Neth. J. Pl. Path. 75 (1969) 113–118

Difolatan, a promising fungicide for control of the tapping panel disease Black Thread in Hevea brasiliensis

J. SCHREURS

Botanical Research Department, Firestone Plantations Co., Harbel, Liberia

Accepted 22 August, 1968

Abstract

In field experiments for control of Black Thread, caused by *Phytophthora palmivora*, the mean damage done to the trees in the previous rainy season should be of the same level for all the treatments. Satisfactory results and better disease control were obtained with Difolatan in weekly applications when compared with some recommended fungicides for tapping panel diseases. No unfavorable side effects were observed on the latex crop or to the trees. Difolatan (active ingredient: N-(1,1,2,2-tetrachloroethylsulfenyl)-cisΔ4-cyclohexene-1,2-dicarboximide) is known to be of low mammalian toxicity.

Introduction

This wide-spread disease of the rubber tree, caused by the fungus *Phytophthora palmivora*, often does considerable damage to the tapping panel of *Hevea* trees in Liberia. Petrolatums and coal-tar derivatives which are emulsifiable with water are used for control and more recently also organic mercurials (Anon., 1965). The petrolatum Waxrex Treseal is applied at the Firestone Plantations in Liberia. Although this grease definitely gives some disease control, it does not prevent severe outbreaks of the disease in very susceptible *Hevea* clones in some years. For finding better ways of disease control, generally recommended fungicides for control of tapping panel diseases were tested in field experiments, as well as other fungicides with promising fungitoxic properties in bio-assays.

Disease symptoms and predisposing factors

The renewing bark of the recently tapped portion of the panel is subject to infection. The first external signs of attack are short, vertical linear, shallow depressions above the cut. In severe cases there are many affected patches which may coalesce laterally, resulting in a continuous wound which extends right across the tapping cut. The affected bark deteriorates and the wood is exposed. Sometimes the lesions enlarge rapidly and practically the whole tapping panel may be ruined; secondary infections with pinhole borers contribute to this. Generally, the wounds start healing with the onset of the dry season (see Fig. 1). Healed wounds have irregular and swollen bark, which is difficult to tap and is possibly of lower production level.

Black Thread infections occur mostly during prolonged periods of cool and rainy weather during the months August, September and October at Harbel; new infections

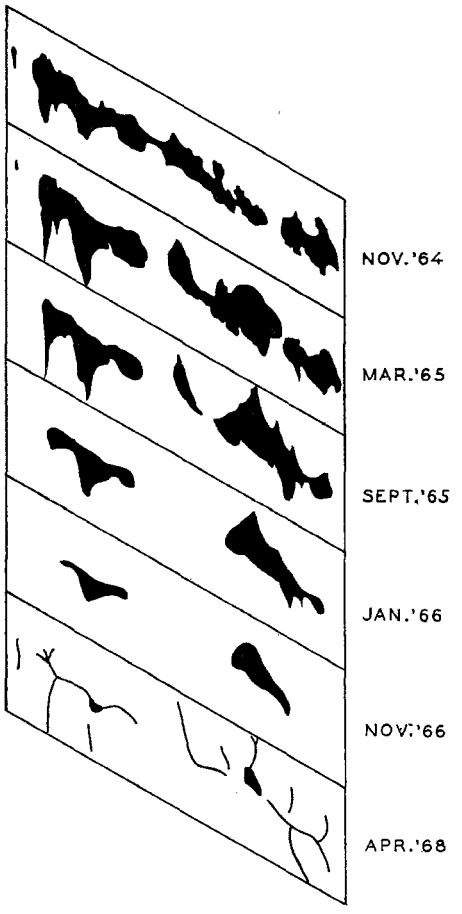

Fig. 1. Appearance of same Black Thread wounds from Nov. 1964 to Apr. 1968.

The blackened areas represent completely dead bark; the scale is 1:10.
Nov. '64: situation 2–3 months after infection.
Mar. and Sept. '65: some wounds are healing, others extending (the disease has spread or already diseased bark has died).
Jan. and Nov. '66: all wounds are healing.
Apr. '68: the wounds have almost healed. Note the scars.

Fig. 1. Het genezingsproces van Streepjeskanker-wonden.

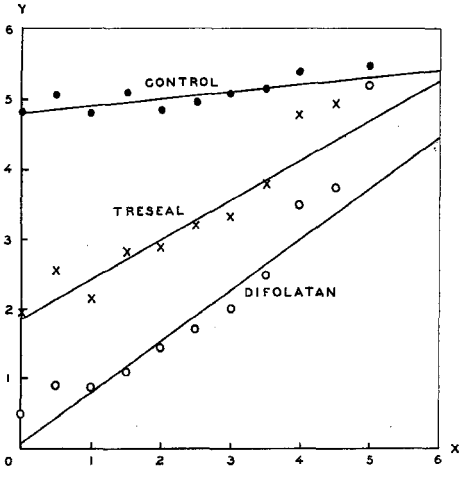

Fig. 2. Incidence of Black Thread on treated and untreated panels, related to pre-treatment damage.

X = pre-treatment disease levels (mean of 1965 and 1966 wounds).
Y = 1967 disease levels.
Regression equations:

$\hat{y}_{\text{control}} = 5.00 + 0.10\,(X - 2.02)$
$\hat{y}_{\text{treseal}} = 2.92 + 0.56\,(X - 1.88)$
$\hat{y}_{\text{difolatan}} = 1.56 + 0.72\,(X - 2.05)$

Fig. 2. Verwonding van behandelde en onbehandelde tapvlakken door Streepjeskanker, gecorreleerd met de schade aangericht in voorafgaande jaren.

are rare during the driest months (January through March). The incidence of the disease may vary considerably from year to year, due to different weather conditions. Most damage is generally found in the lower lying areas.
There is a great variation in susceptibility to Black Thread among *Hevea* clones; a very susceptible clone is Bodjong Datar 5 (BD 5). Although the disease tends to occur in patches, healthy trees are often encountered between trees with badly affected panels, even in monoclonal plantings. Usually, these differences in degree of wounding between trees continue to be the same during consecutive years, provided the general disease incidence is not extremely high. It is shown in Fig. 2 that this positive correlation between the occurrence of old and new wounds is almost lost when the trees of a very susceptible *Hevea* clone are not protected with a fungicide in a severe Black Thread year.

Materials and methods

In bio-assays fungicides were tested for inhibition of mycelium growth of *P. palmivora*. The fungicides were mixed in 15 ml of oatmeal agar (2% oatmeal, 2% agar, pH 6.7) per petri dish. The plates were inoculated in the center with a 7 mm disc of young mycelium. Incubation was up to 6 days at 26 °C.
The products used were obtained from the following companies: Agral wetting agent: Plant Protection Ltd., Fernhurst, England; Antimucin: Sandoz Ltd., Basel, Switzerland; Brunolinum Plantarium: The Standardized Disinfectants Co., London, England; Captan, Difolatan, and Ortho sticker: Chevron Chemical Comp., San Francisco, U.S.A.; Mycocide Latex: Procida, Paris, France; Plyac sticker: General Chemical Division, Allied Chemical and Dye Corporation, Morristown, U.S.A.; Shell TB 192: Shell, London, England; Waxrex Treseal: Mobil Oil Comp., London, England.
The first larger scale field experiment was done on panels protected against rain with polyethylene sheets. This prevented the actual differences in effectiveness among the fungicides being masked by their varying rainfastness. Infections occur under these rainguards, although build-up of the disease is somewhat later and slower.
The field trials were laid out in such a way that the damage done in the previous Black Thread season was of the same level in all treatments, in order to level the chances of infection. The fungicides were applied on the recently tapped bark once or twice a week throughout the rainy season. The petrolatums were applied with the finger and the liquid fungicides by paint brush.
The degree of wounding was estimated at the end of the rainy season, using the following standard of evaluation:

	Approximate % of dead bark up to
0 = healthy panel	0
1 = one or some not very distinct infections	1
2 = a few typical Black Thread infections	$2\frac{1}{2}$
3 = several to many deep, vertical bark depressions	6
4 = as under 3, but diseased parts coalesced	15
5 = large patches of new bark dead	50
6 = most of new bark dead	100

Experiments and results

In bio-assays the strongest fungitoxicities were shown by an organic mercury compound, cycloheximide, Difolatan and Captan, arranged in sequence of lesser activity. Among the other 15 fungicides tested were TMTD, dithiocarbamates and triphenyl tin acetate. Carpenter (1954) reported that Captan was the most promising fungicide among 22 others in preliminary field tests in Costa Rica. In view of these results, Captan and the closely related chemical Difolatan were included in the following experiment.

Field experiment under rainguards

This larger scale trial was designed to find out whether satisfactory disease control could be obtained with some liquid fungicides and with Waxrex Treseal when mixed with promising fungicides.

The experiment was done in a 20 years old BD 5 planting, tapped alternate daily. The experiment had a randomized block design with 15 trees per plot, replicated four times. The fungicide applications were made every fourth day (after two tappings) from July through December 1965. The results were statistically analyzed and the treatments are arranged from most to least effective in Table 1.

The percentages, given in Table 1, refer to the active ingredient for Captan and Difolatan, and to the commercial formulation for the organic mercury compound Mycocide Latex (contains 12% metallic mercury). Plyac sticker (0.035%) and Agral wetting agent (0.02%) were added to all fungicides applied in water. The suspensions were made with Captan 50% wettable powder and Difolatan 80% wettable powder, the emulsions with technical Captan and Difolatan, using dimethylsulfoxide (DMSO) as solvent, xylol and emulsifier.

Disease control with 1% Difolatan suspension was significantly better than Treseal, Captan or Mycocide; there were almost no signs of infection on these Difolatan trea-

Table 1. Results of fungicide treatments on panels protected with rainguards

	Mean damage	*Duncan test at 5% level**
With rainguard:		
1% Difolatan suspension in water	0.15	
0.2% Difolatan suspension in water	0.80	
Treseal + 1% Difolatan + 7% DMSO	0.83	
0.2% Difolatan emulsion in water	0.90	
Treseal + 1% Captan	1.12	
Treseal	1.21	
Treseal + 1% Captan + 20% DMSO	1.25	
1% Captan suspension in water	1.29	
Treseal + 1% Difolatan	1.31	
0.3% Mycocide Latex in water	1.60	
0.2% Captan emulsion in water	1.78	
0.2% Captan suspension in water	1.86	
Without rainguard:		
Treseal	2.32	

* Results connected by a joint line are not significantly different

Tabel 1. Resultaten van fungicide behandelingen op tapvlakken beschermd door plastic schorten

ted panels. Incorporation of Captan or Difolatan into Treseal had little effect. Treseal gave significantly better disease control when the panels were not exposed to rain.

Larger scale field experiment

In 1966 Difolatan was tested on a larger scale under normal field conditions, thus on panels exposed to rain. Also under these conditions better disease control was obtained. The next experiment was done in 1967 in a 20 years old BD 5 planting, tapped monthly periodic. There were about 275 trees per treatment and the trial covered two tapping tasks in the A-farm (tapped July, September, November) and two tasks in the B-farm (tapped August, October, December). Each treatment had a number of adjacent lines with trees in each farm. During the listed months Treseal was applied twice a week and Difolatan once a week. Difolatan 80% wettable powder was applied in a concentration of 1% of the active ingredient in water and 0.1% Ortho sticker was added to the suspension. The results were evaluated during December and are given in Fig. 2. The mean damage was calculated separately for the different pre-treatment wounding levels and this was done for each treatment.

The regression coefficients were highly significant for Treseal and Difolatan but non-significant for the untreated control. The graph shows clearly that Difolatan gave better disease control than Treseal at the different pre-treatment levels.

Results of other experiments

The main results of the 17 field experiments done during 1964–1967 were as follows:

(1) 0.8–1.0% active ingredient of Difolatan 80% wettable powder + 0.1% Ortho sticker in water has given more effective Black Thread control than: (a) The petrolatums Waxrex Treseal and Shell TB 192. (b) The emulsifiable coal-tar derivative Brunolinum Plantarium (10% in water). (c) The organic mercury compounds Mycocide Latex (0.3–0.5% of commercial formulation) and Antimucin (0.6–0.8% of commercial formulation).

(2) It has not yet been proved that the effectiveness of the Difolatan suspension is improved by the addition of stickers.

(3) Difolatan probably has no effect on the thickness of renewing bark; Treseal applications resulted in significantly thicker bark renewal.

(4) Difolatan applications had no effect on the latex production, determined in experiments with a tree plot design.

(5) Evidence was obtained that normal field applications of Difolatan have no noticeably adverse effect on the physical properties of latex rubber; the Difolatan content in the latex was less – possibly far less – than 10 ppm. Difolatan should, however, be used with care as 100 ppm in the latex produced adverse effects. The quality of the blend of the tree lace and cup lump rubber is probably acceptable.

Acknowledgment

The author is indebted to the Firestone Plantations Company for permission to release the results of these investigations.

Samenvatting

Difolatan, een veelbelovend fungicide voor de bestrijding van de tapvlakziekte Streepjeskanker in Hevea brasiliensis

In veldproeven ter bestrijding van de tapvlakziekte Streepjeskanker, veroorzaakt door *Phytophthora palmivora*, dient de gemiddelde schade – aangericht in het voorafgaande regenseizoen – in alle behandelingen van hetzelfde niveau te zijn. Op deze wijze worden de infectie-kansen gelijkelijk verdeeld over de behandelingen, aangezien de oude schade bepalend is voor de mate van infectie. Een betere ziekte-bestrijding werd verkregen met het fungicide Difolatan dan met enkele bekende middelen ter bestrijding van tapvlakziekten. Bevredigende resultaten werden verkregen bij wekelijkse toediening. Behandelingen met Difolatan hebben waarschijnlijk geen onaanvaardbare nevenwerking op de bomen en de latex; het middel is weinig giftig.

Reference

Anonymous, 1965. Fungal disease of the tapping panel. Plrs' Bull. Rubb. Res. Inst. Malaya 81: 263–269.

Carpenter, J. B., 1954. Accelerated screening tests of fungicides for control of Black stripe of the Hevea rubbertree. Pl. Dis. Reptr 38: 487–493.