

SOUTH AMERICAN LEAF BLIGHT: CHANCES OF INTRODUCTION AND LIKELY BEHAVIOUR IN ASIA

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South American leaf blight (SALB) was recognised as a devastating disease of *Hevea* rubber since the first decade of this century when attempts were made in some countries of tropical America to start rubber plantations with the initial high-yielding selections developed in Asia from the WICKHAM COLLECTION (Hilton, 1955). Originally, the distribution of the causal fungus, *Microcyclus ulei*, was apparently coincident with the natural geographical range of the genus *Hevea* in the Amazon Valley. Spreading to cultivated rubber from infection foci in wild *Hevea* trees in the jungle, it became a serious problem in every rubber-growing area in the neotropics, preventing the development of a viable natural rubber industry there.

SALB, as the name implies, is a leaf disease, but can attack any tender part of the plant, including petioles, inflorescences and developing fruits. The symptoms of attack on the foliage depend upon its stage of development. In young expanding leaflets, within about a week from bud-burst, the primary or the asexual stage of the disease develops in the form of grey-black lesions. The leaflets get severely distorted and, in a heavy attack, soon shrivel and drop. It is difficult at this stage to distinguish it from other leaf diseases such as those caused by *Collectotrichum gloeosporioides* and *Helminthosporium heveae*. Leaves that are slightly more advanced in growth, develop the characteristic symptoms of this stage—crinkled leaflets showing dull velvety lesions on the underside covered with olive-green masses of conidia. Infection on slightly older leaves results in less distortion, though they assume a ragged shot-holed appearance, but they do not generally drop. The secondary stage of the disease develops on them in the form of numerous minute charcoal-black bodies arranged round the margin of the holes in concentric rings on the upper surface. These are the pycnidia that produce the second type of asexual spores, the pyconospores. When the leaf becomes fully mature the third spring stage develops on the same site, the ascocarps protecting the sexual ascospores produced inside.

As infection is confined to tender leaves and young tissues, the disease is comparable with those caused by *Oidium heveae* and *C. gloeosporioides*. In nurseries and young plantings where new flushes are produced throughout the year the fungus has a continuous source of host material. Repeated defoliation results in dieback, and even death of plants in the absence of treatment with fungicides, which need to be sprayed weekly almost throughout the year. Older but still immature plants that are difficult to spray from the ground suffer considerable set-back in growth with consequent prolongation of the period of immaturity, if they are able to survive at all. Once the wintering cycle commences the problem becomes one of secondary leaf fall, similar to that caused by *O. heveae* and *C. gloeosporioides*, becoming destructive during periods of annual refoliation after wintering when there is abundant tender leaf material available. If weather conditions favourable to the disease continue, the process of refoliation followed by secondary leaf fall is repeated, with each succeeding set of new foliage becoming fewer in number and smaller in size. The result is a poor canopy with bare twigs sticking out like stag's horns. Though the trees may not die, secondary leaf fall of this severity, repeated year after year, debilitate them and reduce their economic value to the extent of having to abandon the whole field.

Dissemination of SALB

All three spore forms of the fungus are able to germinate, but only the conidia and the ascospores are known to be capable of penetrating the host and start infection. The conidia, produced abundantly during the active season for the disease, are responsible for the quick spread of infection from host to host, and are therefore the main agent of dissemination. The ascospores, on the other hand, are produced in smaller numbers on old leaves, but being well protected inside the ascocarps, they provide for tiding over periods unfavourable to the disease.

Research on the various spore forms and information on their requirements for dispersal, viability and germination are scanty. Recent studies by Holliday (1969) throw some light on conidia. They are relatively large two-celled fusiform spores (average $40 \times 7 \mu$), with the walls collapsed when dry and turgid when moist. They are exposed as a powdery mass on the leaf surface, and are passively discharged, mostly during the day, subsequently blown in the wind or splashed from the surface of rain droplets. Langford (1945) observed that the spores could spread up to a distance of 180 m in a nursery, the disease decreasing in intensity with increasing distance from the source of infection. Conidia germinate within about 90 minutes of coming into contact with water, but can survive conditions of low humidity for about 2 days, and even complete desiccation for up to 18 h. Optimum temperature for germination is 24° - 28° C, but under conditions of darkness high germination rates were obtained over a wider temperature range of 16° - 32° C, becoming negligible only below 8° C and above 32° C. Darkness or natural indoor light also prolonged the viability of conidia, a good proportion being able to germinate even after a fortnight's dry deposition on glass slides. Direct light reduced viability, and exposure to ultra-violet light quickly killed them.

Very little is known of the role of ascospores in the epidemiology of the fungus. Though smaller than conidia, they are not caught in spore traps operated near an infected site (Holliday, 1970). He found that they are discharged from ascocarps at temperatures somewhat below that required for conidia; but only a short period of this low temperature is adequate, perhaps provided by the cooling effect of rain at night. Darkness also favoured the release of ascospores. Leaves collected in the early morning discharged more ascospores than those collected at noon, so are those collected soon after rain, indicating that moisture is favourable for spore release (Chee, personal communication). Being thin walled and able to germinate as easily as the conidia, the survival value of ascospores is doubtful, but the ascocarps which bear the spores are thick walled, and one observation of their prolonged survival on three-year-old stems has been recorded (Weir, 1926).

Chances of spread outside Tropical America

It is often argued that SALB has not appeared for nearly 100 years of the existence of *Hevea* in the Orient and therefore it is unlikely ever to come, due perhaps to the success of phytosanitary precautions taken or to some inherent obstacles to the spread of the pathogen. That it is dangerous to hold this optimistic view is evident from the history of coffee leaf rust fungus, *Hemileia vastatrix*. Originating in East Africa, this fungus destroyed the entire coffee plantation industry in Asia a century ago. The crop has since been grown primarily in Brazil, where it enjoyed complete freedom from coffee leaf rust—a picture similar to that of SALB and rubber, but in the reverse direction. This happy state of affairs ended in 1970 when the disease was discovered to have spread there.

The coffee leaf rust is believed to have been carried through uredospores from West African plantations, blown along with air currents across 1000 km of the Atlantic Ocean. The conidia and ascospores of *M. ulmi*, on the other hand, are much larger spores, unlikely to be carried over such long distances in air currents. A carrier, ideally the host itself, appears to be required for any long-range movement of SALB. Spores that can remain viable even up to a fortnight under conditions of darkness may also be carried as contaminants with other plant materials grown in the same area, or through the agency of air travellers originating from, or passing through, areas in tropical America where rubber is cultivated. 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, personal communication).

It was fortunate that the early introduction of *Hevea* to the east were through seeds, which had to travel many weeks by sea before reaching South East Asia. The seeds collected by Sir Henry Wickham in Brazil in 1876, which formed the main source of rubber cultivation here, were germinated in the Royal Botanical Gardens, Kew, (United Kingdom) and despatched here as seedlings. In fact, this intermediate quarantine has been strictly enforced ever since for the few subsequent consignments of *Hevea* planting material imported for scientific purposes. Imports of plant materials other than that of *Hevea* from tropical American countries have been severely restricted by the rubber-producing countries, or only allowed after stringent quarantine measures were taken.

The position is different today, when even leafy plants can be transported from one continent to another in a matter of hours. The volume of trade in planting materials between countries is increasing day by day, and the profit motive of such trade often attempts to circumvent established quarantine procedures. Further, the national interests of the various countries of South and South East Asia, where 80% of the world's natural rubber is cultivated, are not all alike for appreciating the necessity for safeguards against SALB with equal importance. A country that has only a minor interest in rubber cultivation may indulge in free trade in planting materials without any regard for the safety of the crop that may be of vital concern to its neighbours.

The fast development of air communications between countries since the last war is the greatest single factor that has increased the chances of SALB spreading out of the American tropics. The recent introduction of a direct air service between Brazil and Liberia has openly exposed the rubber plantations of the latter country to the risk of SALB. Once it sets foot in Liberia the largest single hurdle for its global spread—crossing the Atlantic—will have been removed. Its subsequent spread to other rubber-producing countries of West Africa, namely Ivory Coast, Nigeria and Cameroons, would be rapid. The continuous land mass through Africa and Asia provides no obstacles to its finding its way to rubber plantations in Asia in the course of time. There is also the possibility that, with any future establishment of closer airline links between tropical America and any rubber-growing country or its neighbour in Asia through the Pacific, the disease would bypass Africa and come directly to the vast rubber plantations of South East Asia.

Likely behaviour of SALB in Asia

The picture of SALB in tropical America suggests that it would follow a more or less similar pattern in Asia, were it to spread here, because of the similarity of climatic conditions in the rubber-growing areas of both the regions—humid tropical rain forests converted to plantations. There is no doubt that the disease would establish itself firmly and become an important adverse factor in the cultivation of rubber. However, the

likelihood of its becoming much more destructive here than in the Americas is great, because of the extremely high susceptibility of most high-yielding Oriental clones planted over large areas. The failure of repeated attempts to establish plantations with such materials in some South and Central American countries is ample proof of this.

Among the climatic factors that favour SALB, the most important is rainfall, free water or a saturated atmosphere being essential for spore germination. From the present performance of the disease in tropical America where its incidence and severity vary considerably between different regions, a strong effect of rainfall, particularly its distribution through the year, is noticed. Areas of high rainfall well distributed through the year have the highest incidence, followed by areas of moderate rainfall also distributed more or less evenly through the year. It is the existence, or otherwise, of a dry season that is more relevant to the disease than the total yearly rainfall. Susceptible clones have been grown successfully in some areas in Brazil; for example, on the plateau west of Sao Paulo where the total annual rainfall is experienced during only six months of the year. Even where all the twelve months are wet a dry spell of 2-3 weeks during the period of annual refoliation reduces the severity of the disease, as in some parts of the state of Bahia (Rao, 1973).

When considering the possible behaviour of the fungus in Asia it is important to note the diverse rainfall patterns prevailing in the different rubber-growing areas of this region. It is also significant that the prevalence of the two fungi (*O. heveae* and *C. gloeosporioides*) that cause secondary leaf fall here varies considerably in different regions of Asia; similarly SALB would not be expected to be equally devastating in all the areas planted with rubber.

A comparison of the epidemiology of *M. ulmi* with those of *O. heveae* and *C. gloeosporioides* throws some light on how SALB would perform here. *O. heveae* is very destructive in Sri Lanka and in certain parts of Indonesia, particularly in the humid high elevations, while its incidence is only moderate or light in other rubber-growing areas of Asia. It finds expression when cloudy days, cool nights and over-hanging mist or light drizzle prevail at the time of refoliation; prolonged rainfall is unfavourable to it. On the other hand, *C. gloeosporioides* is essentially a wet-weather disease defoliating young flushes in immature rubber and causing secondary leaf fall of mature trees if continuous rains are experienced during refoliation. It is therefore important in areas where the annual rainfall is distributed throughout the year, as in many parts of Malaysia and Indonesia.

Leaf fall caused by *Phytophthora* spp. is another of our wet-weather diseases, but SALB cannot be paralleled with it as the former affects only mature leaves. Though Bird's Eye Spot affects immature leaflets and produces similar symptoms as SALB in the early stages, its epidemiology is not tied up with rainfall,

It appears from the foregoing that among the leaf diseases of rubber already present in Asia, the one that is closest in its epidemiology to SALB is *C. gloeosporioides*. However *M. ulmi*, being known to be a much more virulent pathogen, may bring about more serious effects on the host. It can be expected to be as destructive as in the Americas in nurseries and young plantings; only the flushes developing during dry weather could possibly escape it. The severity of secondary leaf fall in plantations brought to maturity would depend a great deal on wintering characteristics of the clone, in addition to weather conditions at the time of refoliation. For example, in Malaysia, clones that generally winter early and regions where dry weather sets in a little earlier than the rest of the country largely escape secondary leaf fall. A more important factor in determining the incidence and severity of SALB is the varying susceptibility of the different clones, in common with *C. gloeosporioides* and our other leaf diseases. Therefore, in research efforts on this

disease, considerable emphasis has been placed on breeding, in order to combine the resistance of some South American clones with the high yield of Asian clones. A complication however is the presence of many strains of the fungus, each with its own clonal preference; it is unpredictable which of the strains would first find its way to Asia.

CONCLUSIONS

The viability of the natural rubber industry in Asia is largely because of its price competitiveness with synthetic rubber; cost of production therefore is a major consideration, needing attention at all times for effecting economies, in order to maintain the healthy state of the industry. An important factor in this economy is the health of the crop itself. Fortunately the diseases of rubber already existing in this region do not generally demand undue attention and expensive control measures. The same cannot be said if SALB were to come to this region. Expenditure for obtaining even a reasonable degree of control would be prohibitive; in addition to direct crop losses. This is the state of affairs that prevails with the natural rubber industry in the original home of *Hevea*, where the crop can only be grown for local consumption.

A strong phytosanitary barrier against the entry of any material of plant origin from tropical American countries and enforcement of strict control on the movement of people between that region and Asia are the only effective means by which SALB can continue to be kept out. Unilateral action by any country or countries in this regard would be futile. Measures for exclusion of the disease and, in the event of detection of an outbreak, emergency action for attempts to eradicate it, are a common necessity and a joint responsibility of the rubber-growing countries of this region. The FAO Plant Protection Committee for South East Asia and the Pacific Region has played an important role in forging this regional approach and bringing about greater awareness among the rubber-growing countries of the need to formulate joint measures for implementation on a regional basis.

ACKNOWLEDGEMENTS

The author thanks the Director and Board of the Rubber Research Institute of Malaysia for permission to present this paper at the International Rubber Conference, Sri Lanka in June, 1973.

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