PALM OIL DILUENT FOR TAR OIL FUNGICIDES AND ITS EFFECTS ON BARK RENEWAL OF HEVEA

BY

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Introduction

During early work on the official testing of fungicides for treatment of Mouldy Rot, it was found that some of the more successful fungicides left behind a very thin, sticky film on the bark of the trees which had been treated. In subsequent work in this laboratory, on methods of preparation of emulsions of cresylic acid in water, it was found that the addition of a small quantity of vegetable oil increased the efficiency of the fungicide and had a favourable influence on the rate of bark renewal following its application. Previous work on the use of palm oil on tapping panels had indicated the drawback that the oil film broke down to give a layer of white, oxidised, fatty substances which, to the inexpert, resembled closely the white bloom of the Mouldy Rot fungus. Accordingly our attention was turned to the use of cotton seed oil or linseed oil; the latter, being more readily available, was incorporated in a cresylic acid emulsion known as "Linsocresyl" and proved to be very effective in control of Mouldy Rot. It was also found to have a distinctly beneficial effect on wound healing and on the renewal of bark (See R.R.I. *Annual Report* 1934, p. 95 and *J.R.R.I.M.* Vol. 7, No. 1, 1936).

During the past few years the planting industry has been seeking a method of improving the condition of the renewing bark of some of its older rubber trees which, owing to past treatment and cultivation, had become very thin and hard, so that the usual period of seven or eight years for renewal had failed to give a bark of tappable thickness and soft texture.

Meanwhile, a firm of fungicide manufacturers had become interested in the possibility of using a combined fungicide and bark-renewal stimulant for rubber trees and has produced experimental quantities of a special fungicidal oil of three grades, A, B and C, which when diluted with palm oil might serve the dual purpose of controlling bark disease and stimulating bark renewal.

Consignments of these oils were received in 1937 and arrangements were made to carry out experiments on a field scale on four estates in different parts of the country, representing two coastal and two inland types of soil and climate, to determine the

influence of the fungicide—palm oil mixtures on the renewal of the tapped bark of old, hard, thin-barked trees. Secondly, tests of the fungicidal powers of the mixtures were carried out under the writers' supervision in rubber areas in Selangor which were heavily infected with Mouldy Rot disease of the tapping panel.

Dr. Baptist of the Botanical Division of this Institute who is interested in bark growth stimulants assisted in the execution of the work dealt with in section 3 below and further reference to this experiment will be found in his article in this journal. Sections 1, 2 and 4 and the views expressed therein represent the work of the senior author only.

Experimental

The various tests are conveniently divided into four groups:—

(1) Penetration and burning tests to determine what concentration would be safe to use in the field tests (3) and (4) below.

(2) Fungicides tests in Mouldy Rot disease areas to determine the concentration necessary for effective control of the fungus disease caused by *Ceratostomella fimbriata* (E. and H.) Elliot.

(3) Field experiments including six treatments on each of four estates to study the effect of the treatments on rate of renewal of the tapped bark.

(4) A repetition of three treatments used in (3) above to determine the possibility of eliminating the disadvantages of applications of excessive quantities of palm oil to the tapped bark.

(1) Penetration and Burning Tests

The fungicidal oils A., B. and C. each applied at strengths of 5, 10 and 15 per cent in palm oil to the healthy freshly-tapped panels of rubber trees.

Result. Fungicidal oil A is considered harmful to the inner bark and cambial regions at a concentration of 10 and 15 per cent in palm oil. Latex flow was poor and very watery.

Oils B and C showed slight discolouration of the cambial regions at 15 per cent, at which strength the latex flow from the treated surfaces when cut with a penknife was rather watery. The 5 and 10 per cent concentrations appeared to be safe.

(2) Tests for Efficiency as Fungicides

As a result of tests (1) above and in view of the customary deep tapping in the small holdings area in which such tests are

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normally carried out, it was decided not to exceed the 5 per cent strengths of the fungicidal oils which the makers had originally suggested would prove effective. The test plots consisted each of 25 heavily-diseased trees. Treatment by painting the fungicidal-oil palm-oil mixture on the three-inch band of the diseased bark immediately above the tapping cut was commenced on 10.12.37 and the application repeated at weekly intervals, but in this case only the half-inch or so of bark freshly exposed by the week's tapping was treated.

Results. All trees in the treated plots were clear of the active Mouldy Rot fungus after seven treatments. It was found that fungicidal oil A was rather ineffective from the fungicidal point of view during the early period of the test when the weather was very wet.

Oil A showed little control until after 25 days (4 treatments)

Oil B showed over 50 per cent control after 15 days (3 treatments)

Oil C showed about 50 per cent control after 15 days (3 treatments)

The degree of control of Mouldy Rot disease with the fungicidal oils B and C was greater and more rapid than that of oil A.

The treated surface of the bark when scraped with a knife showed good, green, succulent renewal beneath the thin, white film of "decomposed" oil, while the latex flow when the renewed bark was pierced with a knife was fair.

The trees in the control (untreated) plots were heavily diseased, having discoloured bark and large wounds with practically no latex flow from the remaining callus-like bark.

In this experiment the peak numbers of diseased panels occurred during periods not necessarily of heavy rainfall but when, owing to low cloud and drizzle, the sun was unable to penetrate the leaf canopy to the panels below.

(3) Estate field tests of Fungicidal-Oil Palm-Oil Mixtures

For these tests four estates covering widely different conditions of soil and climate were chosen as representative of typical central Malayan conditions. This wide distribution also avoided the necessity of replication and consequent close supervision on each estate.

The estates where managers so kindly undertook this work were,

1. Estate A, Malacca Territory. Inland white alluvial soil, dry climate.

2. Estate B, Port Dickson, Negri Sembilan. Coastal hill soil, average climate.

3. Estate C, Klang, Selangor. Coastal, peat soil, average climate.

4. Estate D, Ulu Selangor. Inland hill areas, average dry climate.

In co-operation with the Botanical Division of the Institute it was decided to include six treatments on each of the four estates as follows:—

1. Fungicidal Oil A. 5 per cent: Palm Oil 95 per cent

2. Fungicidal Oil B. 5 per cent: Palm Oil 95 per cent

3. Fungicidal Oil C. 5 per cent: Palm Oil 95 per cent

4. White Fluid fungicide 3 per cent in water as at present advised for control of Mouldy Rot.

5. Palm Oil alone.

6. Control, untreated, observation task.

Each treatment in these experiments covered one tapping task of about 300 trees. Selected tasks were adjacent to each other and in an area with as little natural variation as possible. The trees were in all cases old with rather poor, hard, renewed bark.

The treatments were applied at weekly intervals, when the lowest three inches of the newly-tapped bark were brushed over with the various preparations.

Measurements of bark thickness at three points just above the tapping cut on each of 50 marked trees throughout each task were taken before commencement of the treatment in November 1937 and at intervals of about three months thereafter.

It was unfortunate that in the early stages bark measurements were taken by two field conductors and owing to the breaking of one of the instruments one of a different type was introduced. It was subsequently found necessary to make corrections for the difference in readings of the two types of instruments, which was kindly undertaken by the Statistician and the Botanist, so that the figures presented in the table of summaries of results may be taken as strictly comparable throughout.

At the same time as the second series of bark measurements were taken on the original marked positions of the tapped panel a second line of three points was taken, again just above the tapping cut, which, as a result of the progression downwards of the tapping cut, was about three inches below the first line of

measured points. This amounted to a duplication of the experiments and has fully confirmed the figures of the rate of renewal at the higher level on the panel.

Both series of measurements indicate that after seven months' treatment the fungicidal oils and palm oil mixtures and the palm oil alone give highly significant improvements in bark renewal over the control and the white fluid treated plots. It is of interest to note that comparatively little difference was recorded in the effect of the fungicidal oil A as compared with that of oils B and C, all being equally good and that the white fluid treated plots showed in some cases inferior bark renewal to that of the control plots.

Growth in bark thickness in mm. for each period:—

Treatment	Treatment means (mm.)		
	d 1	d 2	d 3
Palm Oil	2.51	.93	2.36
Palm Oil—Fungicidal Oil A ...	2.71	.72	2.43
Palm Oil—Fungicidal Oil B ...	2.90	.82	2.42
Palm Oil—Fungicidal Oil C ...	2.87	.88	2.37
White Fluid	2.42	-.01	1.81
Control	1.97	12	1.66
Standard error	.188	.134	.098
Mean Growth	2.56	.58	2.17

Where d 1 = { growth in bark thickness in mm. Oct.—Nov. 1937 to February 1938.

Where d 2 = { growth in bark thickness in mm. February to June 1938, *i.e.* from the fourth to the seventh month after tapping and first treatment.

Where d 3 = { growth in bark thickness in mm. on a second line taken on freshly-tapped and treated bark on the same trees but some three or four inches lower down the panel for the period March to June 1938 (three months).

The differences between the first four treatments are not significant.

The differences between the white fluid treatment and control are not significant.

The differences between the four palm oil treatments and control are highly significant.

The differences in growth of bark with and without palm oil during the three periods observed appear to be appreciably different at the various estates during each period. The excess of growth in plots receiving palm oil over those not receiving it was as follows:—

Estate	Excess Growth (in mm.)		
	d 1	d 2	d 3
A	.23	.94	1.08
B	.98	1.37	.48
C	–.09	.84	.97
D	1.09	–.01	.12
Standard error	.326	.233	.169
Mean	.55	.78	.66
Standard error	.163	.116	.085

Allowing for this possible interaction the analysis of variance is as follows:—

	d. f.	Mean Squares		
		d 1	d 2	d 3
Palm Oil ...	1	1.6317 ss	3.3813 ss	2.3320 ss
Fungicidal Oils ...	4	.1975	.0332	.0158
Estates ...	3	3.2572 ss	1.0937 ss	.7188 ss
Palm Oil x Estates ...	3	.4398 ss	.4480 ss	.2691 ss
Remainder ...	12	.1418	.0723	.0382

ss = highly significant.

In the above tables the plots treated with white fluid and the plots receiving no treatment (control) are together taken as plots receiving no palm oil.

The analyses of variance show that the effect of palm oil, and the interaction between estates and the palm oil treatments are each highly significant. Differences in growth due to presence or absence of fungicidal oils are not significant.

It is unfortunate that further replications of the experiments were not carried out at a larger number of centres so that some correlation might have been obtained regarding the effects of palm oil on growth under various soil conditions and climates.

Mean growth of bark in the various intervals on the four estates were as follows:—

(a) Without Palm Oil

Estate	Mean Growth (mm.)			Soil Type
	d 1	d 2	d 3	
A	1.87	.42	1.63	Flat alluvial
B	2.12	-.285	1.36	Undulating red soil
C	2.00	.06	1.81	Peat—flat
D	2.78	.02	2.12	Granite hill soil
Standard error ...	.266	.190	.138	

(b) With Palm Oil

Estate	d 1	d 2	d 3	Soil Type
A	2.10	1.36	2.72	Flat alluvial
B	3.10	1.100	1.84	Undulating red soil
C	1.91	.90	2.78	Peat—flat
D	3.88	.00	2.24	Granite hill soil
Standard error ...	.188	.134	.098	

(c) Rainfall figures for the four districts are as follows:—

Estate	d 1 Nov.—Feb. 1938	d 2, d 3 Mar.—May 1939
A	26.88″ on 43 days	29.13″ on 55 days
B	23.66″ on 43 days	15.87″ on 35 days
C	20.93″ on 66 days	23.51″ on 47 days
D	33.42″ on 70 days	37.35″ on 64 days

Comparing the growth of bark in columns d1 and d2, which each represent the early period of renewal of bark after tapping,

there is strong indication that better growth of bark with or without treatment generally occurs during periods of higher rainfall or when wet days are more frequent. During such periods the increase in growth in the palm-oil-treated plots over those not receiving palm oil is not so apparent. Also the rate of growth of bark on hilly land is slowest during dry periods when the palm oil appears to have maximum effect. On Estate B, following a dry February and light rains in March, April and May, a shrinkage of bark occurred during the period d2 in the untreated plots, while the palm-oil-treated plots put on a further 1.10 mm. of bark. On estate D the more equably wet weather appears to have promoted growth of bark to such a degree that the differences in the treated and untreated plots are less marked, except during the monsoon period (d1) when heavy rains followed by bright dry periods are usually experienced in this district. On the flat lands of Estates A and C the effects of the treatment are less marked during the monsoon weather of the period d1, when rapid flooding and rapid drying-out of the soil occurs, but are well marked and of a more constant character during the more equable climate of the periods March, April and May (d2 and d3).

From the above it may reasonably be concluded that two distinctly different factors are at work when palm oil is applied to the bark of tapped rubber trees, the one a hormone factor which promotes cambial activity and growth, the other a physical factor, the prevention of excessive evaporation of moisture from the inner cortex exposed by the tapping process. Further experiments on the influence of growth hormones and other factors are being undertaken by the Botanical Division of the Institute, which may throw further light on this interesting problem.

All the above plots treated with the palm oil and palm oil mixtures showed a disappointing feature. The outer renewed bark had been killed inwards in successive layers. The subsequent weekly applications of the mixtures resulted in an accumulation of oxidised, fat decomposition products on the bark surface which in turn resulted in the death of successive layers of bark. In spite of this, however, the living, latex-bearing bark below compared very favourably with that of the best trees in the control plots.

The thickness of renewal after three months' treatment was 25 to 50 per cent greater in the case of the trees treated with palm oil and its mixtures with fungicidal oils as compared with that of the controls.

The second series of measurements taken during the moderately dry mid-year months strongly support the above conclusions, and again 25 to 50 per cent better renewal of bark was obtained in the plots receiving treatment with the palm oil and palm oil

mixtures; in fact, in trees so treated both the bark and the soft wood beneath appear to be so improved as to cause an obvious swelling of the trunk of the tree in the treated zone.

The disadvantages mentioned above of applying excess palm oil to the surface now had to be overcome, as no other drawbacks appeared to be in evidence save that of the tendency to wound the bark during tapping owing to the induced softness of the bark and the slipperiness of the oiled surface. To this end the following test was carried out.

(4) Repetition of Part of Test No. 3

This test was a repetition of part of test No. 3 and consisted of three treatments only, each over one task on each of the four estates.

(1) Fungicidal Oil "A" 5 per cent—Palm Oil 95 per cent.
(2) Palm Oil alone.
(3) Control.

Treatments were carried out weekly as before but in this experiment, while a three-inch zone was treated at the commencement, only a half-inch strip was painted subsequently at weekly intervals so as to avoid overlapping and consequent excess of oil on the panel.

Bark measurements on 50 trees in each task were taken just before the first treatment and three months later.

Result. This experiment has shown that it is possible greatly to reduce the disadvantages found in Experiment 3 and still maintain 25 to 50 per cent increase in thickness of renewed bark by application of palm oil as compared with the untreated plots. In the experiment on Estate B, where the figures are not so significant, it was found that treatment had been given over a period of five weeks only, after which stocks of fungicidal oil and palm oil had run out and the experiment was discontinued.

However, on the remaining three estates the improvement in the renewal as shown by the statistical analysis below is again highly significant.

Growth in bark thickness over a period of three months:—

	Treatment means (mm).
1. Palm Oil	2.23
2. „ „ Fungicidal Oil A.	2.07
3. Control	1.07
Standard error	.065
Mean Growth	1.79

Difference (Palm Oil—No Palm Oil) = 1.08 ± .080 which is very highly significant. The mean initial thickness of bark was 2.43 mm. which is usual for good estate tapping.

Conclusions

(1) The application of controlled quantities of palm oil to the freshly-tapped bark of old hard-barked rubber trees improves the subsequent renewal of bark to a very significant degree. It is not shown that the renewal of bark of young vigorous trees will be similarly stimulated.

This effect of palm oil is claimed by one of us to be due to the presence of physiological quantities of growth hormones which occur in most vegetable oils including linseed oil, which is also known to have a beneficial effect on rate of bark renewal.

It would also appear that the more rapid and succulent development of the renewing bark following treatment of the tapped panel is due to some extent to the oily layer preventing excessive evaporation of water from the delicate inner cortical tissues exposed by the tapping process. This is supported by the fact that a similar though inferior development of bark may be obtained following the application of mineral wax to the exposed surface of the cortex. This treatment, however, cannot be generally adopted in the tropics, as the sun's heat melting the wax causes excessive penetration, blocking of lenticels and subsequent choking of bark surfaces so covered. The use of wax, solar oil—tar oil mixtures for treatment of panel diseases is however popular in some districts where the foliar canopy is sufficiently dense to prevent prolonged heating of the tapping panel surface.

(2) The inclusion of the fungicidal oils A, B and C in the palm oil is of no added advantage unless it is required to control panel diseases.

(3) Fungicidal oil at 5 to 10 per cent in palm oil would be a suitable mixture for treatment of Mouldy Rot disease of rubber trees, acting both as a fungicide and as a promoter of bark renewal.

(4) The application of excessive quantities of palm oil to the panel may have certain disadvantages which, however, can be overcome in ordinary rubber estate practice by avoiding any overlapping of a previously treated section of the panel during subsequent treatments.

Summary

An experiment is described in which the benefits of using palm oil as a diluent for fungicides for application to the tapped panel of rubber trees are determined. The significant influence of this vegetable oil on rate of bark renewal has been demonstrated.

Acknowledgment

We wish to thank the managers of the estates who so kindly undertook the experiments.

We are specially indebted to Mr. H. Fairfield Smith for the statistical analysis of the data.

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