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Preliminary Studies on the Preservation of Rubberwood by Diffusion Treatment

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The rubber tree, *Hevea brasiliensis* (Muell. Arg.) mainly cultivated for the production of latex, is also an important source of wood. As a semi-hard wood, the utilisation of rubber wood for different purposes depends primarily on its durability against fungal and insect attacks. A large number of beetle borers were reported on rubber wood (Tissevera singhe, 1970; Yan *et al.* 1979 Norhara, 1981 and Gnanaharan 1983). The most common among the fungi found associated in the deterioration of rubberwood are the blue stain fungus *Botryodiplodia theobromae* Pat. and the associated moulds *Aspergillus* spp. and *Penicillium* spp, (Ali *et al*; 1980). The brown rot fungus, *Coniophora puteana* and the white rot fungus *Polystictus versicolor* were found to cause the degradation when rubber wood is exposed to those fungi (Ali, 1977). Other natural invaders of rubber wood in the field include *Ganoderma applanatum*, *Lenzites Palisotii*, *Poria* spp; *Schizophyllum commune*, *Trametes corrugata* (Hong, 1982).

At Rubber Rasearch Institute of India, Kottayam a number of wood destroying insects have been collected from rubber wood and identified. These are; *Sinoxylon conigerum* Gerstaecker Family: Bostrychidae (2) *Heterobostychus aequalis* (Waterhouse) Family; Bostrychidae (3) *Dinoderus bifoveolatus* (Wollaston) Family: Bostrychidae (4) *Mynthea rugicollis* (Walker) Family: Lyctidae (5) *Xyleborus perforans* (Wollaston) Family: Scolytidae (6) *Platypus solidus* Walker Family; Platypodidae (7) *Carpophilus* (*Eidocolastus*) *plagiatipennis* (Motschulsky) Family: Nitidulidae (8) *Europs* sp. Family: Rhizophagidae (9) *Cryptolestus* sp. Family : Rhizophagidae (10) *Araecerus fasciculatus* (Degeer) Family : Anthribidae.

The fungi isolated were, *Botryodiplodia theobromae* (sap stain) *Fusarium* spp; *Trichoderma* spp; and the moulds *Aspergillus* spp and *Penicillium* spp.

The natural durability of rubber wood against fungal and insect attack can be enhanced only by improving the quality by chemical treatment. Different methods have been developed to achieve this goal. The most successful among them are the chemical impregnation under vacuum and pressure. The diffusion method by dipping the wood in a preservative chemical and allowing the diffusion to take place for a long period of 4 to 8 weeks is moderately successful. An important limiting factor while treating the rubber wood by the diffusion method is the development of fungi during the diffusion storage period. The present study is conducted to select a suitable and cheaper substitute to NaPCP which is the most widely used preservative for the control of fungi developing during the diffusion storage period and to screen other water soluble insecticides and fungicides for the control of insect borers and fungi that attack during the storage period.

Materials and Methods:

The rubber wood was sawn to planks of required sizes viz; (1) 30 cm, × 4 cm, × 2.5 cm, and (2) 30 cm × 4 cm × 5 cm as early as the trees are felled and immediately used for diffusion treatment. There were 15 treatments in total including the untreated planks which remained as the control. The treatments include both fungicides and insecticides alone or in combination as furnished in table 1.

Table 1 Preservatives used

T 1	NaPCP 0.5%
T 2	Borax 7.5%
T 3	Boric Acid 5.0%+ Borax 7.5%
T 4	Boric Acid 5,0%+ Borax 7.5%+NaPCP 0.5%
T 5	Boric Acid 5.9%+Borax 7.5%+NaPCP 0.5% + Phosphamidon 0.2% +Tridemorph 0.5%
T 6	Monocrotophos 0.2%+Tridemorph 0.5%
T 7	Phosphamidon 0.2%+ Tridemorph 0.5%
T 8	Dimethoate 0.2%+ Tridemorph 0.5%
T 9	Monocrotophos 0.2%+Oxycarbooxin 0.4%
T10	Phosphamidon 0.2%+Oxycarboxin 0.4%
T11	Dimethoate 0.2%+Oxycarboxin 0.4%
T12	Copper Sulphate 10%
T13	Copper Sulphate 10%+Borax 7.5%
T14	Water treatment
T15	Untreated

The diffusion treatment was carried out as per the method followed by Tisseverasinghe (1969) and as per the methods given vide; KFRI information Bull 7:1—4.

A plastic trough of 60 litre capacity having a surface area of 60 cm containing 30 litres of the preservative was used for dipping the planks. In each size, 15 planks were treated in three replications. The planks having 2,50 cm thickness were taken out after 40 minutes and the planks having 5 cm. thickness were taken out after 160 minutes. The planks were then wrapped in polythene sheets. The diffusion storage period was 4 weeks and 8 weeks respectively for planks of 2.50 cm and 5 cm. thickness respectively. After diffusion storage for the specific period, the planks were taken out for observations of fungal attack and they were kept for air drying under shade in a slanting position and stored. During storage period the planks were again air dried under shade every 15 days until the planks were completely dried. Observations were again recorded on fungal and insect borer attack after two months of storage.

The fungal attack and insect attack was assessed as per the following ratings. In the case of insect boreres, the ratings was different for the three insects. The percentage attack was calculated as per the formula.

$$PDI = \frac{\text{Sum of all disease ratings}}{\text{No. of observations} \times \text{Max. grade}} \times 100$$

(Horsfall and Heuberger 1942) Table 2. a & 2. b.

Table 2 (a) Disease ratings for fungi

0	No attack
1	Slight growth, 1 to 10% of the area of the plank attacked
2	Medium growth, 11 to 25% of the area of the plank attacked
3	Medium growth, 26 to 50% of the area of the plank attacked
4	Hevy growth, 51 to 75% of the area of the plank attacked
5	Heavy growth, completely covering the planks.

Table 2 (b) Ratings for Insect attack

	Xyleborus perforans	*Sinoxylon conigerum*	*Heterobostrychus aequalis*
0	No attack	No attack	No attack
1	Upto 4 pinholes	Upto 2 boreholes	Upto 1 borehole
2	Upto 12 pinholes	Upto 6 boreholes	Upto 3 boreholes
3	Upto 40 pinholes	Upto 10 poreholes	Upto 5 boreholes
4	Upto 80 pinholes	Upto 20 boreholes	Upto 10 boreholes
5	Above 80 pinholes	Above 20 boreholes	Above 10 boreholes

Results

During the diffusion storage period in treatments with Na PCP alone or in combination with insecticides there was complete control of all the common fungi viz; *Botryodiplodia theobromae* *Fusarium* spp, *Aspergillus* spp, *Trichoderma* spp and *penicillium* spp. All the planks were practically free from fungus. In tridemorph treated planks the growth of sapstain and *Fusarium* was generally high and the surface mould low or absent, When oxycarboxin was used sapstain and Fusarium development was low in planks of both sizes, but fairgrowth of *Fusarium* sp. was noticed in planks of 5 cm thickness. In planks which were free from sap stain and *Fusarium* considerable growth of *Aspergillus* spp or *Trichoderma* spp was noticed. In copper sulphate treatment both stain development and *Fusarium* development were very high. Mould growth was comparatively low. In water dipped treatment *Fusarium* was very high while stain was absent. In untreated control both stain and *Fusarium* was low, but *Aspergillus* was predominant. Insecticides alone do not have any effect on control of fungi (Table 3 a.)

Table 3 (a) Fungal development during diffusion storage (Percent intensity)

Treatments	Botryodiplodia theobromae		Fusarium sp.		Aspergillus sp.		Trichoderma sp.		Penicillium sp.	
	2.5cm	5.0cm	2.5 cm	5.0 cm	2.5 cm	5.0cm	2.5cm	5.0cm	2.5cm	5.0cm
T 1	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
T 2	55.70	48.10	45.50	73.60	26.50	00.00	00.00	00.00	00.00	00.00
T 3	100.00	86.20	00.00	55.60	00.00	00.00	00.00	00.00	00.00	00 00
T 4	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	66 60
T 5	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00 00	00 00	44.40
T 6	26.50	65.50	00.00	63.00	00.00	00.00	00.00	00.00	00.00	00.00
T 7	6.70	20.00	60.50	74.50	00.00	00 00	00.00	00.00	00.00	00.00
T 8	13.30	80.00	86.50	77.80	33.30	00 00	00.00	00.00	00 00	00.00
T 9	00.00	26.60	00.00	53.80	53.50	00,00	00 00	55.70	00.00	00.00
T 10	13.30	00.00	33.30	55.70	00.00	00.00	00.00	60 50	00.00	00.00
T 11	6.70	13.30	33.30	55.60	00.00	00.00	00.00	25.00	00.00	00.00
T 12	85.60	86.70	33.30	54.50	00.00	00.00	10.00	20.50	00.00	00.00
T 13	93.50	95.00	00 00	93.80	24.60	00.00	01.00	00.00	00.00	00.00
T 14	00.00	00.00	85.60	100.00	00.00	00.00	00.00	00.00	00.00	00.00
T 15	00.00	00.00	6.70	00.00	45.50	75.30	00.00	00.00	00.00	00.00

After two months of storage subsequent to diffusion treatment, Na PCP treated planks still remained free from sap stain attack. But considerable attack of *Aspergillus* spp. was noticed in planks of 5 cm thickness. With tridemorph, sap stain attack was low in general but on planks of 5 cm thickness the attack was high and the planks were almost free from *Aspergillus* spp. Oxycarboxin had better control of sapstain than tridemorph, but the intensity of *Asperdillus* was found to be increasing under storage. Copper Sulphate has no effect on sapstain, the fungus almost covering the planks as a thick cover.

In water dipped planks the sap stain was low in the beginning in 5 cm planks, but intensity was high later on. In untreated control both stain and *Fusarium* was low and attack of *Aspergillus* was high. *Trichoderma* was found to be not at all a serious problem. In all the treatments the growth was almost absent or very low.

Develeopment of *Penicillum* was found to be more in Na PCP treated planks and oxycarboxin treated planks as compared to other treatments (Table 3 b)

Table 3 (b) Fungal development after 2 months of storage subseguent to diffusion treatments (Percent intensity)

Treatments	Botryodiplodia theobromae		Fusarium sp.		Aspergillus sp.		Trichoderma sp.		Penicillium sp.	
	2.5cm	5.0cm	2.5cm	5,0cm	2.5cm	5.0cm	2,5cm	5.0cm	2.5cm	5.0cm
T 1	00.00	8.30	00.00	8.30	8.30	33.30	58.30	00.00	16.70	8.30
T 2	77.80	69.30	00.00	55.70	8.30	73.60	56.70	13.30	00.00	00.00
T 3	93.30	88.40	00.00	55.50	00.00	44 40	33.30	55.60	00.00	00.00
T 4	00.00	6.70	00.00	00.00	00.00	33.30	13.30	20,00	00.00	62.00
T 5	6.70	13.30	00.00	00.00	6.70	00.00	00.00	40.00	00.00	53.30
T 6	26.70	88.30	62.20	66 70	44.40	00.00	20.00	20.00	00.00	00.00
T 7	6.70	20.00	66.70	73.60	00.00	00 00	53.30	13.30	46.70	20.00
T 8	20.00	80.00	85.00	77.80	40.00	00.00	36.70	13.30	6.70	00.00
T 9	00.00	33.30	11.10	25.00	55 60	40.00	11.10	33.30	00.00	66.70
T 10	33.30	43.10	33.30	55.70	00.00	59.30	44.30	59.30	11.10	33.30
T 11	66.70	11.10	33.30	44 40	00.00	66.70	00.00	33.30	00.00	00.00
T 12	88 90	93.80	8.30	25.00	69.40	00 00	58 30	26.60	00.00	00.00
T 13	93.30	95.00	00.00	93.80	25.00	00.00	16.70	00.00	00.00	00.00
T 14	6.70	64.50	40.00	00.00	13.30	86.60	00.00	33.30	6.70	00.00
T 15	00.00	00.00	20.00	00.00	60.00	100.00	00.00	00.00	00.00	00 00

Preliminary observation on insect borer attack during the storage period after diffusion treatment showed that three insect boreres viz; *Xyleborus Perfoarns*; *Sinoxylon conigerum* and *Heterobostrychus aequalis* predominated after two months. These three insect borers, *X Perforans* (Size: 2mm length and 0.5 mm, width) *S conigerum* (size: 4 mm. length and 2 mm, width) and *H. aequalis* (size: 10 mm. length and 4 mm. width) made holes 0.5 mm, 2 mm, and 4 mm, diametres respectivy.

Borer attack was totally absent on planks treated with borax; monocrotophos+ oxycarboxin; phosphamidon+ oxycarboxin; Copper sulphate + borax; and copper sulphate (Table 4).

Table 4 Attack of different insect borers after 2 months of storage subsequent to diffusion treatment (Percent intensity)

Treatments	Xyleborus perforans		Sinyxylon conigerum		Heterobostrychus aequalis	
	2,5cm	5·0cm	2.5cm	5.0 cm	2.5 cm	5.0 cm
T 1	16.67	00.00	8.33	00 00	16.67	00.00
T 2	00.00	00.00	0 00	00.00	00.00	00.00
T 3	16.67	00.00	0.00	00.00	00.00	00.00
T 4	00.00	30.00	0 00	00.00	00.00	10.00
T 5	00.00	00.90	0 00	00.00	00.00	6.67
T 6	00.00	33.33	0 00	00.00	00.00	00.00
T 7	00.00	53.33	0.00	13.33	00.00	13.33
T 8	00.00	20.00	0.00	00.00	00.00	00.00
T 9	00.00	00 00	0.00	00.00	00.00	00.00
T 10	00.00	00.00	0.00	00.00	00.00	00.00
T 11	00.00	22.22	0.0.	00.00	00.00	00.00
T 12	00.00	00.00	0.00	00.00	00.00	00.00
T 13	00.00	00.00	0.00	00.00	00.00	00.00
T 14	00.00	6.67	0.00	00.00	00.00	00.00
T 15	00.00	62.67	0.00	26.67	6.67	52.00

Borer attack was considerably low in treatments viz; boric acid+borax+Na PCP; boric acid+borax; boric acid+borax+Na PCP+ phosphamidon+tridemorph; monocrotophos+tridemorph; dimethoate+tridemorph; dimethoate+oxscarbox in etc.

Attack of the three borers was observed but less on planks treated with Na PCP and phosphamidon+tridemorph

Maximum attack was found on the untreated planks, *X Perfoans* 62.20% *S conigerum* 26,67% and *H. aequalis* 52%. But the attack was absent on the water dipped planks kept under cover except on a few 5 cm thick planks on which 6.67% attack of *X perforans* was noticed.

Discussion

Sodium pentachlorophenate (Na PCP) is the widely accepted preservative for the control of fungi on wood especially sap stain (Tisseverasinghe 1969;1970) Na PCP is well miscible with insecticides and can be used for protection against insect pests also. However, this fungicide is found to be toxic to human beings (Dickon, 1980). So a constant search for equally effective but cheaper alternative which is free from mammalian toxicity is made. A large number of preservatives have been screened but so far no alternative could be spotted out (Ali *et al.* 1980; Plackett 1982). Incorporation of 10% boric acid equivalent (B A E) solution in Na PCP (0.5%) solution was reported to give protection against *Sinoxylon anale* attack on rubber wood (Gnanaharan, 1983).

In the present study also Na PCP proved to be the best antifungal preservative and in combination with insecticides borax, boric acid or phosphamidon completely checks. insect borer attack. Among the other fungicides oxycarboxin is found to be good in controlling sap stain and Fusarium to some extent though not equal to Na PCP. In this case also artack of *Asperqillus* spp and *Trichoderma* spp was more.

Borer attack was completely absent when insecticides like phosphamidon or monocrotophos was incorporated with oxycarboxin. Copper sulphate solution also had complete control of insect borer attack, but had no effect on sapstain and *Fusarium*. In the water dipped planks stain and insect attack was low, because the planks were almost covered by Fusarium spp. In untreated planks, since moisture was low. both stain and Fusarium development

were low, but later heavy attack of Aspergillus was noticed. These planks were showing maximum attack of insects.

Conclusion

Na PCP still remains to be the best preservative and in combination with insecticides, borax and boric acid controls fungal and insect borer attack. Oxycarboxin shows promise in controlling fungi next to Na FCP and incorporation of insecticide viz; monocrotophos and phosphamidon is effective against insect borer. Copper sulphate solution was also found to be effective against insect borer attack for two months. Further observations are required for confirming their effectiveness in the long-term.

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Rubber septa for weevil control

The Scientists of the Regional Research Laporatary and the Central Tuber Crops Research Institute have developed a rubber septa to be used in the "sex pheremone trap" that is laid for the effective control of sweet potato weevil. The rubber septa, developed indigenously, is claimed to be qualitatively superior and far less costly than the ones available now. The research work by the scientists was based on the findings of an American Scientist, Dr, Robert Heath, in 1986.