

PATENT SPECIFICATION

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(54) FUNGICIDE

(71) We, THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYSIA, a Malaysian Body Corporate of 260 Jalan Ampang, Kuala Lumpur, Malaysia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fungicidal compositions and in particular to a method of controlling secondary leaf fall (SLF) in particular *Oidium* SLF of mature rubber using such fungicides.

The best known and most serious leaf disease associated with mature rubber tree undergoing its annual refoliation in March and April immediately after wintering is a destructive pre-mature defoliation known as secondary leaf fall caused by the fungi *Oidium heveae* and/or *Colletotrichum gloeosporioides*. The fungi, alone or in combination, infect the young developing leaves, causing them to fall before reaching maturity, resulting in poor canopy retention and consequent loss in tree growth vigour and yield of rubber. Due to extensive planting in recent post-war years of modern clones selected primarily on high yield, secondary leaf fall, in particular *Oidium* SLF, has greatly increased in overall distribution and severity on susceptible clones in most rubber-growing countries. Although both the fungi attain their maximum virulence during the active refoliating period from mid-February to mid-April when there is an abundance of young susceptible leaves, *Oidium* SLF usually makes its appearance first in the early part of the season when the weather is relatively cool with misty mornings which are often followed by short afternoon showers. Towards the latter part of the refoliating season when the weather becomes more persistently wet, *Colletotrichum* SLF, a wet weather disease, takes over as the dominant cause of the leaf fall.

Since SLF occurs on trees old enough to have developed a wintering pattern, normally from the age of five when trees reach some 10—30 m in height, it poses some problems of control. This is particularly so in Malaysia and Ceylon where much of the rubber is planted on undulating to hilly terrains where tractor-mounted power dusters or sprayers cannot be used.

In the current scheme of control of SLF with protective fungicides, widely practised in Malaysia, Ceylon, India and parts of Africa, several applications during the refoliation season are necessary as a rule, so as to effectively protect the successive flushes of leaves emerging through SLF season. Mainly on account of this, aircraft cannot be economically employed for protective fungicidal spraying owing to its high application cost. Under such situations, dusting or spraying fungicides with portable shoulder-mounted power machines which effect satisfactory coverage of foliage of tall rubber trees on hilly terrain offers the only practical and economic method of control. For the control of *Colletotrichum* SLF, there are a number of fungicides which are effective against it, but none so far is available in the form of a micronized dust like sulphur suitable for dusting from the ground, or can be easily formulated in an oil suitable for effective application as a low-volume spray with a portable power mist-blower. Water-based fungicides for high-volume application can be effectively applied by tractor-mounted sprayers to reach the tall trees against both *O. heveae* and *C. gloeosporioides*, but their use is confined only to rubber growing on flat land. For spraying rubber on hilly terrains where portable power mist blowers such as mini-micron sprayers are employed, these will blow up oil-based fungicides high enough to reach the canopy of tall rubber trees. However, the search so far for a suitable oil as carrier for fungicides has met with little success as immature leaves needing pro-

SPECIFICATION AMENDED - SEE ATTACHED SLIP

tection against SLF are extremely sensitive to scorching by many mineral oils. This task is made more difficult also by the fact that very few of the fungicides found effective against SLF are themselves easily soluble or emulsifiable in oil to form a stable spray. Against Oidium SLF, protective dusting with sulphur, easily made with a shoulder-mounted power duster, has been a standard method of controlling the disease for some 50 years. Being in the form of a protectant dust with no systemic properties, the sulphur normally has to be dusted 4 to 6 rounds at 5 to 7 days intervals as a blanket cover throughout the period of the tree's refoliation. The period being usually characterised by short afternoon showers, sulphur tends to be quickly washed out by rain occurring during dusting or soon after. This, in fact, is largely responsible for the inconsistency in the effect of dusting frequently observed, or results in a higher application cost due to the extra rounds required. Also being hygroscopic and highly inflammable, sulphur presents difficulties both during storage and while in use.

There is therefore a great need to find a more potent alternative fungicide, preferably one with systemic properties that lends itself to easy formulation with a non-phytotoxic oil as a more rain-resistant low-volume spray in place of sulphur.

As a mildewcide, a systemic fungicide has several advantages over sulphur which is merely a protectant dust with no curative action. Following application, systemic fungicides especially when suitably formulated, are rapidly taken up by young growing leaves which are thereby conferred with curative as well as protective properties. Such fungicides are therefore much more resistant to rain-wash or leaching, and hence able to give a longer period of protection to the leaves.

As a carrier for fungicides, especially for low-volume application from the ground, oil has several advantages over water or oil-water mixture. A fungicide based on an emulsifiable paraffinic oil which is lighter and less volatile than water will have a greater chance of being blown up with minimum loss through evaporation to the canopy of tall mature trees at up to 32 m height. Young, immature rubber leaves have extremely waxy surfaces not easily wetted by water-based fungicides. Oils in oil-based fungicides increase the dispersion of the fungicide on leaf surfaces and at the same time facilitate absorption of the fungicidal component by the leaves. Particularly when a surface-active agent is added to the oil, its dispersibility can be further enhanced to effect a maximum deposition of spray droplets on the leaves.

We have discovered an oil-based fungicidal formulation that provides effective coverage and prolongs the period of efficacy of fungicides on leaves that can be applied with existing ground portable power equipment as an effective low-volume spray or fog against Oidium SLF on mature rubber.

The present invention accordingly provides a fungicidal composition which comprises an emulsion or dispersion of a systemic fungicide in a light hydrocarbon oil which is non-phytotoxic to young rubber leaves. In order to enhance the stability and dispersibility of the emulsion, the composition preferably includes a surface active agent.

The fungicide of the present invention is primarily intended for spraying or fogging onto rubber trees so as to inhibit the organisms causing SLF. The invention accordingly includes a method of controlling SLF in rubber trees which method comprises spraying or fogging the leaves of the rubber trees with a fungicidal composition of the invention before and/or during the period in which the leaves are susceptible to the organisms which cause SLF. The leaves are preferably sprayed or fogged at least at the bud-burst stage. In field application of this invention, susceptible leaves once sprayed or fogged at the bud-burst stage are protected throughout their subsequent 7 to 8 days susceptible period. Acting systemically within the treated leaves as an effective spore-suppressant, the fungicide prevents rapid build-up of conidial inoculum and consequent widespread secondary infection that typically characterise an early critical stage of an epidemic-scale attack. Hence, good control of Oidium SLF with the composition of the invention can be achieved with a lesser number of application rounds. For example, we have found that in low-volume spraying or fogging with the composition of the invention, a maximum of 3 rounds at 10 to 12 days intervals are required as compared with 4 to 6 weekly rounds in the case of sulphur dusting. Spraying or fogging with the composition of the invention, moreover, ensures little or no risk of wash-out by rain. Using the composition of the invention, therefore, better and greater consistency in the results are produced. This fact is well brought out by the greater increase in yield of rubber, up to 13% as compared with the untreated trees, shown in plots sprayed or fogged at low volume using the composition of the invention as compared with controls dusted with sulphur.

The systemic fungicide used in the composition of the present invention is one

or more fungicides active systemically against the organism(s) causing SLF. Those active against the mildew fungus are preferred and those displaying therapeutic and spore suppressing activity are particularly preferred. The mildewcide known by the trivial name tridemorph i.e. *N*-tridecyl-2,6-dimethyl-morpholine has been used successfully. This material is available commercially under the trade name Calixin which contains 75% tridemorph.

The light hydrocarbon oil used is a well-refined paraffinic oil which is lighter and less volatile than water and which is non-phytotoxic to young rubber leaves. To ensure non-phytotoxicity a well refined oil will usually be used. Oils which are emulsifiable are preferred. The oils sold under the trade names/trade marks Sunoco Sun-spray 7E, Shell Miscible White Oil and Shellflex 214 NC have been used successfully. All these oils are non-phytotoxic to young rubber leaves. Shellflex 214 NC is preferred on a cost basis.

To ensure stability of the composition during storage and to enhance the dispersibility of the composition during application it is preferred, as is mentioned briefly above, to include a surface active agent in the composition. Clearly the surface active agent, when present, should not be such as to render the composition significantly phytotoxic. The agent is preferably oil soluble and biodegradable. Generally these preferences will mean that the agent is nonionic. The surface active agent octyl-phenoxypolyethoxy ethanol has been used successfully. This material is biodegradable, oil-soluble and nonionic. It is commercially available as 100% material under the trade name Triton X-45.

We envisage that the fungicidal composition of this invention will usually be applied by spraying and/or fogging. We expect that where the fungicidal composition is sprayed, conventional ground based spraying equipment will usually be used. Air-borne spraying can be used but, as is mentioned above, this will not usually be commercially practical because of the nature of the terrain. Typically, presently available portable power sprayers will be used. In this type of spraying the fungicidal composition is sprayed into the air from ground level and drifts up towards the canopy of rubber leaves. When the fungicidal composition is applied by fogging this will usually be done from fogging apparatus which being, at least at present, rather more bulky and heavy than portable sprayers will be mounted or towed by a suitable vehicle. This may place some restraint on the terrain in which fogging can be used but even in fairly hilly country fogging can be useful because it can be operated to cover more trees per pass than portable sprayers. Suitable fogging apparatus is commercially available, producing the fog by a thermal fogging technique, although other techniques for fog production may be used.

We have found that the preferred proportions of the constituents of the fungicidal composition depend somewhat on whether the composition is intended for spraying or fogging. The differences relate principally to the proportion of fungicide used. The amount of fungicide is thus preferably in the range 0.03 to 5% by weight of the composition. For spraying the more preferred range is 0.05 to 1% and for fogging 0.1 to 5%, optionally about 3%. The amount of surface active agent, when used, is generally from 0.1 to 1% by weight of the composition. The remainder of the composition is usually the non-phytotoxic oil typically comprising from 94 to 99.8% by weight. Other materials such as antioxidants and colourants may be included provided they do not make the composition phytotoxic. However, we have not generally found it necessary to include such materials in the compositions of the invention.

A preferred composition comprises:

Shellflex 214 NC	94 to 99.8%
Triton X-45	0.1 to 1.0%
Tridemorph (as a 75% emulsifiable concentrate)	0.05 to 1% for spraying and up to 5%, preferably about 3%, for fogging.

The following examples illustrate the invention.

Example I.

Preparation of the Oil-Based Fungicide.

(a) *Screening of fungicides for spore-suppressing activity against O. heveae.*

A number of systemic fungicides were first screened *in vitro* for their activity

against *O. heveae*. The various fungicides were emulsified or suspended in distilled water at 0.01% to 0.05% concentrations (a.i.). Each fungicide was sprayed using a "Shelltox" hand-sprayer on to both surfaces of detached 7-day-old leaflets of the PB 5/51 and then allowed to dry in air. Five replicate leaflets, including one set sprayed only with distilled water, were inoculated by stroking them with a brush loaded with conidia from 12-day-old colonies of the fungus. Germination rate was assessed at 24 h, mycelial growth on the 5th day and sporulation intensity on the 12th day.

The results (Table 1) showed that of the 11 fungicides tested, 9 were active against *O. heveae*. Of these, 5 suppressed germination and prevented mycelial growth, but only 2 of them, tridemorph and a benzimidazole, proved to be excellent anti-sporulants.

TABLE 1

EFFECT OF SYSTEMIC FUNGICIDES ON GERMINATION, MYCELIAL GROWTH AND SPORULATION
OF *OIDIUM HEVEAE* ON DETACHED LEAVES

Trade name	Fungicide Formulation	Active ingredient	Concentration (%)	Germination (transformed %)	Mycelial growth (mm)	Sporulation (conidiophores/ colony)
Milstem	80%WP	Ethirimol	0.01	18.5	0	—
PP 588	25%EC	Butirinate	0.01	22.5	0	—
Dersol	60%WP	Carbendazin	0.02	32.7	0	—
Milcol	40%EC	Draxoxolon	0.02	32.7	0	—
Bavistin	50%WP	2-(methyl-carbamoyl)- benzimidazole	0.03	24.8	0	—
Folcidin	50%WP	Benzimidazole	0.05	45.2	0.13	0
Calixin	75%OC	Tridemorph	0.01	38.1	0.44	0
Afugan	30%EC	Pyrazophos	0.02	50.7	0.76	11
PP 395	40%EC	Metazoxolon	0.02	53.1	0.94	29
TCMTB	30%EC	2(thiocyanomethylthio) benzothiazole	0.03	40.2	1.67	25
RH 124	50%WP	4-n-butyl-1,2,4-triazole	0.05	78.3	2.95	81
Control	—	—	—	60.2	3.18	131
S.E. (+)	—	—	—	0.25	0.01	0.60
L.S.D. ($P \leq 0.5$)	—	—	—	5.42	0.24	13.34

OC - Oily concentrate

EC - Emulsifiable concentrate

WP - Wettable powder.

(b) *Test of carrier oils for phytotoxicity.*

The test was initially carried out on leaves of clone PB 5/51 grown in pots. The buddings were pruned back at staggered time intervals to produce uniformly-aged leaves at 2—3, 3—5, 7—9 and 10 days from bud-burst. Each oil was sprayed by means of a "Shelltox" hand-sprayer positioned 1 m away from the leaves. Up to 5 quick successive puffs were made to obtain a fine mist on the leaves. At 72 h, any signs of scorching and distortion on the sprayed leaves were recorded, followed by an assessment at 2 weeks of the degree of defoliation.

TABLE 2
EFFECT OF LOW-VOLUME SPRAYING OF MINERAL OILS
ON LEAVES OF PB 5/51 OF FOUR DIFFERENT AGES

Spray oil	Phytotoxicity rating at age from bud-burst			
	2—3 days	3—5 days	7—9 days	10 days
Sunoco Sunspray 7E	+	+	—	—
Shell Miscible White Oil	+	+	—	—
Shellflex 214 NC	+	+	—	—
BP Spray Oil BG 65/100	+++	++	++	+
BP Spray Oil BG 40H	+++	+++	+++	+
Prorex 37 (Trade Mark)	+++	+++	+++	++
Diesylene	++++	++++	++++	++

Phytotoxicity rating: — Leaf as normal

+ A few translucent oil spots visible under hand-lens only

++ Many necrotic oil spots clearly visible

+++ Confluent spots and leaf deformation

++++ Leaf withered away

* Defoliation in two weeks.

The results (Table 2) showed that the 3 relatively well refined paraffinic hydrocarbon oils — Sunoco Sunspray 7E, Shell Miscible White Oil and Shellflex 214 NC were relatively safe to use on the young rubber leaves. Sunoco Sunspray 7E, an imported well-known agricultural spray oil, is prohibitively costly while Shell Miscible White Oil costs twice that of Shellflex 214 NC. The last oil was therefore chosen for further experimentation as a possible carrier for the promising mildewcides.

(c) *Formulation of the oil-based fungicide.*

Attempts were made to prepare stable sprayable emulsions in Shellflex 214 NC with the two mildewcides showing anti-sporulating activity obtained in the *in vitro* screening test. However, only Calixin (a clear oily liquid containing 75% tridemorph as an emulsifiable concentrate) was found to form a stable, clear emulsion with Shellflex 214 NC when the fungicide was used at concentrations from 0.05% to 1.0% active ingredient. The addition of an oil-soluble, anionic surface active agent, Triton X-45, at 0.1% to 1.0% concentrations, enhanced stability of the emulsion during storage for up to 12 months with no evidence of any separation of the fungicide from the oil. In the emulsion with no surfactant added, there was a slight settling down of Calixin from the oil. In addition, the addition of 0.1% to 1.0% Triton X-45 to the fungicide-oil emulsion also caused ready breakdown of the spray into many more droplets of smaller size, when test-sprayed on to leaves in pots by means of a "Shelltox" hand-sprayer (Table 3).

TABLE 3

EFFECT OF VARIOUS TRIDEMORPH FORMULATIONS ON
SPRAY DENSITY AND DROPLET SIZE ON LEAVES

Fungicidal formulation	Density of spray droplets on leaf surface (No./10 cm ²)	Mean size of spray droplets (μ)
0.05% tridemorph in Shell 214 NC alone	135	383
0.05% tridemorph in Shell 214 NC + 0.1% Triton X-45	274	258
0.05% tridemorph in Shell 214 NC + 1.0% Triton X-45	501	259

Example II.

Evaluation of the Oil-Based Fungicide.

(a) *Test for therapeutic action and residual properties of the oil-based fungicide.*

To assess the effect of the fungicidal formulation against *Oidium* infection on leaves, tridemorph at 0.05% in Shellflex 214 NC with 0.1% Triton X-45 added, and the oil carrier alone, were sprayed by means of a hand-sprayer on to 2-3 day-old leaves of PB 5/51 grown in pots. The treated plants were left exposed in the open for 5 days. The treated leaves were then detached and washed in running water for 2-3 minutes. The upper surfaces of the leaflets were inoculated with *Oidium* and incubated for 12 days under optimum conditions for sporulation. The rate of sporulation was observed.

TABLE 4

EFFECT OF TRIDEMORPH IN SHELLFLEX 214 NC ON
SPORULATION BY *OIDIUM HEVEAE*

Treatment	Sporulation intensity at 12 days (conidiophores/colony)
0.5% tridemorph in Shellflex 214 NC	7.0
Shellflex 214 NC alone	57.4
Untreated control	61.2

There was sufficient uptake of the oil-based fungicide by the young leaves to greatly reduce the rate of sporulation (Table 4).

(b) *Field test for phytotoxicity and coverage.*

Tests were carried out on young leaves of different ages on 12-year-old RRIM 701 trees. Stable emulsions of 1.0% tridemorph were prepared in Shellflex 214 NC with 0.1% Triton X-45 added, and in oil-water emulsion (50:50 volume). A dye (Waxoline Red — Trade Mark) was added to the emulsions at 0.1% concentration. For comparison 1.0% tridemorph in water alone was also included in the test. Spraying was carried out between 6.30 am and 10.30 am with a motorized mini-micron sprayer, Wallace Shaw Bombay, India. The sprayer was carried on the shoulders by two men who walked along the tree rows at 2.3 km per hour delivering 11.2 l per ha. Before spraying, rectangular pieces of paper markers stretched out on wire loops (20×28 cm) were hung on branches at heights of 15.2 m and 30.5 m.

The intensity of spray deposit on the paper markers recovered at the two heights was evaluated in the laboratory by obtaining the mean number of coloured droplets under a stereo-microscope. For evidence of phytotoxicity, leaves at three to five, seven to nine and more than ten days from bud-burst were sampled on the third day after treatment at the two heights and similarly examined in the laboratory.

Based on the relative mean numbers of spray droplets deposited on unit area of the paper markers at the two heights, 1.0% tridemorph in Shellflex 214 NC attained the greatest vertical height (Table 5). At 30.5 m ninety-four droplets per 10 cm² were observed, this being considered to be an adequate spray deposit. The same fungicide in oil-water emulsion, however, achieved a much poorer coverage at both levels of the canopy. Formulated in water alone, tridemorph spray was not detected at all at the higher canopy level.

TABLE 5

EFFECT OF LOW-VOLUME GROUND SPRAYING OF TRIDEMORPH
IN THREE FORMULATIONS IN RELATION TO SPRAY COVERAGE AT
TWO CANOPY HEIGHTS

Fungicidal formulation	No. of spray droplets/cm ²	
	15.2 m	30.5 m
1.0% tridemorph in Shellflex 214 NC	302	94
1.0% tridemorph in Shellflex 214 NC-water (50:50)	150	37
1.0% tridemorph in water alone	81	0

(c) *Field evaluation of fungicidal formulations against the disease.*

During the 1975 disease season, two trials against *Oidium* SLF were carried out on mature PB 5/51. The first trial on *Estate A* was on a 14-year-old stand located on hilly terrain in coastal Negri Sembilan, and the second was on a 12-year-old flat planting on *Estate B* in South Perak, where the disease is endemically severe. In both trials, low-volume spraying with three rounds of 1.0% tridemorph in Shellflex 214 NC suspended in the same carrier oil, at 10–12 day intervals, was compared with 3–5 rounds of sulphur dusting at 5 to 7-day intervals. Each treatment comprised three to four replicate tapping tasks of 400–500 trees. Spraying and dusting commenced following the first occurrence of an infection period as deduced from temperature and humidity records. The intensity of *Oidium* SLF was assessed by weekly counts of fallen diseased leaves collected throughout the disease season in three 3.5 m² wire nets placed at random in the interrows of each treatment plot. The thickness of the developing canopy was estimated using Haines' method. On *Estate A*, the fortnightly yield of the central twenty-five trees was recorded in normal tapping days using the cup coagulation method.

TABLE 6

EFFECT OF LOW-VOLUME SPRAYING OF SYSTEMIC FUNGICIDE
IN OIL AND SULPHUR DUSTING, AND *RAINFALL DURING
DISEASE SEASON ON OIDIUM SLF AND CANOPY DENSITY,
ESTATE A, 1975

Treatment	Total fall of diseased leaflets (leaflets/3.5m ²)	Canopy density at 8th week (%)
1.0% tridemorph in Shellflex 214 NC	280	77.1
Sulphur dusting	753	62.4
Control	1219	50.5

* Total rainfall from infection day (23rd Feb.) to 31st April: 432.2 mm.
Number of rainy days: 27 out of a total of 67 days.

TABLE 7

EFFECT OF LOW-VOLUME SPRAYING OF SYSTEMIC FUNGICIDE
IN OIL AND SULPHUR DUSTING, AND *RAINFALL DURING
DISEASE SEASON ON OIDIUM SLF AND CANOPY DENSITY,
ESTATE B, 1975

Treatment	Total fall of diseased leaflets (leaflets/3.5 m ²)	Canopy density at 8th week (%)
1.0% tridemorph in Shellflex 214 NC	806	88.5
Sulphur dusting	1014	70.8
Control	2490	49.9

* Total rainfall from infection day (26th Feb.) to 31st April: 431.6 mm.
Number of rainy days: 33 out of a total of 64 days.

Total counts of the fallen diseased leaves showed 1.0% tridemorph in Shellflex 214 NC to be most effective in reducing leaf fall (Tables 6 and 7). This was subsequently reflected in the thickest canopy retained in the treatment plot. More significantly, this fungicidal formulation stood up well against washing by rain which occurred frequently during the period of spraying on both the estates. The results of sulphur dusting in both trials, adversely affected by rain, were poor besides being erratic. On *Estate A*, the average monthly yield increases recorded over the twelve-month period from March 1975 to February 1976 in the tridemorph and sulphur treatment plots were respectively 13.0% and 0.6% over the control (Table 8).

TABLE 8

EFFECT OF LOW-VOLUME SPRAYING OF 1.0% TRIDEMORPH IN SHELLFLEX 214 NC AND SULPHUR DUSTING ON YIELD, ESTATE A, 1975

Month	Mean yield (g/tree/tapping) and % difference from control		
	Control	1.0% tridemorph in Shellflex 214 NC	Sulphur dusting
1975 March	28.0	27.5 - 1.8	25.6 - 8.6
April	33.1	36.1 + 9.1	29.8 - 10.0
May	36.6	39.9 + 9.0	38.3 + 4.6
June	35.7	39.6 + 10.9	35.0 - 2.0
July	36.2	41.9 + 15.8	37.9 + 4.7
August	32.1	39.2 + 22.1	32.4 + 0.9
September	31.2	38.3 + 22.8	31.2 0
October	30.8	32.3 + 4.9	31.1 + 0.7
November	33.3	38.0 + 14.1	32.4 - 2.7
December	24.6	29.8 + 21.1	24.9 + 1.2
1976 January	20.3	24.4 + 20.2	21.8 + 7.4
February	30.7	33.1 + 7.8	32.3 + 5.2
Mean		+ 13.0	+ 0.6

Example III.

Thermal fogging trial:

During the 1977 disease season, one trial against *Oidium* SLF was carried out on an 18-year-old PB 5/63 on *Estate C*. The field in question was on a gentle undulating terrain located in coastal Malacca where *Oidium* is habitually severe. The fungicidal formulation used was made up of 3.0% tridemorph in Shellflex 214 NC with 0.1% Triton X-45 added. For fogging, a new powerful trailer-mounted thermal fogging machine, TART (Tifa Co., Sterling, U.S.A.) specifically introduced in 1976 for use on mature rubber, was employed. Fogging of the oil-based fungicide was carried out between 6.30 a.m. and 10.30 a.m., the machine being driven at 3-4 kph along every tenth row, delivering 4.5 l/ha. Prior to the treatments, calibration of the fogging machine in applying the oil-based fungicide was carried out to estimate its effective vertical and horizontal range of coverage. Glass slides held in wire loops were hung on branches of selected trees along every first, fifth, tenth, fifteenth and twentieth rows on either side of the machine during fogging at heights of 13.7 m, 19.8 m and 27.4 m. The intensity of fog deposit on the slides recovered at the end of fogging was evaluated in the laboratory by obtaining the mean number of fog droplets under a stereo-microscope. The results summarized in Table 9 showed that adequate fog deposit was obtained at the three heights of the canopy with its effective range extending horizontally up to a minimum of ten rows.

TABLE 9

DEPOSITION OF FOG ON GLASS SLIDES AT VARYING
HEIGHTS AND DISTANCES FROM THE FOGGING MACHINE

Distance of slide from machine (m) Slide height above ground (m)	Number of fog droplets/cm ²				
	3.0 1st row	33.5 5th row	67.0 10th row	100.6 15th row	134.1 20th row
13.7	23.0	21.0	11.9	8.2	0
19.8	21.2	18.4	9.1	6.9	0
27.4	17.5	14.8	9.5	3.1	0

Planting distance of trees: 6.7 m × 3.4 m

In the actual trial against the disease, three rounds of fogging at 10—12 day intervals were compared with 4 weekly rounds of sulphur dusting. Each treatment, including an untreated control, comprised 4 replicated tapping tasks of 400—500 trees each. Treatment applications commenced following the first occurrence of an infection period as deduced from temperature and humidity records. The intensity of *Oidium SLF* was assessed by weekly counts of fallen diseased leaves collected throughout the disease season in three 3.5 m² wire nets placed at random in the interrows of each treatment plot. The thickness of the developing canopy was estimated using Haines' method.

Total counts of the fallen leaves showed fogging oil-based systemic fungicide to be more effective than sulphur dusting in reduced leaf fall (Table 10). This was subsequently reflected in the thickest canopy retained in the fogged plot.

TABLE 10

EFFECT OF THERMAL FOGGING OF SYSTEMIC FUNGICIDE
IN OIL AND SULPHUR DUSTING ON *OIDIUM SLF* AND
CANOPY DENSITY, ESTATE C, 1977

Treatment	Total fall of diseased leaflets (leaflets/3.5 m ²)	Canopy density at 8th week (%)
3.0% tridemorph in Shellflex 214 NC	571	86.9
Sulphur dusting	946	71.3
Control	2041	55.2

WHAT WE CLAIM IS:—

1. A fungicidal composition which comprises an emulsion or dispersion of a systemic fungicide in a light hydrocarbon oil which is non-phytotoxic to young rubber leaves.
2. A composition as claimed in claim 1 additionally including a surface active agent.
3. A composition as claimed in claim 2 wherein the surface active agent is an oil soluble, biodegradable nonionic surface active agent.
4. A composition as claimed in either claim 2 or claim 3 wherein the surface active agent is octylphenoxypolyethoxy ethanol.
5. A composition as claimed in any one of claims 2 to 4 containing from 0.1 to 1% by weight of the surface active agent.



TABLE 9

DEPOSITION OF FOG ON GLASS SLIDES AT VARYING HEIGHTS AND DISTANCES FROM THE FOGGING MACHINE

Distance of slide from machine (m) Slide height above ground (m)	Number of fog droplets/cm ²				
	3.0 1st row	33.5 5th row	67.0 10th row	100.6 15th row	134.1 20th row
13.7	23.0	21.0	11.9	8.2	0
19.8	21.2	18.4	9.1	6.9	0
27.4	17.5	14.8	9.5	3.1	0

Planting distance of trees: 6.7 m × 3.4 m

In the actual trial against the disease, three rounds of fogging at 10—12 day intervals were compared with 4 weekly rounds of sulphur dusting. Each treatment, including an untreated control, comprised 4 replicated tapping tasks of 400—500 trees each. Treatment applications commenced following the first occurrence of an infection period as deduced from temperature and humidity records. The intensity of Oidium SLF was assessed by weekly counts of fallen diseased leaves collected throughout the disease season in three 3.5 m² wire nets placed at random in the interrows of each treatment plot. The thickness of the developing canopy was estimated using Haines' method.

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TABLE 10

EFFECT OF THERMAL FOGGING OF SYSTEMIC FUNGICIDE IN OIL AND SULPHUR DUSTING ON OIDIUM SLF AND CANOPY DENSITY, ESTATE C, 1977

Treatment	Total fall of diseased leaflets (leaflets/3.5 m ²)	Canopy density at 8th week (%)
3.0% tridemorph in Shellflex 214 NC	571	86.9
Sulphur dusting	946	71.3
Control	2041	55.2

WHAT WE CLAIM IS:—

1. A fungicidal composition which comprises an emulsion or dispersion of a systemic fungicide in a light hydrocarbon oil which is non-phytotoxic to young rubber leaves.

2. A composition as claimed in claim 1 additionally including a surface active agent.

3. A composition as claimed in claim 2 wherein the surface active agent is an oil soluble, biodegradable nonionic surface active agent.

4. A composition as claimed in either claim 2 or claim 3 wherein the surface active agent is octylphenoxypolyethoxy ethanol.

5. A composition as claimed in any one of claims 2 to 4 containing from 0.1 to 1% by weight of the surface active agent.



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6. A composition as claimed in any one of claims 1 to 5 wherein the fungicide is tridemorph.

7. A composition as claimed in any one of claims 1 to 6 containing from 0.03 to 5% by weight of the fungicide.

5 8. A composition as claimed in claim 7 wherein the amount of fungicide is from 0.05 to 1% by weight. 5

9. A composition as claimed in claim 7 wherein the amount of fungicide is from 0.5 to 5% by weight.

10 10. A composition as claimed in claim 9 wherein the amount of fungicide is about 3% by weight. 10

11. A composition as claimed in any one of claims 1 to 10 wherein the oil is a well refined light hydrocarbon oil.

12. A composition as claimed in any one of claims 1 to 11 wherein the oil is emulsifiable.

15 13. A fungicidal composition having the formulation by weight: 15

octylphenoxypolyethoxy ethanol	0.1 to 1.0%
tridemorph	0.05 to 5%

the remainder being an emulsifiable, well refined, light hydrocarbon oil which is non-phytotoxic to young rubber leaves.

20 14. A composition as claimed in any one of claims 1 to 13 and substantially as hereinbefore described. 20

25 15. A method of controlling SLF in rubber trees which method comprises spraying or fogging the leaves of the rubber trees with a fungicidal composition as claimed in any one of claims 1 to 14 before and/or during the period in which the leaves are susceptible to the organisms which cause SLF. 25

16. A method as claimed in claim 15 wherein the trees are sprayed or fogged at least at the bud-burst stage.

17. A method as claimed in either claim 15 or 16 and substantially as hereinbefore described.

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PATENTS ACT 1949

SPECIFICATION NO 1596262

In pursuance of Section 15 of the Patents Act, 1949, the Specification has been amended in the following manner:

- Page 1, line 6, *after* relates to *insert* treating rubber trees with
- Page 2, line 33, *delete* an oil-based fungicidal formulation that provides *insert* that an oil-based fungicidal formulation can provide
- Page 2, line 37, *after* provides *insert* a method of treating rubber trees which comprises applying to the rubber trees
- Page 2, lines 42 and 54, *for* of the *read* used in the
- Page 2, lines 45 and 46, *delete* a fungicidal composition of the invention *insert* such a fungicidal composition
- Page 2, lines 56 and 58, *delete* with the composition of *insert* according to
- Page 2, line 59, *delete* composition *insert* method
- Page 2, line 63, *delete* using the composition of *insert* according to
- Page 2, line 64, *delete* the composition of
- Page 3, line 9, *delete* will usually be *insert* is
- Page 3, line 23, *delete* fungicidal composition *insert* method
- Page 3, line 24, *delete* applied *insert* carried out by applying the fungicidal composition
- Page 3, line 43, *delete* 0.1 *insert* 0.5
- Page 3, lines 48 and 49, *delete* compositions of the invention *insert* fungicidal compositions
- Page 11, line 16, *after* 1. A *insert* method of treating rubber trees which comprises applying to the rubber trees a
- Page 11, lines 19, 21, 23 and 25, Page 12, lines 1, 3, 5, 7, 9, 11 and 13, *delete* composition *insert* method
- Page 11, line 19, *delete* additionally including *insert* wherein the composition additionally includes
- Page 11, line 25, Page 12, line 3, *delete* containing *insert* wherein the composition contains
- Page 12, line 15, *delete* having *insert* has
- Page 12, *delete* lines 20 to 22, *insert* 14. A method as claimed in anyone of claims 1 to 13 for the control of SLF in rubber trees which comprises
- Page 12, lines 23 and 24, *delete* a fungicidal composition as claimed in any one of claims 1 to 14 *insert* the fungicidal composition
- Page 12, *for* claims 16 and 17, *read* 15 and 16
- Page 12, line 26, *for* 15 *read* 14
- Page 12, line 28, *delete* either claim 15 or 16, *insert* any one of claims 1 to 15
- Page 12, line 15, *after* A *insert* method as claimed in any one of claims 1 to 12 wherein the