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CHEMICAL MIXTURES FOR RUBBER WOOD TREATMENT BY DIFFUSION PROCESS

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Experiments were conducted to find out an effective combination of chemicals for preservation of rubber wood by diffusion process. The preservatives tried included solutions of inorganic chemicals, organic chemicals and their various combinations. The results indicated that the com binations of borax, boric acid and sodium pentachlorophenate (NaPCP), phosphamidon and oxycarboxin, monocrotophos and oxycarboxin were the best against the sap stain fungus *Botryodiplodia theobromae*. The growth of *Fusarium* sp., *Aspergillus* sp., *Trichoderma* sp., and *Penicillium sp.* was significantly less in most of the treatments. Insect borers were effectively controlled by borax + boric acid + NaPCP, dimethoate + oxycarboxin, dimethoate + tridemorph and copper sulphate + borax .

Sodium pentachlorophenate proved to be an important adjuvant for the diffusion treatment of rubber wood though a few combinations devoid of NaPCP also showed encouraging results. The chemical combination of dimethoate and oxycarboxin can be considered an organic substitute in view of the toxicity of PCP compounds. Copper sulphate and its combinations with other chemicals gave good protection against insect borers but were effective against fungi only if NaPCP was added.

Key words: *Hevea brasiliensis*, Wood preservation, Diffusion, Insect borers, Sapstain fungus.

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INTRODUCTION

The rubber tree, *Hevea brasiliensis*, is cultivated for the extraction of latex. On termination of exploitation for latex, the rubber trees are valued as quality timber. The area under rubber during the year 1994-95 was 515572 hectares (Rubber Board, 1996) . On an average 6000 hectares are replanted each year. Joseph and George (1994) reported that 1.235 million m^3 of rubber wood was available for industrial uses during 1993-94, out of which 0.741 million m^3 was stem wood and was used for packing cases, safety matches, plywood, treated wood for furniture, etc. The rest constituted branch wood, mostly used for cottage industries and household firewood requirements .

Rubber wood is infested by several borer beetles viz., *Heterobostrychus aequalis*, *Sinoxylon conigerum* (Tisseverasinghe, 1970), *Minthea rugicollis* (Norhara, 1981), *Sinoxylon anale*, *Platipus latifinis*, *P. solidus*; *Xyleborus similis* (Mathew, 1987) and *X. perforans* (Jose *et al.*, 1989). The fungi found associated with the biodeterioration of rubber wood are *Botryodiplodia theobromae* (sap/blue stain fungus), *Aspergillus* sp., *Penicillium* sp. (Ali *et al.*, 1980), *Trichoderma* sp. (Hong, 1981) and *Fusarium* sp. (Jose, *et al.*, 1989).

The deterioration of rubber wood due to the attack of fungi and borer beetles is prevented by means of chemical treatments. One such treatment involves the vacuum-pressure impregnation of rubber wood with chemical mixtures. Another method is a nonpressure method *ie.,* the diffusion process. Many plywood manufacturing units use diffusion process for treatment of veneers. The diffusion treatment is done by dipping the wood in a preservative solution. Diffusion is a process in which a solution of higher concentration diffuses into a solution of lower concentration through a permeable material. Rubber wood is permeable and diffusion of toxic ions in the preservative solutions takes place easily into the free water present in the wood.

The combination of sodium pentachlorophenate (NaPCP), borax and boric acid was reported to be a very effective chemical mixture against fungal and insect attacks on rubber wood. Since NaPCP has been banned in several countries, a substitute combination of chemicals should be preferred. With this objective, some organic insecticides and fungicides were tested separately and in combination in two trials conducted at RRII and the results are presented in this paper.

MATERIALS AND METHODS

Two experiments were conducted for evaluating combinations of chemicals for effective rubber wood preservation. Freshly sawn rubber wood planks of size 30 cm x 4 cm x 2.5 cm were subjected to diffusion process (Tisseverasinghe, 1969; Kerala Forest Research Institute, 1984).

The treatment combinations and concentrations are given in Tables 1 and 2. Dipping was done in a wide mouthed plastic trough of 60 litre capacity having a diameter of 64 cm containing 30 litres of the preservative. Each treatment had 5 planks dipped in the solution for 40 minutes. There were 3 replications. The immersion time was fixed as 40 minutes for the planks of 2.5 cm thickness based on a report of Gnanaharan and Mathew (1982). The planks were then taken out and wrapped in polythene sheets allowing diffusion to take place for 30 days. The planks were kept in an open shed having humidity ranging from 79-93 per cent. The planks were unwrapped and kept for air drying under shade in a slanting position for a day and were then stacked one across the other giving enough space for air flow which enhanced air drying. Observations were made for fungal attack and for insect borer attack and the intensity after two months of storage (Jose *et al.,* 1989). The ratings were converted to percentages (Horsfall and Heuberger, 1942). (Table 3a & b.) The final observation on percent infection index with regard to fungal growth and insect borer attack was recorded after 3 years of storage. The data were analysed statistically.

RESULTS AND DISCUSSION

The results of the first experiment on the effect of the combination of inorganic chemicals, sodium pentachlorophenate, borax, boric acid and copper sulphate and organic pesticides monocrotophos, phosphamidon, dimethoate, tridemorph and oxycarboxin on rubber wood preservation are given in Table 1 . The sapstain fungus *B. theobromae* is controlled by treatments borax + boric acid + NaPCP (T4), Borax + boric acid + NaPCP+ phosphamidon + tridemorph (T_5), monocrotophos + oxycarboxin (T_9) phosphamidon + oxycarboxin (T_{10}) and dimethoate + oxycarboxin (T_{11}). The growth of *Fusarium* sp. and *Aspergillus* sp. was controlled by a 11 the treatments except dimethoate + oxycarboxin (T_{11}) and copper sulphate (T_{12}). There was no growth of *Trichoderma* sp. and *Penicillium* sp. on any of the treat-

Table 1. **Effect of treatments on various wood degrading fungi and insect borers [percentage infection index]**

Treatments and concentration, %	*B. theobromae*	*Fusarium* sp.	*Aspergillus* sp.	*X. perforans*	*H. aequalis*
T_1 NaPCP 0.5	0 (0.71)	0 (0.71)	0 (0.71)	41.30 (40.0)	74.58 59.68
T_2 Borax 7.5	48.87 (44.34)	0 (0.71)	0 (0.71)	7.14 (15.47)	38.49 (38.34)
T_3 Borax 7.5 + boric acid 5	83.33 (66.14)	0 (0.71)	0 (0.71)	4.48 (12.22)	0 (0.71)
T_4 Borax 7.5 + boric acid 5 + NaPCP 0.5	0 (0.71)	0 (0.71)	0 (0.71)	0 (0.71)	2.65 (9.33)
T_5 Borax 7.5 + boric acid 5 + NaPCP 0.5 + phos-phamidon 0.2 + tridemorph 0.5	0 (0.71)	0 (0.71)	0 (0.71)	0 (0.71)	25.36 (30.24)
T_6 Monocrotophos 0.2 + tridemorph 0.5	22.67 (28.36)	0 (0.71)	0 (0.71)	0 (0.71)	28.36 (32.16)
T_7 Phosphamidon 0.2 + tridemorph 0.5	0.78 (5.08)	0.57 (4.32)	1.38 (6.62)	12.25 (20.47)	7.69 (16.10)
T_8 Dimethoate 0.2 + tridemorph 0.5	9.33 (17.76)	2.68 (9.39)	1.57 (7.23)	0 (0.71)	3.30 (10.47)
T_9 Monocrotophos 0.2 + oxycarboxin 0.4	0 (0.71)	0 (0.71)	1.38 (6.62)	0 (0.71)	37.31 (37.65)
T_{10} Phosphamidon 0.2 + oxycarboxin 0.4	0 (0.71)	4.70 (12.52)	9.50 (17.95)	44.96 (42.11)	21.09 (27.34)
T_{11} Dimethoate 0.2 + oxycarboxin 0.4	0.69 (4.78)	12.29 (24.09)	16.67 (24.05)	0 (0.71)	0 (0.71)
T_{12} Copper sulphate 10	77.14 (61.46)	20.67 (19.04)	7.74 (16.16)	2.67 (9.33)	0 (0.71)
T_{13} Copper sulphate 10 + borax 7.5	70.0 (57.72)	0 (0.71)	0 (0.71)	0 (0.71)	0 (0.71)
T_{14} Water dipped	0.97 (5.68)	24.43 (29.46)	0 (0.71)	15.11 (22.88)	80.58 (63.86)
T_{15} Control (untreated)	4.21 (11.68)	2.68 (9.33)	64.67 (53.55)	36.49 (37.16)	65.28 (53.87)
S.EM.	2.87	3.65	4.16	9.28	9.42
CD(P = 0.05)	8.31	10.57	12.04	26.87	27.29

Figures in parentheses are angular transformed values

Table 2. **Effect of different treatments against various wood degrading fungi and insect borers (percentage infection index)**

	Treatments and concentration, %	*B. theobromae*	*Fusarium* sp.	*Aspergillus* sp.	*Penicillium* sp.	*X. perforans* and *H. aequalis*
T_1	Copper sulphate 10 + Na PCP 0.5	4.0 (9.56)	2.67(5.95)	4,0 (9.56)	1.33 (4.32)	0 (0.71)
T_2	Copper sulphate 10 + oxycarboxin 0.4	42.67 (40.70)	33.33(35.14)	3.33(14.57)	4.67(12.03)	0 (0.71)
T_3	Copper sulphate 10 + Na PCP 0.5 + oxycarboxin 0.4	16.0 (23.47)	1.33(4.32)	5.33 (8.33)	1.33 (4.32)	0 (0.71)
T_4	Copper sulphate 10 + NaPCP 0.5 + oxycarbo-xin 0.4 + phosphamidon 0.2	0 (0.71)	1.33(4.32)	6.67(11.54)	0 (0.71)	0 (0.71)
T_5	Copper sulphate 10 + borax 7.5 + boric acid 5 + NaPCP 0.5	0 (0.71)	0(0.71)	30.0 (33.0)	20 (26.09)	0 (0.71)
T_6	Copper sulphate 10 + borax 7.5 + boric acid 5 + NaPCP 0.5 + oxycarboxin 0.4	1.33 (4.32)	1.33(4.32)	9.33(17.71)	0 (0.71)	0 (0.71)
T_7	Borax 7.5 + boric acid 5 + oxycarboxin 0.4	36.0 (36.55)	14.67(18.87)	0 (0.71)	2.67 (7.95)	0 (0.71)
T_8	Borax 7.5 + boric acid 5 + NaPCP 0.5 + oxycarboxin 0.4	1.33 (4.32)	0(0.71)	0 (0.71)	0 (0.71)	0 (0.71)
T_9	Phosphamidon 0.2 + oxycarboxin 0.4 + NaPCP 0.5	0 (0.71)	0(0.71)	0 (0.71)	4.0 (7.23)	0 (0.71)
T_{10}	Borax 7.5 + boric acid 5 + NaPCP 0.5 + oxycarbo-xin 0.4 + phosphamidon 0.2	0 (0.71)	0(0.71)	1.33 (4.32)	2.67 (7.93)	0 (0.71)
T_{11}	Control (untreated)	100 (88.20)	80(63.43)	0 (0.71)	0 (0.71)	45.30 (42.29)
S. EM.		3.07	3.59	3.80	3:37	0.84
CD (P = 0.05)		9.06	10.59	11.21	9.94	2.48

Figures in parentheses are angular transformed values ments . The attack of borer beetles was effectively controlled by the treatments dimethoate + oxycarboxin (T_{11}) , borax + boric acid + NaPCP (T_4), dimethoate + tridemorph (T_8) and copper sulphate + borax (T_{13}) .

Table 3 a. **Ratings for fungal growth**

Rate	Intensity of infection	
	Nature of growth	% area affected
0	Nil	-
1	Slight	< 10
2	Low	11-25
3	Medium	26-50
4	Heavy	51-75
5	Very heavy	76-100

In the second experiment, five treatments viz., copper sulphate + NaPCP + oxycarboxin + phosphamidon (T_4), copper sulphate + borax + boric acid + NaPCP (T_5), copper sulphate + borax + boric acid + NaPCP + oxycarboxin (T_6), borax + boric acid + NaPCP + oxycarboxin (T_8) and borax + boric acid + NaPCP + oxycarboxin + phosphamidon (T_{10}) were significantly superior in controlling the sap stain fungus (Table 2). The growth of *Fusarium* sp. was significantly less in most of the treatments except copper sulphate + oxycarboxin (T_2) and borax + boric acid + oxycarboxin (T_7). *Aspergillus* sp. was significantly controlled in all the treatments except copper sulphate + borax + boric acid + NaPCP (T_5) and copper sulphate + borax + boric acid + NaPCP + oxycarboxin (T_6). The growth of *Penicillium* sp. and *Trichoderma* sp. was negligible in all the treatments. There was no incidence of insect borers in any of the treatments .

Attack of *B. theobromae* affects the quality of the rubber wood more than that by *Fusarium* sp., *Aspergillus* sp., *Penicillium* sp. and *Trichoderma* sp. *Fusarium* sp. initially formed a thick sheath-like outgrowth but after drying, it did not leave much markings on the wood. In some cases, the thick growth of *Fusarium* sp. and the growth of *Aspergillus* sp. even suppressed the infection by *Botryodiplodia*.

The combination of borax + boric acid + NaPCP proved to be an effective treatment for the control of sapstain fungus, other moulds and insect borers. Similar observations were made by Gnanaharan and Mathew (1982) in the preservation of rubber wood. Borer attack was completely absent in the treatments where phospha - midon or monocrotophos or copper sulphate or borates were incorporated. The water dipped planks showed low incidence of sapstain and borer attack. Thick outgrowth of *Fusarium* sp. developed on the water dipped planks would have suppressed the growth of the sapstain fungus. The low intensity of borer attack may be due to depletion of nutrients from the planks subjected to water treatment. Such observations were reported earlier (Tisseverasinghe, 1969, 1970; Richardson, 1978; Gnanaharan and Mathew, 1982 and Tan *et al.*, 1983).

Table 3 b. **Ratings for insect borer attack**

Rate	Intensity of attack on plank		
	*X. perforans**	*S. conigerum***	*H. aequalis***
0	0	0	0
1	≤ 4	≤ 2	1
2	≤ 12	≤ 6	≤ 3
3	≤ 40	≤ 10	≤ 5
4	≤ 80	≤ 20	≤ 10
5	≥ 80	≥ 20	≥ 10

* No. of pin holes ** No. of bore holes

The experiments indicate that sodium pentachlorophenate is an important adjuvant for the diffusion treatment of rubber wood, though a few combinations devoid of NaPCP also showed equally encouraging results. The chemical combination of dimethoate and oxycarboxin can be considered as an alternative organic substitute while considering the toxicity of PCP compounds. Copper sulphate and its combinations with other chemicals gave good control of insect borers but to fungi it is more effective if NaPCP is added.

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