BIOLOGICAL CONTROL OF THE DISEASES OF THE HEVEA RUBBER TREE

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INTRODUCTION

It is important to define what is meant by "biological control of plant diseases", before setting out to describe the efficacy of such systems developed for any crop plant. Most plant diseases are caused by fungi; and the usual method of controlling such diseases is to use a fungicide, which will effectively kill off the fungus, eliminating the disease. However, there are other methods of controlling plant diseases or reducing their economic effect, so that the damage caused is minimal and monetary losses are contained. The use of resistant plants, adjusting planting date or depth of planting, so as to reduce disease incidence (disease escape), applying the knowledge available on the factors leading to disease severity to avoid plant disease epidemics, reducing the inoculum potential of the pathogen by various devices to reduce infection, altering the soil organic matter content or reaction, so as to create conditions inimical to the pathogen and all other devices that can be used to reduce or eliminate the use of fungicides, can be regarded as biological means of controlling diseases. We will use this broad concept of the subject, in this paper, in order to describe the many facets of this interesting problem, as it applies to the rubber industry, pointing out the success we have achieved, by intensive study of simple ideas and fitting the data on to a larger canvas, to find solutions to the original question.

The rubber tree (Hevea brasiliensis, Muell.Arg.) is susceptible to a number of diseases, like most other crop plants. The diseases of economic importance of this tree in Sri Lanka are the following, grouped according to the parts of the plant affected by each disease:

Root – white root and black root disease, caused by Rigidoporus lignosus and Xylaria thwaitsii, respectively.

Stem and bark – bark rot and die back, caused by Phytophthora meadii

Leaf – Oidium leaf disease, caused by Oidium heveae, Phytophthora leaf fall caused by Phytophthora meadii and Gloeosporium leaf disease caused by Colletotrichum gloeosporioides

Intensive studies have been carried out on all these diseases by the Rubber Research Institute of Sri Lanka (RRISL) and, in nearly all cases, successful methods for their biological control have been developed, based on data gathered on the biology of the causal fungus of each disease, its methods of infection and spread in the field, and the effect of weather conditions on the severity of the disease. These methods have been tried and tested over several years, generally from about the early 1960s, so that we now spend very little money on the control of the diseases of the rubber tree. This is one of the important factors that has contributed to the survival of the rubber industry in Sri Lanka; as costs of disease control have been reduced from about =/12 cts per kg of dry rubber produced, to about half a cent per kg.

ROOT DISEASES

There are several root diseases affecting rubber trees in different countries, but the only one of economic importance in Sri Lanka is white root disease, caused by the fungus R. lignosus. This is considered to be the most important disease of rubber today (Liyanage, 1977a). Black root disease, caused by X. thwaitsii occurs only in certain parts of Sri Lanka, mainly in the Kegalle District. This is as virulent a disease as the former; but due to its restricted distribution it is not as important. Essentially the same methods are recommended for the control of both diseases, so that only white root disease will be described in detail here. Both diseases are essentially replant diseases ie. their incidence creates a problem mainly in replanted areas.

Elimination of inoculum

The fungi R. lignosus, is a weak parasite, in the sense that it requires a large source of inoculum, usually an infected old root, to cause infection of a new plant. Therefore, one of the classical methods of controlling this disease was to prepare a disease free area for planting rubber, by uprooting and burning all roots infected by root diseases at the time of planting. All vegetable matter rots after a certain period of burial in the soil. Therefore, the same result as uprooting and burning can be achieved by leaving the soil fallow for 1-2 years before replanting, so as to enable infected roots time to rot. The same result can be achieved by another neat method by changing the planting position at each round of replanting. This gives time for infected roots of the previous trees to disintegrate before the roots of the new replants reach them (Liyanage et al, 1984).

Intensification of rotting

We have also found that any method of encouraging the rate of rotting of old infected roots, in replanted areas, reduces the incidence (Liyanage & Peries, 1984) of white root disease (Liyanage & Peries, 1983). Two methods are usually recommended; (a) the use of various chemicals on the cut surfaces of tree stumps eg urea, borates and certain hormones, (b) the growth of legume ground covers in replanted areas, which apparently encourage the growth of wood rotting fungi and bacteria (Liyanage, 1980). This method also depends on the principle that a large source of innoculum is necessary to cause infection and contact must be established between the healthy root and the fungus, for infection to take place. Therefore, the more rapid the rate of wood rot, the less chance there is for contact between healthy roots and the pathogen before the source of innoculum becomes too small to support an infection.

Soil amendment

The composition of the soil microbial content can be altered by various methods such as altering the soil reaction, its nutritive content or its organic matter composition. The RRISL recommends the use of approximately 110 g of sulphur per square metre of soil surface in infected sites, to reduce the incidence of this disease (Peries et al, 1964). The addition of sulphur rapidly increases the acidity of the soil and increases the population of Trichoderma spp. and Penicillium spp. in the soil. Both these fungal species are antagonistic to the pathogen and reduces disease incidence in high risk areas. Sulphur is very expensive now, and its use is recommended only in areas where the old rubber stand showed a high incidence of white root disease (Peries & Liyanage,1983).

STEM AND BARK DISEASES

The only stem and bark diseases of any significance on Hevea in Sri Lanka are stem die back of young plants and bark rot of mature trees, both caused by P. meadii. Both these diseases have been successfully controlled in our country by biological means. The main source of infection by P. meadii is the zoospore, which is produced almost entirely on mature rubber pods. Our strategy to reduce disease incidence is to reduce pod set in rubber trees to a bare minimum, just sufficient to produce enough seed for the rubber stock nurseries. This happy situation is achieved by the judicious control of Oidium leaf disease. The causal fungus of this disease, O. heveae, also infects rubber flowers. Therefore, by reducing the intensity of Oidium control, and letting the fungus, infect a majority of rubber flowers, we have reduced pod set and thereby reduced the substrate on which P. meadii can grow and sporulate (Liyanage & Peries, 1983 b). This strategy has enabled us not only to reduce expenditure on Oidium leaf disease control, but virtually eliminate the necessity to control Phytophthora die back and bark rot.

In the rare cases where shoot die back of young plants does occur now, we have found that it is more important to pick off the rubber pods from the mature trees surrounding the young replanted area rather than use fungicides to control the disease on affected plants. The incidence of this disease is rare at present; because estate managers are alive to the fact that young plants should not be placed in the shadow of mature trees, bearing large numbers of infected pods, and take necessary action to avoid this.

The use of fungicides, for the control of bark rot, has practically been eliminated since the mid - 1960s in Sri Lanka; because, in addition to the reduction in pod set, the RRISL has insisted that rubber trees should not be tapped soon after rain, when there are pods infected by P. meadii on the trees (Peries, 1975). This is because there is always the possibility that the zoospores of the fungus will swim down to the tapping cut, in the surface moisture, and cause bark rot infection, if tapping is done before the moisture dries off the surface of the tree. This advice and its acceptance by rubber growers has made bark rot of rubber trees an unusual sight in Sri Lanka - a far cry from the situation in the 1950s, when all estates used bark rot fungicides as a routine measure on all mature clearings.

LEAF DISEASES

There were three leaf diseases of Hevea of economic importance in Sri Lanka up to mid - 1960s; however, now except for Gloeosporium leaf disease, which causes some concern in wet years on young replanted rubber, these diseases cause no economic damage in this country any longer. This satisfactory position has been achieved by the development of biological methods of control that keep their incidence at sub-economic levels.

Oidium leaf disease

The most important methods of controlling Oidium leaf disease in Sri Lanka are: (a) the use of disease tolerant clones and (b) the restriction of rubber planting to areas below 300 m above mean sea level. This together with the fact that we have found that, the incidence of Phytophthora leaf, bark and stem diseases can be kept down to satisfactory levels by allowing a large proportion of flowers to be infected by this pathogen and thus abort themselves, has helped us eliminate the expenses on Oidium control.

The clones like Tjir 1 and BD 5, which were popular in Sri Lanka up to the early 1950s had thin cuticles and the new leaf surfaces took a long time to harden after bud-burst. This allowed the conidia of the pathogen ample time to germinate on the leaf surfaces, penetrate into the leaf and establish infection. The most popular clone, used in the early days of the rubber replanting subsidy scheme (RRSS), started in 1953, was PB 86. The leaves of this clone have a thicker cuticle and one of its most important characteristics is the rapidity with which leaf fall is followed by refoliation and the hardening of the cuticle after wintering. The new leaves of PB 86 reach maturity in about 7 days compared to about 10-14 days in clones like Tjir 1 and BD 5. Therefore, sulphur dusting is not required to control Oidium on clone PB 86, at sea level and elevations up to 2-300m above mean sea level.

The pathogen causing Oidium leaf disease grows best under conditions of high humidity, temperatures slightly lower than normal for the wet low country areas i.e. at 25-28°C, low light intensities and the absence of prolonged rainfall. Therefore, the disease caused by O. heveae is more virulent in areas where there is heavy mist in the mornings, occasional showers in the evenings with clear nights and slightly lower temperatures: conditions more likely to occur at higher elevations, above 300 m, than at sea level or the low country elevations. These are the reasons why the RRISL recommends that rubber be planted at elevations below 300 m above mean sea level. However, the new clones developed by the RRISL, particularly RRIC 102, with leaves which mature rapidly after wintering, and a cuticle, thicker than PB 86, can be planted successfully at higher elevations like Gampola and the lower reaches of Badulla District (Fernando, personal communication).

Phytophthora leaf disease

The most important factors that led to the recommendation made by the RRISL that *Phytophthora* leaf disease does not warrant the use of control methods under Sri Lankan conditions were: (a) the causal fungus sporulates mainly on rubber pods and pod set can be reduced by a reduction in the intensity of *Oidium* leaf disease control (b) the weather conditions in Sri Lanka during the rubber seeding season, with bright, hot, sunny days occurring between the rainy spells, were not conducive to the development of *Phytophthora* leaf disease epidemics (c) the loss of a few leaves from the rubber tree, due to *Phytophthora* infection, did not cause any deleterious effects on yield; as most rubber trees produced an excess of leaves (Peries et al, 1964; Liyanage, 1976). These simple pieces of information were put together and the RRISL advised all rubber growers, as far back as 1963 that the damage caused by this disease did not warrant the adoption of control measures. This recommendation has saved the rubber growing industry millions of rupees, and, in fact, the industry would not have been viable in this country, if this disease had to be controlled by the use of copper fungicides.

Gloeosporium leaf disease

This disease is of minor importance in Sri Lanka, compared to its considerable importance in Malaysia. It causes occasional concern in wet years in both immature rubber and mature rubber, the latter only immediately after refoliation. The damage done to mature trees is often limited; as the loss of a few leaves from the large number set after wintering is of no consequence. However, the loss of a whole whorl of new leaves from an immature plant, can cause concern. Many of the new RRIC clones, particularly RRIC 102, are tolerant to *Gloeosporium* leaf disease, and as these clones are now being recommended for planting almost exclusively in the replanted areas, the damage done by this disease can be expected to tail off in the future.

DISCUSSION

The results of long years of studies, which have been summarised here, in a simplified form, show that biological methods of disease control can be developed for many crops, by careful study of the biology of the fungal pathogens and the host plant. Often, control of diseases is based on simple observations of day to day growth of the host and pathogen and their interaction with each other. The example of the control of *Phytophthora* leaf and bark diseases is important here. The effect one disease has on the incidence of another, several months later, is interesting.

The control of white root disease of rubber by purely biological means is one of he most important developments in plant disease control achieved by the RRISL. This shows that critical developments in science can be made by local scientists by conscientious effort. We trust that this will encourage more research workers to expend their efforts in this country, to produce satisfying results both for themselves and their own land.

The work described here also shows the value of research to an industry. The rubber industry would have found the economics of production untenable had the many diseases now being controlled by biological means to be controlled chemically.

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