispersion, grinding and bonding. Since it was very difficult to control the conditions in an indentical manner in the preparation of the masterbatches and since variation in the degree of dispersion, grinding and bonding can affect the extent of reinforcement, a statistical method had to be followed in evaluating the properties of the black masterbatches. Variations have been kept under control by using this design.

Summary and Conclusion

Carbon black-latex masterbatches both dispersant and dispersant-free types were prepared and the properties evaluated in comparison with the mill mixed samples. The study was based on completely randomised design and the analysis of the results indicated that the masterbatches were having properties comparable with the mill mixed sample.

Acknowledgements

Authors are grateful to the Director, Rubber Research Institute of India for his keen interest in the study. They also wish to express their thanks to their colleagues in the Chemistry and Rubber Technology Division for their valuable suggestions and useful discussions. Thanks are also due to the officers of the Statistics Department for their help in the preparation of the layout of the experiments and analysis of data. Cooperation extended by the Cabot Corporation, U. S. A. in the evaluation of the dispersion of carbon black in the vulcanisates is also remembered with thanks.

Fig. I

Fig. II

Pig. III

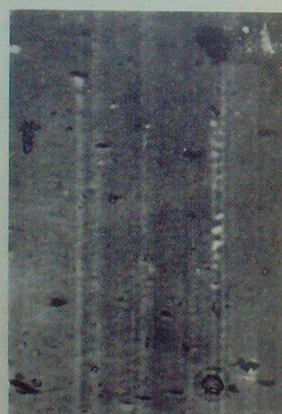

Fig. IV

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Fig. I


Fig. II


Fig. III

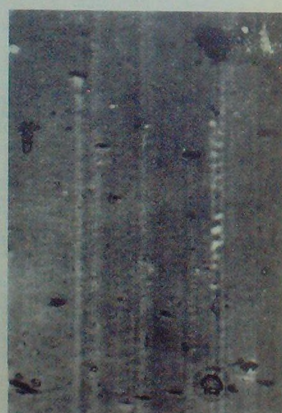
Fig. IV

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A Comparative study of the Processibility and Vulcanizate Properties of solid block rubber with the Conventional Grades of dry Natural Rubber

Baby Kuriakose, MK Balagopalan Nair and **EV Thomas,**
Rubber Research Institute of India, Kottayam 686 009

Abstract

Solid block rubber produced in the country is evaluated in comparison with the conventional grades of dry natural rubber, processed from the same source of starting raw materials. The dirt removal and the removal of volatile matter in the newly processed rubbers were always more pronounced than in the conventionally processed rubbers. The technological properties were found to be comparable for the rubbers derived from latex. Improvement in some of the technological properties was observed for the solid block rubbers derived from scrap when compared to crepe rubbers.

Introduction

There has been a general feeling amongst the rubber manufacturers that the conventionally processed sheet and crepe rubbers graded by the visual comparison method are out dated. This became all the more obvious with the introduction of uniformly packed and technically specified synthetic rubbers. So a similar development in natural rubber industry became necessary and the modern solid block type of processing was introduced in this context. Malaysia, the biggest natural rubber producer, has made considerable advancement in this field. The manufacturing industry is also showing keen interest in the raw rubbers presented in this new form and so other natural rubber producing countries also have taken steps to implement this type of processing. In India, at present there are four block rubber processing units with an annual production capacity of about 8000 tonnes. It is reported from Malaysia (4) that the block rubbers produced in that country has an undisputed consumer preference over block rubbers produced from many other countries, owing to consistancy of Malaysian specified rubbers. In this context, it was felt necessary to undertake a study with the following objectives.

(a) A comparative evaluation of processibility of block rubbers with sheet and crepe rubbers;

(b) To compare the cure properties of compounded stocks and physical properties of vulcanizates prepared from block rubbers and the conventional grades of dry natural rubber;

(c) To assess the consistancy of properties of block rubbers;

(d) To compare the advantages of using special grades of block rubbers;

(e) To examine the handling and storage advantages of solid block rubbers.

Materials and Methods

The block rubber samples evaluated in the comparative study were collected from a block rubber processing factory which is also having facilities for processing rubber in the conventional and crepe form. The experiment was laid down on a statistical basis and the following four treatments were tried using Randomised Complete Block Design, with six replications.

A — Sheet from latex.
B — Block from latex.
C — Crepe from scrap.
D — Block from Scrap.

The steps involved in the block rubber processing are, coagulation of latex at field dry rubber content, maceration and creping to reduce the thickness of the coagulum, followed by crumbling in a high speed hammer mill. The crumbs are received in a pool of water, washed and then dried in a current of hot air at 80–100°C. This is then cooled and pressed to standard size and weight in a baling press. The bales are then technically specified and packed in polythene sheets. Samples for the study were taken from the corners of such bales. The properties evaluated are, the raw rubber specification properties, other than copper and manganese as per the ISI Standards, mooney viscosity as per ASTM standards, specific gravity, the physical properties of gum (ACSI test recipe) and filled (ACS 1-1 test recipe) vulcanizates. The change of mooney viscosity of the above four and that of a controlled

Table I

Sl. No.	Treat-ment	Volatile Matter % by weight	Wallace Plasticity	Moony Viscosity ML (1+4)100°C	Plasticity Retention Index (PRI)	Dirt content % by weight	Nigrogen content % by weight	Total Ash % by weight	Specific Gravity
		Mean SE-0.0830 CD—0.25002+ 0.34627++	Mean SE-2.72 CD-8.193+ 11.348	Mean SE-3.24 CD- —	Mean SE- 4.47 CD- 13.47+ 18.65+	Mean SE-0.034 CD- 0.10453+ 0.14477++	Mean SE-0.0119 CD—	Mean SE-0.0506 CD- 0.15242+ 0.21110++	Mean SE-0.0126 CD- —
1	A	0.6x29	52(2	84.3	76.0	0.1091	0.4733	0.4480	0.9106
2	B	0(2489	52(2	81.3	86.8	0.0436	0.4433	0.30x2	0.9144
3	C	0.7141	44(2	75.0	40.0	0.4729	0.4690	0.6995	0.8774
4	D	0.3196	37.0	72.5	59.0	0.3098	0.4351	0.7034	0.8860
General Mean		0.4739	46.4	78.3	65.5	0(2338	0.4551	0.5380	0.8971

+Significant at 5% level. *+ + Significant at 1% level.

Table II

Sl. No.	Treat-ment	Scorch Time (gum) at 121°C (Minutes)	Scorch Time (filled) at x21 C (Minutes)	Cure Time (gum at 150°C (Minutes)	Cure Time (filled) at150°C (Minutes)	Hardness (gum) (Shore A)	Hardness (filled) (Shore A)	Rebound Resilience (gun)m	Rebound Resilience (filled)	Abrasion Resistance (gum) Loss in cc/hr	Abrasion Resistance (filled) Loss in cc/hr.
		Mean SE-0.70 CD—	Mean SE-0.58 CD-1.75— 2.42++	Mean SE-1.03 CD—	Mean SE-0.38 CD—	Mean SE-0.58 CD-1.75+ 2.42++	Mean SE-0.46 CD-1.39+ 1.92++	Mean SE-0.90 CD-2.7111+ 3.755++	Mean SE-0.68 CD- —	Mean SE-0(2068 CD-0.62294+ 0.86376++	Mean SE-0.0145 CD- —
1	A	10.7	16.8	24.3	16.7	32.3	57.5	75.38	67.70	2.1779	0.2101
2	B	10.8	19(2	23.5	17.5	31.0	56.3	74.40	68(20	2.3777	0.2174
3	C	10.8	16.5	22.8	16.3	30.0	56.3	71.70	65.70	3.1965	0.2411
4	D	9.0	16.8	20(2	16(2	32.3	58.0	75.07	66.55	2.1136	0.2065
General Mean		10.30	17(3	22.7	16.7	31.4	57.0	74.14	67.04	2.4662	0.2188

+Significant at 5% level. ++Significant at 1% level.

Table III

Sl. No.	Treat-ment	Modulus (gum) kg/cm2 M600 Mean SE-7.04 CD- —	Modulus (filled) kg/cm2 M300 Mean SE-3.73 CD- —	Tensile strength (filled) kg/cm2 Mean SE-5.24 CD- —	Elongation at Break (filled %) Mean Mean SE-5.29 CD- —	Modulus filled (M300) % Retention after aging. Mean SE-2.72 CD- —	Tensile Strength-Filled % Retention after aging Mean SE-2.41 CD- —	Elongation at Break (filled %) Retention after aging. Mean SE-1.25 CD- —
1	A	113(2	185.5	306.7	429.8	109(2	87.3	87(2
2	B	95.8	176.7	294(2	432(2	105.7	84.8	86.5
3	C	90.8	178.0	285.8	416.0	105.0	82.3	85.8
4	D	107.0	183.3	290.0	416.0	108(2	84.3	84.7
General Mean		101.7	180.9	294(2	423.5	107.0	84.7	86.0

Aging of the samples was carried out at 70 C for 96 hours.

TABLE IV

Sample No.	Mooney Viscosity ML(1+4) 100°C	Wallace plasticity	P.R.I.	Ash Content (%by weight)
1	67	33	55	0.632
2	70	33	58	0.648
3	71	34	53	0.576
4	69	32	59	0.616
5	70	34	53	0.610
6	66	29	52	0.637
7	66	30	63	0.646
8	63	28	64	0.746
9	68	31	65	0.717
10	65	31	65	0.630
11	63	29	48	0.663
12	66	30	60	0.589
13	66	30	67	0.716
14	66	32	66	0.657
15	65	30	60	0.679
16	68	33	48	0.705
17	68	32	47	0.716
18	66	31	61	0.695
19	69	31	68	0.722
20	67	32	59	0.713
21	72	35	54	0.703
22	67	31	45	0.659
23	69	33	52	0.695
24	69	35	57	0.678
25	68	34	59	0.738
26	63	29	52	0.713
27	67	33	58	0.742
28	65	30	50	0.698
29	66	33	58	0.790
30	68	33	52	0.736

viscosity rubber, with the time of mastication was also evaluated in a 42 inch mill. For the evaluation of consistancy of properties among blocks, money viscosity, plasticity retention index, initial wallace plasticity and ash content were examined in thirty different samples from one ton of block rubber. Observations were also taken in the storage qualities of solid block rubbers with respect to its resistance to fungal attack.

Results and Discussions

Results of the study were analysed statistically and the data are shown in Tables I, II and III. Changes in Mooney Viscosity with mastication time for the different samples are shown in Figure 1. The results of the evaluation of consistancy in properties are given in Table IV. It may be seen from Table I that the volatile matter is less in the case of block rubber samples when compared with sheet and crepe rubbers. Plasticity Retention Index was found to be higher for the block rubber derived from scrap rubber when compared with crepe rubber. But a similar phenomenon was not observed for the block rubbers, prepared from latex, when compared with sheet rubber. Block rubbers derived from scrap grades were found to be superior to crepe rubbers in that, the dirt content was lower in these samples. Here again, the block from latex was found to be comparable to sheet rubber. Other specification properties were found to be comparable in all grades. The technological properties shown in Tables II and III were comparable for both block and sheet rubbers prepared from latex. This observation is in agreement with the findings of Sekhar (7) who observed that "the physical properties of block rubbers are equal in all respects to those of the conventionally processed rubbers". The gum vulcanizates of block rubber prepared from scrap rubber were found to be better than those from crepe rubber in hardness, Rebound Resilience and Abrasion Resistance. The data in Table IV were subjected to statistical analysis and the results showed that there is a co-efficient of variation of 18.05% for Mooney Viscosity and 31.89% for Wallace Plasticity. These results are in agreement with the findings of Chin Peng Sung et al (4). It may be seen from Figure I that the percentage drop in Mooney Viscosity by mechanical and thermal breakdown is higher for the sheet rubbers when compared with block rubbers processed from latex. Similarly in the case of scrap grades, better resistance to break down was shown by block rubber than by crepe rubber. At the same time it was observed that the band forming times for the block rubbers and that of the conventional grades are more or less the same. Hence it is expected that the compounded samples from the block rubbers can ensure a better dispersion of the compounding ingredients, because of their higher viscosity after the band formation (2) (6). The graph showing the breakdown behaviour of the controlled viscosity sample is nearly parallel to the time axis, indicating that it has formed the band with the minimum breakdown energy.

Block rubbers were found to have definite advantages in storage in that they have very high resistance to fungal attack. The blocks stored on concrete floors for over six months were found to be free from fungal attack. This may be due to their neat packing and high degree of dryness. The compact bales can resist the interior penetration of moulds. This is a real advantage to the rubber plantation industry, as mould growth is a serious problem, especially during humid seasons. The handling, testing and processing advantages of block rubbers were discussed in detail by several previous workers (3) (1).

Conclusions

Block rubbers derived from latex were found to be superior to sheet rubbers in their high degree of dryness. The blocks from scrap rubber were superior to crepe rubbers in their degree of dryness, low dirt content and high oxidation

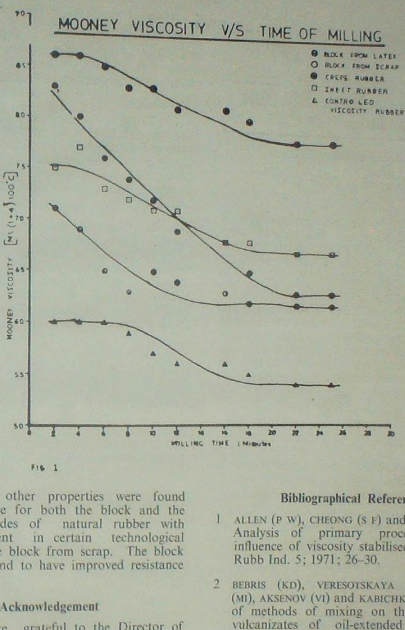

FIG 1

resistance. All other properties were found to be comparable for both the block and the conventional grades of natural rubber with slight improvement in certain technological properties for the block from scrap. The block rubbers were found to have improved resistance to mould growth.

Acknowledgement

The authors are grateful to the Director of Research, Rubber Research Institute of India, for his keen interest in this work. The valuable assistance provided by the Assistant Statistician Shri G. Subbarayalu in analysing the data statistically is also gratefully acknowledged. The samples used in this study were collected from the crumb rubber factories established under the Palai Marketing Cooperative Society, Palai, Kerala and M/s. Heveacrumb Pvt. Ltd., Paika, Kerala. The large scale mastication trials were carried out at the Kerala Rubber and Allied Products, Kottayam, Kerala. The Co-operation extended by these factories are also remembered with thanks. Thanks are also due to Smt. Leelamma Varghese and Smt. C. K. Premaletha for the valuable assistance they have provided in analysing the samples.

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Block rubbers derived from latex were found to be superior to sheet rubbers in their high degree of dryness. The blocks from scrap rubber were superior to crepe rubbers in their degree of dryness, low dirt content and high oxidation

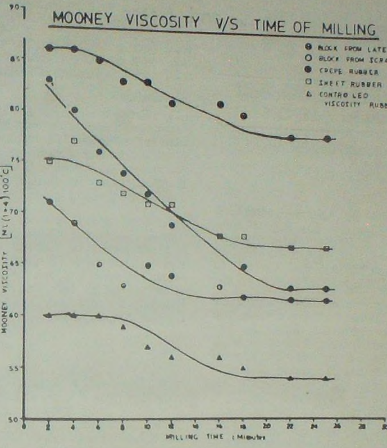

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TABLE IV

Sample No.	Mooney Viscosity ML(1+4) 100°C	Wallace plasticity	P.R.I.	Ash Content (%by weight)
1	67	33	55	0.632
2	70	33	58	0.648
3	71	34	53	0.576
4	69	32	59	0.616
5	70	34	53	0.610
6	66	29	52	0.637
7	66	30	63	0.646
8	63	28	64	0.746
9	68	31	65	0.717
10	65	31	65	0.630
11	63	29	48	0.663
12	66	30	60	0.589
13	66	30	67	0.716
14	66	32	66	0.657
15	65	30	60	0.679
16	68	33	48	0.705
17	68	32	47	0.716
18	66	31	61	0.695
19	69	31	68	0.722
20	67	32	59	0.713
21	72	35	54	0.703
22	67	31	45	0.659
23	69	33	52	0.695
24	69	35	57	0.678
25	68	34	59	0.738
26	63	29	52	0.713
27	67	33	58	0.742
28	65	30	50	0.698
29	66	33	58	0.790
30	68	33	52	0.736

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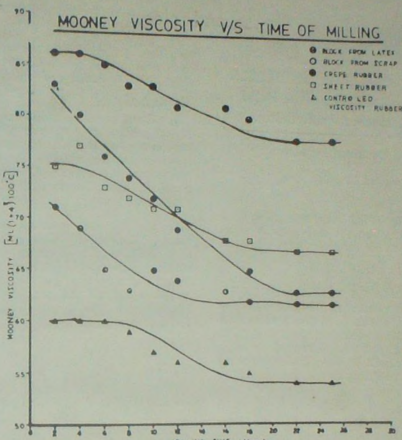

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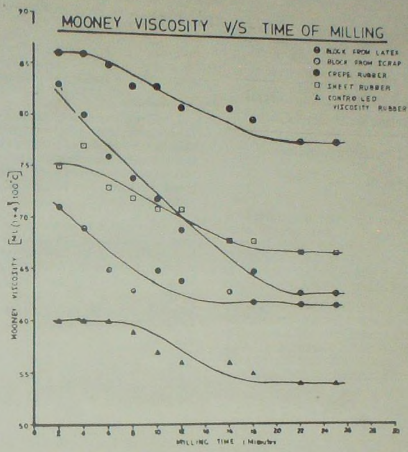

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Fai-Fao Seminar held at New Delhi during December 9–11, 1976

Conclusions and Recommendations

Economics of Fertiliser Use

Conclusions

Benefit cost ratio is the main motivation for a farmer to use fertiliser. It has various components, i. e., prices of fertiliser and agricultural produce, efficiency of fertiliser use, response to fertiliser use, research and extension support to the farmer, a suitable marketing strategy, etc.

2. High fertiliser price in 1973–74 was the one single factor which inhibited fertiliser consumption the most over the period that followed. The output-input price relationship dropped so much that the farmer refused to risk fertiliser application under uncertain conditions and decided to await better days.

3. Drop in fertiliser prices during 1975 and 1976, particularly of P_2O_5 through the price subsidy, has changed the situation for the better and there are signs of resumption in fertiliser demand. It is realised that large jumps in fertiliser consumption year after year will not henceforth be maintained.

4. Based on past experience, the farmer has come to regard a cost benefit ratio of 1 : 2.5 and 1 : 3.0 for paddy and wheat respectively as the minimum acceptable to him as a motivation for using fertilisers. The corresponding current ratios are 1 : 1.9 and 1 : 2.54.

Recommendations

5. Since for sound economic reasons the foodgrains prices are not being increased, the price of fertiliser should be reduced further to provide to the farmer a cost benefit ratio that is close to his expectation. At the same time, with current costs of inputs, the ex-factory realisation for the manufacturers or the dealer commission cannot be lowered. The obvious remedy is to free fertilisers from the burden of taxes and other imposts like Pool equalisation charge, excise duty, sales-taxes, etc. which on urea, for example can be as high as Rs. 450/- per tonne. In addition, subsidy on fertilisers may be necessary in some cases, e. g. phosphatic.

6. Sale and other local taxes on fertilisers should be immediately abolished to enable a corresponding reduction in consumer prices.

Package of Practices

Conclusions

7. Fertiliser consumption has still not reached the optimum level in any part of the country, not even in the Punjab. The response to fertiliser use is still on the increase and has not reached the plateau of the curve. A considerable scope, therefore, exists for further increasing fertiliser consumption.

8. Fertiliser is the costliest of all agricultural inputs. The farmer will go in for its use only if in his judgement he finds its use economically viable. High costs of fertilisers notwithstanding, farmer's profitability can be increased by the adoption of all the practices that influence fertiliser use efficiency. This will stimulate fertiliser consumption.

9. The package of these practices comprises proper seed bed preparation, selection of a suitable crop variety, proper seed rate and method and time of sowing, cropping sequence, control of pests, diseases and weeds and adoption of suitable fertiliser use practices. It must be emphasised that fertiliser use is no substitute for bad agronomical practices. Lack of attention to any of these will adversely affect crop yields and diminish fertiliser use efficiency.

Recommendation

10. For a successful replication of experimental results achieved at the agricultural universities and research stations on the farmers' field, it is essential that the farmer is first convinced of the utility of the package of practices and also their synergetic effect. The concept of package of practices should then be actively propagated. Extensive extension and promotional work by Government and the Industry is necessary for this purpose.

Balanced Fertilisation

Conclusion

11. Crop yield increases with an appropriately balanced fertiliser application, as is borne out by an analysis of the yield of wheat in different districts in Punjab. There is urgent need to get this message across to all extension workers and farmers.

Recommendation

12. The concept of balanced fertilisation must be vigorously propagated.

Fertiliser Use Efficiency

Conclusion

13. Cost of cultivation can also be decreased through increased fixation of nitrogen (symbiotic and asymbiotic) from nature and by more efficient use of phosphorus and potash.

Recommendation

14 To achieve these objectives more basic research is necessary which must be pursued actively in various research bodies like agricultural universities.

Dry Farming

Conclusion

15. Massive investments are no doubt planned during the Fifth and Sixth Five Year Plans in irrigation This will substantially increase the area under irrigation. But still bulk of cropped area in the country will remain under conditions of inadequate rainfall and in droughtprone areas. Because of their vastness, even a marginal increase in fertiliser consumption therein can mean a large increase in total fertiliser consumption. These areas, therefore, offer a big challenge not only for stimulating fertiliser consumption but also for raising the economic position of the poorer sections of the farming community. Dry farming technology has, therefore, to be further improved to increase crop yields.

Recommendations

16. Research in our Universities etc. should be intensified to evolve an improved dry farming technology and making it known to the farmers.

17. It has to be recognised that tapping the potential for fertiliser use in the dry land areas will require massive effort and expense. Perhaps as a first step, pilot projects may be undertaken in blocks of 200 hectares on a consortium basis to gain more knowledge of the problems involved so that a suitable strategy could be evolved. The Industry, the banks and the Government could perhaps comprise the consortium.

Fertiliser Marketing

Conclusion

18. Fertiliser consumption can be stimulated only through hard selling which would involve innovative, effective and intensive promotional efforts and adequate availability of credit.

Fertiliser Promotion

Conclusions

19. The fertiliser industry in India has used a wide variety of promotional tools and their combinations. Many innovations have been made.

20. A variety of Village Adoption Programmes have been stated to be effective in promoting fertiliser consumption. These programmes have had an impact on rural development as well as on fertiliser consumption. An in-depth evaluation of these programmes was considered essential to facilitate their adoption on a wider scale in the country.

Recommendation

21. The FAI may organise a Workshop to discuss case studies of such programmes and arrive at an objective evaluation of their role and effectiveness.

Conclusion

22. No one communication medium is most effective under all situations. Exposure to an appropriate and location specific mediamix beamed at the target audience in a logical sequence results in a most effective communication of the lowest cost. Also, situations are dynamic and strategy must be reviewed to meet changing needs.

Recommendations

23. It is wasteful to deploy all the available communication media to promote fertiliser use. The effectiveness of each medium or media mix must be scientifically evaluated for each location to decide on the most effective media mix. The results of such evaluation may at times be contrary to normal expectations.

24. It should be our continuing effort to perfect the effectiveness of existing media mix, to evolve new ones and evaluate their cost benefit through research and experimentation which may be conducted on a collaborative basis by the concerned interests.

Distribution

Conclusion

25. The distribution system must be in tune with the current requirements and aim at making available the right quality of the product at the time of its application in the right quantity virtually at the door step of the farmer and at the minimum cost. The fertiliser marketer must not only sell the fertiliser but sell the prosperity that its efficient use promises.

Recommendation

26. The industry's approach to marketing of fertiliser must aim at selling prosperity to the farmer through its efficient use.

Conclusion

27. The restructured distribution strategy may also involve in appropriate cases penetration into the country side through opening up of retail outlets in the interior and establishment of field

godowns. These outlets to be economically viable must have a certain minimum turnover.

Recommendation

28. Industry must widen the base of fertiliser distribution by opening more retail outlets particularly in the interior areas where these may not be viable. The use of mobile vans selling fertilier in the village on specified days during the season which have been successfully deployed in certain areas was commended.

Conclusion

29. The current pricing structure does not offer enough incentives to a dealer to open up retail points in the remote interior areas.

Recommendation

30. A system of permitting recovery of additional secondary transport cost from the railhead to the interior point needs to be established. In order that this does not increase the consumer price, some sort of subsidy may need to be provided for movement of material to remote locations. Some other alternatives may also have to be evolved.

Conclusion

31. Product exchange may help it cutting down distribution costs. Procedural problems involved therein should be resolved.

Recommendations

32. Industry should actively pursue this concept and adopt it wherever practicable. Government should facilitate the process by eliminating procedural hurdles.

33. To further reduce distribution costs, it was agreed that if abolition of sales tax is not a practical proposition, fertiliser should be termed a declared commodity like sugar. This will save at least avoidable investment on such field warehouses as are being set up simply to avoid payment of Central sales-tax or multiple taxes.

Credit

Conclusion

34. Adequate credit availability—both distribution and production—is a vital pre-requisite to stimulating fertiliser consumption. It is also essential that fertiliser industry should enjoy a preferential rate of interest.

Recommendation

35. The related problems are, however, complex and they need a specialised study. FAI may organise separate workshops to resolve this problem.

Crop Insurance

Conclusion

36. In view of the risks involved in dry farming areas in using expensive inputs like fertiliser, the introduction of some sort of a crop insurance scheme appears inescapable.

Recommendation

37. Crop insurance in the country is in its infancy. All the expertise available in the country will need to be pooled to discuss its necessity and feasibility in depth. FAI may organise a separate workshop for this purpose.

Breaking the Fertiliser Cycle

Conclusion

38. The ill-effects of the cycles of over production (and low prices) and inadequate production (and high prices) in the international market can perhaps be alleviated through evolving a long term strategy between the producers and the buyers. Its component should be long term agreements for purchase and sale, assurance of resonable prices for sellers of the raw materials and finished products and sharing of the inflationary costs by all concerned, namely producers, intermediaries and the users.

Recommendation

39. The above approach was commended to buyers & sellers for their consideration.

FAI Awards

With a view to encouraging authors to contribute a larger number of quality articles for its various publications, the Fertiliser Association of India had instituted in 1971 annual awards to be given to authors of outstanding articles published in its journals. It is generally agreed that these awards have been instrumental in increasing the flow of contributions and upgrading their quality. These awards have, therefore, helped in achieving the objectives for which these were established. In recognition of this fact and to provide a further stimulus, some member firms of FAI have kindly offered to establish a new series of awards to substitute the old ones. The quantum of awards for the first and second prizes has been substantially increased. Besides, a third prize has been introduced for each series are recommended by the various Selection Committees over the last couple of years.

These awards will become operative in 1977 (for the period October 1976 to September 1977). It is our earnest belief that the munificence of the donors of the new awards will attract a larger number of contributions for our publications and further improve the quality of writing in these journals. Further detarils can be had from the Fertilizer Association of India, Near Jawaharlal Nehru University, New Delhi-110 057.

Fellowship to Dr. Matthan

Dr. RK Matthan, the Indian Representative of Malaysian Rubber Research and Development Board, Kuala Lumpur, Malaysia has been awarded the Fellowship of the Plastics and Rubber Institute (London).

This Fellowship has been bestowed upon Dr. Matthan for his significant contributions to the development of the rubber industry in India, according to a press note issued by Malaysian Rubber Bureau, Madras.

Obituary

Chacko A. Kallivayalil

Shri Chacko A. Kallivayalil (62) an enterprising pioneer in planting and an intimate associate of the Rubber Board died on 6th July 1977 at the Medical College Hospital, Trivandrum. He has served as a member of the Board's delegation to Malaysia, Andaman Nicobar Islands and Goa. He had been chairman of the MPA and a member of the Coffee Board. The credit for establishing the first crumb rubber factory in India in the private sector goes to Shri Chacko.

W. H. Armstrong

Death occured at Bangalore of Shri W. H. Armstrong on 22nd March 1977 due to cardiac arrest. He was 52. Shri. Amstrong popularly known as 'Billy' among friends was superintendent of the TR & T estates when he died. He was a member of the Rubber Board from 1971 to 1974. In his death the rubber plantation industry has lost an enterprising stalwart.

K. K. Warrier

Shri K. K. Warrier, a former member of the Rubber Board died on 12th June 1977 at the Medical College Hospital, Trivandrum. An efficient parliamentarian and a veteran journalist, Sri Warrier had a pride of place in the public life of Kerala.

T. D. Mathew

Shri TD Mathew, a leading planter and rubber dealer died at the age of 64 on 12th June 1977. He was a member of the Board from 1949 to 1951.

godowns. These outlets to be economically viable must have a certain minimum turnover.

Recommendation

28. Industry must widen the base of fertiliser distribution by opening more retail outlets particularly in the interior areas where these may not be viable. The use of mobile vans selling fertilier in the village on specified days during the season which have been successfully deployed in certain areas was commended.

Conclusion

29. The current pricing structure does not offer enough incentives to a dealer to open up retail points in the remote interior areas.

Recommendation

30. A system of permitting recovery of additional secondary transport cost from the rail-head to the interior point needs to be established. In order that this does not increase the consumer price, some sort of subsidy may need to be provided for movement of material to remote locations. Some other alternatives may also have to be evolved.

Conclusion

31. Product exchange may help it cutting down distribution costs. Procedural problems involved therein should be resolved.

Recommendations

32. Industry should actively pursue this concept and adopt it wherever practicable. Government should facilitate the process by eliminating procedural hurdles.

33. To further reduce distribution costs, it was agreed that if abolition of sales tax is not a practical proposition, fertiliser should be termed a declared commodity like sugar. This will save at least avoidable investment on such field warehouses as are being set up simply to avoid payment of Central sales-tax or multiple taxes.

Credit

Conclusion

34. Adequate credit availability—both distribution and production—is a vital pre-requisite to stimulating fertiliser consumption. It is also essential that fertiliser industry should enjoy a preferential rate of interest.

Recommendation

35. The related problems are, however, complex and they need a specialised study. FAI may organise separate workshops to resolve this problem.

Crop Insurance

Conclusion

36. In view of the risks involved in dry farming areas in using expensive inputs like fertiliser, the introduction of some sort of a crop insurance scheme appears inescapable.

Recommendation

37. Crop insurance in the country is in its infancy. All the expertise available in the country will need to be pooled to discuss its necessity and feasibility in depth. FAI may organise a separate workshop for this purpose.

Breaking the Fertiliser Cycle

Conclusion

38. The ill-effects of the cycles of over production (and low prices) and inadequate production (and high prices) in the international market can perhaps be alleviated through evolving a long term strategy between the producers and the buyers. Its component should be long term agreements for purchase and sale, assurance of resonable prices for sellers of the raw materials and finished products and sharing of the inflationary costs by all concerned, namely producers, intermediaries and the users.

Recommendation

39. The above approach was commended to buyers & sellers for their consideration.

FAI Awards

With a view to encouraging authors to contribute a larger number of quality articles for its various publications, the Fertiliser Association of India had instituted in 1971 annual awards to be given to authors of outstanding articles published in its journals. It is generally agreed that these awards have been instrumental in increasing the flow of contributions and upgrading their quality. These awards have, therefore, helped in achieving the objectives for which these were established. In recognition of this fact and to provide a further stimulus, some member firms of FAI have kindly offered to establish a new series of awards to substitute the old ones. The quantum of awards for the first and second prizes has been substantially increased. Besides, a third prize has been introduced for each series are recommended by the various Selection Committees over the last couple of years.

These awards will become operative in 1977 (for the period October 1976 to September 1977). It is our earnest belief that the munificence of the donors of the new awards will attract a larger number of contributions for our publications and further improve the quality of writing in these journals. Further detarils can be had from the Fertilizer Association of India, Near Jawaharlal Nehru University, New Delhi-110 057.

Fellowship to Dr. Matthan

Dr. RK Matthan, the Indian Representative of Malaysian Rubber Research and Development Board, Kuala Lumpur, Malaysia has been awarded the Fellowship of the Plastics and Rubber Institute (London).

This Fellowship has been bestowed upon Dr. Matthan for his significant contributions to the development of the rubber industry in India, according to a press note issued by Malaysian Rubber Bureau, Madras.

Obituary

Chacko A. Kallivayalil

Shri Chacko A. Kallivayalil (62) an enterprising pioneer in planting and an intimate associate of the Rubber Board died on 6th July 1977 at the Medical College Hospital, Trivandrum. He has served as a member of the Board's delegation to Malaysia, Andaman Nicobar Islands and Goa. He had been chairman of the MPA and a member of the Coffee Board. The credit for establishing the first crumb rubber factory in India in the private sector goes to Shri Chacko.

W. H. Armstrong

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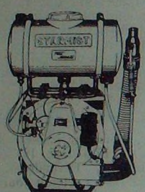

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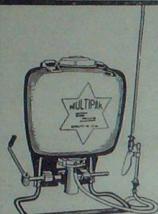

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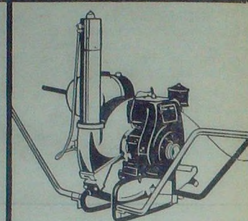

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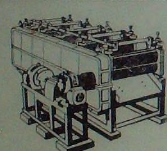

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rubber board bulletin

Cover: RRII 118—A vigorous Indian clone which matures in 6 years

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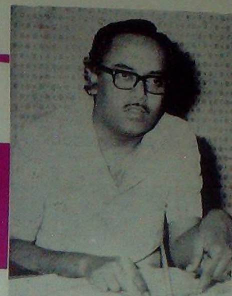
S.G.SUNDARAM
NEW CHAIRMAN



Shri S. G. Sundaram IAS, Chairman, Cardamom Board assumed additional charge of the post of the Rubber Board on 17th May 1978. He took over from Shri T. V. Antony IAS, Joint Secretary, Ministry of Commerce, who was acting as Chairman, Rubber Board till then.

Born on 1st January 1938, Shri S. Gomathy Sundaram hails from Ambasamudram of Tinneveli District of Tamil Nadu. He did his B. Com. (Hons.) from Madras University and M. A. in Development Economics from Williams College, Massachusetts, U. S. A. Shri Sundaram entered Government service in 1960 as an officer of the Indian Revenue Service. In 1962 he entered the I. A. S. and was sent to the Punjab Cadre. With the formation of the State of Haryana Shri Sundaram was allotted to Haryana service. He has been Joint Director of Industries Punjab and Haryana, Deputy Secretary to Government for Industries, Haryana and Under Secretary to Government of India in the Ministry of Agriculture. Shri Sundaram has also held the position of Managing Director of Haryana Breweries Ltd. He was on the Board of Directors of 17 companies representing the Government of Haryana, and was the Director of Training & Employment in Haryana. Shri Sundaram was the Joint Secretary (Finance) to Government of Haryana when he was appointed as Chairman, Cardamom Board, in January 1976. He has also held additional charge of the post of the Chairman of the Marine Products Export Development Authority at Cochin for about a year in 1977-78. Shri Sundaram who is also a Chartered Accountant is interested in Management studies as well.

RRII 118 - A vigorous Indian rubber clone which matures in 6 years

RRII-118 is a high yielding rubber clone evolved at the Rubber Research Institute of India by a cross between the Sri Lanka variteies Millakande 3/2 and Hilcroft 28. This hybrid strain which has exhibited unusually vigorous growth in the early years was released for experimental planting since 1969. One such trial planting done in 1972 in 9 acres using this new variety at the Malankara Rubber Estate near Thodupuzha in Kerala has come into bearing in the 6th year as against the normal gestation period of 7 years. At a time when exhaustive probes are being made to reduce the immaturity period of rubber trees the fact that RRII-118 matured for tapping in 6 years under normal conditions, is considered to be a very significant stride. This is attributed to the inherent ability of this clone to grow vigorously. Reports from other regions where this clone has been planted on experimental scale also reveal that it has unusual vitality and vigour of growth. The reduction of immaturity period of rubber by one year at no extra cost and effort is indeed a very desirable change.

Though it is too early to arrive at rigid conclusions on the yielding capacity of this clone, figures collected from experimental plantings during the first four years of tapping work out an average of 5.57 kg per tree per year.

Rubb Board bull. 13, 4; 1976 ; 83—93.

Progress in the Production of Technically Specified Rubber in India

EV Thomas and **K Kochappan Nair**
Rubber Research Institute of India, Kottayam 686 009

Introduction

Production of technically specified solid block rubber started in India only by the year 1974. Two solid block rubber processing units were almost simultaneously commissioned in that year in Meenachil Taluk, one of the most densely rubber cultivated areas in Kerala. Subsequently block rubber production was started by three more units by 1975. One of these units is under a large estate and is using imported machinery for the processing operation. All the other processing units are working on machinery developed indigenously.

Background to Development

India is not a natural rubber exporting country, unlike other South East Asian rubber producing countries. The limited export done in 1974 and 1975 was mainly because of the high growth rate in NR production compared to the growth rate of industrial consumption. Table 1 below shows the NR consumption and production in India for the past ten years.

It may be seen from the table that India was not producing enough natural rubber to meet its internal requirements until 1972–73. Rubber prices were regulated in India in the interest of the producer as well as the consumer. Rationalisation of supplies through imports and exports and fixation of minimum and maximum prices were important instruments of regulation. When conditions of surplus production arose, the consuming industries started showing preference for the top quality rubbers; but a sizable quantity of the rubber produced in 1974–75 period was sold as RSS-4 or as lower grades. Table 2 shows the variation in production of different grades of rubber for the past ten years.

TABLE 1

Year	Total production of Natural Rubber	Total consumption of NR.	Imports of NR.	Exports
		(In Tons)		
1965–66	50,530	63,765	16,357	—
1966–67	54,818	68,685	23,544	—
1967–68	64,458	74,518	9,551	—
1968–69	71,054	86,615	8,548	—
1969–70	81,953	86,213	17,821	—
1970–71	92,171	87,237	2,469	—
1971–72	101,210	96,454	437	—
1972–73	112,364	104,028	380	—
1973–74	125,153	130,302	652	2700
1974–75	130,143	132,604	—	350

TABLE 2

Year	RMA IX & 1	RMA 2 & 3 (in Tons)	RMA 4 & 5	% of RMA 1 (on total consumption)
1965–66	20,352	13,754	7,396	31.92
1966–67	21,680	19,218	7,680	31.56
1967–68	19,621	17,270	14,084	26.33
1968–69	29,413	22,941	9,965	33.96
1969–70	23,729	27,214	9,967	27.52
1970–71	23,226	21,223	16,444	26.62
1971–72	22,527	16,310	29,832	23.36
1972–73	18,399	18,964	33,099	17.69
1973–74	22,835	24,453	47,843	17.52
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It may be seen from the table that the percentage production of RMA-1 or the top quality sheet rubber was steadily declining although the total production was nearly doubled in ten years. The quantity of RMA-1 & IX produced in 1974-75 was more or less the same as that produced in 1964-65. This would incline one to think that the grading of the visaully classified rubbers was not done in an objective manner and the system provided ample opportunity for marketing malpractices. So the Rubber Board, the organisation established to promote by all means the development of rubber industry in India, decided to encourage production of technically specified rubber using modern processing methods. For the development of machinery required in modern processing a pilot research project was also started under the Board. By 1973 suitable indigenous sources were located for the supply of machinery required in a modern solid block rubber processing plant. Initially there were several problems for the units started on indigenous machinery and in no case the designed capacity was attained. But most of the difficulties were overcome in about a year and some of the units are now working very near to their designed output.

Production of specified rubbers in India

Details of different processing units producing technically specified rubber in India are given in Table 3.

It may be seen from the table that all the factories are designed on low output when compared to the technically specified rubber factories in Malaysia, where the output of units vary from 6 tons to 24 tons per day. The production of TSR in relation to the conventional grades is shown in the following histogram (Fig. 1).

It may be seen from the histogram that the production of technically specified rubber in India has recorded a satisfactory growth rate in the first two years. In the first year itself three units could produce about 670 tons. At the developing stage in Malaysia thirty registered producers gave an output of only 707 tons (W. P. Chang et al—IRC 1975 Kuala Lumpur). A number of new units have also now come forward to join the group of TSR producers. Details of location of the TSR producing units already established and proposed to be established are shown in Fig. 2.

Short account of Processing and Machinery

Most of the processing units established in India are working on the mechanical crumbling process, using the combined action of macerators, crepers and hammer mill. In certain cases vegetable oils also were used to improve the efficiency of crumbling. In general, crumbling of scrap and latex grades were found possible without oil. The imported machinery installed at M/s. Travancore Rubber & Tea Company (Table 3) makes use of the extruders for size reduction. The output of extruders were very low and found not to match with the output of the dryer.

In general macerators and crepers were made of cast iron and the slow speed rollers were mounted on bush bearings. Roller special bearings were used for the high r. p. m. rollers. In one factory, they have used chilled cast iron rollers, for the macerators and crepers and have found the slippage action very much on the rolls, resulting in reduced output. Similar results were observed by RRIC (Quarterly Jl. of RRIC 50, 144, 1973) also.

Most of the hammer mills installed make use of 50 H. P. motor. The r. p. m. of the mill in most cases is around 2000. The specifications of the crumbling machinery published by Sethu et al (Proceedings of RRIM Planters' Conf. 1972 p 181) had been taken as guidline by most of the producers.

Most of the processing units are using furnace or light diesel oil as fuel for the dryer. In one of the units, which is the biggest at present, drying is exclusively done by electrical energy. Since India is an oil deficient country, the mineral based fuel is becoming costlier year by year. Electricity is at present cheaper and many of the new units are trying to acquire dryers based on it. The dryer designed and developed for the pilot crumb rubber research project of the Rubber Board also is based on electrical energy. A peculiarity of this dryer is that the blower of this dryer mounted vertically above the drying chamber. (Figures 3 and 4).

Only three units are at present processing latex rubbers, one under the cooperative sector and the other two by big estates. In the co-operative processing factory, latex is collected through depots and coagulated in the depot itself. This is transferred to factory in the form of coagula either on the same day or early on the next day. In the estate factories, latex coagulated on the previous day is subjected to crumbling operation. In general colour specific grades were not produced in any of the units, as there is no specific demand for these grades.

For the scrap and coagulam grades, one to two days soaking is given in suitable tanks prior to milling. In some forms of scrap rubbers the extent of oxidised portion was large and so it was difficult to obtain processed rubbers of acceptable PRI. So in such cases blending with rejected smoked sheets (80:20 scrap to sheet) or chemical treatment or even both are practised. In scrap processing two step hammer milling is given to improve blending and dirt removal. Some buyers insist that 80:20 scrap to sheet blending may be

TABLE 3

Sl. No.	Name of the processing unit	Nature of the unit	Designed output tons/day 3 shift	Month & year of commissioning	Output attained by June 1976 in tons/day 3 shift	Type of processing machinery	Remarks
1.	Hevea crumb.	Private ownership. Mainly processing scrap grades.	10	January 1974	7	Indigenous mechanical crumbling using hammer mill.	Regular commercial production started.
2.	Rubber-O-Dynat.	Do.	5	September 1975	5	Do.	Regular production now in progress. Produces as per the requirement of one consumer.
3.	Palai Marketing Society.	Owned by co-operative society. Processing latex and scrap.	5	March 1974	3	Do.	Regular production of A & B grades.
4.	Travancore Rubber & Tea Company	Owned by large estate (Pvt.). Processing latex and scrap.	10	July 1974	5	Imported machinery. Extrusion device for size reduction.	Regular production of A & B grades.
5.	Plantation Corporation of Kerala Ltd.	Do. (Government estate)	10	August 1975	3	Mechanical crumbling using hammer mill.	Do.
6.	Mambad Rubber Mfg. Company.	Private ownership. Processing scrap.	10	March 1976	3	Do. Batch dryer is used.	Regular production yet to start.
7.	Rubber Board Pilot Research Project.	Research unit of the Rubber Board.	5	January 1976	3	Do. Tunnel type continuous dryer.	Research Unit. No commercial production.

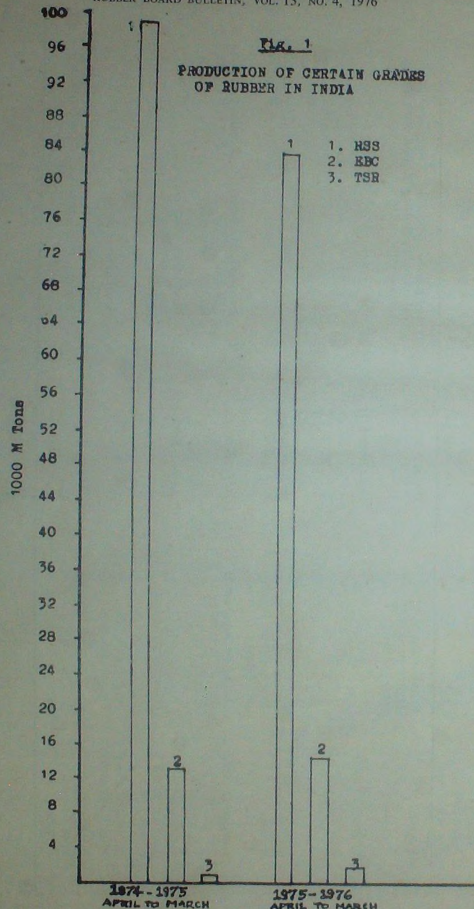

Fig. 1
PRODUCTION OF CERTAIN GRADES OF RUBBER IN INDIA

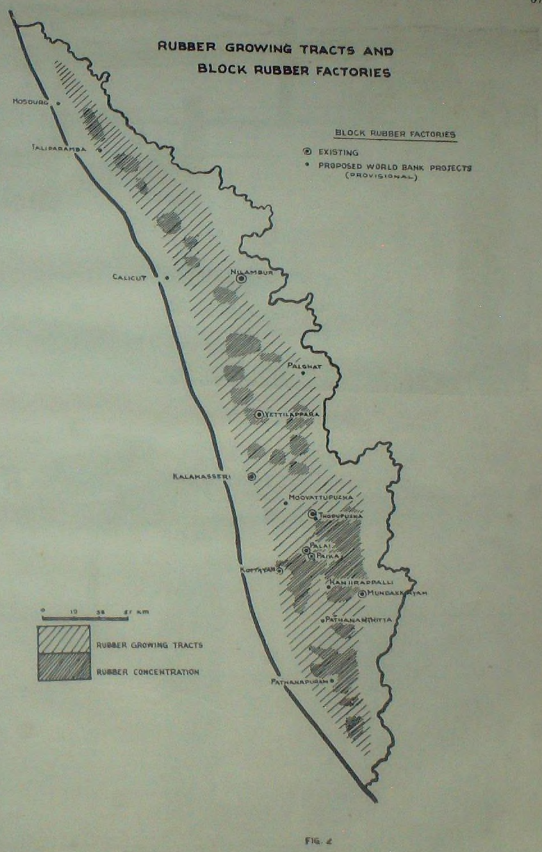
RUBBER GROWING TRACTS AND
BLOCK RUBBER FACTORIES
BLOCK RUBBER FACTORIES
EXISTING
PROPOSED WORLD BANK PROJECTS
(PROVISIONAL)
HOSDURG
TALIPARAMBA
CALICUT
NILAMBUR
PALGHAT
VETTILAPPARA
KALAMASSERI
MOOVATTUPUZHA
THODUPUZHA
PALAI
PAIKA
KOTTAYAM
KANJIRAPPALLI
MUNDAKKAYAM
PATHANAMTHITTA
PATHANAPURAM
RUBBER GROWING TRACTS
RUBBER CONCENTRATION

FIG. 2

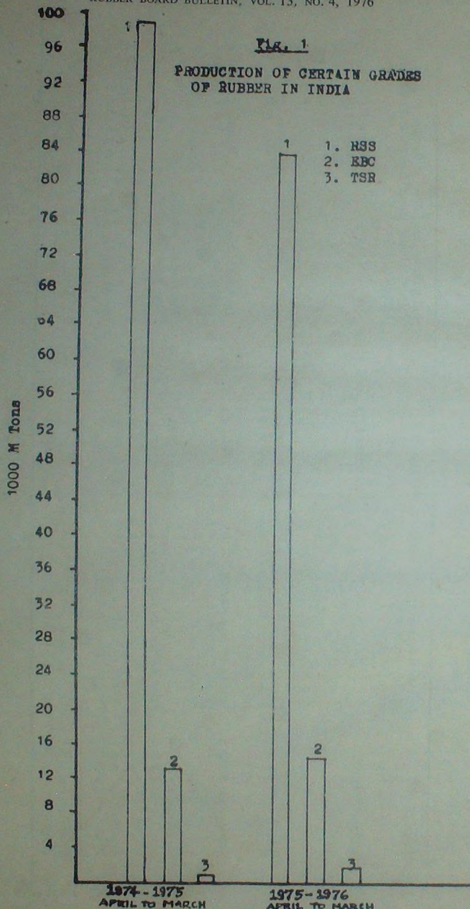
Fig. 1
PRODUCTION OF CERTAIN GRADES OF RUBBER IN INDIA
1. RSS
2. EBC
3. TSR
1000 M Tons
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
1974 - 1975
APRIL TO MARCH
1975 - 1976
APRIL TO MARCH

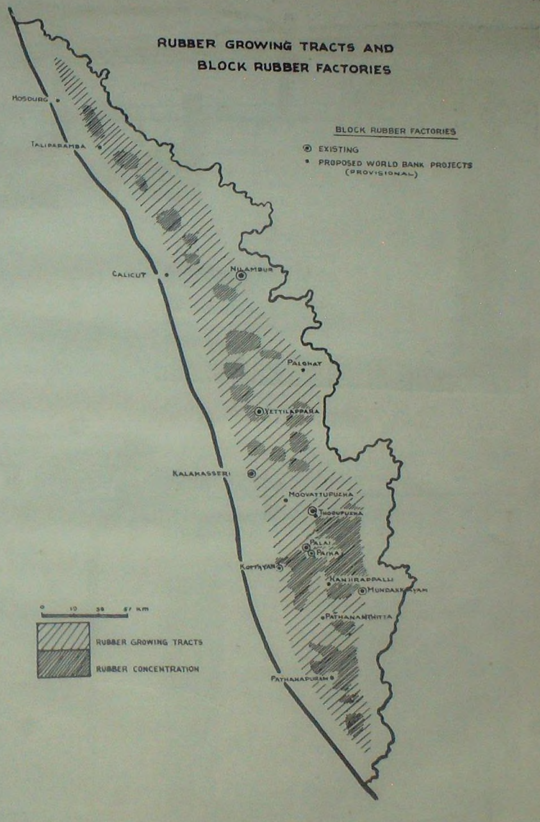
RUBBER GROWING TRACTS AND
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FIG. 2

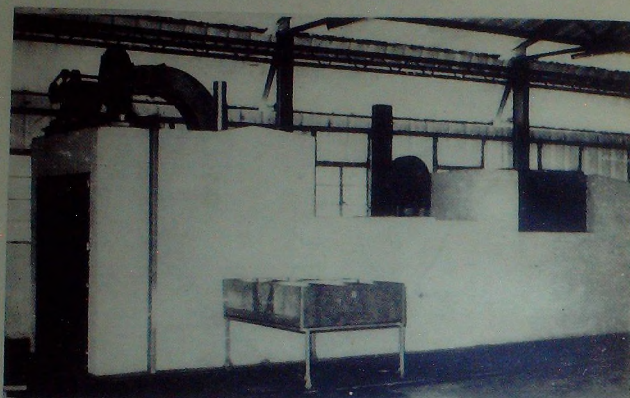

Fig. 3

Fig. 4

adopted in processing for obtaining desirable properties for the final product.

Most of the factories are not using mechanised movement of goods, as labour is comparatively cheap in the state. The dimensions of the block produced in the various units were almost the same viz. 28″×14″×5″ and the weight of the block was 25kg. Palletisation also is not practised by the units at present as all the specified rubbers produced is consumed in the country itself. Further, in many of the transhipment points and ware-houses forklift trucks are not available at present. The block of standard weight is packed in polythene sheets which are compatible with natural rubber and two blocks are put in a high density polythene woven bag and tightly stitched. Movement of rubber to consuming factories is mostly by lorry. Packaging cost in pallets and details of loading charges now prevalent are given in table below.

TABLE 4

Packing cost/Ton using HDP	Packing cost/Ton when palletised	Loading (9 Tons) charge per Lorry
Rs.	Rs.	Rs.
120	250	27

It may be seen from the table that use of pallets and fork lifts are not economically advantageous under Indian conditions. In one lorry load itself use of pallets might necessitate extra expenditure of Rupees one thousand and two hundred.

Specifications and Controls

Indian Standards Institution has formulated specifications for natural rubber as early as 1968. The function of ISI is to formulate specifications for all commodities and to grant licence to interested agencies to market their product as per ISI standards. ISI makes no compulsion in adoption of its standards by the producers. So until 1974 Indian natural rubber producers have not taken any serious step in marketing their product as per the standards. Further administration of technical specification scheme on conventional RSS sheets or EBC grades was difficult and cumbersome owing to problems of variability. The specifications adopted by the Indian Standards Institution in 1968 were almost similar to the original SMR specifications (Plrs' Bull. No. 78, 1965). Variation is observed only in ash and manganese content limits. The problems in metal content estimation also is a factor responsible for the delay in the implementation of the standards. The Indian Standards Institution have recently modified the specifications and the present accepted specifications are given in table 5.

TABLE 5

	A1	A2	B	C
Dirt (% by wt.)	0.05	0.05	0.2	0.5
Ash ,,	0.6	0.6	1.0	1.5
Volatile matter ,,	1.0	1.0	1.0	1.0
Nitrogen ,,	0.7	0.7	0.7	0.7
PRI Min.	80	60	40	30
Initial plasticity Min.	30	30	30	30

Grade A1 is provided in the standard on the basis of the special representation made by the largest tyre producing company in the country. Even in the modified standards colour limit, mooney viscosity, acetone extract or curing characteristics are not included.

Although Indian Standards Institution is the supreme agency in the country on all matters concerning specifications and standardisation of commodities, it is not preventing any other agency in taking steps to improve quality. Rubber Board, under which the Rubber Research Institute of India functions, has enough legal powers to ensure production and marketing of natural rubber as per the standards prescribed by any national or international agency. So by 1974, the Board in consultation with the Indian Standards Institution made certain legal provisions thereby making it obligatory on the part of all solid block rubber producers (TSR producers) to market their product in accordance with the standards prescribed by ISI from time to time.

The block rubber factories started in the country were given licence only on condition that they will ensure production of materials of prescribed quality. If violation is observed at any instance, the Board can withdraw the licence granted, thereby compelling the party to stop production.

Indian Standards Institution will permit an agency to use their registered mark on a commodity only if they acquire a licence from them. For this, producers will have to establish their own testing facilities and should agree to the statistical quality control methods suggested by ISI or their authorised representatives. They also will have to pay the prescribed marking fee to ISI for the entire quantity of specified rubber sold out.

ISI, in turn, takes all possible steps to ensure that the products marketed under their label confirm to the prescribed standards. Procedures like periodic inspection and collection of samples from processing units, collection of samples from various transhipment points and warehouses are some of the steps adopted by them for this purpose. The samples collected by ISI will be analysed in independent testing laboratories. Rubber Research Institute provides all assistance

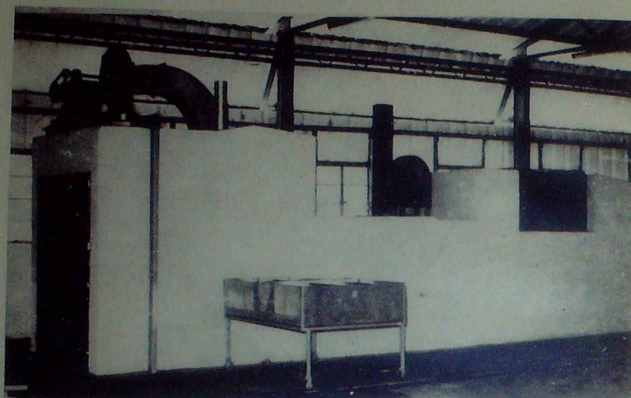

Fig. 3

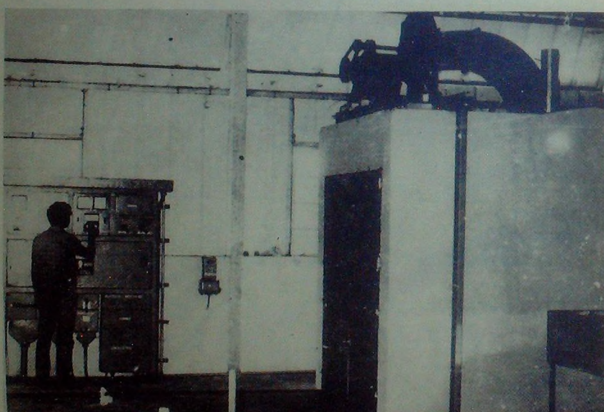

Fig. 4

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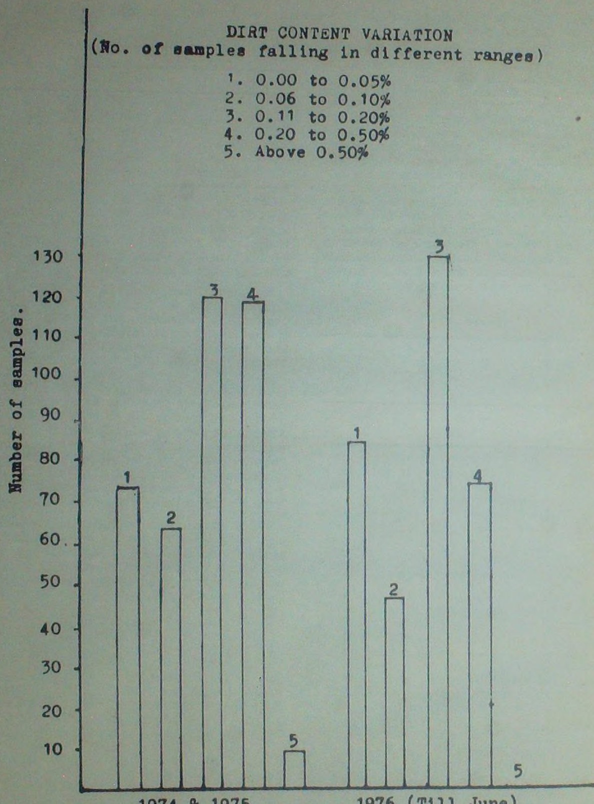
DIRT CONTENT VARIATION
(No. of samples falling in different ranges)
1. 0.00 to 0.05%
2. 0.06 to 0.10%
3. 0.11 to 0.20%
4. 0.20 to 0.50%
5. Above 0.50%
Number of samples.
130
120
110
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
1
2
3
4
5
1974 & 1975
1976 (Till June)

Fig. 5

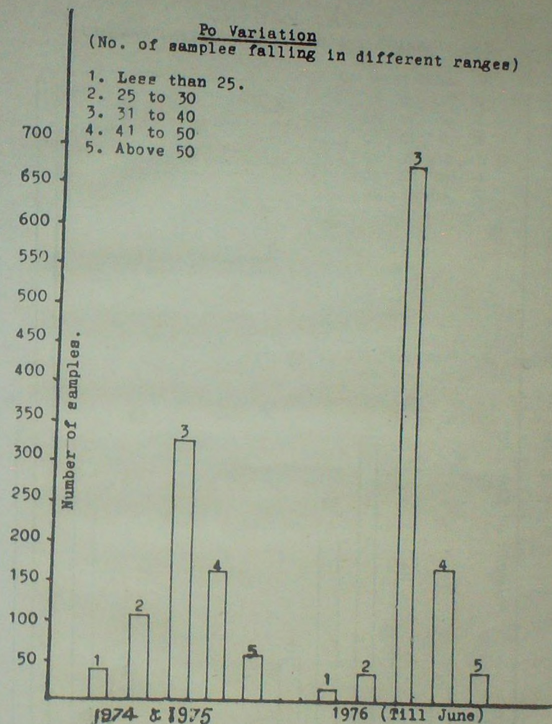
Po Variation
(No. of samplee falling in different rangee)
1. Less than 25.
2. 25 to 30
3. 31 to 40
4. 41 to 50
5. Above 50
Number of samples.
700
650
600
550
500
450
400
350
300
250
200
150
100
50
1
2
3
4
5
1
2
3
4
5
1974 & 1975
1976 (Till June)

Fig. 6

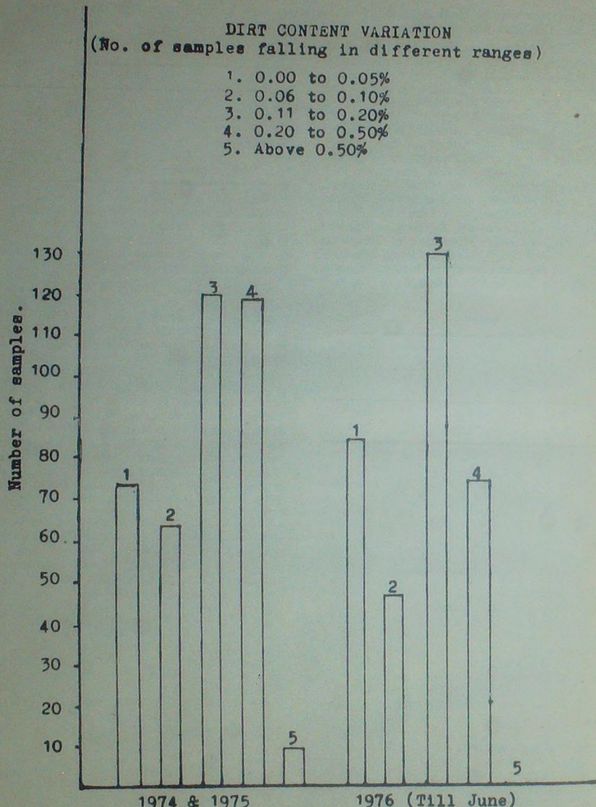
DIRT CONTENT VARIATION
(No. of samples falling in different ranges)
1. 0.00 to 0.05%
2. 0.06 to 0.10%
3. 0.11 to 0.20%
4. 0.20 to 0.50%
5. Above 0.50%
Number of samples.
130
120
110
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
1
2
3
4
5
1974 & 1975
1976 (Till June)

Fig. 5

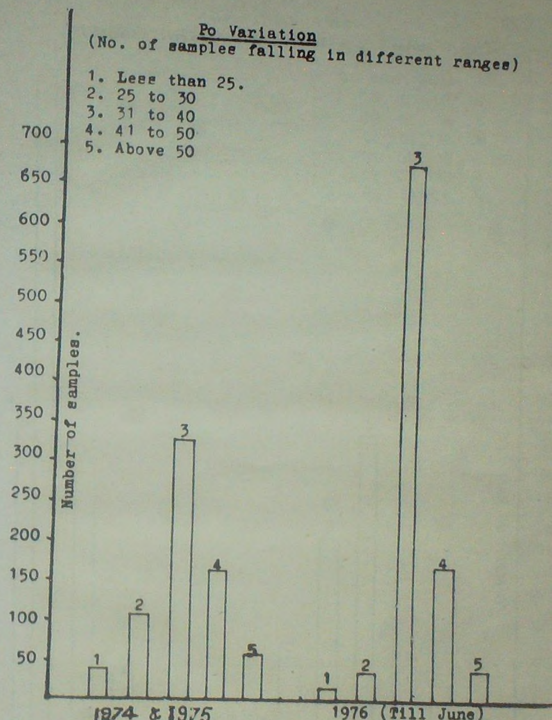
Po Variation
(No. of samples falling in different ranges)
1. Less than 25.
2. 25 to 30
3. 31 to 40
4. 41 to 50
5. Above 50
700
650
600
550
500
450
400
350
300
250
200
150
100
50
Number of samples.
1
2
3
4
5
1974 & 1975
1976 (Till June)

Fig. 6

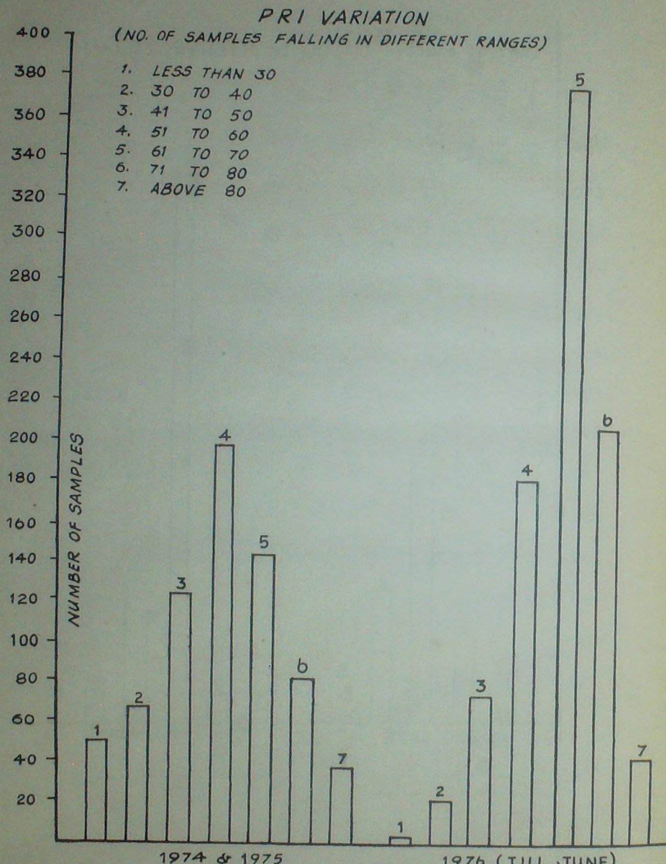
PRI VARIATION
(NO. OF SAMPLES FALLING IN DIFFERENT RANGES)
1. LESS THAN 30
2. 30 TO 40
3. 41 TO 50
4. 51 TO 60
5. 61 TO 70
6. 71 TO 80
7. ABOVE 80
NUMBER OF SAMPLES
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
1
2
3
4
5
6
7
1974 & 1975
1976 (TILL JUNE)

Fig. 7

to ISI in the implementation of the specification scheme for block rubbers. All TSR producers have now taken steps to acquire ISI licence. Preliminary inspection of all the units have already been completed. ISI licence will soon be granted to some of the major producers.

At present block rubber producers send samples to the Rubber Research Institute's laboratory from their daily production and utilise analytical report of the Institute for classifying their produce. Often the consumers will bargain with the producers on certain specific quality requirements and will suggest certain producers for improvement.

Typical results of analysis of dirt, Po and PRI for the samples received at the Institute during 1974 and 1975 are given in Figures 5, 6 & 7.

It may be seen from the details that there is steady improvement in the quality of block rubber as the producers gained experience in the process.

Future prospects

Block rubber producers initially had numerous difficulties in selling their product. Small manufacturers expressed the fear that the blocks will increase the load on their mills and cause rupture of the roll housing. Big Manufacturers raised objections like wet patches in the blocks, low PRI and inferior physical properties. On a detailed examination it was observed that many of the complaints were not of a serious nature. One consumer complained that removal of the polythene sheets is costing him much labour and so he cannot use block rubber. But it was shown to him that this sheet is easily compatible with rubber. Now there is practically no difficulty in selling block rubbers. The low dirt content and high degree of dryness of this commodity are always approved by the consumers. Within a short period of two years the limited number of producing units could impress upon the manufacturers the superiority of technically specified rubbers.

Rubber Board has programmes to establish ten block rubber factories under co-operative societies in different rubber growing tracts. In addition some large estates have also taken steps in the production of specified rubbers. It is expected that by 1980 at least 20 per cent of the total rubber produced will be in technically specified solid block form.

Rubb Board bull. 13, 4; 1976 ; 94—98.

Studies on Natural Rubber/Emulsion Polybutadiene Blends Prepared from Mixture of Latices

NM Mathew and **EV Thomas,**
Rubber Research Institute of India, Kottayam 686 009

Natural rubber has been widely used in tyres since the beginning of the industry. Its use is based on the excellent properties like good tack in the unvulcanised state and high elongation, tensile strength, tear resistance, abrasion resistance and low hysteresis in the vulcanised state. The growth of rubber industry after the second world war was so enormous that the natural rubber produced became inadequate to meet the demand of the consuming industry. In 1975, total world consumption of elastomers was 10.4 million tons, out of which the contribution of natural rubber was only 3.4 million tons (10). So even in areas like tyre manufacture, where natural rubber is the desirable polymer, it became necessary to use blends of natural rubber with various synthetic rubbers in order to reduce its volume requirement.

Blends of polybutadiene with natural rubber was found to be an ideal combination in the production of certain component parts of the tyres. It has been reported by Glanville (3) that blending of natural rubber with polybutadiene, improves heat stability at high curing temperatures. Grimberg (4) has reported that addition of cis polybutadiene to natural rubber decreases tensile strength and modulus and improves abrasion resistance and elasticity. In earlier studies blending of these polymers was done in dry stage by mechanical working. Since the coagulation of mixture of latices may be a random process, entirely dependant upon concentration of stabilisers (soaps in most cases) latex blending offers the possibility of finer dispersion than solution blending or mechanical mixing.

The present study is taken up in this context to investigate the properties of natural rubber/emulsion polybutadiene blends prepared by coprecipitating these rubbers from mixtures of their latices. The raw rubber properties are also investigated as the blend obtained is a new raw elastomer from commercial view point.

Materials and Methods

Emulsion polybutadiene rubber latex (EBR) required for this study was supplied by M/s. Synthetics & Chemicals, Bombay. The latex was supplied as a 20% solid emulsion polybutadiene. Natural rubber (NR) latex required for the study was collected from the experiment station of the Rubber Research Institute of India. Mixing of latices was done in coagulation tanks by simple addition and hand stirring and coagulation was brought about by addition of acetic acid at the rate of 5 ml per kg of dry rubber content. Coagulation was complete in about 3 hours and there was practically no loss of rubber in the serum. The wet coagulum was then processed as solid block rubber in the pilot crumb rubber factory of the Rubber Research Institute of India.

Blends of three different compositions of natural rubber/emulsion polybutadiene, viz. 90/10, 80/20 and 70/30 and control NR were prepared from the same batch of latices. Natural rubber and viscosity stabilised form of natural rubber (4) were prepared from another batch of field latex for comparative evaluation.

The blends and control samples were examined for their raw rubber properties like Mooney viscosity, Wallace plasticity, Plasticity retention index, Acetone extract (5–7) and Accelerated storage hardening (11). The various blends and control samples were then compounded in standard procedure (Loccit) in a two roll mill in ACSI formulation and in the following tyre tread recipe.

Polymer	100	HAF black	50
ZnO	5	Aromatic oil	5
Stearic acid	2	CBS	0.6
PBN	1	Sulphur	2.5
Santoflex IP	1		

Processing properties like mill shrinkage (2) time for band formation and for complete mixing were also noted. The compounded samples were evaluated for assessment of their scorch (8) optimum cure and reversion resistance (12). The samples were then cured and various physical and dynamic properties were determined (9).

Results and Discussion

Table I gives the raw rubber properties of the blends and control samples. It may be seen from the table that there is progressive reduction in Mooney viscosity and Wallace plasticity in the blends with increase in concentration of EBR. But plasticity retention index (PRI) is found to decrease with increase in the EBR content. The inferior aging properties of the raw blends, as evidenced by the low PRI values, may be due to the lack of antioxidants in the EBR latex. Further there was some iron contamination in the EBR latex and its pro-oxidant action also might have contributed to the higher raw rubber oxidation. The most interesting observation was the prevention of storage hardening in the blends when compared to the control NR. A comparative study of the blend with conventional CV rubber was separately undertaken because of the viscosity stabilisation properties observed in the blends. In this study only the 90/10 NR/EBR blend was used and while preparing it steps were taken to minimise the pro-oxidant action of iron by complexing it with EDTA. The raw rubber properties of the blend and the controls prepared for evaluation of viscosity stabilisation properties are given in Table II. The 90/10 NR/EBR blend gave a higher PRI value. The increase in Wallace plasticity after accelerated storage hardening in the case of the 90/10 blend was only six units, while it was 19 units for the control NR. Here it may be pointed out that the criterion for viscosity stabilisation is that the increase in plasticity ($\triangle P$) should not exceed 8 units (Loccit).

Tables III and IV give the processing and cure properties of the blends and the control in ACSI and tread compounds. The processing and cure properties of the 90/10 NR/EBR blend and conventional CV rubber are compared with those of control NR in Table V and VI. The results in these tables indicate that the blends take less time for band formation and for complete mixing.

Mill shrinkage is found to increase with increase in the concentration of EBR and is found to be more pronounced in the gum compounds. The scorch and cure properties are generally comparable. The blends, in general, show better reversion resistance than NR compounds. This observation is in agreement with that of Glanville (Loccit).

The physical and dynamic properties of the blends are shown in Tables VII and VIII. In Table IX the physical properties of the 90/10 NR/EBR blend and conventional CV rubber are compared with those of NR. It may be seen from these tables that the abrasion resistance of the vulcanisates derived from the blends increases with increase in the concentration of EBR. Tear strength and compression set of the blends are found to be better when compared with NR. Resilience and hardness are found comparable. Tensile strength of the blends, in general, are found to be slightly lower than that of NR. Grimberg (Loccit) has also made a similar observation. The dynamic properties of the blends also are found to be superior to those of NR. From an assessment of the various physical properties of the 90/10 NR/EBR blend and that of the viscosity stabilised NR it is possible to say that the blending of polybutadiene in latex stage with natural rubber provides viscosity stabilisation properties to the blend along with its other advantages.

Summary and Conclusions

Blends of NR/EBR can easily be prepared by co-precipitation from mixtures of their latices. The raw blends show lower viscosity than natural rubber and better resistance to storage hardening tendencies. The compounds of the blends show better reversion resistance and the vulcanisates have higher abrasion resistance. The tensile properties of the blends are slightly lower than those of natural rubber.

Acknowledgement

The authors are grateful to Dr. C. K. N. Nair, Director, RRII for his keen interest in this work. The EBR latex required for this study was supplied by M/s. Synthetics & Chemicals, Bombay and we would like to thank them for their special interest in this work. Thanks are also due to our colleagues in the Chemistry Division for their generous assistance in the completion of this work. The dynamic properties reported in this paper were determined at the IIT, Kharagpur and the assistance provided in this respect is gratefully acknowledged.

TABLE I

Raw rubber properties of the blends and NR

Property	NR	90:10 NR:EBR	80:20 NR:EBR	70:30 NR:EBR
Mooney viscosity ML (1+4) 100°C	94	83	67	55
Wallace plasticity Po	65	48	36	28
Plasticity retention index	74	73	55	48
Accelerated storage hardening test $\triangle P$	10	2	0	0
Acetone extract %	2.78	3.13	3.77	4.24

TABLE II

Raw rubber properties of the 90/10 blend, CV rubber & natural rubber

Property	NR	CV	90:10 NR:EBR
Mooney viscosity ML (1 + 4) 100°C	86	75	78
Wallace plasticity Po	60	47	51
Plasticity retention index	72	74	80
Accelerated storage hardening test △P	19	1	6

TABLE III

Processing and cure properties of the blends & NR–ACSI compounds
Temperature of mixing 50°C

Property	NR	90:10 NR:EBR	80:20 NR:EBR	70:30 NR:EBR
Time for band formation. min.	6	4	3	3
Time for complete mixing. min.	22	20	18	17
Mill shrinkage %	39	52	64	68
Mooney scorch at 121°C. min.	16	14	14	15
Optimum cure at 150°C. min.	20	20	23	24
Time for 2% reversion at 160°C. min.	50	52	53	56

TABLE IV

Processing and cure properties of the blends & NR—Tread compound
Temperature of mixing 70°C.

Property	NR	90:10 NR:EBR	80:20 NR:EBR	70:30 NR:EBR
TIme for band formation. min.	5	4	3	3
Time for complete mixing. min.	35	33	31	30
Mill shrinkage %	28	31	36	43
Mooney scorch at 121°C. min.	14	14	15	15
Optimum cure at 150°C. min.	17	22	25	29
Time for 2% reversion at 160°C. min.	25	28	35	47

TABLE V

Processing and cure properties of the 90:10 blend, CV rubber and NR/ACSI compound
Temperature of mixing 50°C.

Property	NR	CV	90:10 NR:EBR
Time for band formation. min.	6	4	4
Time for complete mixing. min.	18	18	17
Mill shrinkage %	48	46	60
Mooney scorch at 121°C. min.	12	15	12
Optimum cure at 150°C. min.	20	20	20
Time for 2% reversion at 160°C. min.	52	50	54

TABLE VI

Processing and cure properties of the 90:10 blend, CV rubber and NR/Tread compounds
Temperature of mixing 70°C.

Property	NR	CV	90:10 NR:EBR
Time for band formation. Min.	5	4	4
Time for complete mixing. min.	33	30	32
Mill shrinkage %	31	31	34
Mooney scorch at 121°C. min.	15	15	15
Optimum cure at 150°C. min.	17	17	18
Time for 2% reversion at 160°C. min	23	23	28

TABLE VII

Physical properties of the blends and NR—Tread compounds

Property		NR	90:10 NR:EBR	80:20 NR:EBR	70:30 NR:EBR
Modulus 300% kg/cm²	BA	154.1	152.3	143.7	127.4
	AA	174.1	166.7	—	—
	% retention	112.9	109.5	—	—
Tensile strength kg/cm²	BA	289.4	277.0	218.8	183.8
	AA	228.3	186.7	172.7	170.2
	% retention	78.9	67.4	78.9	92.6
Elongation at break %	BA	465	450	417	393
	AA	380	325	290	270
	% retention	81.7	72.2	69.6	68.7
Specific gravity		1.145	1.149	1.146	1.142
Abrasion loss cc/hr		0.7841	0.4573	0.3996	0.3185
Resilience %		59	57.4	53.9	53
Hardness shore A		58	58	59	59
Compression set %		29.5	24.3	22.3	25.0
Tear Strength lbs/in.		456	476	470	480

BA—Before aging. AA—After aging at 70 ± 1°C. for 96 hours.

TABLE VIII

Dynamic properties of the blends and NR—Tread compound

Property	NR	90:10 NR:EBR	80:20 NR:EBR	70:30 NR:EBR
Heat build up at 20th minute °C Initial temp. 50°C. Load 10.9 kg Stroke 4.45 mm.	31	29	26	25.5
Permenent set %	13.7	8.1	7.5	6.3
Flex cracking k/c	470	850	700	960

TABLE IX

Physical properties of the 90/10 blend, CV rubber and natural rubber Tread compound

Property		NR	CV	90:10 NR:EBR
Modulus 300% kg/cm²	BA	132.9	128.5	123.8
	AA	181.5	176.0	174.4
	% retention	136.6	137.0	140.9
Tensile strength kg/cm²	BA	255.6	259.9	219.8
	AA	263.0	260.8	195.5
	% retention	102.9	100.3	88.9
Elongation at break %	BA	476	485	462
	AA	407	416	333
	% retention	85.5	85.8	72.1
Specific gravity		1.137	1.137	1.138
Abrasion loss cc/hr		0.7303	0.7153	0.4294
Hardness shore A		58	58	59
Resilience %		52	53	53.9
Compression set %		29.7	30.3	27.1
Tear strength lbs/in.		483	475	494

BA—Before aging. AA—After aging at 70 ± 1°C. for 96 hours.

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Rubb Board bull. 13, 3 ; 1976 ; 99—106.

Branch Induction of Young Trees*

The benefit of increasing the leaf area by inducing extra branches for better tree growth has been emphasised in recent years. Many methods are available to induce the tree to branch, but none except the method using the double-blade ring-cut device is satisfactory for commercial application. The use of the double-blade ring-cut device for branch induction has been described in the *Planters' Bulletin No. 130*. Unfortunately the use of this device is limited to green brown or brown tissues and is not satisfactory on green tissues. Optimum benefit from branch induction would be obtained if the trees were induced to branch as early as possible. As such a need arises for a method suitable for younger tissues. Experiments were conducted to investigate more branch induction methods. The results of this investigation are documented in the booklet, 'Some branch induction methods for young buddings'. This article summarises two methods, the leaf folding and leaf cap, which were found suitable on young trees.

The Tree

The tree should be 2 to 2.4 m high to ensure that the induce branches arise at a suitable height although the methods are applicable for taller or shorter trees. The terminal whorl of leaves on the tree can be at any stages of maturity. The stages of maturity of the terminal whorl of leaves are arbitrarily classified as follows:

1. Hardened stage (*Plate 1a*). The leaves of the terminal whorl have fully expanded and hardened.
2. Pendant stage (*Plate 1b*). The leaves of the terminal whorl are nearly or completely expanded and green but still limp.
3. Leaflet stage (*Plate 1c*). The leaves of the terminal whorl are stilling and expanding and are copper to reddish in colour.
4. Budbreak stage (*Plate 1d*). The bud has emerged. The stage can be further subdivided into two, depending on the length of the bud.

   (i) budbreak (buds less than 2 cm) stage

   (ii) budbreak (buds greater than 2 cm) stage

The Methods

The choice of which method to use depends on the maturity of the terminal whorl of leaves on the tree at the time of induction.

1. Leaf folding method (*Plate 2*). This method is for trees with terminal whorl of leaves at either hardened, pendant, or budbreak (bud less than 2 cm) stage. In this method the top whorl of leaves are folded down utilising only the upper few leaves to enclose the apical bud. The leaves are tied with a piece of rubber band going round once or twice. After three to four weeks, the leaves are released by removing the rubber band if it has not already self broken by that time.
2. Leaf cap method (*Plate 3*). This method is for trees with terminal whorl of leaves at either leaflet or budbreak (buds greater than 2 cm) stage. Three matured leaflets are taken to form a cap to enclose the apical bud. The cap of leaflets is tied with a rubber band going round once or twice. If three leaflets are not enough to enclose the bud, more leaflets can be used. The cap is removed three to four weeks later.

Branching

The results of these methods on branch induction success are summarised in *Table 1* and illustrated in *Plate 4*. Both the leaf folding and leaf cap methods were effective in promoting branching. Some of the terminal shoots after the treatment may appear sickly or retarded but they will eventually recover under normal growing conditions. Observations on the successful branch induced trees show that in some cases the terminal shoot elongates through the enclosing leaves (*Plate 5*). In other cases the terminal elongation is obstructed by the enclosing leaves resulting in a bent terminal (*Plate 6a* and *b*) or broken terminal (*Plate 6c* and *d*). However, such incidences were very low. The bent terminal will generally straighten on subsequent growth and continue to be the leader. In the case of broken terminal where the tree is without the leader, corrective pruning is required to train an induced branch to become the leader.

* Reproduced from Planters' Bulletin Number 147

Hardened Stage

Pendant Stage

Leaflet Stage

Bud-break Stage

Plate I. Terminal Whorl Stage

Plate 2. Folding method for terminals at hardened, pendant and bud-break (bud less than 2 cm) stages (a, b & c). Leaves are folded down (d) and tied with a rubber band (e, f & g) going round once or twice. For one round, the rubber band is shortened by making a knot at the centre (g).

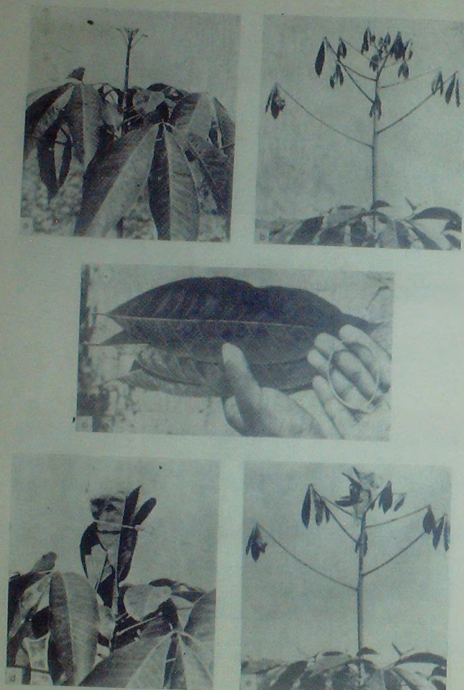

Plate 3. Leaf cap method for terminals at bud-break (bud more than 2 cm) and leaflet stages (a & b). Three matured leaflets (c) are used to form a cup to enclose the apical bud (d & e).

Bud-break 2<cm Bud-break 2<cm Leaflet

Pendant Hardened

Plate 4. Responses of terminals at bud-break (bud less than 2 cm) (a); bud-break (bud more than 2 cm) (b); leaflet (c); pendant (d) and hardened (e) stages to folding and leaf cap methods after 5 weeks.

Plate 5. Successful branch induced trees with terminals growing through the centre of the enclosing leaves (a) and (b) and side of the enclosing leaves (c) and (d)

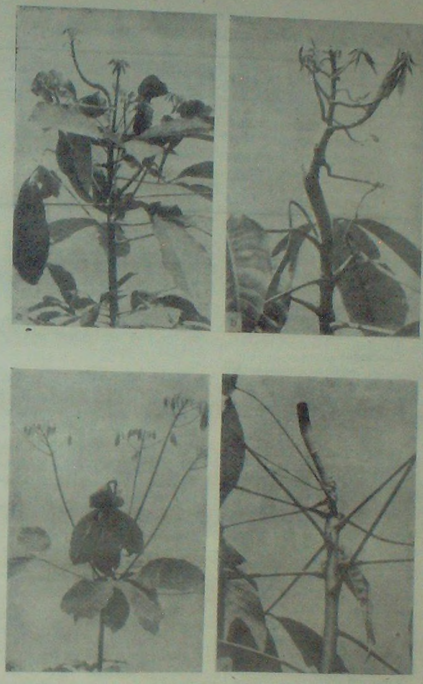

Plate 6. Successful branch induced trees with terminals bent (a) and (b) and broken (c) and (d).

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TABLE 1

*Effects of folding and leaf cap methods on branch induction success (%)**

Treatment	Terminal whorl stage					
	Hardened[a]	Pendant[a]	Budbreak[a] bud < 2 cm	Budbreak[b] bud > 2 cm	Leaflet[b]	Mean
1 round rubber band	62.8	76.0	50.0	50.0	55.0	58.8
2 rounds rubber band	76.5	80.7	68.2	66.7	73.9	73.2
Mean	69.7	78.4	58.1	58.4	64.5	66.0
Control	25.7	22.9	12.5	0	0	12.2

Note:
a Leaf folding method *b Leaf cap method*
* *Observed at five weeks after application*

Post Induction Care

Prophylactic treatments are to be applied during periods when leaf diseases are prevalent to ensure healthy new shoot growth.

Conclusion

Two branch induction methods are available for young trees depending on the maturity of the terminal whorl of leaves as summarised below:

Stages of maturity	*Method of branch induction*
Hardened	Leaf folding
Pendant	Leaf folding
Budbreak (bud less than 2 cm)	Leaf folding
Budbreak (bud greater than 2 cm)	Leaf cap
Leaflet	Leaf cap

One round of branch induction is to be carried out on trees using either the leaf cap or leaf folding method. At three to four weeks later, the cap is removed or the enclosing leaves are released by breaking the rubber band which has not already self-broken.

There will be branch induction failures, which in most cases would be small. However, there may be the rare occasion where the percentage failure may be much higher. In such cases a second round of branch induction can be carried out either on the young trees again or later when the trees become older using the double-blade ring-cut device.

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Studies on the Role of Wind and Insects in the Dissemination of Abnormal Leaf Fall Disease of Rubber in South India

Thomson T Edathil and **PN Radhakrishna Pillai**
Rubber Research Institute of India, Kottayam 686 009, Kerala, India.

Different species of *Phytophthora* are observed to cause many diseases to *Hevea brasiliensis*. Among the various diseases, the abnormal leaf fall disease is the most serious disease of rubber in India. The disease occurs on an epiphytotic scale during the south-west monsoon period. Rain fall is the most important factor influencing the onset of the disease. A study of the meteorological data from different rubber growing tracts in the country revealed that the intensity of rain fall during the months of May to August influenced the severity of the disease. When continuous and heavy rain fall is received the mean minimum temperature will be between 15.6°C to 28.9°C which is very much favourable for sporangial formation of *Phytophthora* and consequent spread of abnormal leaf fall disease. Along with this relative humidity also increases considerably ranging from 80–100%. Studies on over summering of *Phytophthora* have revealed that the oospores contained in the soil and in the infected and dried up plant parts during the previous season play an important role in the development of primary inoculum (1). By the advent of favourable climatic conditions during the subsequent disease season the oospores germinate to produce the nucleus of primary inoculum, which is disseminated by different methods. It is generally believed that wind and insects have major roles in it.

On the dissemination of the disease, different opinions have been reported. Ramakrishnan (5) has reported that aeroscopes exposed at a height of 2.5 metres and about 15 metres away from a mature rubber stand have collected air borne sporangia of *Phytophthora palmivora* (Butl.) in the months of June and July. But Peries (3) has reported that neither a Hirst spore trap operated at regular intervals throughout the disease season, over a period of twelve years, nor grease-coated slides exposed in the diseased areas, have ever trapped *Phytophthora* sporangia. Hence further investigations were carried out continuously for a period of 4 years for re-examining the problem of dissemination of abnormal leaf fall disease of rubber.

Materials and methods

Locally built rectangular box type spore traps, made of galvanized iron, with either end open, of size 16×9×6 cm were used in this study. A vane of 22×9 cm size was attached, vertical to its breadth, at one end. At the other end, 5 cm away from the opening, on the base of the box, there is a slit running all along the width. This slit corresponds with a pair of holders, fitted on either side of the box for holding the slide. There is a slide guard fitting exactly on the floor of the box at the slit area, which can be removed for inserting and taking out the slide. The spore traps were fixed exactly at the centre to freely rotating cycle hubs. These were erected on 2.5 metre long teak poles. With this arrangement the mouth of the spore trap holding the slide will be always directed towards the wind (Figs. 1–3).

Twenty numbers of such spore traps were erected at different places of RRII experiment station from six to hundred and twenty metres away from mature rubber area. Colourless vaseline-coated slides were placed inside the spore traps. The exposed slides were collected and observed regularly at 24 hours interval through out the south-west monsoon period, during the last 4 years.

During the abnormal leaf fall disease season, it was observed that so many insects like cockroach, ants, vinegarflies and beetles visited *Phytophthora* infected fruits in large numbers. Larvae of insects were noticed inside the infected fruits and even inside the seeds. References are available regarding the role of insects in the dissemination of diseases caused by *Phytophthora* in other crops (2, 6).

Live insects, were collected from the RRII experiment station during the disease season. These insects were washed in sterile distilled water. Fresh, disease free, rubber leaves were collected and inoculated, with the body washing of the insects, by placing cotten swabs, dipped in it, on

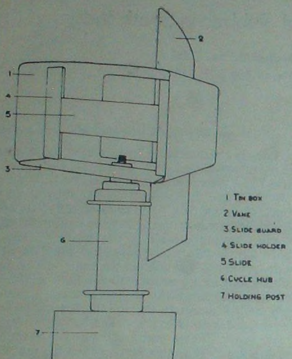


Fig. 1

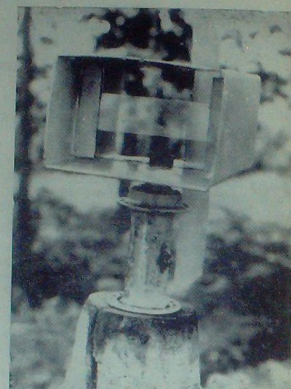


Fig. 2

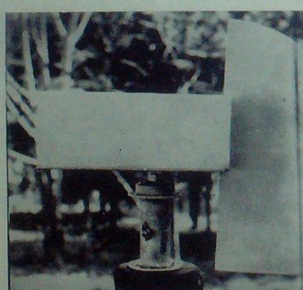
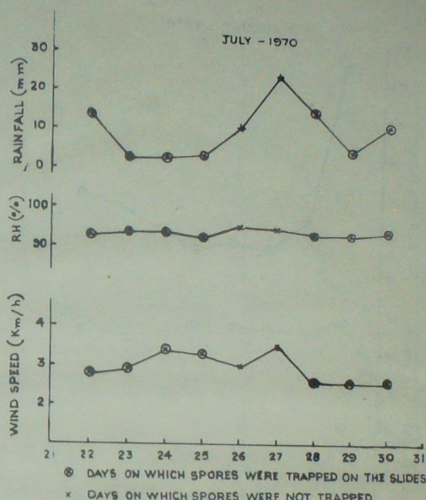


Fig. 3


JULY - 1970
RAINFALL (m m)
30
20
10
0
RH (%)
100
90
WIND SPEED (Km/h)
4
3
2
21
22
23
24
25
26
27
28
29
30
31
⊗ DAYS ON WHICH SPORES WERE TRAPPED ON THE SLIDES
× DAYS ON WHICH SPORES WERE NOT TRAPPED

Fig, 4

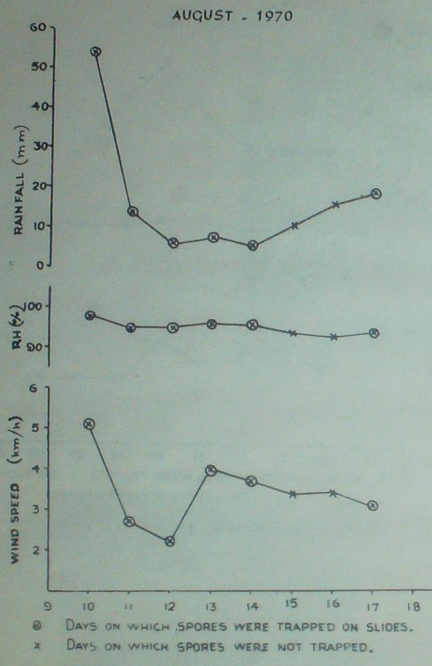

AUGUST - 1970
RAINFALL (mm)
60
50
40
30
20
10
0
RH (%)
100
90
WIND SPEED (km/h)
6
5
4
3
2
9
10
11
12
13
14
15
16
17
18
⊗ DAYS ON WHICH SPORES WERE TRAPPED ON SLIDES.
x DAYS ON WHICH SPORES WERE NOT TRAPPED.

Fig. 5

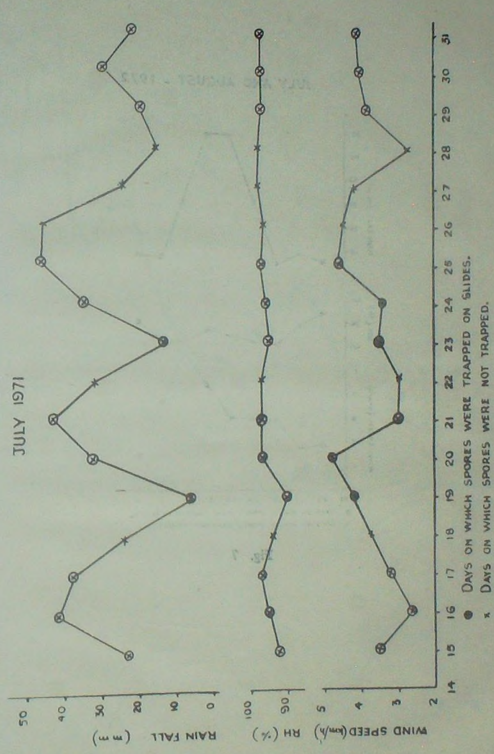

JULY 1971
RAIN FALL (mm)
RH (%)
WIND SPEED (km/h)
0 10 20 30 40 50
90 100
2 3 4 5
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
● DAYS ON WHICH SPORES WERE TRAPPED ON SLIDES.
x DAYS ON WHICH SPORES WERE NOT TRAPPED.

Fig. 6

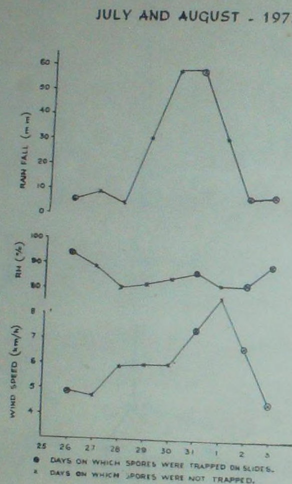
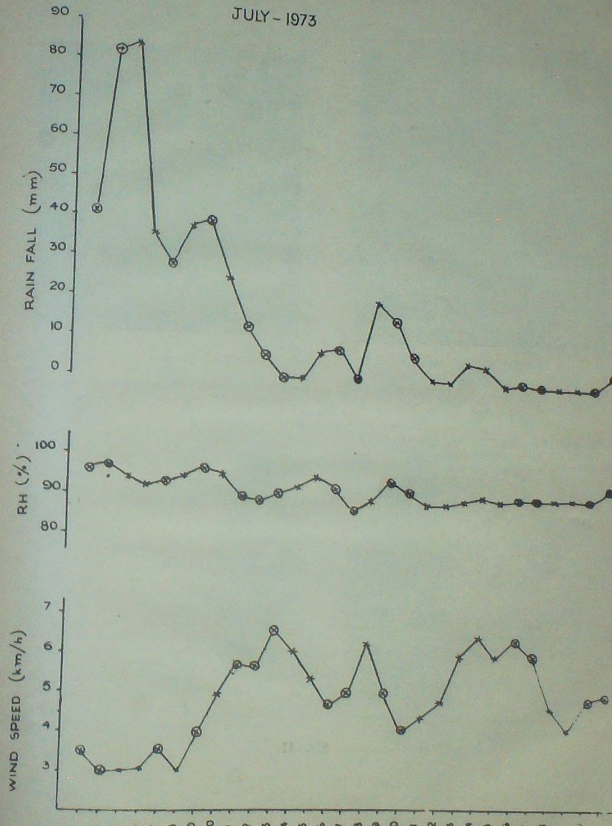

JULY AND AUGUST - 1972
RAIN FALL (mm)
0
10
20
30
40
50
60
RH (%)
80
90
100
WIND SPEED (km/h)
4
5
6
7
8
25 26 27 28 29 30 31 1 2 3
DAYS ON WHICH SPORES WERE TRAPPED ON SLIDES.
DAYS ON WHICH SPORES WERE NOT TRAPPED.

Fig. 7



⊗ DAYS ON WHICH SPORES WERE TRAPPED ON THE SLIDES.

× DAYS ON WHICH SPORES WERE NOT TRAPPED.

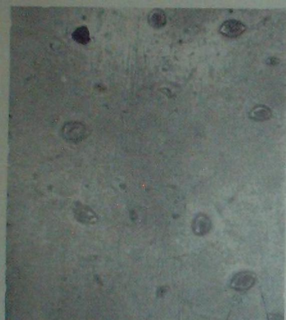


Fig. 9

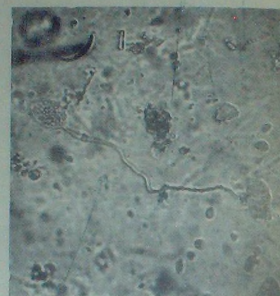


Fig. 10

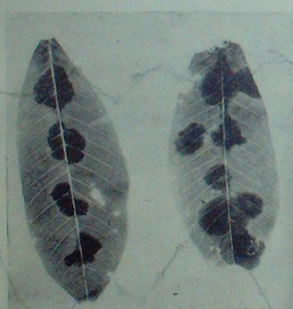


Fig. 11

the lamina. The inoculated leaves were incubated at 20 ± 2°C in a moist chamber for 48 hours. The body washing of the insects was also plated in rubber leaf extract agar and incubated at 20 ± 2°C for 48 hours. Disease free green pods were collected, surface sterilized with 0.1% mercuric chloride for one minute and washed with several changes of sterile distilled water. These pods were kept in a moist chamber along with live insects, collected from infected pods. The pods along with live insects were incubated at 20 ± 2°C for 48 hours.

Results and discussion

Healthy and viable sporangia of *Phytophthora* contained in small water particles were caught on all slides exposed on spore traps irrespective of the distance at which the spore traps were installed from mature rubber area during the disease season (July and August). The rain fall data of the days, when *Phytophthora* sporangia were observed on the slides exposed in spore traps, range from 0.4 to 82.3 mm. The average relative humidity was above 82% and the velocity of the wind was 2.2 to 7.4 km/h (Figs. 4–8).

The slides, with *Phytophthora* sporangia removed from spore traps, were kept in moist chambers and incubated under room temperature. After 24 hours the slides were examined and direct germination of sporangia was noticed (Figs. 9, 10).

Another set of slides, containing sporangia were placed over rubber leaf extract agar for 48 hours and incubated at 20 ± 2°C. *Phytophthora* growth was noticed in the culture plates. When artificial inoculation was carried out with LBA culture of this isolate on RRIM 701 twigs adopting the method described by Pillay and Chee (4), 98% infection was noticed. This isolate was identified as *Phytophthora meadii* (Mc Rae) by the Commonwealth Mycological Institute.

Large number of *Phytophthora* sporangia were observed on the body washing of the insects which were observed to visit rotting pods on the trees in the field during the disease season. *Phytophthora* infection was noticed, on the mid ribs and on the lamina of the leaves inoculated with body washing of the insects after 48 hours (Fig. 11). The infected portions of the leaves were tissue cultured on rubber leaf-extract agar. *Phytophhora meadii* (Mc Rae) was reisolated.

Phytophthora growth has been observed on the plated body washing of the insects after 48 hours. From this also *Phytophthora meadii* (Mc Rae) was reisolated.

Phytophthora infection was observed on the surface sterilized pods, which were incubated with live insects, after 48 hours. *Phytophthora meadii* (Mc Rae) was reisolated from this also by tissue culturing the infected portions of the pods.

Summary

On rainy days healthy and viable sporangia contained in small water particles blown by wind were caught on the slides exposed in spore traps which were placed 6–120 metres away from mature rubber area at different locations of the RRII Experiment station. Insects, which were observed to visit infected fruits were found to carry large number of viable sporangia on their body parts. Such sporangia, contained in water particles blown by wind and carried by insects on their body parts, germinated readily and took infection on leaves and fruits of *Hevea* when artificial inoculation was carried out. Hence dissemination of abnormal leaf fall disease could be clearly possible with the help of these two agencies.

Acknowledgement

The authors are thankful to Dr. C. K. N. Nair, Director, for evincing keen interest in the preparation of this paper.

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Rubb Board bull. 13, 3; 1976; 116—118.

Aerial Spraying Against Abnormal Leaf Fall Disease of Rubber in India*

PN Radhakrishna Pillai

Rubber Research Institute of India, Kottayam 686 009

Abnormal leaf fall disease caused by the fungus *Phytophthora* is the most serious disease of rubber in India. This is an annually recurring disease during the south west monsoon month of June, July and August. The fungus infects the fruits, leaves and small twigs of rubber plants. The reaction of unselected seedling rubber to this disease is observed to be varied and defoliation in this planting material is observed to be not uniformly severe. But all high yielding clones and clonal seedlings are observed to be highly susceptible to this disease. In these varieties, this disease causes very extensive defoliation often ranging from 75—95% and very severe die back.

In India the total area under rubber is 224 228 hectares. In this, an area of 59 969 ha is planted with low yielding unselected seedling rubber which is not generally being sprayed and protected. Immature rubber occupy an area of 45 700 hectares. Because of comparatively low south west monsoon received, an area of 10 821 ha of rubber in Kanyakumari district is free from this disease or the incidence is very mild; where annual control operations are not being carried out. Hence, the remaining area of 107 738 ha of high yielding mature rubber in India is exposed to this disease incidence.

Yield loss due to abnormal leaf fall disease incidence in high yielding clones and clonal seedlings is reported to be between 30—50%. In a field trial conducted, it is reported that the yield loss due to this disease incidence in clones BD 5, Tjir 1 and Gl 1 was 38%, 56% and 50% respectively.

In a recent field experiment conducted to assess the effect of defoliation on the yield of *Hevea* it is observed that in plots where 75% defoliation was carried out the yield loss was 31% and 33% in two consecutive years. In this experiment no appreciable refoliation was noticed in 25%, 50% and 75% defoliated plants. In the case of severe abnormal leaf fall disease incidence also, refoliation in affected plants is observed to be very little till general refoliation after subsequent wintering. Hence in both cases the plants may have only a very sparse canopy for about eight months from June to January. In the case of severe disease incidence the effect of extensive die back, and the general debility caused to the plants due to a severe pathogenic infection are additional factors adversely affecting the yield. Hence, it could be stated that yield loss above 30% could always be expected in high yielding areas when severely affected by abnormal leaf fall disease.

The total production of rubber from 107 738 ha of high yielding varieties, which is liable to be affected by abnormal leaf fall disease annually in India is 83 174 tonnes, based on the average production of 772 kg per hectare. If left to the ravages of the disease the possible loss of production is 24 952 tonnes valued at Rs. 185 543 072 at the rate of Rs. 7436 per tonne, the average price of rubber during the year 1975-76. Since very severe disease incidence is noticed mainly for high yielding clones and clonal seedlings only, the possible actual loss of production will be very much higher than the figure given above as yield in such planting material will be higher than the average per hectare production of 772 kg considered for the purpose of calculation. From the estimate of the loss of production given above, the importance of this problem to the rubber plantation industry in India could be appreciated.

In view of the heavy loss the incidence of abnormal leaf fall disease can cause to the rubber plantation industry, adoption of proper control measures against this disease is an imperative need. In earlier years, high volume spraying using Bordeaux mixture was recommended for the control of this disease. This method of protection is being extensively practised by small growers for immature and mature rubber and by large growers for immature areas even now. But this is a very laborious, time consuming and costly operation. The difficulties involved could be easily understood when it is known that about 4300 to 5400 litres of mixture per hectare may have to be sprayed by climbing each and every rubber tree. The labour required for this purpose on an average is thirty man days per hectare. The cost of this operation has gone up considerably as indicated in *Table 1.*

* The paper presented at the Seminar on Agricultural Aviation 1977, held in Kuala Lampur.

TABLE 1

Cost of spraying (per hectare) in rupees from 1972 onwards

Year	Bordeaux mixture spraying (Rs.)	Micron spraying (Rs.)	Aerial spraying (Rs.)
1972	504.00	221.00	300.00
1973	569.00	234.00	315.00
1974	749.00	468.00	586.00
1975	817 00	475.00	598.00
1976	835.00	380.00	475.00

An alternative method of spraying rubber is by using Micron 420, Mini-micron 77 or shaw duster/sprayer. In this case copper oxychloride dispersed in agricultural grade diluent mineral oil is being used with success. This method of spraying also has got limitations even though the cost of spraying is comparatively low (*Table 1*). When large acreage is to be covered during the effective spraying period of six to eight weeks before commencement of the monsoon, micron spraying also becomes a slow operation as one machine could cover only 4—5 ha per day. Hence, the necessity of a more quick and comparatively easy method of prophylactic spraying against abnormal leaf fall disease was felt especially for the larger estates.

First aerial spraying field trial was carried out in the year 1960 when an area of about 64 ha of old unselected seedling rubber was aerial sprayed using a Bell D1 helicopter. In this field trial copper oxychloride dispersed in mineral oil was sprayed at the rate of about 43 litres per hectare. Encouraged by the results of this field trial aerial spraying was taken up as a routine practice during subsequent years also.

In the year 1961 a total area of 4800 ha was aerial sprayed in different rubber growing regions in the country using Bell 47D and Hiller 12E helicopters and Piper PA 18A fixed wing aircraft. Trials during 1962 using helicopter and fixed wing aircraft proved that satisfactory results could be achieved with both types of aircrafts. However, it was also observed that operation of fixed wing aircrafts for aerial spraying of rubber may not be as practicable as helicopters, as the former required longer landing grounds which were not readily available in rubber estates. When operated from landing strips away from plantations the dead flight required for each sorty increased considerably. It was also observed that terrain encountered in several estates were also difficult for manoeuvring the fixed wing aircraft when compared to helicopters even though it is stated that operation of fixed wing aircrafts may be cheaper for aerial spraying of rubber.

From 1963 onwards commercial aerial spraying of rubber was continued and the area sprayed is on the increase as shown in *Table 2*.

TABLE 2

Area aerial sprayed (in hectares) from 1960 onwards

Year	Area (ha)
1960	64
1961	4 800
1962	13 800
1963	13 800
1964	15 000
1965	15 400
1966	15 400
1967	14 600
1968	14 400
1969	15 500
1970	20 400
1971	24 400
1972	33 900
1973	35 500
1974	34 200
1975	37 600
1976	40 400

During earlier years this method of spraying also encountered several problems. The fungicide used in aerial spraying is in a suspension in oil and hence the spray nozzles of the aircraft used to get blocked frequently. This problem was solved by improving the fungicide formulation year after year and eliminating all foreign particles by sieving the mixture after preparation and pouring it into the spray tank of the aircraft through another fine filter attached to the opening.

Demarcating the boundaries was yet another problem in aerial spraying. Positioning of gas filled balloons over the canopy was found suitable in earlier years but there were practical difficulties in adopting this method. However, this problem was solved by flagging the boundaries using suitable coloured flags fixed on bamboo poles which are tied vertically on top of rubber trees raising the flags 2—3 m above the canopy.

In the beginning small helicopters capable of carrying a volume of 120 to 170 litres of spray mixture were employed for rubber spraying. But now bigger helicopters, Bell 47 G5, capable of carrying 300 to 350 litres are being employed. Now one sorty could cover 7 to 8 ha whereas previously 3 to 4 ha were only covered. For full dose spraying, about 43 litres of fungicide mixture is being used per hectare. However, dosages lower than this are also being adopted by individual planters on their estates. All the bigger estates now have one or more helipads with permanent fungicide mixing arrangements. Because of this the time taken for spraying one sorty including loading of the fungicide mixture is only 3 to 8 min depending on the distance of the field to be sprayed from the helipad. The spraying operation generally commences by early morning and continues upto the time cross winds are observed by afternoon. In about 6 h of spraying 200 to 250 ha will be normally covered in a day.

In aerial spraying operations one problem which remains to be solved is the occurrence of missed swaths. In aerial sprayed areas missed swaths showing very severe or almost complete defoliation is noticed in about 5 to 10% of the total area sprayed. Elimination of missed swaths entirely depends on the skill of the pilot. Missed swaths occur when the pilot fails to overlap or commence spraying exactly at the boundary of the previous sorty which he has completed just before. Missed swaths about 20 to 35 m wide may be left out in between two sorties sometimes to the entire length of the spray run adopted by the pilot while spraying a particular field. Experienced pilots report that they could identify the border of the previous sorty which they have sprayed because of the colour of the sprayed leaves and also due to the glistening noticed on the oil sprayed canopy. They also say that natural land marks help them in locating the border of different sorties. However, every year missed swaths are being noticed in aerial sprayed rubber areas.

The height maintained by the aircraft from the canopy during spraying is also important. Experienced pilots while spraying keep flying close to the canopy as possible and generally a height of 3—5 m is considered necessary for achieving good results. If the height maintained by the aircraft from the canopy while spraying is too much the spray mist is likely to drift and settle on areas away from the swath which is being sprayed.

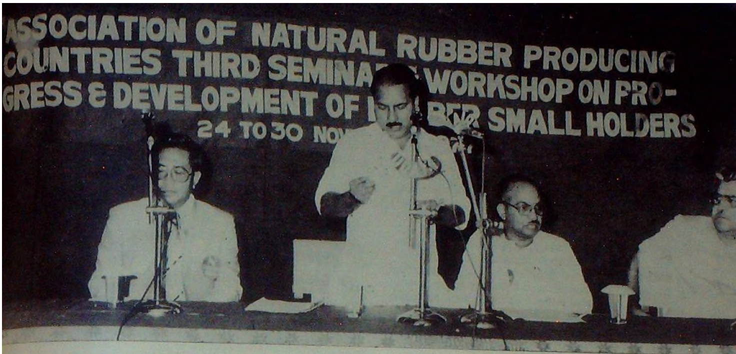
For spraying large areas substantial quantity of fungicide and oil may have to be mixed in a very short time. For this, permanent mixing tanks with bottom taps, kept raised on platforms have been built in several bigger estates. In other estates oil drums of 205 to 210 litre capacity fitted with bottom taps kept raised on platforms are being used. The fungicide required for 4—8 ha is put into the tank first, depending on the size of the tank available, and required quantity of oil is added while stirring the mixture vigorously. The fungicide mixture is then sieved and loaded into the spray tank of the aircraft through the sieve kept at the opening. Pumping of the filtered fungicide from mixing tanks to the aircraft is also being done to save time.

In aerial application the spray droplets are somewhat coarse even though much smaller than the droplet size achieved in high volume spraying. Normally in aerial spraying coverage could be expected only on the upper surface of leaves. However, this is not the case in actual practice. The swirling action of wind produced by the aircraft above the canopy, turns the leaves in all directions at the time of spraying whereby coverage is achieved on both surfaces. Spray penetration obtained is also good in aerial spraying, as satisfactory coverage is noticed in aerial sprayed areas on leaves at different heights of plants.

The cost of aerial spraying has gone up considerably. This is mainly due to the increase in cost of fungicide and oil. Increase in the case of application charges is only marginal. However, the expenditure of Rs. 475 per hectare during 1976 season for aerial spraying cannot be considered high when a minimum crop loss of 231 kg per hectare costing Rs. 1718 can be anticipated if high yielding plants are left unsprayed. Apart from the yield loss the general weakening of the plants due to virulent pathogenic infection year after year is an additional factor which may have to be considered if plants are left unprotected. Hence, adoption of systematic annual plant protection measures against abnormal leaf fall disease is unavoidable. Considering the various practical aspects of the different methods of spraying low volume spraying using oil based copper dispersed in mineral oil, through helicopters, is the most suitable, easy and convenient operation for larger estates. Because of this, aerial spraying has become a regular and very popular method of spraying large estates in India.

Acknowledgement

The author is thankful to Dr. C. K. N. Nair, Director, Rubber Research Institute of India for the useful suggestions given for the preparation of this paper.



Shri A. K. Antoney, the Hon'ble Chief Minister of Kerala inaugurated the conference and workshop

The Third Seminar and Workshop on Progress and Development of Rubber Small Holders

The Third Seminar and Workshop on Progress and Development of Rubber Smallholders was held in Cochin 24–30 November 1977 under the auspices of the Association of Natural Rubber Producing Countries (ANRPC). The delegates from six ANRPC countries viz. India, Indonesia, Malaysia, Papua New Guinea, Sri Lanka and Thailand participated. About 130 participants from the host country, India also attended the Seminar. Representatives from International Organisations viz. ESCAP, FAO and International Agricultural Advisory Service also participated in the Seminar and Workshop.

Inauguration

Shri. A. K. Antoney, the Honourable Chief Minister of Kerala who inaugurated the Seminar and Workshop on 24th November, stressed that success of natural rubber production in the country would largely depend on the performance of small holder sector in India. He pointed out that the most important problem facing the industry was poor production in the small holders' sector and expressed the hope that the seminar would give due consideration to the steps to be taken to raise the economic status of the smallholders.

Prof. K. M. Chandy, Chairman of the organising committee while welcoming all participants reviewed the progress made by the rubber plantation industry in India. He wanted to make smallholdings economically viable by maximising production with minimum inputs. Rubber Research Institutes in the producing countries had made considerable headway in evolving high yielding planting materials, plant protection measures, improved cultural practices and improvement in processing, but transfering this know-how to the small growers is a problem of great magnitude, he said.

The Secretary-General of the ANRPC, Dr. Moeljono described briefly the historical development of the ANRPC for the benefit of the participants who attended the seminar and workshop for the first time. The Fifth Assembly of ANRPC held at Jakarta, in 1976 agreed that a workshop be organised in conjunction with the seminar. In the context of the socio-economic factors impinging on smallholder development, Member countries should recognise the need for modernising rubber small holders through a dynamic production policy. The solutions to problems of small holder development required both short and long term measures. He hoped that the measures would be discussed in depth by both the seminar and the workshop. Shri. P. Mukundan Menon, Rubber production Commissioner, Rubber Board and Secretary of the Organising Committee proposed a vote of thanks.

Key-note Address

Dr. B. C. Sekhar, one of the eminent rubber scientists and Chairman of the Malaysian Rubber Research and Development Board delivered the keynote address on 'Plans and strategies for small holders Development', in the special session. Mr. Arumugam Rasiah was the Rapporteur. Having discussed the grievances of the small holders in detail Dr. Sekhar said that the problems of the small holders were complex and multifaceted. Scientifically and technologically a number of innovations and developments are available to stem some of the problems. The requirements of the small holder sector should be viewed in the context of what must be ideally achieved, circumscribed by what could be practically done using available technologies within the constraints of facilities, finance and organisational limitations. Ideally of-course, economic consolidation of small holdings offer the 'key' to a permanent problem. This is a long term process and even the long-term satisfactory methods of approach are yet to be formulated to counter the problems of fragmentation, land ownership, inheritance and other socio-economic factors. Based on such an integrated approach and using Malaysian experience and organisational support, Dr. Sekhar suggested that a programme of action could be formulated for the small holder sector of the ANRPC region.

Seminar Session

The first seminar session was presided over by Dr. C. K. N. Nair. Mrs. Tan Gaik Sim was the Rapporteur. Six country reports were presented. Sri. P. Mukundan Menon presented the report from India. All the reports had close bearing on the stand adopted by each country vis-a-vis the question of small holder development. The recommendations found in their reports were of paramount relevance to the specific needs and demands of each member country.

The theme of the second session was "Progress in the use of high yielding planting materials and stimulants". Dr. P. D. Abraham presided. Mr. Arumugam Rasiah was the Rapporteur. The paper on Problems of Planting in small holdings in India by Messers A. O. N. Panikkar, V. K. Bhaskaran Nair, and P. J. George, the paper on use of double cut tapping systems and stimulants in small holdings in India by Messers M. J. George, M. R. Sethuraj and V. K. Bhaskaran Nair, the paper on promotion of Field Budding on Rubber Replanted holdings in Thailand,by Mr. Manop Kaeobamrung, the paper on preliminary results of High Level Micro-tapping by Mr. Kanchit Tanisro of Thailand were presented. In the paper on Problems of planting materials, the authors had provided information on the materials used in small holdings in Kerala State and indicated that small holders generally relied on high yielding materials when available. Results of tapping experiment comparing double cut system with single cut system were presented in the paper on prospects of double cut tapping system and stimulation in small holdings. Mr. Manop's paper outlined the method Thailand used to meet the demand for planting material for accelerated replanting rate. The paper presented by Mr. Kanchit Tamisro explored the possibility of exploiting good original high panel of trees before felling, as an alternative to high level tapping with Ethrel stimulation.

Marketing and Processing

Mr. Rosli Kassim presided over the Third Session, the theme of which was "Processing and

The delegates

Marketing of small holders' Rubber". Mr. Arumugam Rasiah was the Rapporteur. Mr. George Jacob presented his paper on 'Marketing of Small growers' rubber—A case study in a village in India'. The paper analysed the marketing problems encountered by the rubber small holders in India, evaluated the remedial measures taken and exploited the future possibilities. Messers M. K. Balagopalan Nair, P. U. George, and E. V. Thomas in their paper on "smallest economically viable block rubber processing unit under Indian conditions" analysed the result of a study to determine the smallest economically viable block rubber processing unit under local conditions. The paper on the effect of processing conditions on the quality of sheet rubber produced in small holdings in India by Messers K. S. Gopalakrishnan, Baby Kuriakose, E. V. Thomas and Mrs. C. K. Premalatha, outlined the processing conditions prevailing in small holdings and their effect on the quality of sheet rubber. Mr. JMDJN Senevisatine who presented the paper on Sri Lanka experience in block rubber manufacture from Small holders lately discussed the problems and other aspects of block rubber manufacture in Sri Lanka.

Experiment and Experience

In the Special Session that followed Mr. Sulaiman Manan spoke of the 'Experiment and Experience in the processing and Marketing of Natural Rubber in Malaysia'. Tan Sri. Dr. B. C. Sekhar was the Chairman of the session. Mr. Arumugam Rasiah was present as Rapporteur. Mr. Manan advocated a planned programme to improve the processing and marketing of small holders rubber at the farm-gate level, to replace the traditional marketing pattern which was both suppressive and exploitative. He stressed the need for a fully integrated approach in dealing with this multidimensional problem. He said that irrespective of instrumentalities or modalities that were adopted by a country, one should not derogate from the basic premises to have an integrated approach.

The integrated approach could be naturally imposed and governmentally inspired at the Centre. He quoted MARDEC as an example of Malaysian experience and experiment. The smallholders were in an apparent dilemma, whether to sell latex unprocessed or to convert latex into sheet. The dilemma was apparent than real. This should not be perpetuated. The small holders were properly educated to face the dilemma and their rubber is now converted into good quality specified rubber through organised processing. In India, as in Malaysia, for improving their lot, small holders should embark on a planned programme of converting conventional rubbers into Technically specified rubber or they would probably face obsolescence, Mr. Manan concluded.

New Strategy

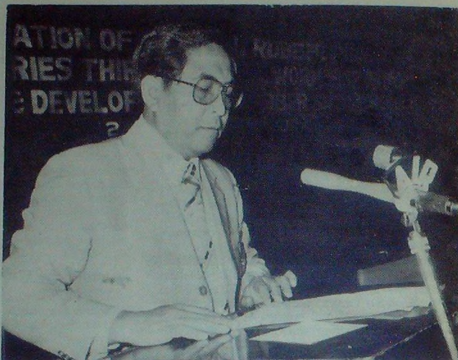
The Fourth session concentrated on the New strategy towards rubber small holders development such as an Integrated Development approach. Mr. Sjahrum Lubis was the Chairman and Mr. Arumugam Rasiah, the Rapporteur. Mr. P. K. Narayanan presented the paper on the "Role Co-operatives can play for Modernisation of Small growers' sector of the Rubber Plantation Industry in India". Group production, its possibilities in rubber small holders was another paper presented by Sri. N. D. B. H. Gunasekara. Both the papers stressed the importance of cooperatives as the new strategy towards rubber small holders development. For development, the expenses narrated in both the papers created a climate for a new approach.

Extension and Training

The Fifth session discussed the theme—Extension and Training of Rubber Development Officers and small holders. Mr. G. L. Rao presided over the session. Mr. Abu Asmara Hj. Mohamed was the Rapporteur. Mr. A. B. Dissanayake presented his paper on 'Accelerating the Adoption and Diffusion of Innovations in Rubber small holdings.' The paper defined the terms of innovation, adoption and diffusion and the characteristics of innovation were explained. The criteria for accepting an innovation could be the suitability and the innovation in a particular area, its profitability, availability and cost of inputs. Dr. Samsudin Tugiman presented his paper entitled 'An analysis of the training needs for extension personnel working in the small holder sector of the Rubber Industry in Peninsular Malaysia'. The paper on Disscussion of Group Processing Schemes, the progress and problems—was presented by Mr. R. P. M. de Zokjsa. Dr. Samudin observed that percieved importance was highly associated witn percieved needs for training each of the mini-training areas. The paper by Mr. RPM de Zoysa dealt in detail the progress achieved, the problems and the possible solutions in working Group Processing Centres programmes.

Socio-economic Factors

Under the chairmanship of Mr. A. B. Dissanayake the 6th session discussed the theme—Socio-economic factors affecting the development of small holders. The Rapporteur of the session was Mrs. Tan Gaik Sim. Messers Cheah Joo Peng, Abu Asmara Hj. Mohammed, and Rosli Kassim presented papers on Modernisation of the rubber small holders sector, an analysis of small holders tenure system in Peninsular Malaysia and the Socio-economic acceptance of SMR scheme among small holders in West Malaysia. Mr. J. P. Cheah in his paper pointed out that the rubber small



Introductory Speach: Dr. Moeljono, Secretary General of the ANRPC.

holders encountered a magnitude and complexity of problems. The Malaysian Government's new economic policy which aimed at eradicating the poverty among all Malaysians provided new hopes and aspirations for the small holders. Mr. Abu Asmara Hj. Mohammed dealt primarily with the analysis of the small holders' land tenure system in relation to the developmental process adopted in Peninsular Malaysia. Mr. Rosli Kassim described MARDEC's efforts in evaluating the response of small holders towards the acceptance of its SMR schemes in West Malaysia.

Other Topics

'Other topics' came up for discussion at the Seventh Seminar with Promdej Sucharit in the chair. Mr. Arumugam Rasiah was the Rapporteur. The paper on 'Problems of Plant Protection in Rubber small holdings in India' by Messers P. N. Radhakrishna Pillai and Thomas T. Edathil dealt with the main diseases commonly affecting the small rubber plantations and the various assistance provided by the Rubber Board, India in supplementing the efforts of small rubber growers in controlling those diseases. A paper on Intercrops in smallholdings in India presented by M. P. N. Krishnankutty highlighted ginger as the most profitable intercrop. He described the various aspects like the cost of raising various intercrops etc. and worked out the return in detail. Mr. V. Haridasan presented his paper on the 'Utilisation of rubber seeds in India'. A short account of the extent of utilisation of rubber seeds from rubber plantation in two southern states of India was presented in the paper.

After the seminar, the delegates proceeded for a field visit. They visited a few selected co-operative societies, Rubber Research Institute of India and Rubber Board's pilot block rubber factory at Kottayam, selected smallholdings, Rubber Board's Central Nursery at Karikkattoor and the Factory of M/s. Hindustan Latex Ltd., Trivandrum.

Workshop session

The Workshop that followed was held on Tuesday 29th November, 1977 at the Bolgatty Palace, Cochin. The delegates from six ANRPC Member countries and representatives of International organisations attended the workshop. Six papers were presented. All of them focussed attention on specific measures for the modernisation of smallholders within the context of a dynamic production policy for natural rubber in the ANRPC countries.

Prof. K. M. Chandy was in the chair at the plenary session. Mrs. Tan Gaik Sim and Mr. Arumugam Rasiah were the Rapporteurs. Mr. P. O. Thomas of the Malaysian Rubber Research and Development Board presented his paper on 'Dynamic Production policy for the ANRPC countries'. The paper outlined the dynamic production policy in the context of world output of NR. It was a concerted, coordinated approach to develop NR industry, to increase the production of NR to meet the world's future demand. The three aspects of dynamic production policy viz. rationality, relevance and requirement were stressed in the paper. The different measures to achieve a dynamic production were enumerated.

Integrated area development

Mrs. Soon Eng Eng of the Rubber Industry Smallholders Development Authority, Malaysia presented her paper—Towards an Integrated Area Development Approach. The paper elaborated the activities of RISDA aiming at improving the family welfare of the small holders. It was argued that this could be achieved only if an integrated area development approach was adopted. The paper on choice of planting materials and exploiation procedures for rubber smallholders was presented by Dr. P. D. Abraham, Rubber Research Institute of Malaysia.

Mr. Rosli Kassim of MARDEC presented his paper on 'New development in the processing and marketing of smallholders rubber in Malaysia'. He dealt with the efforts of the Malaysian Rubber Development Corporation in attempting for evaluating the response of smallholders towards the acceptance of its SMR scheme in West Malaysia. The paper on socio-economic factors affecting smallholders development was presented by Mr. Muljadi Sukandar and Mr. Syahrum Lubis. Mr. Chammong Kongsil of the Rubber Research Institute of Thailand presented his paper on some experience on training course for the smallholders in Thailand. Workshop discussions were followed. Workshop (1) discussed the recommendations concerning a dynamic production policy for ANRPC countries. Dr. C. K. N. Nair presided. Under the Chairmanship of Mr. A. B. Disanayake, Workshop (2) discussed recommendations concerning the processing and the marketing of smallholders rubber. Workshop (3) discussed recommendations for the adoption of an Integrated Development Approach, effective training programmes and systematic evaluation of programmes. Dr. Samsudin Tugiman was the Chairman. The Rapporteurs of the three group discussions were Mrs. Tan Gaik Sim, Mr. Arumugam Rasiah and Mr. Abu Asmara. The subject of the plenary session held on 30th November was Discussion and adoption of recommendations of Group discussions. Dr. Moeljono Partosoedarso presided. Mrs. Tan Gaik Sim and Mr. R. Arumugam Rasiah were the Rapporteurs.

Closing session

Dr. Moeljono, Secretary General of ANRPC, in his statement at the closing session expressed his sincere appreciation and gratitude to the Government of India, Chairman of the Organising Committee and all his staff members for the able manner with which the whole arrangements had been made for making the overseas participants' stay in Cochin a pleasant and memorable one. He explained the various important formulations arrived at the seminar and workshop which covered areas such as a dynamic production policy for ANRPC countries, an integrated area development approach, training programmes for smallholders and the processing and marketing of their rubber. Mr. Moeljono continued:

"This Third Seminar and workshop recognised that in order for the ANRPC Member countries to meet the increasing demand of total elastomers including natural rubber, there is a need to step up the production of natural rubber. It is encouraging to note that Member Governments of the ANRPC at the Fifth Assembly held in Jakarta in November 1976 adopted a dynamic production policy for natural rubber to meet the expected increase in demand. Since the areas under smallholdings in the major natural rubber producing countries accounts for between 50% and 95% of the total planted area, and productivity in the smallholdings is far below that of the Estates, the role and contribution of smallholders in the development of this policy is of paramount importance. Therefore this seminar and workshop recommends that Member Governments of the ANRPC incorporates in their national development plans the concept of a dynamic natural rubber production policy and a scheme of action whereby the required production increase could be achieved."

Factors of production

Mr. Moeljono said that the two major factors influencing production increase were planting materials and exploitation techniques. On planting materials he advocated discouraging the use of seedlings by smallholders. Each member country of the ANRPC should make available adequate supply of high yielding materials and the choice of planting materials should take into consideration the enviromax approach.

To improve the livelihood of rubber smallholders and increase their income level, it was suggested that organised marketing such as marketing cooperatives in India and improved processing of smallholders rubber, be encouraged and expanded in all the ANRPC Member countries. In addition it was recommended that the adoption of an integrated smallholder development approach towards modernising rubber smallholder sector was an essential part of the whole development programme. Mr. Moeljono concluded that inter disciplinary effort in extension work in the form of close coordination of work between extension department and related technical institutions be further encouraged.

The Chairman of the organising committee, Prof. K. M. Chandy in his closing address briefly summarised the fruitful discussions and recommendations reached by both the seminar and workshop participants and wished them very pleasant trips home.

The Honourable Chief justice of Kerala Shri. V. P. Gopalan Nambiyar in his closing statement stressed that although his address was essentially a symbolic one, he felt that future seminars and workshops could look into other areas of small-holder development which were not dealt with by the third seminar and workshop.

The representative of Sri Lanka Mr. Dissnayake expressed his gratitude to the Indian Government for hosting the seminar and workshop and stressed for quick decision and action in the various member countries based on those resolutions. He further elaborated on the usefulness of Seminars where ideas and experiences could be freely exchanged.

Dr. C. K. N. Nair in his vote of thanks expressed appreciation and gratitude to the Chief Justice of Kerala for closing the Seminar and Workshop and to the Chairman of the Rubber Board, Chairman of the organising committee and staff who worked very hard for the success of the seminar and to the numerous public and private sector organisations for extending their warm hospitality.

Variety entertainments arranged for the overseas participants included a Kathakali "Kalyaana-saugandhikam" organised by M/s. FACT Ltd. at Ambalavayal and a Mohiniyattam recital by Ushabhai Thankachi conducted by Rubber Board.

ARAVINDAKSHAN NAIR

Rubb Board bull. 13, 3; 1976; 125—129.

Rubber Plantations in Kerala—A Review

RV Jose Thomas,
Research Fellow, University of Cochin

The plantation industry has an important role to play in the economic development of India as it provides some of the basic raw materials which are necessary for industrial development. As far as natural rubber is concerned, it is a strategic raw material. It caters to a wide range of industries engaged with manufacture of a variety of products.

Importance of Rubber Plantations

Agriculture is still the dominating sector in Indian economy and rubber enjoys an important place among the commercial crops. India has only limited areas suitable for rubber plantation. The State of Kerala accounts for about 94% of the land under rubber cultivation, the balance being distributed in Tamil Nadu, Karnataka, Goa, Assam, Tripura, Andamans and Nicobar Islands. Natural rubber which comes second only to coconut, contributes over Rs. 1000 million to the gross income of Kerala (4). Rubber latex as well as the timber and seed provides some base for industries and creates opportunities for employment.

In Kerala, rubber cultivation covers a total area of 205383 hectares. The rubber plantation industry in Kerala is composed of organised and unorganised sectors. The organised sector comprises well-organised estates and the unorganised sector represents thousands of small growers, isolated and scattered. The unorganised sector has, by comparison many disadvantages. Absence of collective bargaining power and staying capacity, prevalence of traditional and uneconomic methods of cultivation, unhealthy practices of middlemen etc., continue to plague the unorganised sector. The size of the 'small grower sector' shows its decisive role in the development of rubber plantation industry. The growth of this sector over the years has made rubber almost a small growers' crop.

The rubber plantation industry has recorded a phenomenal growth during the post independence period and is characterised by an upward trend in the production range from "import necessitating situation" to the "exportable surplus condition."

The following table gives the details.

TABLE 1

Year	Total area (Hectares)	Tappable area (Hectares)	Production (Tonnes)	Average yield kg. Hectare
1950—51	69001	55800	15830	284
1955—56	83867	67200	23730	353
1960—61	129905	70300	25697	365
1965—66	164713	112700	50530	448
1970—71	203098	141200	92171	653
1974—75	221265	170900	130143	762

From the above table it can be seen that the area under rubber increased from 69001 hectares in 1950-51 to 221265 hectares in 1974-75. This shows an increase of 220.67%. The same upward trend is traceable in production too. It has increased from 15830 metric tonnes in 1950-51 to 130143 metric tonnes in 1974-75 i.e. an increase of 722.13%. Further, productivity in terms of yield per hectare has increased from 284 Kgs in 1950-51 to 762 Kgs. in 1974-75, i. e. an inerease of 168.31%. Above all, this period witnessed the stoppage of imports and the occurrence of some exports. Quantitatively, India's place in the world production of rubber is hardly significant. This can be discerned from the following table.

TABLE 2

India's production in relation to the production of rubber in the major rubber producing countries of the world.

In 1000 Metric Tonnes

Year	India's production	World production	Percentage
1965—66	49.4	2352.5	2.10
1966—67	53.2	2392.5	2.22
1967—68	62.3	2522.5	2.47
1968—69	68.8	2685.0	2.56
1969—70	80.0	2995.0	2.67
1970—71	89.9	3102.5	2.90
1971—72	98.9	3085.0	3.21
1972—73	109.1	3120.0	3.50
1973—74	123.2	3505.0	3.51
1974—75	128.4	3440.0	3.73

From the table it can be seen that India contributes only 3.68 per cent to the world's production.

Growth of the Industry

It may be stated here that in the early stages of production the lion's share of the rubber produced in India was exported. "In 1938 the internal consumption of rubber in India was only 5,600 tonnes out of a total annual production of about 14,000 tonnes." (8). Since then, with the growth and expansion of rubber manufacturing industry in India, the position has been reversed and at present the entire indigenous production is absorbed by the Indian rubber manufacturing sector.

Though the rubber plantation industry in India was started about seven or eight decades ago, the rubber manufacturing industry is comparatively of recent origin. It started only in the 1920's but has acquired power and strength within a very short time. World War II generated some favourable conditions for its growth. But substantial progress occurred only after independence. The post independent era is noted for the remarkable growth of rubber manufacturing industry. The same is the case with rubber plantation industry also. At present, the industry consumes about 1,30,000 tonnes of raw rubber annually, and the whole lot is produced indigenously.

Today, India produces, practically every kind of rubber goods to satisfy internal requirements. Further, India is exporting finished goods to foreign markets such as the Middle East, Burma, Shri Lanka etc. India is different from other countries in the field of rubber in the sense that she is now in the unique position of being a producer of raw rubber as well as a manufacturer of rubber goods. The rubber plantation industry has succeeded to a very great extent in increasing its production to meet the demands of the manufacturer so as to make India self sufficient in her requirements of raw rubber.

Acute shortage of rubber during the World War II led to the search for synthetic substitutes. The lead in this search was taken by the United States of America whose efforts have had remarkable success. Today, the output of synthetic rubber has assumed dynamic proportions. Now synthetic rubber competes with natural rubber in the crucial field of tyre manufacture. The conventional raw materials required for the manufacturing of synthetic rubber are the petro-chemicals. The cost of production of synthetic rubber in India remains the highest, because the raw materials being used are not the conventional petro-chemicals but alcohol and benzene. Alcohol is produced from molasses and Benzene from steel industry. The higher cost of production of synthetic rubber and the present energy crisis has, however brightened the future of natural rubber industry.

Structure of the Industry

Size

The British planters has started rubber cultivation on a plantation scale. At a later stage a number of indigenous planters started cultivation of rubber on a small scale basis. These small holders now predominate the rubber plantation industry.

Indian Rubber Plantations range in size from holdings having less than 1 hectare to estates of nearly 10000 hectares. Under the Rubber Act, rubber plantations of over 20.23 hectares (50 acres) under a single ownership is treated as estates, and those whose area range upto 20.23 hectares are treated as holdings.

As already pointed out, today the rubber plantation industry is dominated by small growers. The Table given below furnishes statistics regarding the number of rubber growing units registered with the Rubber Board at the end of March 1975.

TABLE No. 3

Year	Holdings	Estates	Total
1950–51	13472	13929	
1955–56	26787	14627	
1960–61	57174		
1965–66	75504		
1970–71	110929		
1974–75			

The table indicates that the number of rubber growing units registered with the Rubber Board at the end of March 1975 was 132,047 out of which 598 were estates, as against 647 at the end of March 1970. The registered area under rubber at the end of March 1975 increased to 2,24,428 hectares from 187,514 hectares at the end of March 1970. The share of the small holdings in the total area during the five years (1970–75) increased from 65% to 73%.

Ownership

Here the classification is made on the basis of ownership. The nature of ownership is represented by the nationality of the majority of the share holders of the company. Thus the classification may be made into Indian, foreign-owned and partially foreign-owned.

The following table shows the details.

TABLE 4

Nature of ownership	Units	Area (Hectare)
Indian	88	24531
Foreign	2	9070
Partially foreign	3	3912
Total area	93	37513 Hectares

There are only two fully foreign-owned companies in India. They are M/s. Malayalam Plantations having an area of 8954 hectares and M/s. Green Ham Estates Pvt. Ltd. (Kanyakumari) having an area of 116 hectares. There are only three partially foreign-owned companies in India at present. They are M/s. Pullangode Rubber & Produce Co. Ltd. (864 Hectares), Cochin Malabar Estates Ltd. (2379 hectares) and Thiruvampady Rubber Co. Ltd. (669 hectares).

Climatic and other conditions

"Rubber grows in the tropical belt lying within 15° North and 10° South of the Equator and generally at elevations below 1000 ft." A stiff loamy soil of good texture to hard laterite soils are often preferred. Besides, rubber requires:—

(i) a warm tropical temperature about 21°C—35°C without much variation during the different seasons of the year and (ii) an annual rain fall ranging from 200 cms to 300 cms distributed throughout the year.

A study of the list of the rubber growing countries in the world and their locations, in fact, shows that world's rubber plantations are limited only to a land roughly 15° North and South of the Equator. The main rubber growing regions in India also come mostly within the world's rubber belt. In India conditions approximate to these are obtained in Andaman and Nicobar Islands and in Kerala in the hills of western ghats. These rubber growing regions are confined to the South Western region of India consisting of Karnataka, Tamil Nadu and Kerala. The rainfall in these regions is not as well distributed as in the case of the other rubber growing countries such as Indonesia and Sri Lanka. Further, a long spell of dry hot season followed by heavy monsoon is found in the rubber growing regions of India, and to that extent it affects the growth and yield of rubber trees.

Rubber plantations in India are concentrated, to a large extent, in Kerala State and to a smaller extent in Tamil Nadu, Karnataka and Andamans. In the South, it extends from the Kanayakumari District of Tamilnadu State to the Coorg District of Karnataka State in the North and, in general, lies west of the western ghats. The rubber growing area may be divided into three categories (2).

(1) High land region

(2) Middle land region

(3) Low land region

(1) The High land region is mostly mountainous and consists of reserve forests and other plantation crops.

(2) The middle or lower upland region consists of small hilly areas of varying heights and sizes and the resultant valleys.

(3) The low land region denotes the flat alluvial and sandy tracts along the Arabian sea coasts.

Of these three divisions of land, the middle land region is a narrow belt of nearly 400 Kms. length and contains most of the rubber plantations. The land in this belt is generally hilly in nature. From south to north, the climatic conditions prevailing in this belt varies especially in the case of annual rainfall and distribution.

The variation in the climatic and soil conditions in the main rubber growing belt shown above leads to a classification of the belt into different agro-climatic regions. This classification is useful for offering recommendations regarding planting and the management of the plantations.

Role of the Rubber Board

Rubber is one of the commodities controlled by the Union Government. The formation of the Rubber Board has been a turning point in the development of the Rubber Plantation Industry. The Rubber Act (Production and Marketing) was passed in 1947. The Rubber Board was constituted under this Act. One of the important functions of the Board as defined in the Act is to promote the interests of the rubber industry by such measures as it thinks fit for its development so far as the production and marketing of rubber are concerned.

A major task before the Rubber Board at the time of its constitution was to increase the production of natural rubber as a sizable quantity of rubber was imported then to feed the internal manufacturing industries. Therefore, the emphasis was placed on the modernisation of the rubber plantation industry. In 1957 the replanting subsidy scheme was initiated to help the growers in replacing the old low yielding trees with hig yielding varieties. In 1965 an ambitious target of replanting 2000 hectares annually was fixed. Further, the Board opened a Central Nursery and four regional nurseries to ensure regular supply of high yielding planting materials. Since the requirements were greater than the Board's supply, certain private nurseries were approved to supplement the needs.

In the Rubber Act, the provisions regarding marketing and the prices are contained in sections 11, 13, 14, 15, 16 and 21.

The Act vests with the Government powers for prohibiting, restricting or otherwise controlling the import or export of rubber either generally or in specified classes of cases. The Act also empowers the Central Government to notify prices. Minimum and maximum prices are fixed and notified so that growers may know what minimum prices they are entitled to and the rubber users may know what prices have to be paid by them.

Co-operatives

The co-operative movement was introduced into the rubber plantation industry a decade ago, on the basis of the recommendation of the Plantation Inquiry Commission (1956). The Commission made comprehensive recommendations for stabilising the small holding sector through the media of co-operatives and the Rubber Board started the implementation of the recommendations in 1962–63. Since then the movement has made rapid progress in the rubber plantation industry.

To get the rubber growers attracted to the co-operative movement, the Rubber Board chalked out some schemes for implementation through co-operatives with the motive of making the benefits under these schemes available only to the members of the co-operatives. This arrangement was made to ensure the effective involvement of the entire small holding community into the development of the Rubber Plantation Industry (7).

The vital need for developing co-operatives in the small holding sector is evident from the fact that about 90% of small holders own less than 5 acres of rubber each. Co-operative organisations have the advantage of combining the benefits of individual initiative and small scale pattern with those of large scale organisations and management. In view of the innumerable number of small holders, co-operatives are the best media for the Government or the Rubber Board or any other agency to reach the individual small growers and render them any assistance. Co-operatives of small growers, in this context, assume importance and only through a net work of co-operatives can any scheme intended for the uplift of the small growers be successfully implemented. The Co-operatives now form the media for channelising the assistance rendered by the Rubber Board to small growers, such as manure subsidy, spraying subsidy etc. The Board also assists co-operatives to establish technically sound processing units under them. Most of the small holders were not able to make full-fledged smoke houses of their own. The Rubber Board came to the field by offering to subsidise (75%) the construction of smoke houses built by co-operatives so that these smoke houses could serve as group processing centres. In addition to this Co-operative Societies were encouraged to construct crepe mills by giving them financial assistance. The co-operatives have played a very important role in the price support operations of the Government which were introduced with a view to ensuring the minimum notified prices to the small growers and implemented through the State Trading Corporation of India and the Kerala State Co-operative Rubber Marketing Federation.

Employment

Almost all the developing economies are dominated by the agricultural sector which offers vast employment potential. Plantations form an important sub sector of Agriculture in many developing countries.

Plantation industries are generally labour intensive and rubber plantation industry is no exception to this. Generally manufacturing industries are capital intensive and hence they cannot absorb the excess man power available, especially during the initial stages of development.

In this context rubber plantation industry has a vital role to play in the economy in providing large scale employment opportunities for the people in India (3). It is estimated that the rubber plantations employ about 1,50,000 workers—a major portion of the total work force in the whole plantation industry in India. The significance of the rubber plantation industry in Kerala is that it is mainly confined to this State. In the rubber plantation, men, women and even children are absorbed as workers. Another advantage of this industry is that it provides employment opportunities for the unskilled labourers as well. Indigenous labour can effectively contribute to the development of the rubber plantation industry. To quote the Tariff Commission "If labour in other countries like Malaya can show better productivity there is no reason why indigenous labour which does not lack the skill or capacity should lag behind" (8).

The table below shows the average daily employment in rubber plantations.

TABLE 5

Year	Number
1950—51	N. A.
1955—56	—
1960—61	93754
1965—66	122481
1970—71	146591
1974—75	151357

There are three categories of workers who are engaged in rubber plantations.

(a) Land-less labourers—they contribute the highest percentage.

(b) Labourers who own land—In addition to wages they get some income from farming also.

(c) Part time artisans or village workers—those who work as agricultural labourers also such as village blacksmiths, carpenters etc.

Water-tight division is not possible here. However, we can broadly divide workers into two groups (4).

(a) Those who get the major share of their income from their employment in rubber plantations and

(b) those who supplement their income by their employment in the rubber plantations.

While considering the employment strength in the rubber plantation Industry, one should take into account both workers who are engaged in tapping and other field operations such as weeding, pruning, manuring, spraying, fencing and those who work at the managerial level.

A statistical study of the rubber plantations of Malaysia as an employment providing sector is interesting. It is stated in the "1957 Federation of Malaya population census" that 616589 of the economically active population are directly employed in the rubber industry.

According to Lester R. Brown, it is estimated that the level of unemployment in India has increased from 11% of the labour force in 1951 to 15% in 1961. We are still in the 70's. Brown says Indian labour force is "projected" to increase from 210 to 273 million, an increment of 60 million (1).

In addition to the direct employment provided in the rubber plantation industry, there are so many indirect openings for employment facilities. The development of the rubber plantation industry paves the way for the expansion and growth of the rubber based industries, development of transport and communications, house building industry and other related social overheads which in turn provide employment channels and generate income.

The close co-relation between the expansion of exports and economic growth means that the developing economies like India have to gain greater access to export markets. Labour intensive products such as farm products or agricultural commodities such as rubber, coffee etc. which suits the 'Indian condition' must be exported in increasing quantities since they represent an 'export of labour' and in turn the necessary foreign exchange for economic growth.

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News and Notes

Rubber Board Office shifted

The central office of the Rubber Board which was functioning in the Rubber Research Institute of India Buildings at Puthuppally have been shifted to the new premises on 29th October 1977 at the first floor of the Public Library Buildings, Sastri Road, Kottayam-686 001. Prof. K. M. Chandy, the then Chairman of Rubber Board formally inaugurated the functioning of the office at the new premises.

Besides the offices of the Chairman and the Secretary the central office have the Statistics and Planning Division and the Excise duty, Publicity, Establishment, Cost accounts, Internal Audit, Labour Welfare and Legal sections. All enquiries to the Rubber Board should be addressed to the Secretary, Rubber Board, PB No. 280, Sastri Road, Kottayam-686 001. The following are the telephone numbers:

Chairman	3522
Office	3231, 3232, 3233, 5234
Telex	RUBR KTM 205.

AGRI EXPO-77

The Rubber Board participated in the AGRI EXPO-77 held in Pragathi Maidan, New Delhi between November 14 to December 13, 1977. The Exhibition was organised by the Trade Fair Authority of India on behalf of the Govt. of India.

The objective of the Fair was to disseminate information on India's progress in the fields of agriculture and allied sectors since independence and to explore the avenues for development of co-operation in these fields with the participating foreign countries.

The Rubber Board's pavilion in this Fair had won a silver medal being the second best among Public sector institutions.

Farewell to Prof. K. M. Chandy

Prof. K. M. Chandy laid down office as Chairman of the Rubber Board on 18th January 1978. He joined the Rubber Board on 14th March 1972. Prof. Chandy had been the head of the department of English, St. Thomas College, Palai, when he was appointed as Chairman, Rubber Board. His term has been extended twice during his tenure in the Rubber Board. His contributions to the growth and development of Rubber Plantation Industry in India have been well recognised by planting community as a whole.

Farm School on the Air Programme on Scientific Rubber Cultivation

The Rubber Board with the active association of AIR Station at Trichur has commenced a 'Rubber School on air' since November 1977.

The course on rubber cultivation popularly known as 'Krishipatam' formally inaugurated on the Radio by Prof. K. M. Chandy, Chairman of the Rubber Board on the 5th of November at 7.05 a. m. The first lesson in the course was broadcast on 8th November.

The present pattern of broadcast of the course is to present a new lesson every Tuesday at 7.05 a. m., repeat the lesson in full the next Thursday and to broadcast the questions raised by the listeners along with replies prepared by experts the following Saturday. As such the course would be completed in 40 weeks.

AIR Trichur was the first station in India to start a systematic educational programme for the benefit of the farming community based on a carefully chalked out syllabus on a selected topic. Each course is designed to cover all aspects about a selected topic.