

SOUTH AMERICAN LEAF BLIGHT — AN OVERVIEW

C. K. JOHN, ABDUL AZIZ KADIR AND S. SUBRAMANIAM
(Rubber Research Institute of Malaysia, Kuala Lumpur, Malaysia.)

SUMMARY

South American Leaf Blight (SALB) caused by Microcyclus ulei is the most destructive disease of Hevea brasiliensis, and has been largely responsible for the absence of a viable natural rubber (NR) industry in tropical America. The NR industry in the Orient has hitherto remained free from SALB. However, with the increase in traffic from the American Tropics to the rubber growing areas in the Orient, the chances of its accidental introduction have vastly increased.

If the disease is to come to the Orient, it is likely to establish itself firmly, adversely affecting the cultivation of rubber. A strong phytosanitary barrier against the entry of any plant material from tropical America and enforcement of strict control on the direct movement of people are the only effective means of keeping the SALB out of the region. Measures for early detection of the disease, and the emergency action for its eradication, in the event of its detection, are to be considered as a common necessity and a joint responsibility of the rubber-growing countries of this region. Besides reporting on the details of the eradication procedure, the paper also recommends a programme for regional co-operation.

Commercial scale fungicidal spraying of mature trees is now being increasingly practised in Brazil. Newer and more potent fungicides are being screened and the promising ones are being treated in the field. However, breeding clones for resistance appears to be the only permanent solution to the threat by SALB.

INTRODUCTION

Hevea brasiliensis (Muell. Arg.) introduced to the Orient about a century ago from its original habitat in the Amazon Valley, today covers about six million hectares in South and South East Asia, a third of this area being in Malaysia alone. The success of the NR industry in this region is to a great extent attributable to its being free from introduced diseases. Nearly all diseases of rubber are caused by indigenous fungal parasites. The post-war emphasis on clones with high yield, with little consideration of disease susceptibility markedly increased the severity of many diseases. Presently rubber trees suffer from a variety of major and minor maladies affecting the root, panel, stem and leaf.

Several fungi are known to infect the foliage of rubber, however, none of them has so far assumed the devastating role of South American Leaf Blight (SALB) caused by *Microcyclus ulei* in tropical America.

Although SALB is primarily a leaf disease, it can also attack the tender parts of the plant, including petioles, inflorescences and developing fruits. Its attack on leaves consists of a primary stage occurring on the very young pendant leaves, and a secondary stage affecting the leaves that have managed to survive the primary infection. The symptoms of the disease have been well described and illustrated by many workers (Stahel, 1917; Hilton, 1955; Holliday, 1970; Rao, 1973a). Repeated defoliation results in dieback of shoots, and even death of young plants.

SALB is thus the most serious disease of rubber in South America and has therefore been a major factor in preventing the development of a viable natural rubber industry in tropical America. Hilton (1955) and Holliday (1970) have given

a fuller account of the historical devastation caused by the disease in rubber plantations in America. The collapse of the industry in the Guianas in the first decade of this century, and later the failure of major rubber-producing companies to grow rubber in South and Central America are attributed to the ravages of this pathogen. The disease has spread throughout tropical America where *Hevea* is grown, apparently through movement of planting material and personnel. It was reported in Trinidad in 1916, Panama and Costa Rica in 1935, Mexico in 1946 and Guatemala and Honduras in 1948. In 1930, it also spread to the state of Bahia in Brazil; the latest record of its presence in the state of Sao Paulo, Brazil, in 1960, represents its most southerly limit of extension (24°S), and Mexico is the most northerly one (18°N) (Rao, 1973a).

Economic Importance to Asia

Over 90% of the world's natural rubber is produced in Asia. Peninsular Malaysia, the largest single NR producer alone has more than 1.7 million ha (about 50% the cultivated area) of susceptible rubber holdings in a nearly continuous belt stretching about 800 km, contributing about 17% of the Gross Domestic Product of the country (Rubber Research Institute of Malaysia, 1974). Similarly many other countries in Asia, particularly in South East Asia, depend on the rubber industry for their economic well being.

Observations in Brazil and Central America have revealed that all of the high-yielding Asian clones are extremely susceptible to the disease (Hilton, 1955). There is little doubt, therefore, that should the disease be introduced into Asia it would spread rapidly through the vast, often contiguous rubber plantations, causing heavy damage to the economy of these countries. It is therefore in the interest of all the rubber growing countries to realise the full implication of the devastating effect of this disease.

Dissemination of SALB

Both conidia and ascospores are known to be capable of infecting the host. The conidia, relatively large, dry spores borne in powdery masses close to the plant surface and produced during the primary stage of infection, are dispersed through the wind or splashed in rain droplets (Holliday, 1969); but their short-term viability limits their dissemination to relatively short distances (Langford, 1945). Conidia germinate within about 90 minutes of coming into contact with water, the rate of germination ranging from about 10% to over 90% depending on weather conditions (Chee, 1975). The optimum temperature for germination is 24 - 28° C but a wider temperature range of 16 - 32°C is tolerated under conditions of darkness. Darkness also prolongs the viability of conidia, a good proportion being able to germinate even after a fortnight's dry deposition on glass slides (Rao, 1973c).

Not much is known about the role of ascospores produced during the secondary stage of infection, in the epidemiology of the fungus. However, ascospores from fallen leaves appear to constitute the main source of inoculum for infection during refoliation, whereas those from green leaves start off a new cycle at the onset of wet weather (Chee, 1975). Further, ascocarps enclosing the ascospores are more resistant and can survive longer periods of time (Weir, 1928). It is therefore reasonable to assume that ascospores are important means of transmission of the disease.

Possible Introduction into Asia

As mentioned earlier, SALB at present is confined to Central and South America. It is unlikely that the disease could be introduced into countries outside the Americas through air as the *M. ulei* conidia and ascospores are quite large. A carrier appears

to be required for any long range movement of SALB (Rao, 1973c). It is not known how long the more resistant ascocarps remain viable and continue producing ascospores, but they can only be carried through host material from which they are not easily detached (Chee, unpublished). Thus there are two primary means by which the disease could be introduced; it could enter through movement of infected material originating in the American Tropics or involuntarily through contamination introduced by air travellers. The increasing volume and speed of air traffic in the recent past has greatly increased the possibility of such introduction. Therefore the opinion that SALB is unlikely to come to Asian countries, as it has not happened for nearly 100 years of its existence, is unrealistic and even dangerous.

If the disease is to come to Asian rubber growing countries, it is quite likely that the disease would establish itself firmly and become an important adverse factor in the cultivation of rubber, particularly because of the extremely high susceptibility of most high yielding Oriental clones planted over large areas. However, it is unlikely that SALB would be equally devastating in all rubber-growing areas, as climate may have a profound effect on the severity of the disease (Tollenaar, 1954). Holliday (1970) recognised three levels of incidence based on the total and seasonal distribution of rain. They are: (1) areas of moderate rainfall with a dry season of 3—4 months which are least affected; (2) areas of moderate rainfall but without a long dry season giving rise to intermediate incidence and, (3) areas with well distributed rainfall with no dry season which are associated with high disease incidence. Diverse rainfall patterns prevail in the different rubber growing areas of Asia and therefore SALB would not be expected to be equally devastating in all the areas planted with rubber.

Preventive measures

In view of the serious consequences of a possible introduction of SALB, there is a very real need for rubber growing countries here to ensure that the necessary preventive measures are made operative in the region. Stringent phytosanitary measures by concerted international action is the only effective means of keeping out the disease. A Plant Protection Committee for the South East Asia and Pacific Region was set up in 1954 under the auspices of the Food and Agriculture Organisation; a Plant Protection Agreement was signed and adhered to by many countries of the region, specifying mandatory measures to exclude *M. ulèi*, and action to control plant imports from infected areas by legislation. Under the terms of these agreements the import of any plant or plant parts of the genus *Hevea* from the American Tropics is prohibited. In the case of exceptional imports, planting materials should have been grown for an adequate period at an intermediate plant quarantine station situated outside the region and outside the American Tropics and subjected to stringent post-entry quarantine measures. Consignments of seeds should be opened, treated and re-packed in fresh containers in the intermediate quarantine station. It should be the responsibility of all rubber-growing countries to effectively implement these measures.

The import of planting materials other than *Hevea* is largely left to the discretion of the importing country, having not made specific in the Plant Protection Agreement. Some countries that are not signatories to the Agreement have a lucrative trade in the import and export of planting materials, and are therefore unwilling to accept any restrictions that may affect their profits. There is, therefore, an urgent necessity to strengthen quarantine measures in these countries to impose additional safeguards.

In addition, visitors from any country within the geographical range of SALB, or after breaking the journey in any country therein should, as far as possible, be encouraged to arrive here after a lapse of some days, or after breaking the journey

for a specified period in an intermediate country. For visits of research workers and plantation personnel from SALB infected areas, and for letters and parcels received from there, precautionary procedures are recommended to be strictly followed (Rubber Research Institute of Malaysia, 1971).

Eradication of SALB

While we are confident that the strict phytosanitary measures and other precautions taken by these countries will succeed in keeping SALB out of the region, it is nevertheless necessary to be well prepared with emergency measures in the event of an accidental introduction. At the moment there is no commonly acceptable eradication programme formulated by the countries concerned, neither a mechanism for joint action to give effect to it. What is required is an immediate isolation and eradication of the disease by destroying all infected plants. Since *M. ulei* has a limited host range, the chances for a successful eradication programme is good, provided the outbreak is detected early, the eradication measures are efficient and put into operation speedily.

A scheme for the eradication of the disease developed by the Rubber Research Institute of Malaysia following several trials with defoliants (Altson, 1953a, b; Hutchison, 1958; Newsam, 1954; and Rao, 1967) should be adequate to meet any emergency situation. The emergency programme which will be put into action in the event of an outbreak of SALB is as follows :—

1. The infected area and a 500-metre belt around it are immediately cordoned off.
2. All rubber trees in this area are serially defoliated with 35 litres of n-butyl ester of 2, 4, 5 - T in 3 litres of dieseline per hectare. Trees shorter than 20 metres are defoliated with 21 %; 2, 4, 5 - T in 3 litres of dieseline per hectare, using a portable fogging machine, best done during conditions of windlessness.
3. A day later, the trees are sprayed with a strong fungicide such as 1 % pentachlorophenol.
4. Entry of persons and livestock into the treated area is restricted for at least one month and those leaving the area thoroughly disinfested at the edge of the cordoned area.

The above procedures were recommended by the International Rubber Research and Development Board (IRRDB) to the Association of Natural Rubber Producing Countries (ANRPC) and were accepted by the ANRPC's Technical Committee on SALB in 1975 (ANRPC, 1975). Since there is no further development in the eradication procedures, it is proposed that the above emergency eradication be adopted as a standard programme at national level by members of ANRPC.

In addition, a programme for regional co-operation is also recommended, involving the following :—

Joint warning system : Any country detecting the disease should promptly inform other countries, the Regional Plant Protection Committee of the FAO and the ANRPC Secretariat on the outbreak and the progress of the emergency eradication programme undertaken.

Training of personnel : A training programme be initiated so that at least one pathologist in each country of the region is trained to be adequately familiar

with the disease symptoms and the eradication procedures. The RRIM's research station at Trinidad or any other research institute actively involved in SALB work in South America may be asked to provide such training facilities.

Resources : Each country should keep in readiness, chemicals and other facilities necessary for the eradication. Wherever possible participating countries should be encouraged to pool their resources to ensure an effective eradication programme.

Breeding for resistance

Breeding and selection : Breeding clones for resistance appears to be the only economical and permanent solution to the threat by SALB. Initial work on the breeding for SALB resistance was carried out in Brazil by the Ford Motor Company when clones imported from South East Asia were crossed with their primary clones of the FA and FB series, producing the FX series. Later these FX clones were backcrossed to produce the IAN series (Townsend, 1960). The Ford Motor Company's early breeding programme has produced a number of promising clones such as FX 25, FX 3899 and FX 3164 which are currently being planted in Brazil.

Another programme on breeding for resistance is the one carried out by Firestone Rubber Company in Liberia and Guatemala (Bos & McIndoe, 1967). The exploitation of the *Hevea brasiliensis* seedlings of Madre de Dios origin however has given better results. This non-Wickham pedigree has given rise to a number of resistant clones in their MDF and MDX series.

The SALB resistance breeding programme in the Asian region has been primarily by the RRIM and the Rubber Research Institute of Sri Lanka (RRISL). The programme was initiated in the fifties with the importation of resistant clones from Brazil by the RRIM and RRISL (Brookson, 1956 ; Baptiste, 1961). The performance in Malaysia was reported by Subramaniam (1969 and 1970) who concluded that the *Hevea brasiliensis* from Madre de Dios and *Hevea benthamiana* from Rio Negro were useful as source of resistance against SALB. The subsequent work on screening carried out by the RRIM Unit in Trinidad consisted mainly of material bred for resistance against SALB in RRIM and RRISL.

Up to now the SALB breeding in the East has been carried out in two phases : (1) Importation of the genotypes resistant to SALB from South America ; (2) Crossing the best genotypes from among them with the Oriental material followed by using the backcross breeding method of Briggs & Allard (1953). These two phases of approach were not without its deficiencies. Firstly, the material imported did not have enough variability and secondly, the Oriental parents used did not have the prepotence for yield. The following steps are therefore recommended to be adopted to make the SALB breeding programme more effective.

1. A larger collection of *Hevea* should be imported, giving special attention to regions such as the banks of Rio Negro for *Hevea benthamiana*, and the Madre de Dios region in Columbia for *Hevea brasiliensis* populations.
2. The collection should be screened against the different physiological races of the *M. ulei* and the resistant selections be hybridised with Oriental clones possessing high general combining ability.
3. The progenies should be screened in the nursery for yield and the resulting selections tested as clones in field plantings in regions where the different races of *M. ulei* are endemic.

Crown budding: Selection of trees combining high yield with disease resistance takes at least twenty years to accomplish. An alternative method of combining disease resistance with high yield is to establish a three-part-tree (Yoon, 1972). Crown budding is being employed on a large scale in South America for this very purpose. Yield is determined mainly by the trunk, whereas resistance is well established by the crown. In spite of its many drawbacks, crown budding can be thought about as a means of reducing the ravaging impacts of SALB. SALB-susceptible clones such as PR 107, RRIM 600 and GT 1 were crown budded with the resistant clones FX 25, FX 637, FX 2784 and FX 4421 to observe yield and trunk effect on diseases susceptibility. Initial observation indicated that the FX 25 crown on the trunks of the above Oriental clones became susceptible while the FX 25 crown on its own trunk remained resistant (Chee, unpublished). This observation warrants further investigations.

Chemical control

Large scale chemical control in mature trees was not considered in the past on economic grounds (Carpenter, 1950). The use of fungicides has therefore been restricted generally to nursery practice. Of late there was a strong tendency to use fungicides on a large scale. Where top-budding with a resistant crown clone is done, the high yielding but susceptible panel clone is sprayed until old enough to be top worked. Further, commercial scale aerial spraying of mature trees is now being anticipated by the tyre companies in Brazil.

Insoluble copper formulations were used at first (Langford, 1943). Later, ethylene bis-dithiocarbamate (Dithane Z-78) was found to be more effective (Langford & Townsend, 1954). Recently, Rogers & Peterson (1975) reported good control of the disease when Dithane M 45 (three applications of 3 kg/ha) or Benlate (four applications of 0.3 kg/ha) was applied aerially.

It was claimed that yield increase justified chemical control expenditure in Brazil where rubber price is supported at US \$ 1.33 per kg. A yield decline in the first year and an apparent increase in the second year as compared to the pre-treatment yield data were observed. It was further anticipated that the yield would increase with time and with continued spraying but no conclusive evidence has yet emerged from these trials.

A number of newer fungicides have been recently screened in the RRIM laboratory at Trinidad and the promising ones are being further tested in the nursery (Chee, unpublished). Thus it would appear that further extensive investigations will have to be carried out before being sure of the chemical control of SALB.

CONCLUSION

During nearly a century of its existence in the Orient, rubber has fortunately remained free from introduced diseases and pests. The diseases of rubber already existing in this region do not generally demand undue attention and expensive control measures. However, the same cannot be said if SALB were to come to this region. The use of fungicide in SALB areas until recently has been restricted to nurseries and to areas where high yielding susceptible panel clones are planted for top-budding with resistant crown clones. Recent developments indicate that commercial scale spraying of mature trees also may be considered.

On a long term basis the only permanent solution to the SALB threat is the breeding of resistant clones. In the meantime the only effective means of keeping the disease out of the Orient is by stringently enforcing the phytosanitary measures. However, it is necessary to be well prepared with emergency measures of eradication in the event of an accidental introduction of the disease.

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