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PRINCIPLES AND PRACTICES OF PREVENTING AND CONTROLLING RUBBER DISEASES IN SRI LANKA

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ABSTRACT

Rubber plants in Sri Lanka are susceptible to several diseases of economic importance. The most damaging canopy diseases are the leaf falls caused by the fungi *Corynespora, Oidium, Phytophthora* and *Colletotrichum*. Significant root and panel diseases include white root and black stripes respectively. The yield losses caused by these diseases are a key factor affecting the national productivity. In this presentation principles and disease management strategies are reviewed emphasizing current practices in Sri Lanka. Importance of the adaptation of correct cultural practices and use of the genetic resistance in disease management have been highlighted, as rubber is a marginally profitable crop today.

Key words: biological control, chemical control, correct cultural practices, disease management, *Hevea brasiliensis*, plant quarantine, resistant clones

INTRODUCTION

In Sri Lanka, rubber cultivations are affected by a number of diseases. The severity of each disease varies according to the prevailing climatic conditions, locality and cultural conditions under which the crop is grown. Planting monoclone blocks of high yielding new clones resulted a tremendous improvement in productivity. At the same time some of these breeds succumbed to new diseases changing the disease scenario of the rubber tree.

Leaf diseases are mostly associated with abnormal or secondary leaf fall of mature or immature leaves. *Corynespora* leaf fall (CLF), a foliar disease with relatively a recent origin has now become a grave threat to the natural rubber industry in the island. Two outstranding clones namely RRIC 103 and RRIC 110 have already succumbed to the disease resulting die-back symptoms. The other economically important canopy diseases are *Oidium* leaf disease, *Colletotrichum* leaf disease and *Phytophthora* leaf fall. Bird's eye spot disease is found only in nursery plants. Presently stem and panel diseases do not pose a threat to the rubber plantations. Black stripe or bark rot is the most common panel disease and stem diseases namely *Ustulina* stem rot and pink disease occur sporadically. The most economically significant disease next to CLF is the white root disease (WRD). Today nearly 4% of the cultivated rubber lands are affected with this disease and management of WRD still remains cumbersome. Black root disease is limited to relatively dry areas and no significant crop loss is reported due to it.

Several successful methods have been developed in controlling all economically important diseases based on the observations of experiments carried out nearly for a century by the *Hevea* Pathologists. Each method to be employed depends on (a) epidemiology and biology of the pathogen, (b) prevailing climatic conditions, (c) severity of the disease, (d) economic loss due to the disease and (e) cost involved in the operation.

In this presentation principles and management strategies of the control of rubber diseases are reviewed, emphasizing current practices in Sri Lanka. A special effort is made to highlight the importance of the adoption of correct cultural practices and use of genetic resistance in disease management as cultivation of rubber is a marginally profitable venture today.

Chemical control

The most popular method of controlling rubber diseases in the past in Sri Lanka was the use of fungicides (Table 1). Chemical control was widely accepted since the beginning of the 20th century without paying much attention to the economic benefits, health hazards and environmental pollution. However these chemicals effectively destroyed the fungus eliminating the disease.

Table 1. *Old recommendations in management of rubber diseases*

Disease	Recommendation
Oidium leaf disease	Dusting of sulphur throughout the refoliation period in all rubber growing regions in Sri Lanka. 8 kg of S/ha/round. Usually 10-12 rounds during the *Oidium* season.
Phytophthora leaf fall	Dusting of copper powder. 140 kg of Cu/ha during May to September in 24 rounds.
Colletotrichum leaf disease	Spraying copper or organo mercurial fungicides during wet weather.
Black stripe	Routine application of panel dressings; Antimucin, Filomac 90, Difolatan or Brunolinum
White root disease	Application of a collar protectant containing pentachloronitrobenzene/grease based Fomac 2.

Today use of fungicides to control leaf diseases is generally confined to the nurseries and immature clearings. Canopy disease management using chemicals encounter several limitations. The major problem faced is the low economic benefits as rubber cultivation is not economically attractive today. The height of trees and hilly terrain of the rubber lands pose further limitation to the spraying or dusting of chemicals demanding high powered costly machinery. Difficulties encountered in prediction of disease epidemics also play a significant role in canopy disease management as most of the recommended chemicals have preventive rather than curative effect. However, application of chemicals to avoid black stripe during South-West monsoon period and use of fungicides to manage white root disease are being continued.

Table 2. *Present recommendations in chemical control*

Leaf diseases in nurseries	Routine spraying of fungicides from group I and group II alternatively. Group I fungicides; mancozeb, benomyl, captan, propineb. Group II fungicides; Cu based chemicals. Application of sulphur dust or wettable sulphur during January to March is also recommended if nurseries are affected with *Oidium* leaf disease.
Leaf diseases in immature clearings	Systemic or Cu based fungicides depending on the climatic conditions and the severity of the disease.
Canopy diseases of mature clearings	Presently chemical application is recommended to control *Oidium* leaf disease only at higher elevations (above 90 m). Sulphur dust is recommended at a rate of 8 kg/ha/round. The number of dusting rounds, depends on leaf maturity.

Stem diseases	Prophylactic application of phenolic compounds/fungicides containing metalaxyl or mancozeb only during South-West monsoon to avoid black stripe. Use of "Bordeaux mixture" or commercial products with tridemorph in the management of pink disease. Application of thiram, benomyl, carbendazim or thiophanate methyl in a petroleum wound dressing after the surgical treatment in the case of treating dry rot caused by *Ustulina deusta*.
Root diseases	Application of collar protectants containing phenol after removing the fungal mycelia on the root system to manage white root, black root and brown root diseases. Drenching of systemic fungicides with tebuconazole or hexaconazole to control white root disease. Sprinkling sulphur (110 g) on the surface of the soil around the plant just after planting to minimise the white root disease incidence.
Mechanical damages	Use of petroleum by-products as wound dressings to protect the exposed surfaces after applying phenolic fungicides.

Breeding for resistance

The economical and most appropriate approach to manage diseases in rubber plantations is the use of clones resistant to diseases (Table 3). Present day attitude is to select plants not only resistant to a wide range of races of a particular pathogen (HR) but to several different genera. Even today no breeding programmes have been designed specifically to produce disease resistant material anywhere in the rubber growing countries. Conventional selection for resistance is being practiced after establishing trials in disease prone areas. However, damage caused by panel diseases and most of the canopy diseases have been reduced to uneconomical levels in Sri Lanka mainly by selecting clones resistant to those diseases. At present less emphasis is drawn for the development of genetical resistance for root diseases as root – stocks of rubber plants arises from a genetically heterozygous population.

The disadvantage of breeding for resistance is that the dynamic changes of the pathogen may interfere with the long lasting resistance of this perennial crop resulting the breaking down in disease tolerance. An ideal example of this is the recent (1995) *Corynespora* leaf fall (CLF) epidemic on the clone RRISL 110. The outstanding rubber clone, RRIC 110 which succumbed to CLF in 1995 was a resistant clone in 1985 when CLF was first detected in Sri Lanka.

Table 3. *Clonal susceptibility to rubber diseases*

Oidium leaf disease

Late wintering clones namely RRIC 45, RRIC 121, PB 28/59, RRIM 712 generally succumb to the disease. The clones such as RRIC 100, RRIC 102, RRIC 130 and RRIC 203 are resistant to the disease. The clone PB 86 also generally escapes the disease as it winters early.

Colletotrichum leaf disease

Rubebr clones; RRIC 100, RRIC 102 and RRIC 130 are resistant to the disease while PB 86 and RRIC 45 succumb to the disease.

Phytophthora leaf disease

A marked variation in disease susceptibility is noticed for *Phytophthora* leaf fall. The clones such as RRIC 100, RRIC 102 and RRIC 130 are highly resistant while RRIC 121, PB 86, RRIC 45, RRIC 203 and RRIM 600 succumb to the disease severely during epidemics.

Corynespora leaf disease

All highly susceptible clones have now been removed from the plantations and the clone recommendation, e.g. RRIC 103, RRIC 52, RRIM 725, RRIC 110 and Tjir 1. All the other clones presently recommended are either immune or tolerant to the disease in the field. However, polybag plants of all clones and seedlings succumb to the disease in nurseries.

Black stripe

Clones namely PB 86, RRIC 45, RRIM 600, RRIC 130 are susceptible while RRIC 100, RRIC 102, RRIC 121 tolerate the disease.

Adoption of correct cultural practices

Valuable recommendations on correct cultural practices have been provided by the Rubber Research Institute of Sri Lanka (RRISL) since it's establishment in early 1930's (Table 4). Most of these recommendations are very simple, inexpensive and easy to follow. However, some of these valuable recommendations are not being followed by the growers. This may be due to negligence, lack of awareness or economic reasons. This non-adoption of recommended practices results in unexpected problems leading to total destruction of field plants and nurseries.

Table 4. *Cultural practices recommended by the RRISL in order to raise quality nursery plants and prevent rubber diseases in the field*

Recommendation	Benefits encounted
Use of river sand instead of top soil with organic matter for the establishment of seed germination beds.	Prevents the hypocotyl rot in germinating seeds.
Removal of the germinated seeds from the seed germination beds with the appearance of radical.	Minimises the chances of collar rot and target leaf spot disease.
Preparation of beds for seedling nurseries without root debris and decaying organic matter.	Protects the seedlings from White root disease and *Geotrichum* associations.

Increasing the distance as much as possible between plants in polybag nurseries.	Reduces the incidence of *Oidium*, *Phytophthora*, *Corynespora*, *Colletotrichum* diseases.
Regular weeding of the nurseries and immature clearings	Avoids die-back of plants and target leaf spot disease
Adequate and timely watering during dry weather conditions	Saves the seedlings and polybag plants from foot canker and sudden wilt.
Selection of proper sites for the establishment of nurseries	Minimises *Oidium*, *Phytophthora*, *Colletotrichum* and *Corynespora* attacks.
e.g. Sites not adjoining to mature plantations; places where mist is not accumulated; localities with full exposure to sunlight.	
Judicious removal of the shade in polybag nurseries	Protects the plants from common nursery pest and diseases.
Thorough clearing of the uprooted areas and removal of all infected root debris.	Prevent white root disease in mature clearings.
Demarcation of the "Fomes" patches in the old clearings before uprooting.	Provides an opportunity to pay special attention to potential sites of infection.
Planting budded stumps without damaging the tap roots.	Keeps the plants free from wilt caused by *Fusarium*
Avoiding the South-West monsoon period (specially in *Phytophthora* epidemic years)	Reduces the black stripe incidence
(a) in the commencement of tapping new clearings and	
(b) during the changing the tapping panels, specially BO-1 to BO-2.	
Careful weeding, grooming trees to remove moss and pruning selected branches during SW monsoon to minimise the humidity and encourage the rapid drying.	Reduces the black stripe incidence
Making sure that wet trees are not tapped specially during SW monsoon period in *Phytophthora* epidemic years.	Reduces the black stripe incidence
Timely application of correct dose of fertilizer	Protects the canopies from leaf diseases by increasing the vigor and accelerating the maturity of leaves during refoliation
Establishment of cover crops.	Accelerates the decay of root debris and dissipates the inoculum in the clearings with "Fomes" infections.

Biological control

In general, biological control is interpreted as the reduction in the incidence of disease caused by the pathogen through an agency of any other living organism. In some cases antagonists to pathogens are added to the environment, in other cases the environment is modified to favour antagonists. Biological control offers an alternative to the traditional chemical-based control of agricultural pests. The microbial agents used in biological control are safer to handle, specific to target species, no toxic chemicals are involved and can be produced at low cost. They are therefore ideal for integrated pest management strategies.

Decades of research led by the Pathologists have provided a wealth of information on biology and epidemiology of the *Hevea* pathogens. Successful biological control measures have been developed to control several economically important rubber diseases based on these information. Classic examples of this are the management of white root, abnormal leaf fall and black stripe diseases.

Management of white root disease

(a) In the management of white root disease an environment is created by adding 'S' (sprinkling of 110 g of S to the soil around planting hole) that is more conducive to the antagonist flora in the soil.

(b) Accelerate the decay of food bases by [I] enhancing the growth of wood decaying flora by introducing urea/borate/2.4.5.T and [II] allowing cover crops to spread.

Prevention of abnormal leaf fall and black stripe

Restricting *Oidium* leaf disease control in the months of January and February. The fungus infects flowers resulting in poor pod set. This prevents the build up of required inoculum potential to cause *Phytophthora* epidemics in May to September.

Plant quarantine

Rubber plantations in Sri Lanka are free from several serious pests and diseases which affect rubber in other countries specially in South American region (Table 5).

Enforcement of strict regulations with the view of preventing the introduction of unwanted exotic pests is the principle involved in "Plant Quarantine" (PQ). PQ to be fully effective, team work is essential at the outer perimeter of the island. This team work involves Custom Officers as well as Quarantine Officers. It is a well-accepted fact that quarantine is the best management strategy against exotic pests as once a new pest is established it is difficult, if not impossible to eradicate it.

In Sri Lanka, strict phytosanitory regulations have been enforced to the extent that no any plant or part of a plant originating in American Tropics are allowed into the country. These measures have been implemented mainly to protect the rubber plantations from the pests of South American origin specially from *Microcyclus ulei*, the causative fungus of South American leaf blight.

Table 5. *Pests and diseases of quarantine importance to Sri Lanka*

Name of the disease	Causative	Present distribution
South American leaf blight	*Microcyclus ulei*	Tropical America
Target leaf spot	**Thanatephorus cucumeris*	Tropical America
Black crust	*Phyllachora huberi*	Tropical America
Fusicoccum leaf blight	*Fusicoccum* sp.	Malaysia
Phytophthora leaf wither	*Phytophthora capsici*	Tropical America
Mandarova attack	*Erinyis ello*	Tropical America
Lace bug attack	*Leptopharsa heveae*	Tropical America

*The pathogen was reported from several Asian countries including Sri Lanka recently

Plant Protection Ordinance No. 10 of 1924 (New ordinance – Plant Protection Act No 35 of 1999) provides access for the protection of Sri Lankan territory against unwanted exotic pests. According to the Regulation 2(I) of the Part I, importation of any plant or part of a plant capable of further growth or propagation and originating in the American Tropics or in any other country where South American Leaf Blight occurs is prohibited. This regulation provides the legal basis to avoid possible contamination of Sri Lankan territory through infected or contaminated planting material from American Tropics.

Artificial defoliation

A technique of artificially defoliating susceptible clones prior to normal wintering has been developed in Malaysia in order to reduce secondary leaf fall incidence. This process encourages trees to refoliate earlier than normal when the weather is not conducive to the pathogen and before the development of high level of inoculum potential. In Sri Lanka it was shown that defoliant, triclopyr could be used for this purpose at a concentration of 400 g of the chemical in 40 litres of diesel/ha.

Crown budding

Crown budding (tri part tree) is an ideal solution for the clones with high yielding trunks but severely susceptible to one or several leaf diseases. Introduction of resistant crowns to disease susceptible high yielding clones has been used on a large scale in Brazil as a management strategy for South American leaf blight.

In Sri Lanka this technique was recommended in 1987 to save the trunks of the prestigious clone RRIC 103 when it succumbed to *Corynespora* leaf fall. During CLF epidemic it was noticed that a significant percentage of trees affected with the disease was in the age group of 2-3 years. At this stage crown budding was the only option available for the introduction of resistant genetic material to the susceptible field plants.

Unfortunately this technique did not gain popularity during that time probably due to lack of experience, practical difficulties and also due to the unavailability of information on trunk/crown interactions.

CONCLUSIONS

The yield losses caused by diseases is a key factor affecting the national productivity level of rubber cultivations. Use of chemicals, most widely accepted pest control strategy worldwide alone does not appear to be an ideal solution in the management of rubber diseases. Low economic benefits, environmental and health hazards and practical difficulties encountered discourage the chemical control of canopy diseases in this 20-30 m high, perennial crop with dense canopies cultivated mostly in hilly terrains. With this background a combination of crop sanitation, disease resistance, cultural, biological, quarantine and chemical procedures are now being recommended for management of maladies of the rubber tree in Sri Lanka. It was shown that this integrated approach minimises the disease incidence at a very low cost with minimum damage to the environment. The methods described in this presentation to control several diseases involve no cost at all.

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