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THE CONTROL OF WHITE ROOT DISEASE IN SRI LANKA

BY

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INTRODUCTION

The most important root disease of *Hevea* in Sri Lanka is caused by the fungus *Fomes lignosus* (Klotch), it is popularly known as White Root Disease. The fungus is of great economic importance as it causes heavy losses in immature replantings and sometimes in mature areas.

In the early studies on root disease control, it was established that the disease originated from infected trees and stumps. Petch (1921) recognising the need of a food base for the establishment of the infection, advocated the removal of all *Fomes*-infected trees and stumps for the control of the disease. However, the infected trees were detected only at a late stage of development. Napper (1932) brought a major change in this method of control. He found that the epiphytic mycelium of *Fomes lignosus* extends ahead of its penetration and, based on this character, he was able to locate the diseased trees by tree to tree collar examination at frequent intervals. When a tree was detected with fungal strands at the collar, the food base was traced and eradicated along with infected parts of the root system. Further, the exposed healthy part of the root system was painted with a 2% $CuSO_4$ solution as a prophylactic measure, after scraping off the external fungal mat. Young (1952) recommended the adoption of Napper's method in Sri Lanka. Later, Riggenbach (1957) claimed that the use of $CuSO_4$ gave disappointing results and recommended in its place the use of a 2% organo mercurial fungicide, with the brand name "Tillex". Peries *et al.* (1963; 1965) proved conclusively that 60-80% of infected trees could be saved merely by the removal of the food base alone, and that the use of fungicides was not justifiable.

John (1958) found that the epiphytic advance of the fungus could be arrested by removal of rhizomorphs frequently, thus the infection of the root is prevented. These findings led Fox (1965) to study the possibility of isolating a sufficiently presistent fungistatic preparation that would arrest the epiphytic advance of *Fomes*. He found that a grease-based formulation containing 20% penta-chloro-nitro-benzene (PCNB) was effective for this purpose. When this was applied over the collar region, it prevented the infection of that part of the tap root and reduced the disease incidence. This material was effective in the soil for at least two years, during which period the food base could be expected to rot and become ineffective.

METHODS AND RESULTS

The food base

Fomes-infected timber is referred to as a food base and it is from such material that the infection can spread to a healthy tree. It provides energy for the fungal inoculum in the process of infection. The food base can be considered to be the key to *Fomes* control. Studies on the biology of *Fomes lignosus* by Fox (1961) have shown that it is essentially a weak parasite in relation to *Hevea* and requires a large inoculum to cause a successful infection. Therefore, the size of the food base is an important factor. Alston (1951) showed that a volume of at least five cubic inches of *Fomes*-infected wood was necessary to cause infection of young nursery plants. The results of Alston's experiments on the size of the food base, are summarised in Table 1.

TABLE 1

EFFECT OF INOCULUM VOLUME ON SUCCESS OF ROOT INOCULATION WITH *FOMES LIGNOSUS* IN INFECTED WOOD SEGMENTS

No. of seedlings inoculated	15	13	9	8	18
Volume of inoculum (in3.)	5.0+	5.0-1.0	1.0-0.5	0.5-0.25	0:25
Percentage of successful inoculation	100	69	22	12	0

De Jong (1933) found that in many cases, infections in his experimental inoculations healed on their own accord. Field observations made on trees infected with *Fomes* showed that a few trees recovered spontaneously, even when the food base was not eradicated. In this connexion, Peries (1965) found that the fungus becomes self propagating and independent of the external food base, only when a sufficient volume of the root is infected to take the place of the external food base. John (1960) reported that the fungus was not viable after a period of 12 to 15 months on *Fomes*-infected root sections. Satchuthananthavale (1971) and Satchuthananthavale & Halangoda (1971) confirmed that the fungus did not retain its viability especially when the soil is treated with sulphur.

The continued viability of the rubber industry depends on the reduction of the cost of production; therefore, there is an urgent necessity to reduce the costs involved in the establishment of the crop. The usual practice at uprooting is to fell the trees using monkey grubbers. The stumps are grubbed along with some main laterals and the timber is sometimes burnt. This method is laborious and expensive. The costs involved in establishment could be possibly reduced, by allowing the timber to undergo natural decay *in situ*. But infected timber when allowed to remain as described may act as food bases and form the foci of infection. However, the infected timber is also liable to be colonised by other saprophytic fungi which cause natural decay of timber. Therefore, the likehood of the formation of new foci of infection is reduced.

It should be possible to retain the timber on the land without risk of high disease incidence, provided the incidence of the disease in the previous stand was low. The results of studies carried out on this subject on a commercial estate are given in Table 2.

TABLE 2

CUMULATIVE LOSSES FROM WHITE ROOT DISEASE IN A REPLANTING FOLLOWING 4 METHODS OF CLEARING

Treatment	Number of trees dead by *Fomes* root rot during the period from 1967 to 1971 November				
	1968	1969	1970	1971	Total loss
1. T. & S. burnt	3	2	5	3	13
2. T. & S. not burnt	2	5	6	3	16
3. S. burnt, T. stacked	2	5	2	7	16
4. T. & S. not burnt but Sulphur used	Nil	3	4	3	10

T=Timber S=Stumps

Not significant at 1% level.

These results show that there is no significant difference between the treatments, therefore; in areas where *Fomes* infection in the old stand is low, the timber of the previous stand could be safely retained.

Decay of rubber wood

If the key to *Fomes* control is the eradication of the food base, then the rate of decay of rubber wood is of vital importance; because the sooner the inoculum decays, the sooner the danger is got rid of. Therefore, any method of increasing the rate of decay of wood is important in the control of this disease. The decay process could be accelerated by employing selected species of wood rotting fungi. Studies made elsewhere on wood colonization by fungi have shown that considerable volumes of wood are often occupied by a single fungal colony. Thus a situation could arise in dying or dead tree roots, where there is competition between two or more fungi for the colonisation of the wood. This situation was demonstrated in the field by Rishbeth (1950; 1951) in his work on *Fomes annosus*, the causal agent of root rot on pine trees in temperate regions of the world, and he showed that certain saprophytic fungi can successfully compete with the pathogen. Meredith (1960) made a careful study on such a succession of fungi occuring in unprotected pine stumps and confirmed Rishbeth's work. Therefore, one fungus can and does replace another on a substrate under natural conditions. This fact can be used to advantage by encouraging the growth of selected fungi by artificial methods. Rishbeth (1951) using this principle, successfully controlled *Fomes annosus* by inoculating freshly cut pine stumps with basiodiospores of the saprophyte *Peniophora gigantea*. This was the first demonstration of a method of biological control of a root disease in a perennial crop. This common competitor of *Fomes annosus* arrests the growth of the latter along the pine roots and replaces it on infected stumps.

Wood rotting fungi have been isolated from decaying rubber wood and the rate of decay of wood by them, has been determined *in vitro*. Five of the saprophytes isolated have caused more than 30% mean loss in dry weight over a period of 3 months. These are now being tested for their competitive ability against *Fomes lignosus*.

Parallel studies have been carried out on the rate of decay of rubber wood under field conditions. The importance of this subject has already been discussed in relation to root disease incidence in replantings. The preliminary results are presented here. The rate of decay was determined under two different ground cover conditions, one being *Pueraria* and other naturals; because it has been shown in Malaysia that rubber wood decays faster under legume covers (Newsam, 1963). However, our studies have indicated that there is no significant difference between legume covers and naturals in this respect

(*See Table 3—page 204*)

TABLE 3

THE RATE OF DECAY OF RUBBER WOOD* BY DIFFERENT FUNGI
(ADJUSTED MEANS OF WEIGHT LOSS IN G/MONTH)

	Under cover (*Pueraria*)	Under natural over (grasses and broad leaf weeds)
1st month	1.97	2.22
2nd month	2.48	4.69
3rd month	6.17	7.33
4th month	9.99	13.73
5th month	13.35	—
6th month	19.69	14.99
7th month	—	17.14
8th month	23.13	18.97

*EFFECTIVE BLOCK SIZE USED IS 1" X 1" X 6", AND DRIED AT 105 °C TO CONSTANT WEIGHT. DIFFERENCES NOT SIGNIFICANT AT 5% LEVEL.

Ring barking and tree poisoning methods:

These methods are used essentially to encourage the rapid decay of the root system, Ring barking and poisoning of trees before uprooting kill the root system gradually so that the sugars and starch are translocated away from it. This encourages the rapid colonisation of the roots by saprophytes and the exclusion of *Fomes*. The adoption of the above methods are governed by two main factors. Firstly, the costs that may be involved in adopting the methods and secondly the loss of crop that may occur during the last part of the life of the tree. The feasibility of adopting these methods under our conditions is now under consideration. The latter method is widely practised in Malaysia as the most effective way of disposing of the old stand, the poison being used is 2, 4, 5, Trichlorophenoxy acetic acid.

Soil manipulation

Studies have been undertaken to establish biological means of controlling White Root disease too. It has been shown that a certain degree of reduction in the incidence of White Root disease can be achieved biologically by means of soil management. Peries (1965; 1966 & 1972) demonstrated that the amendment of the soil in planting holes with 4 oz of sulphur, was a cheap and effective method of reducing *Fomes* incidence. Sulphur applied in this manner can be used to protect the trees during the first 2-3 years after replanting. At that stage it is possible that a majority of food bases would have decayed, and the further use of sulphur, except in exceptional cases, would not be warranted.

Stand per acre

It is essential to have an optimum stand per acre, when an area is brought into tapping, in order to harvest an optimum yield, which would give maximum returns for the capital invested in replantings. Therefore, control measures should aim at obtaining a disease free stand at the tappable age, and this must be achieved at the lowest possible cost.

CURRENT RECOMMENDATION

Now, having considered the various methods of control adopted, it remains for us to give our present recommendations for the control of this disease with reasons for our adoption of these methods. Our present recommendations on White Root disease control, aim at preventing the establishment of *Fomes* infection and its spread from tree to tree in the young stand.

Control measures should start at the time of uprooting of the old stand. The root system of the uprooted trees should be inspected soon after uprooting, as the fungal rhizomorphs become discoloured on exposure to air, and may be difficult to indentify after sometime. The sites of infected trees should be marked, and special attention given to them, to remove as much of the old roots as possible, to ensure that fungal food bases are not left behind. The planting point and the area immediately around it should be treated with sulphur, as the rate of approximately 4 oz per square yard. This is an added precaution to minimise the possibility of infection.

After planting, infected plants are detected by foliar symptoms and they are used as indicators of foci of infection. Tree to tree collar examination is not advocated, since it could lead to root damage which results in high incidences of White Root disease; because the injured root is more susceptible to infection (Peries & Irugalbandara, 1973). The infected trees, except in a very few instances, are beyond the stage of saving. As the neighbouring trees are usually affected too, they have to be inspected and treated along the line until the first healthy trees are located.

The effected root systems are exposed. The food bases are traced along the laterals and are eradicated. If the lateral roots are dead, they are cut off at the point of attachment to the tap root. This ensures the complete eradication of infected material. As an added precautionary measure the superficial hyphae are scraped off, and all infected plant material is then burnt on the site.

We advocate the use of PCNB-based collar protectants, especially in areas where it is important to maintain the stand per acre. PCNB-based collar protectants are used to paint the collar and 9-12" of the laterals of all treated trees and the first healthy tree along the row so that infection would not recur at least for another two years.

The isolation of diseased trees by means of trenches is not recommended now. It involves high labour costs. Further, disease could spread to healthy trees *via* infected root contacts by the healthy roots which can grow under the trench.

REFERENCES

ALSTON, R. A. (1951). Disease of the root system. *Rep. Rubb. Res. Inst. Malaya.* 1951 p. 34.

DE JONG (1933). Hot parasitisma van Rigidioporus microporus van Overeem Syn. *Fomes lignosus.* Klotzsela bij *Hevea brasiliensis. Archf. Rubber Cult. Ned. Indië* **17,** 83-100.

FOX, R. A. (1961). White root disease of *Hevea brasiliensis:* recent developments in control techniques. *Rep. 6th Commonw. Mycol. Conf.* 1960. pp 97-100.

FOX, R. A. (1965). The role of biological eradication in root disease control in replantings of *Hevea brasiliensis.* In *Ecology of Soil borne Plant Pathogens.* K. F. Baker and W. C. Synder, ed. London: John Murray, pp. 348-362.

JOHN, K. P. (1958). Inoculation experiments with *Fomes lignosus. J. Rubb. Res. Inst. Malaya* **15,** 223-230.

JOHN, K. P. (1960). Loss of viability of three parasites in infected root sections buried in soil. *J. Rubb. Res. Inst. Malaya* **16,** 173-177.

MEREDITH, D. S. (1960). Further observations on fungi inhabiting pine stumps. *Ann. Bot.* **24,** 63-78.

NAPPER, R. P. N. (1932 a). Observation on the root disease of rubber trees caused by *Fomes lignosus. J. Rubb. Res. Inst. Malaya* **4,** 5-33.

NAPPER, R. P. N. (1932 b). A scheme of treatments for the control of *Fomes lignosus* in young rubber areas. *J. Rubb. Res. Inst. Malaya* **4,** 34-38.

NEWSAM, A. (1963). Cover and Root diseases. *Plrs' Bull. Rubb. Res. Inst. Malaya* No. 68, p. 177.

PERIES, O. S. (1965). Recent developments in the control of the diseases of *Hevea* rubber tree. *Q. Jl. Rubb. Res. Inst. Ceylon* **41,** 33-46.

PERIES, O. S. (1966). The Economics of disease control in *Hevea. RRIC Bulletin.* **1,** 27—33

PERIES, O. S. (1972). Annual Review for 1971. *Ann. Rev. Rubb. Res. Inst. Ceylon* pp. 51—61.

PERIES, O. S. AND IRUGALBANDARA, Z. E. (1973) Histology of *Hevea* roots infected by *Fomes lignosus. Ann. Appl. Biol.* **73,** 1—7.

PERIES, O. S., FERNANDO, T. M. AND SAMARAWEERA, S. K. (1963). Field evaluations of methods for the control of white root disease (*Fomes lignosus*) of *Hevea. Q. Jl. Rubb. Res. Inst. Ceylon* **39,** 9-15.

PERIES, O. S., FERNANDO, T. M. AND SAMARAWEERA, S. K. (1965). Control of white root disease *Fomes lignosus* of *Hevea brasiliensis. Q. Jl. Rubb. Res. Inst. Ceylon* **41,** 81-89.

PETCH, T. (1921). *The diseases and pests of the rubber tree*. London: MacMillan & Co., Ltd.

RISBETH, J. (1950). Observations on the biology of *Fomes annosus*. I. The outbreaks of disease and ecological status of the fungus. *Ann. Bot.* **14**, 365-83.

RISBETH, J. (1951). Observations on the biology of *Fomes annosus* II. Spore production, stump infection and saprophytic activity in stumps. *Ann. Bot.* **15**, 1-21.

RIGGENBACH, A. (1957). Report of the Plant Pathology Dept. *A. Rep. Rubb. Res. Inst. Ceylon* 1957; 49-57.

RIGGENBACH, A. (1964). On the control of the white root disease of the para rubber tree, *Hevea brasiliensis*. *Q. Jl. Rubb. Res. Inst. Ceylon* **40**, 35-55.

SATCHUTHANANTHAVALE, V. (1971). Annual Review for 1970. *Ann. Rev. Rubb. Res. Inst. Ceylon* 1970 p. 43.

SATCHUTHANANTHAVALE, V. AND HALANGODA, L. (1971). Sulphur in the control of white root disease. *Q. Jl. Rubb. Res. Inst. Ceylon* **48**, 82-91.

YOUNG, H. E. (1952). Root disease in replanted areas. *Quart. Circ. Rubb. Res. Inst. Ceylon* **17**, 19-23