VOLUME 16 PART 4

Loss of Viability of Three Root Parasites in Infected Root Sections Buried in Soil

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An account is given of observations carried out over a period of several years on the viability of the three major root diseases of Hevea in sections of buried roots.

The rubber tree becomes infected with root disease by vegetative growth of the fungus from diseased material in soil, most usually by root-to-root contact. It is well known that the root parasites can remain viable in large stumps for several years, but there are no data for fragments of diseased roots buried in soil—a point of considerable importance in relation to root disease control in replanting, particularly when clearing by mechanical methods, which leave diseased root fragments widely distributed in the soil.

Reference has already been made in the annual reports of the Institute (NEWSAM, 1953; ALTSON, 1953a and 1953b) to an experiment laid down to investigate the survival of root disease fungi in buried root sections. A full account of the experiment is now presented, with related observations from later experiments.

EXPERIMENTAL METHODS

An area of about 1000 sq. ft in Field 37 on the R.R.I.M. Experiment Station was thoroughly dug over to a depth of two feet and all buried timber and roots removed. The soil (a sandy loam) was kept clean-weeded throughout, and in it, roots infected with each of the three major root diseases—*Fomes lignosus* Klotzsch, *Fomes noxius* Corner and *Ganoderma pseudoferreum* (Wakef.), van O. et St.—were buried as material became available. The root sections were placed at a depth of one foot, arranged in six groups according to thickness and into two groups according to length, as shown in Table 1. The roots selected for use were well penetrated by the pathogen, yet still hard; those which had reached the advanced state of decay known as soft rot were rejected.

Enough material was buried to allow for sampling of the smaller roots over a period of two years and of the larger roots over four years. A total of 1296 root sections were buried.

Pairs of roots of each size class and for each pathogen were removed for examination

TABLE 1. APPROXIMATE VOLUMES OF ROOT SECTIONS BURIED (CUBIC INCHES)

Length of root, inches	Diameter of root, in inches:					
	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	2	3
12	0.2	0 6	2.4	9.4	37	85
24	0.4	1.2	4.7	19	75	170

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at intervals of two months, the fungus being recorded as viable if it could be seen growing on the surface of the root or be isolated from within it. It does not follow that a root section thus classified as containing a viable fungus could still be infective.

RESULTS

The results, presented in Figure 1, show that the rate of loss of viability was inversely related to the size of the root, and that it varied relatively little with the different parasites. The difference in rate of loss of viability between *F. noxius* and *F. lignosus* which had been apparent after twelve months burial, was less evident after two years. *G. pseudoferreum* was the most persistent of the three parasites.

In the process of disintegration of roots, particularly those infected with *F. lignosus* and *F. noxius*, the wood rots away first, the bark remaining firm for a few months longer. Fresh growth of the fungus was often found on the surface of such persisting bark even after the entire wood had rotted away.

Observations on the Loss of Viability of F. lignosus from Other Sources

Inoculation experiments with *F. lignosus* subsequently carried out elsewhere on the R.R.I.M. Experiment Station gave further opportunities to study the behaviour of naturally infected root sections, in the presence of roots of rubber and cover plants.

In his first inoculation experiment with *F. lignosus*, JOHN (1958) found that root sections used as inocula, ranging in size from about 12 to 61 cubic inches, were partially or completely disintegrated after being in the soil for one year, the pathogen being no longer viable.

In the second inoculation experiment (initially designed to test the suitability of various fungicides for the prevention of superficial growth of *F. lignosus* on roots), the sections of infected root, ranging in size from about 5 to 100 cubic inches, were buried in contact with roots of three-year-old rubber trees growing in a sandy loam. The fungicides, which were applied around the collar and tap root and over a six-inch length of the base of the laterals, could not have had any effect on the inocula, which were buried eighteen inches away from the collar. There was a fairly heavy growth of natural covers in the inter-rows, and some grass in the planting rows, where the root sections were buried. These were examined one year after burying, when the results of inoculation were being assessed. The condition of the root sections is summarised in Table 2, which shows that 110 out of 130 were completely disintegrated. In some of the remaining 20 root sections the wood cylinder had entirely disintegrated while the bark retained the outer form; in others there was a soft black or jelly-like rot. In no root section was *F. lignosus* still viable. It is noteworthy that the rotting roots were frequently and extensively penetrated by feeding roots of rubber, sometimes also by the roots of cover plants.

TABLE 2. THE CONDITION OF ROOT SECTIONS INFECTED WITH FOMES LIGNOSUS TWELVE MONTHS AFTER BURIAL

Volume (cu. in.)	Number of roots	No. of roots totally disintegrated	No. of roots with black rot or completely rotted apart from bark
Below 10	26	24 (92%)	2 (8%)
10 – 30	54	46 (85%)	8 (15%)
31 – 50	30	28 (93%)	2 (7%)
51 – 70	10	3 (30%)	7 (70%)
71 – 100	10	9 (90%)	1 (10%)
Total	130	110 (84.6%)	20 (15.4%)

In the third experiment (also designed to test the suitability of various fungicides for the prevention of superficial growth of *F. lignosus* on roots), 120 naturally infected root sections were buried in contact with roots of seven-year-old trees growing in a peaty sand. As in the second experiment, the fungicides which were applied around the collar and tap root, and over a six-inch length of the laterals, could not have had any effect on the inocula, which were buried eighteen inches away from the collar. The natural cover plants in this area had practically died out before the experiment was started. Once again the root sections varied in volume from 5 to 100 cubic inches. They were dug out and examined fifteen months after burial, with the results presented in Table 3, which shows that all except 28 of the 120 roots had completely disintegrated. Of the 28 that remained, only parts could be recovered. In most instances the wood cylinder had disintegrated completely, while the bark kept the form of the root. Both the decaying wood and bark were penetrated by feeding roots of rubber. *F. lignosus* was not viable in any of them.

DISCUSSION AND CONCLUSIONS

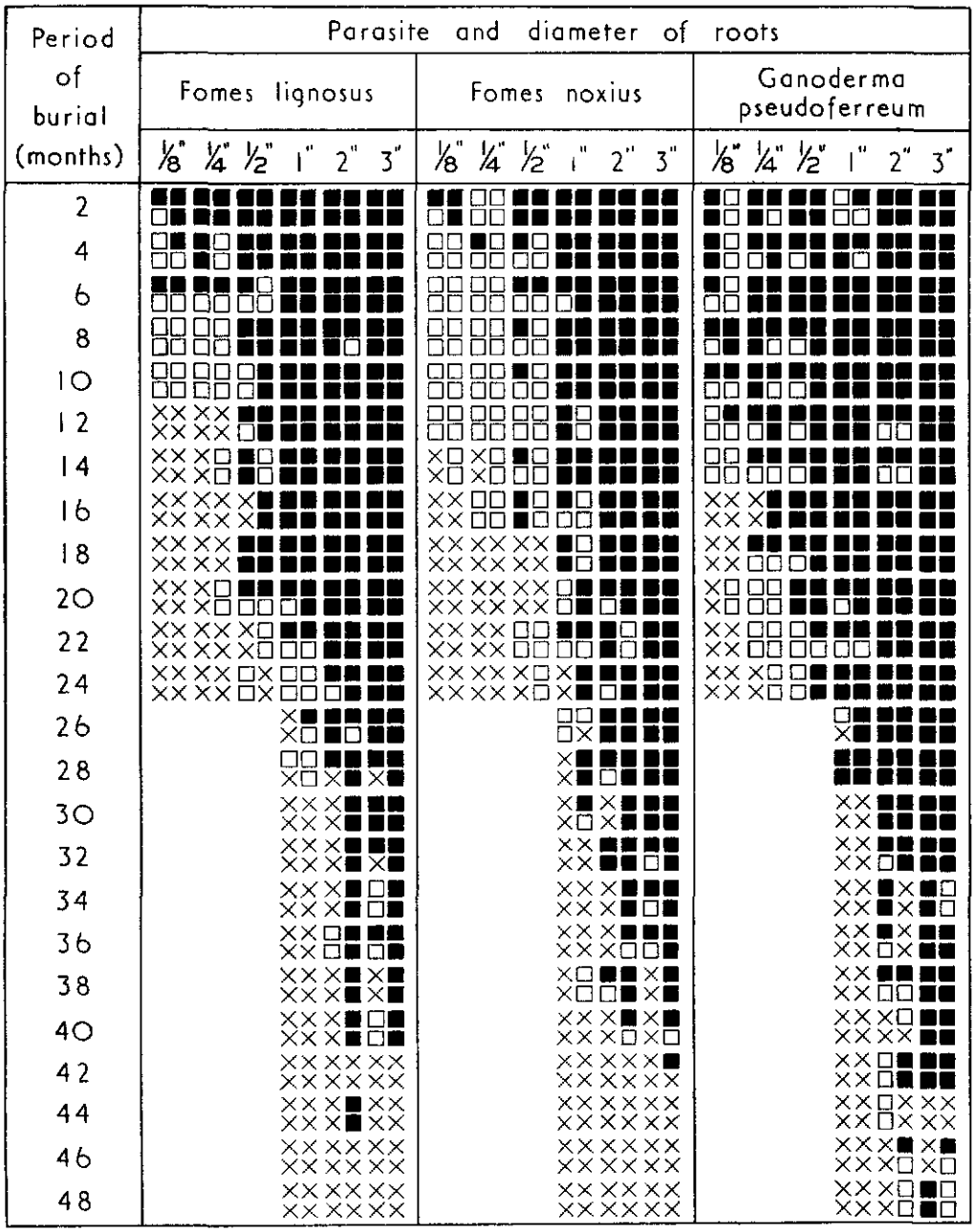
In the burial experiment (Figure 1) the rate of disintegration of infected root sections and the resulting loss of viability of the parasites clearly depended on the size of the root. Here the soil was of low biotic activity, with no living roots and low organic matter content. The root sections used as inocula in the inoculation experiments disintegrated much more quickly, under conditions where the soil was shaded, richer in organic matter, and penetrated by roots. Although an effect of size of the root section on persistence of the parasite could be seen in the third inoculation experiment (Table 3), it was not apparent in the second experiment (Table 2), where loss of viability was more rapid, perhaps because of the heavier ground cover.

There are indications that the feeding roots of rubber assist the disintegration of infected roots, suggesting that the *Hevea* mycorrhiza might be investigated to see whether it is a factor of importance in this regard.

The most significant result of these observations from a practical point of view is the profound effect of soil conditions on the rate of disintegration of infected roots; while the burial experiment showed that the root disease fungi can persist for up to four years in roots three inches in diameter, the inoculation experiments indicate how much more quickly the process of decay can proceed when the area is planted with rubber trees and cover crops. *F. lignosus* was no longer viable in the largest root sections used as inocula after twelve or fifteen months. The inocula must

TABLE 3. THE CONDITION OF ROOT SECTIONS INFECTED WITH FOMES LIGNOSUS FIFTEEN MONTHS AFTER BURIAL

Volume (cu. in.)	Number of roots	No. of roots totally disintegrated	No. of roots with black rot or completely rotted apart from bark
Below 10	20	18 (90%)	2 (10%)
10 – 30	56	48 (86%)	8 (14%)
31 – 50	22	15 (68%)	7 (32%)
51 – 70	10	7 (70%)	3 (30%)
71 – 100	12	4 (33%)	8 (67%)
Total	120	92 (76.6%)	28 (23.4%)



Loss of viability of root parasites in diseased roots; the roots ranged in diameter from ⅛ in. to 3 in. and were either 1 ft or 2 ft in length. The results for each diameter are in pairs: left, length 1 ft; right, length 2 ft.

have ceased to be infective considerably sooner than this. It may be concluded that root fragments remaining after clearing old rubber for replanting are not likely to be more than a passing hazard, even if diseased. The most important consideration is to increase the biological activity of the soil by quickly establishing a good ground cover, so hastening the decay of root fragments.

ACKNOWLEDGEMENT

The author is greatly indebted to Dr A. Newsam, Head of Pathological Division, for his help in preparing the manuscript for publication.

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Kuala Lumpur *September 1960*

REFERENCES

ALTSON, R. A. (1953a) Pathological Division. Report for the year 1950. *Rep. Rubb. Res. Inst. Malaya 1950*, 6.

ALTSON, R. A. (1953b) Pathological Division. Report for the year 1951. *Rep. Rubb. Res. Inst. Malaya 1951*, 6.

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

NEWSAM, A. (1953) Pathological Division. Report for the year 1949. *Rep. Rubb. Res. Inst. Malaya 1949*, 12.