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REVIEW

PHYTOPHTHORA EPIDEMICS - POSSIBILITY OF MANAGEMENT USING RESISTANT CLONES

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SUMMARY

Diseases on rubber caused by *Phytophthora* spp. occur in Sri Lanka in epidemic proportions from May to September each year when the weather and other factors are conducive to the pathogen. The first out-break of the disease was detected in 1916. Since then several epidemics were reported and the epidemic in 1993 was the highest recorded since 1959.

Copper oxychloride in mineral oil is extensively used in India as a prophylactic spraying in management of abnormal leaf fall. The Rubber Research Institute of Malaysia also recommends spraying of fungicides as a prophylactic measure. During early 1960's it was a practice in Sri Lanka to dust 23 rounds of copper as a prophylactic measure against secondary leaf fall. However, the subsequent research findings of Rubber Research Institute of Sri Lanka clearly showed that the severity and frequency of Phytophthora leaf fall in Sri Lanka does not warrant prophylactic fungicide applications.

However, it should be noted that fungicides are recommended in all rubber growing countries including Sri Lanka to manage black stripe, the second phase of the disease. It has also been shown that improvement of cultural practices are also important in the management of diseases caused by *Phytophthora* spp.

Eventhough most of the clones grown in the past in Sri Lanka were highly susceptible to diseases caused by *Phytophthora*, at present out of the recommended clones only two clones from Group I are susceptible to these diseases. Present replanting trend shows that only the resistant clones are being accepted by rubber growers and it was shown statistically that most of the new clearings in Sri Lanka consist of tolerant clones. Therefore, the chances of epidemics and subsequent yield losses due to Phytophthora diseases are very remote in the future. This is an ideal example where a successful effort was made to eliminate an economically important disease merely by the introduction of resistant clones in the plantation sector.

Key words: bark rot, black stripe, chemical control, Phytophthora leaf fall, resistant clones

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INTRODUCTION

The fungus *Phytophthora* is a genus belonging to class Phycomycetes with world wide distribution and a wide host range including *Hevea brasiliensis* Muell. Arg. There are several diseases of *Hevea* namely, black stripe (Fig. 1), canker (bark rot), abnormal leaf fall (Fig. 2), leaf wither, pod rot and die back of green twigs, seedlings and polybag plants caused by species of the genus *Phytophthora*.

Diseases caused by *Phytophthora* spp. are present in all countries where rubber is grown. The abnormal leaf fall is of a major importance in India, Thailand, China, Sri Lanka, Central and South America. For instance, yield loss of 37.7 to 50.5% was recorded in susceptible clones in India due to Phytophthora leaf fall (Jayaratnam *et al.*, 1987). Black stripe causes a considerable economical loss in Malaysia, Indonesia, Thailand, India, China, Sri Lanka, Indochina and Central and South America. In general, all rubber growing areas in Africa are free from severe *Phytophthora* infection.

More than eight species of the genus *Phytophthora* have been identified as pathogens of *Hevea brasiliensis*. These are *P. meadii* Mc Rae, *P. palmivora* (Butl.) Butl, *P. botryosa* Chee, *P. citrophthora* (Smith & Smith) Leonian, *P. cactorum* (Lebert & Cohn) Schroeter *P. capsici* Leonian, *P. micotianae* Van breda de Haan Var. parasitica (Datsur) Waterhouse and *P. citricola* Sawada. The dominant species in Sri Lanka are *P. meadii* and *P. palmivora*.

All diseases caused by *Phytophthora* spp. require wet weather for best development and production of sporangia which release motile zoospores. Generally these motile zoospores are the infective propergules. Other spore forms are oospores and chlamydospores with thick walls and resistance to adverse conditions.

Predisposing factors

Without doubt wet weather is the major cause of all outbreaks of *Phytophthora* infections. Heavy rainfall during the South West monsoon (May - September), especially if the rains protract over several months predisposes the susceptible clones to heavy infection resulting in epidemics.

Further, it has been clearly shown that there is a direct relationship between pod set and *Phytophthora* incidence. Green pods were found to be the most susceptible to infection. Sporulation was also most prolific on them (Peries, 1969). This accounts for a close relationship between pod set and Phytophthora leaf fall, the pods being infected first and providing the inoculum for leaf infection. This was further confirmed by work of Satchuthananthavale (1970) and Liyanage (1983).

Phytophthora epidemics

Incidence of *Oidium* is an important factor that affects the pod set. *Oidium heveae* affects the flowers and when incidence of *Oidium* is severe there is a marked reduction in the number of pods and consequently less leaf-fall due to *Phytophthora* (Satchuthananthavale & Dantanarayana, 1973).

The formula for forecasting epidemics of abnormal leaf fall postulated by Peries in 1969 states that "if the temperature is not above 20 °C; relative humidity above 80%, at least 0.1 inch of rain per day and less than 3 hours of sunshine per day prevail for 4 consecutive days, when infected fully mature green pods are present on the trees, leaf fall epidemics can be expected to occur within next fourteen days". Satchuthananthavale and Dantanarayana in 1973 suggested that daily rainfall is more important in governing the severity of the disease during the period when mature pods are present in the field.

Disease history

According to Petch (1921) the fungus *Phytophthora* has been first detected in Sri Lanka on rubber pods in 1905. In 1921 Petch suggested that two species of *Phytophthora viz P. faberi* and *P. meadii* could cause abnormal leaf fall, occur in S. India, Ceylon and Burma. He also stated that the leaf fall cased by *P. meadii* resulted in more damage and greater reduction in yield than by *P. faberi*.

Since its first detection in Sri Lanka the disease has been reported annually in endemic proportions from May to September in each year reaching epidemic proportions when the weather and other factors are conducive to the pathogen. The first outbreak of the disease was detected in 1916 on susceptible clones. The next epidemic of *Phytophthora* leaf fall (PLF) occurred for three consecutive years commencing in 1922. Since then PLF reached epidemic proportions once in 5-6 years till 1959. It is worthy to note that diseases caused by *Phytophthora* remained mild or moderate for 20 years from 1960 to 1979. The first outbreak after 1959 occurred in 1980 and subsequent epidemics took place in 1988, 1992 and 1993 (Figure 5). However, the 1993 epidemic was the highest recorded since 1959.

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Management strategies in South East Asia

Abnormal Leaf Fall caused by *Phytophthora* spp. is the most devastating leaf disease of rubber in Southern India (McRae, 1918; Petch, 1921; Radhakrishnapillay 1977) and most damaging disease of nurseries and mature rubber in Burma (Turner & Myint, 1980). It causes massive defoliation under favourable weather conditions in South Thailand and in the northern parts of West Malaysia (Tan, 1979).

Copper oxychloride in mineral oil is extensively used in India as a prophylactic spraying in management of Abnormal Leaf Fall. One application not more than six weeks before the on set of the monsoon is recommended using 6 kg *a.i.* copper oxychloride in 30 litres of agriculture spray oil per ha. The spraying is done routinely in India using helicopters on the larger estates and using mist blowers in small holdings. It has been shown that 9 to 16% yield loss in susceptible clones of 10-25 years of age can be encounted when prophylactic spraying is skipped for one season (Jacob *et al.*, 1989).

The Rubber Research Institute of Malaysia also recommends spraying of fungicides as a prophylactic measure in management of PLF. For aerial application, the rate used is 6 kg *a.i.* copper oxychloride in 25 l of oil/ha and with minimicron sprayers the rate of application is 3.5 kg *a.i.* copper oxychloride in 25 l of oil/ha. However this is not practiced by the growers routinely in Malaysia as in India.

During early 1960's it was a tradition in estates managed by Agency Houses in Sri Lanka to dust 23 rounds of copper at a rate of 6 kg of copper per ha during South West monsoon period. Subsequently extensive research programmes were launched to review this tradition and it was concluded that the severity and frequency of Phytophthora Leaf Fall in Sri Lanka does not warrant extensive control measures annually (Lloyd, 1963; Peries, 1965).

Black Stripe, the second phase of disease can cause serious damage especially in areas with high rain fall and constantly high relative humidity. Such periods occur in some parts of Burma, India, Thailand, Indonesia, Malaysia and Sri Lanka. Damage can be severe in these places unless prophylactic measures are practiced.

Over the years various fungicides have been used successfully as a prophylactic measure by growers in all rubber growing countries. These fungicides are recommended for use during the *Phytophthora* season when leaf fall and infected pods are present. This treatment should begin with the onset of wet weather and continue until the end of rainy season. The present recommended fungicides include 0.8% *a.i.* captafol, 0.2% *a.i.* metalaxyl (Tan, 1983); 15% brunolinum plantarium, 0.4% metalaxyl oxadixyl in a paste (Liyanage, 1983) and 0.8% mancozeb (Edathil *et al.*, 1988). More recently trials carried out in Malaysia showed fungicides, 0.4%

(Propineb 56% + Oxadixyl 10%), 0.4% (Oxadixyl 10% + Mancozeb 56%) and 0.2% (10% metalaxyl and 40% folpet) in 3% methycellulose solution applied at weekly intervals were effective in controlling the disease (Tan, 1989).

Besides chemical control, management strategies are also dependent on cultural practices as development of the disease is governed by the environmental conditions. It is important to ensure that wet trees are not tapped during monsoon season, when infected pods are also present on trees. In Burma, India and Sri Lanka Black Stripe incidence has been reduced from severe to negligible levels entirely by careful supervision of tapping, confining it to dry days during the monsoon (Radhakrishna Pillay, 1969; Peries, 1986).

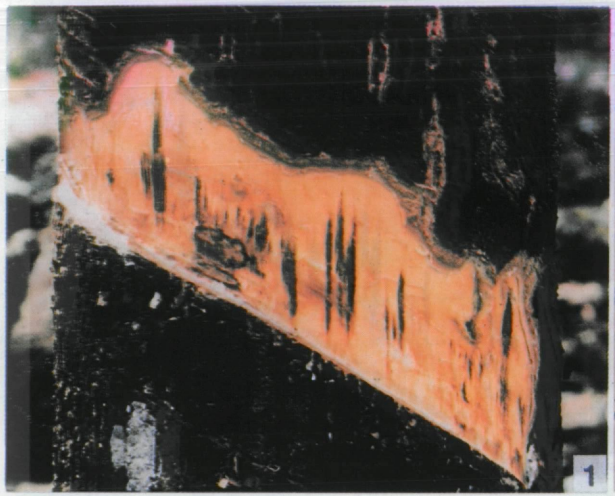
Other precautions in the same vein are careful weeding, tree grooming to remove moss and selective branch pruning to reduce humidity. It was not allowed to open tapping panels or change panels during disease period as virgin bark is highly susceptible to Black Stripe. It is worthy to note that severe black stripes were detected even on the tapping panels of the clone RRIC 100 (one of the highly resistant clones) where tapping commenced during the recent *Phytophthora* epidemic in Sri Lanka (Figure 4).

Fig. 1 Characteristic symptoms of the bark rot or black stripe disease on clone PB 86. Note that the infected bark has been removed to show black stripes.

Fig. 2 Severely defoliated tree due to Phytophthora of a susceptible clone. Note the large number of rotted pods where the inoculum develops.

Fig. 3 Appearance of resistant and susceptible clearings in a same locality during the Phytophthora epidemic in 1993. Note the heavy canopy in the resistant clone RRIC 100 (left)

Fig. 4 Black stripes symptoms on the tapping panel of a resistant clone (RRIC 100) where tapping has commenced during Phytophthora season.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Clonal susceptibility and potential threat to Sri Lanka in future

Most of the clones grown in the past were highly susceptible to diseases caused by *Phytophthora*. For instance well accepted clones in the past namely AVROS 352, LCB 870, RRIM 600, RRIM 623, RRIC 36, RRIC 45, PB 86, Tjir 1 and PB 28/59 were severely affected by abnormal leaf fall and bark rot.

However, it is worthy to note, that only two clones namely PB 28/59 and RRIC 121 from Group 1 presently recommended for planting are susceptible to diseases caused by *Phytophthora*. Further, recent studies show that though RRIC 121 is highly susceptible to abnormal leaf fall it can withstand black stripe disease just like any other resistant clone (Jayasinghe & Wettasinghe, 1992).

The present replanting trend shows that only the resistant clones such as RRIC 100 (Fig. 3) and RRIC 102 are being widely accepted by the growers. For instance, as shown in Figures 6 and 7, during replanting the highly susceptible clone PB 86 is being replaced at a considerable rate by the newly recommended RRIC series clones ever since 1980. During the year 1993 in the smallholder sector only around 5% of replantings were carried out with the susceptible clone PB 86 whereas 91% of the replantings were with PB 86 in 1988 (Figure 6). With regards to the estate sector, by the year 1985 the planting of susceptible clone PB 86 has dropped to 10% (Figure 7) and presently no planting is undertaken with the susceptible clone PB 86. On the light of this situation with time to come there will be a marked reduction in the extent of *Phytophthora* susceptible clones throughout the Island.

Fig. 5 The incidence of Phytophthora leaf fall from 1905 todate (Modified after Lloid 1965)

Fig. 6 Percentage of susceptible (PB 86) and resistant (RRIC 100) clones grown in smallholdings during recent past. Note: the drastic reduction of the cultivation of susceptible clone PB 86. (source: Rubber Control Department and Advisory Services Dept.)

Fig. 7. Percentage of susceptible (PB 86) and resistant (RRIC 100, RRIC 102 and RRIC 103) clones grown in 1979 to 1985 in State Plantations. Note: the drastic reduction of the cultivation of susceptible clone PB 86 (Source: Liyanage *et al.*, 1989)

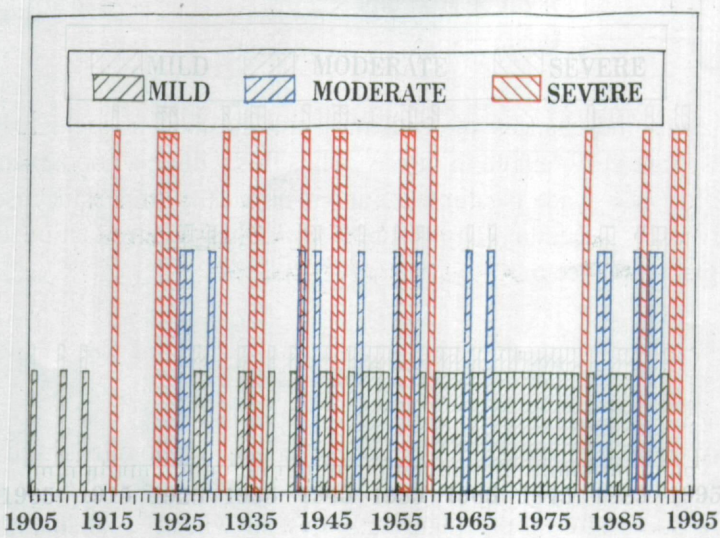

Fig 5

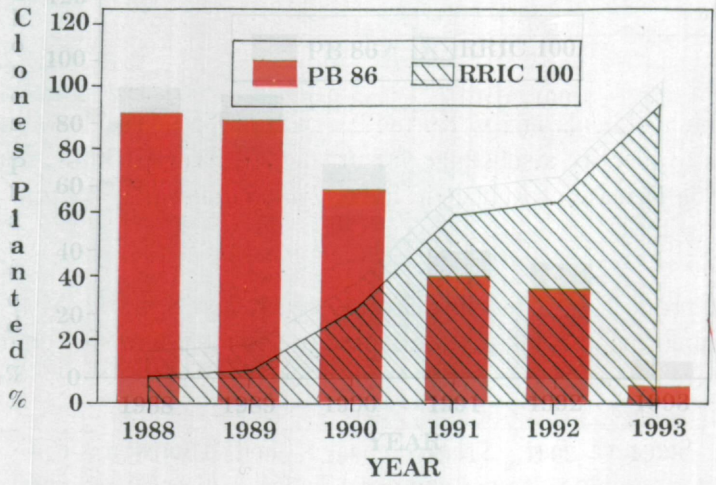

Fig 6

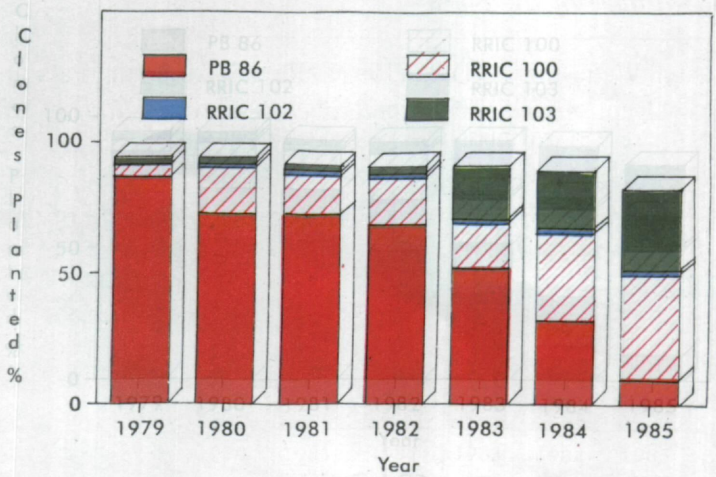

Fig 7

Therefore it seems the chances of epidemics and subsequent yield losses due to *Phytophthora* sp. are very remote in future. Thus this will be a good example where a successful effort was made to eliminate an economically important disease which first appeared nearly a century ago, merely through the introduction of resistant clones in the plantation sector.

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