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PROTECTION OF RUBBER WOOD FROM INSECT BORERS

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ABSTRACT

The efficacy of selected insecticides *viz.,* Chlorpyriphos (0.1 to 0.5%). Fenvalerate (0.01 to 0.1 *Yo),* Cypermethrin (0.01 to 0.1 %) and boric acid (3 to 10%) individually as well as in combination with a fungicide, Chlorothalonil (0.5%) was evaluated both in the laboratory and in the field against major insect pests of rubber wood *viz., Sinoxylon anale, Heterobostrychus aequalis, Minthea rugicollis* and *Lyctus brunneus.* Chlorothalonil was used mainly to prevent incidence of sap stain fungi.

The solution pick-up and chemical retention were also studied. There was no major variation in the solution pick-up of different chemicals. The values ranged from 101 kg/m^3 for boric acid (5%) to 129 kg/m^3 for Chlorpyriphos (0.2%).The chemical retention ranged from 0.01 kg/m^3 for Cypermethrin (0.01%) to 10.87 kg/m^3 for boric acid (10%).The difference in retention was mainly because of the difference in the concentrations used.

All the insecticides used in this study were found to be equally effective against borers. As the lowest concentration of different chemicals gave effective protection, the threshold values for these chemicals will be lower than that of the lowest concentration tried. However, for commercial application, it is safe to use at least the lowest concentration of different chemicals tried. Considering the effectiveness in controlling insect and fungal problems, treatments with Chlorpyriphos 20 EC (0.5%) or Fenvalerate 20 EC (0.1%) with Chlorothalonil 75 WP (0.5%) are recommended for commercial use.

Key words: *rubber wood, protection, insect borers.*

INTRODUCTION

Due to acute scarcity of wood, various perishable timber species, mostly from non-conventional sources, are currently being utilized as a substitute for timber harvested from natural forests. Rubber wood is one of the important non-conventional timber resource that is in great demand in Kerala as a raw material for many wood-based industries. According to an estimate by the Rubber Research Institute of India (RRII, 1992). the annual production of rubber wood in India is about 1.37 million cu.m. Kerala State accounts for 86% of the total area under rubber cultivation in India (Mannothra, 1993: George and Joseph, 1993). As such, Kerala has the highest production of rubber wood which is expected to add substantially to the quantity of non-conventional timber produced from this State.

In Kerala, rubber wood is used for packing cases, match veneers and splints, brush handles, bobbins, doors and windows. furniture making etc. However, its susceptibility to various bio-degrading organisms *viz.,* insect borers and staining fungi, is a serious problem for the effective utilization of this timber. In a study carried out by Mathew (1982), about a dozen species of beetles were recorded as pests of this timber in Kerala, of which maximum damage was reported to be caused by the bostrychids, *Sinoxylon anale* Les. and *Heterobostrychus aequalis* Wat. and the lyctids, *Minthea rugicollis* Wlk., and *Lyctus brunneus* (Steph.). Brief accounts of these insects are given below:

Sinoxylon anale Les.

This is one of the principal timber pests in India as well as in several countries in the Oriental Region having an unusually wide host range. Beeson (1941) listed as many as 68 species of timber as its host. The adult beetles are small in size measuring 4 to 5.5 mm. Prothorax is convex and puncturate bearing a transverse band of rasps at the antero-lateral margin. Elytra is truncate. wide at the apical region and bear two sharp teeth on the apical declivity (Fig. 1). The larvae bore radial galleries causing serious economic loss. Usually its attack is serious in converted timber.

Heterobostrychus aequalis Wat.

This highly polyphagous borer, attacking about 36 timber species in India (Beeson. 1941). is a common borer in packing cases, tea chests, veneers, etc. The beetles are brown in colour and measure about 6 to 10 mm in size. The prothorax is rough and hood-like. The elytra exhibit dense puncturations; its apical margin is turned upwards and is provided with marginal tubercles (Fig. 2). Larval galleries are radial. Infestation by this beetle usually goes unnoticed as the frass formed usually remain stuffed within the larval tunnels. This insect is a major pest of rubber wood in Sri Lanka. In Kerala, this insect is considered as a potential pest.

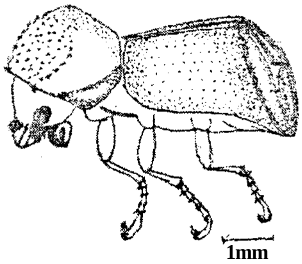

Fig. 1. *Sinoxylon anale*

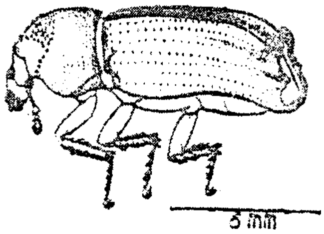

Fig.2. *Heterobostrychus aequalis*

Minthea rugicollis Wlk.

It is a polyphagous beetle attacking about 33 species of timber in India (Beeson,1941). It is a flat, dark brown beetle measuring about 2 to 3.5 mm in size. The body is covered with white scales, those on the sides being more pronounced and appearing as a fringe (Fig. 3). The nature of damage is similar to that of *L. brunneus.*

Lyctus brunneus (Stephens)

This insect is dark brown in colour measuring 2 to 3 mm in size. It is polyphagous, attacking about 17 species of timber. The insect is characterised by its rectangular pronotum. Elytra faintly striate and pubescent. Body puncturate with spinules bordering the antero-lateral margin (Fig. 4).

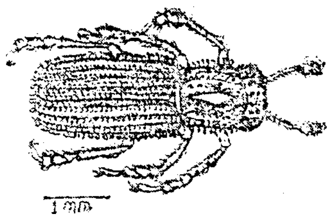

Fig.3. *Minthea rugicollis*

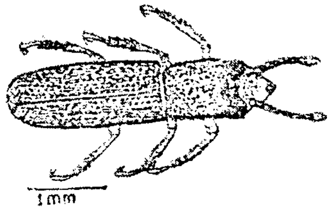

Fig. 4. *Lyctus brunneus*

Control studies for protecting rubber wood from borer attack

Wood borers usually gain entry into the timber when the logs are stored in the field or when the sawn timber is stored in the factory for processing. By giving appropriate prophylactic chemical treatment and by maintaining good sanitary conditions, possible build up of pests can be prevented. The converted timber also requires adequate chemical treatment before it could be used for any commercial purpose.

Various studies have been made in the past on the protection of rubber wood by treatment with different chemicals. These studies broadly belong to two classes: 1) pressure method in which the preservative solution is forced through the conducting tissues of wood at high pressure and 2) diffusion method in which the preservative chemical is applied to the green timber either by momentary dipping or by immersing for longer periods and storing the timber under cover so as to permit uniform diffusion of the chemical. The diffusion storage period depends on the thickness of timber. concentration of treatment solution, the dry salt retention required, etc. (Dhamodaran and Gnanaharan. 1984: 1996).

Gnanaharan and Mathew (1982) suggested a simple diffusion process using boric acid and borax. This involved immersion of freshly sawn green timber in a 10% boric acid equivalent (BAE) solution and stacking the treated wood for a specified period to allow diffusion process to complete. Remadevi and Muthukrishnan (1997) treated rubber wood using Chlorpyriphos as a protectant against borers and termites. It was shown that while low concentrations gave protection only for a short period. higher concentaration (0.4% a. i.) gave protection for longer periods (up to 7 months). This difference is related to the chemical imbibed by the wood. Ananthapadmanabha and Srinivasan (1993) reported that K-Otek. a commercial product containing deltamethrin, TCMTB *(2* thio cyano methyl thio benzothiozole) and MBT (methyl bis thiocyanate) offer adequate protection of treated rubber wood against biodegrading agents.

Retention of chemical in the wood is an important factor that determines the relative resistance of treated timber against various pests. It is known that certain chemicals such as baron are not fixed in the wood and leach out slowly when the treated wood is exposed to outdoor or wet conditions. In the trials carried out by Cnanaharan and Mathew (1982). the dry salt retention achieved using boron chemicals was enough to offer adequate protection against bostrychid and lyctid borers. Because of the simplicity of the process, this treatment was adopted by several industrial units. However, instances of borer attack mainly by the ambrosia beetles

(*Platypus solidus* Wlk. and *P. latifinis* Wlk.) have been noticed on some occasions in treated timber stored in the storage yards of some industrial units around Trichur. These insects are usually associated with round logs with intact bark and are seldom found to cause damage to converted timber. Since any sign of insect attack may affect the commercial value of treated rubber wood, it was necessary to develop a treatment strategy that will take care of a wide range of insect pests.

In this study, several chemicals that are locally available were screened for their efficacy in protecting rubber wood from borer attack. Since rubber wood is also used for making packing cases meant for transporting edible items such as fruits and vegetables, use of highly toxic chemicals which have implications on health and environment has to be avoided. It may be noted here that in some industrial units various toxic chemicals such as Lindane *(gamma* BHC) having high mammalian toxicity were being used for achieving full protection from insect pests. In this context, it is also necessary to educate the entrepreneurs on the adverse effects of using such highly toxic chemicals and to suggest safe chemicals and dosages for treating rubber wood. As has already been pointed out, insects and fungi are the important wood deteriorating organisms. Recently, a study has been made on the staining fungi associated with rubber wood and their management (Florence *et al.,* 1996). Treatment with Busan 1009 (1% a.i.) mixed with boric acid (1%) and borax (1%) was found to be effective in controlling fungal growth. The findings on the efficacy of various chemicals in protecting rubber wood from borer and stain fungi are presented herein.

MATERIALS AND METHODS

Since the powder post beetles, *Sinoxylon anale* Les. and *Lyctus brunneus* Steph. are the major pests of rubber wood in Kerala, these insects were used for laboratory testing. Of these, *S. anale* has preference for fresh. sawn logs while *L. brunneus* is known to build up in logs that have been under storage for a long period. In order to test the short term as well as long term effect of treatment, samples were exposed to cultures of both the insects and observations recorded every month, In order to evaluate the possibility of treated rubber wood being attacked under out door conditions, samples were kept in the storage yards of industrial units so as to expose them to acquire natural infestation.

Maintenance of laboratory cultures of insect borers

Laboratory cultures of the test insects were maintained on dried tapioca chips as well as on rubber wood. Dried tapioca chips were already reported to be a good alternative diet for breeding powder post beetles (Nair and Mathew, 1984).Tapioca chips were made in the laboratory by drying thick slices of raw tapioca in an oven at 60°C.

Field collected samples of the test insects were released into glass troughs of 0.7 m x 0.2 m x 0.45 m containing dry tapioca chips. The troughs were covered with lids fitted with fine mesh and were mounted on wooden stands, the legs of which were immersed in water in order to prevent attack by ants. The cultures were ready in about two months and the maturity of insects was established by extracting the insects from the culture and examining the stages. Since the generations are continuous, large insect population could be built up within a short period.

Experimental design and chemicals used

Two sets of experiments were carried out:

1) using thick planks, and
2) using thin veneers.

Experiment using planks

In the first set of experiments using planks, three trials were carried out using Chlorpyriphos, Fenvalerate. Cypermethrin and Boric acid + Borax.

Planks of 0.45 m length and 50 mm x 15 mm and 40 mm x 40 mm cross section were used for the first trial. In the second and third trials, planks of 0.9 m length and 25 mm x 25 mm cross section were used. Nine planks were used for each treatment.

For all chemicals except Boric acid + Borax (BAB), three arbitrarily fixed concentrations *viz.,* low, medium and high were tried. For BAB, only one concentration (Boric acid + Borax in 1:1.5 ratio, ie., 10% BAE) was used. Thus there were 11 treatments including control. Altogether three trials were carried out, of which the first two trials were carried out using the chemicals separately while in the third trial, the chemicals were used in combination with BAE. The chemicals and concentrations used for the three trials are given in Tables 1 and 2.

Table 1. Chemicals and doses used in the first and second trials using planks

Treatment No.	Treatments (%)
1	Chlorpyriphos 20 EC* (0.1)
2	Chlorpyriphos 20 EC (0.2)
1	Chlorpyriphos 20 EC (0.5)
4	Fenvalerate 20 EC (0.01)
5	Fenvalerate 20 EC (0.05)
6	Fenvalerate 20 EC (0.1)
7	Cypermethrin 25 EC (0.01)
8	Cypermethrin 25 EC (0.05)
9	Cypermethrin 25 EC (0.1)
10	Boric acid + Borax (1:1.5 ratio) (10 % BAE)
11	Control (untreated planks)

*EC-Emulsifiable concentrate.

The treatment was carried out by immersing the planks in the solution kept in a treatment tank of 100 litre capacity. The immersion time was fixed as 15 minutes so as to enable the solution to be picked up by the wood. After treatment, the planks were stacked and allowed to dry in the open so as to simulate general factory conditions. Fresh, untreated planks were used for control.

When fully dry, the treated planks were made into three separate bundles in such a way that each bundle contained samples of each treatment. One bundle was exposed to laboratory bred cultures of powder-post beetles by keeping the bundle in the trough containing the culture. The remaining two bundles were stacked in the storage yards of rubber wood industrial units at Ollur (Evershine Industries) and Kodumon (Plantation Corporation of Kerala) exposing them to natural Infestation. It may be noted here that residual population of different species of borers was already present in the logs and scraps accumulated in the factory premises. Monthly observations were made for a period of one year.

Table 2. Chemicals and doses used in the third trial using planks

Treatment No.	Treatments (%)
1	Chlorpyriphos 20 EC* (0.1)+ BAE (10 %)
2	Chlorpyriphos 20 EC (0.2)+ BAE (10 %)
3	Chlorpyriphos 20 EC (0.5)+ BAE (10 %)
4	Fenvalerate 20 EC (0.01) + BAE (10 %)
5	Fenvalerate 20 EC (0.05)+ BAE (10 %)
6	Fenvalerate 20 EC (0.1) + BAE (10%)
7	Cypermethrin 25 EC (0.01)+ BAE (10 %)
8	Cypermethrin 25 EC (0.05)+ BAE (10 %)
9	Cypermethrin 25 EC (0.1)+ BAE(10%)
10	Control (untreated planks)

* EC-Emulsifiable concentrate

Experiment using veneers

A set of three experiments using veneers was carried out to determine the threshold values of salt retention in treated rubber wood in order to afford protection from insect borers. Veneers of 1.5 mm thickness and of 200 mm x 50 mm size peeled from fresh logs of rubber wood were used. Fifteen veneers were made into a bundle and for each treatment 3 such bundles were used. The treatment was carried out by immersing the bundles in the respective chemical solution for 15 minutes. In the case of control. the veneers were immersed in water. After treatment, the veneers were dried and made into three bundles in such a way that each bundle contained samples of all the treatments. The bundles were tested both in the laboratory as well as in the field as done earlier and monthly observations were made for a period of one year.

Apart from insect damage, fungal attack is also frequently a serious problem for the successful utilisation of rubber wood. Therefore, in this study attempts were also made to screen a combination of an insecticide and fungicide. Earlier, NaPCP (Sodium penta chlorophenate) was tried in combination with boric acid for protection against fungal attack. However, because of its high toxicity and harmfui effects, NaPCP is currently banned and hence a relatively safe fungicide, Chlorothalonil was tested in combination with boric acid, Chlorpyriphos and Fenvalerate. Doses of chemicals used are given in Table 3.

Table 3. Chemicals and doses used for treatment of veneers

Trial No.	Treatment	Concentration (%)
1	Chlorpyriphos 20 EC*	0.1
2	Chlorpyriphos 20 EC	0.2
3	Chlorpyriphos 20 EC	0.5
4	Fenvalerate 20 EC	0.01
5	Fenvalerate 20 EC	0.05
6	Fenvalerate 20 EC	0.1
7	Cypermethrin 25 EC	0.01
8	Cypermethrin 25 EC	0.05
9	Cypermethrin 25 EC	0.1
10	Boric acid	3
11	Boric acid	5
12	Boric acid	10
13	Boric acid and Chlorothalonil 75WP*	3 + 0.5
14	Chlorpyriphos 20EC and Chlorothalonil 75WP	0.5 + 0.5
15	Fenvalerate 20EC and Chlorothalonil 75 WP	0.1 + 0.5
16	Control (water)	

* EC-Emulsifiable concentrate

*W-Wettable powder

Calculation of dry salt retention(DSR)in the treated wood

The chemicals retained by the wood after treatment determine the level of deterrence to biodegrading organisms. Rubber wood being highly permeable, the chemical get easily absorbed when the wood is immersed in the treatment solution. The chemical solution pick up of the sample was calculated by dividing the weight difference due to treatment by the volume of the sample and is expressed in terms of kilogram per cubic meter (kg/m^3) using the following formula:

Chemical solution pick up (in kg/m^3) = 10000 (B-A) / CDE

where,

B = Weight of veneer after treatment in g.
A = Weight of veneer before treatment in g.
C = Length of veneer in cm.
D = Breadth of veneer in cm.
E = Thickness of veneer in mm.

The dry salt retention (kg/m^3) was calculated by multiplying the chemical solution pick-up with the concentration of the solution.

RESULTS AND DISCUSSION

1. Evaluation of chemicals for protection of rubber wood

Trials using planks

Laboratory trials

In the laboratory trials, *Sinoxylon anale* and *Lyctus brunneus* were used as test insects. No trace of infestation by any of these beetles was recorded in any of the treated planks although build up of insects was noticed in the control (see Tables 4 and 5).

Field trials

In field trials, no build up of insects was recorded in any of the treatments except in control both at Kodumon and Ollur, indicating that all chemicals at all concentrations tested were effective in preventing borer attack. At Ollur, the control showed infestation by *L. brunneus* whereas at Kodumon. incidence of *S. anale* and *H. aequalis* was noticed. Thus all insecticides tested here gave effective protection even at the lowest concentration (Tables 4 and 5).

Table 4. Insect activity recorded in laboratory and field trials using treated planks

No.	Treatment	Insect activity	
		Laboratory	Field
1	Chlorpyriphos 0.1%	Nil	Nil
2	Chlorpyriphos 0.2%	Nil	Nil
3	Chlorpyriphos 0.5%	Nil	Nil
4	Fenvalerate 0.01%	Nil	Nil
5	Fenvalerate 0.05%	Nil	Nil
6	Fenvalerate 0.1%	Nil	Nil
7	Cypermethrin 0.01%	Nil	Nil
8	Cypermethrin 0.05%	Nil	Nil
9	Cypermethrin 0.1%	Nil	Nil
10	Boric acid + Borax	Nil	Nil
11	Control	Slight feeding by test insects	Heavy feeding by *S. anale* and *Heterobostrychus aequalis* (at Kodumon) and by *Lyctus brunneus* (at Ollur)

Table 5. Insect activity recorded in labortatory and field trials using treated planks

No	Treatment	Insect activity	
		Laboratory	Field
1	Chlorpyriphos 0.1% + 10% BAE	Nil	Nil
2	Chlorpyriphos 0.2% + 10% BAE	Nil	Nil
3	Chlorpyriphos 0.5% + 10% BAE	Nil	Nil
4	Fenvalerate 0.01% + 10% BAE	Nil	Nil
5	Fenvalerate 0.05%	Nil	Nil
6	Fenvalerate 0.1% + 10% BAE	Nil	Nil
7	Cypermethrin 0.01% + 10% BAE	Nil	Nil
8	Cypermethrin 0.05% + 10% BAE	Nil	Nil
9	Cypermethrin 0.1% + 10% BAE	Nil	Nil
10	Control	Slight feeding by test insects	Slight feeding by *S. anale, Heterobostrychus aequalis* and *Lyctus brunneus*

Laboratory trials

Laboratory trials using veneers were carried out with *L.brunneus* as the test insect. The bundles of treated veneers were stacked in the glass trough containing a stock culture of the insect and monthly observations were made on insect activity for a period of one year. The insect activity observed in the various treatments is given in Table 6.

Excepting treatments 14 (Chlorpyriphos 0.5% + Chlorothalonil 0.5%)and 15 (Fenvalerate 0.1% + Chlorothalonil 0.5%), presence of insects was noticed in all other treatments. The insects were found between the veneers that have been bundled for each treatment. The insects were active, but no boring or establishment in the veneers was noticed. Fungal attack was present on veneers in most of the treatments except 14 and 15 where the fungicide, Chlorothalonil was used along with the insecticide. Since there were no pest build up in any of the treatments, all the treatments can be considered as equally effective. However, only the treatments 14 and 15 showed absolute freedom from both insects and fungi and hence these may be considered as quite satisfactory for routine preservative treatment in industrial units.

Table 6. Insect activity recorded in the laboratory trials using veneers

Sl. No.	Treatments	Trial			Insect activity
		1	2	3	
5	Fenvalerate 0.05%	*	*	-	Live beetles in trials 1 an *2.* but no trace of feeding. Fungal growth in trial ***3.***
6	Fenvalerate 0.1%		-	-	Noinsects.
7	Cypermethrin 0.01%	*	*	-	Live beetles in trials I and 2, but no feeding.
8	Cypermethrin 0.05%	*	-	-	Live beetles in trial 1. but no feeding. Fungal growth in trials 2 and 3.
9	Cypermethrin 0.1%		*	-	Live beetles in trial 2, but no feeding. Fungal growth in trials 2 and 3.
10	Boric acid 3%			-	No insects. Fungal growth in trial 1.
11	Boric acid 5%		*	-	Live beetles in trial 2. but no feeding. Fungal growth in trial 3.
12	Boric acid 10%	*	-	-	Live beetles in trial 1. but no feeding. Fungal growth in trials 2 and 3.
13	Boric acid (3 % + Chlorothalonil (0.5%)	+	-	-	Live beetles in trial 1, but no feeding.
14	Chlorpyrip-hos(0.5%) + Chlorothalonil (0.5%)			-	No insect or fungal attack
15	Fenvalerate (0.1%) + Chlorothaionil (0.5%)			-	No insect or fungal attack
16	Control (Water)	*	*	*	Live beetles and traces of infestation in all the trials.

- No insect present
* Insect present

Field trials

Observations made each month for a period of one year on treated samples stacked along with converted rubber wood in the storage yards of industrial units at Ollur and Kodumon showed absolute deterrence of treated veneers to borers. With regard to fungal attack, only the treatments with Chlorothalonil were free from fungal attack and the results indicate that the treatments 14 and 15 (Chlorpyriphos/Fenvalerate with Chlorothalonil) were the most effective.

The results obtained in the control were also interesting in that no insect build up had occurred. While in the first experiment using planks the control samples were heavily attacked by *S. anale* within a few months, no infestation was noticed in the experiment using veneers. It may be pointed out here that in our trials using planks, the control samples were not subjected to treatment in water whereas in the trials using veneers the control samples were kept immersed in water and then dried in the air. Since the veneers are thin, treatment in water must have resulted in the leaching out of soluble sugars and starch which are known to attract insects to initiate infestation. Water treatment of sawn timber may be helpful in preventing borer infestation and this aspect is worth exploring.

Retention of chemicals in treated rubber wood

The quantity of chemicals retained in the treated wood is a factor that explains the deterrence to bio-degradation. Core loading of 0.2% boric acid has been shown to provide protection of treated wood from insect borers. In order to attain this the overall dry salt retention should be about 1% (McQuire.1962). Rubber wood treated to an overall retention of 0.4 %BAE was found to give protection against *S. anale* (Gnanaharan *et al*, 1983) and along with NaPCP, against termites (Varma and Gnanaharan, 1989). The solution pick up and chemical retention with various chemicals used in this study are given in Table 7. The solution pick up ranged from 101 l/m^3 (Boric acid 5%)to 129 l/m^3 (Chlorpyriphos 0.2%). There was no clear trend in solution pick-up which may be due to the difference in viscosity of solutions. Fifteen minutes immersion was found to be enough to attain a solution pick-up in the range of 100-130 l/m^3.

Table 7. Basic characteristics of solution pick up and chemical retention in different treatments

No.	Treatments	Concent-ration (A)	Solution pick-up l/m3 (B)	Retention kg/m3 A x B
1	Chlorpyriphos 20 EC	(0.1%)	107.61	0.10
2	Chlorpyriphos 20 EC	(0.2%)	128.99	0.25
3	Chlorpyriphos 20 EC	(0.5%)	116.95	0.58
4	Fenvalerate 20 EC	(0.01%)	108.43	0.01
5	Fenvalerate 20 EC	(0.05%)	109.68	0.05
6	Fenvalerate 20 EC	(0.1%)	116.41	0.11
7	Cypermethrin 25 EC	(0.01%)	102.96	0.01
8	Cypermethrin 25 EC	(0.05%)	105.60	0.05
9	Cypermethrin 25 EC	(0.1%)	113.79	0.11
10	Boric acid	(3%)	106.46	3.19
11	Boric acid	(5%)	101.37	5.06
12	Boric acid	(10%)	108.72	10.87
13	Boric acid + Chlorothalonil 75 WP	(3%) (0.5%)	114.22	3.99
14	Chlorothalonil 75 WP + Chlorpyriphos 20 EC	(0.5%) (0.5%)	117.38	1.17
15	Chlorothalonil 75 WP + Fenvalerate 20 EC	(0.5%) (0.1%)	119.41	0.71
16	Control (Water)		116.53	0

Similarly the chemical retention ranged from 0.01 kg/m^3 (Cypermethrin 0.01%) to 10.87 kg/m^3 (Boric acid 10%). The difference in retention was mainly because of the chemical and the concentration used. In this study, it was seen that even the lowest concentration tried gave effective protection. Therefore, the threshold values for these chemicals will be lower than that of the lowest concentrations tried. As all the treatments were effective, statistically it is not advisable to compare retention of one chemical in rubber wood to that of other chemicals. As the veneers are thin, retention of the retained chemical would be uniform. However, this cannot be expected in thicker sections. However, when thicker sections are treated commercially, at least the lowest concentration of different chemicals tried should be used.

CONCLUSIONS

Insect attack coupled with fungal stain is a major problem in the utlilisation of rubber wood especially during the rainy season, when the humidity is high. Therefore, a combination of an insecticide and a fungicide will be a better option for managing both problems. All the chemicals screened in this study viz., Boric acid, Fenvalerate, Cypermethrin and Chlorpyriphos were found to be equally effective against insect borers. A combination of Chlorpriphos 20 EC (0.5% a.i.) or Fenvalerate 20 EC (0.1%) with Chlorothalonil 75 WP (0.5% a.i.) was found to be effective against insect and fungal attack for use by commercial or industrial units.

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