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**भारतीय फ्लाइवुड उद्योग अनुसंधान और प्रशिक्षण संस्थान**  
**INDIAN PLYWOOD INDUSTRIES RESEARCH AND TRAINING INSTITUTE**

(भारत सरकार, पर्यावरण एवं वन मंत्रालय का स्वायत्त निकाय)  
(Autonomous Body of the Ministry of Environment & Forests, Government of India)  
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Post Bag No. 2273, Tumkur Road, Bangalore-560 022

सं./No.

दिनांक/Date.....

Bio./ 1298

25.05.2005

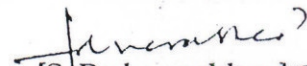
M/s. FMC India Pvt. Ltd.,  
17/2, Palace Road,  
High Grounds,  
Bangalore - 560 052.

Dear Sirs,

The project work on "Evaluation of Bifenthrin against Powder Post Beetle attack for Protection of Wood and Wood Based Panels" was carried out in this Institute under a sponsored project by FMC India Pvt. Ltd. The duration of the study against the powder post beetle attack was 36 months. The report is herewith enclosed.

Thanking you,

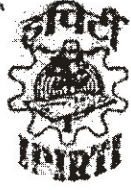
Yours faithfully,

  
[S. Padmanabhan]  
Head, Biology

Encl: a/a

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Post Bag No. 2273, Tumkur Road, Bangalore-560 022

सं./No.


दिनांक/Date.....

30-5-2005

M/s.FMC India Pvt.Ltd.,  
17/2, Palace Road,  
High Grounds,  
Bangalore-560 052.

CERTIFICATE

This is to certify that the Project Work on "Evaluation of Bifenthrin against powder post beetle attack for protection of wood and wood based panels" was carried out in this Institute under a sponsored project by FMC India Pvt. Ltd., Bangalore. Evaluation of Bifenthrin on plywood and solid timber against powder post beetle attack was carried out for 36 months in Bangalore.

  
(C.N. Pandey)  
Director \*

## **Evaluation of Bifenthrin 2.5EC for protection of wood and wood based panels against powder post beetles**

By

S.Z.M. Kamal & S. Padmanabhan

### **INTRODUCTION**

It is a well-known fact that wood/plywood from broad-leaved species (hard wood) are susceptible to infestation by a wide group of insects such as Lyctidae, Bostrichidae, and Temitidae. The first two are termed as powder post beetles. These beetles attack dry seasoned hardwoods having enough starch. Insects belonging to termitidae, are known as termites which attack both green and dry wood.

The commonest and economically most important borer found attacking seasoned hardwood and plywood manufactured with hardwood is Lyctus sp. Softwood such as pine, firs and spruce are never attacked by Lyctidae. Two conditions that govern the susceptibility of Lyctus attack on any timber are the starch content of the sapwood and size of the pores. Starch is essential for the nutrition of these borers, and timbers with a high starch content usually suffer most damage.

Lyctid borers pass through four distinct stages in their development, namely egg, larva pupa and the adult. The adult gravid female beetles crawl or fly to find out starch containing sapwood to lay eggs into the pores of hardwoods. Within fortnight, eggs hatch out and the larva that comes out feeds on starch present in the sapwood, by making tunnels normally along the grain, the tunnels are filled with fine powder. The feeding period during which the bulk of damage is done to material is as short as three months in favourable conditions (warm, humid and abundant food material), but may extend up to 18 months under adverse conditions. When fully grown, larvae pupate and after a short pupal period of few days, the mature adults emerge. Adults may live for 2-3 weeks. During emergence, adults cut exit holes(emergence holes) in wood or lining materials like hard board, laminates and even thin sheet of metals.

### **BIFENTHRIN-A NEW WOOD PRESERVATIVE**

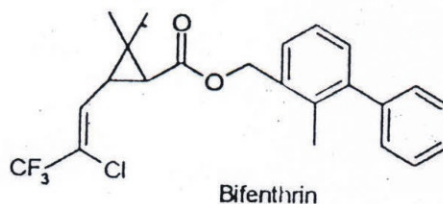
There continues to be a need for new insecticides in the wood protection industry to supplement or replace earlier generation products. New compounds should meet a broad spectrum of requirements, such as efficacy, cost effectiveness and public health & environmental acceptance.

Bifenthrin, a novel pyrethroid from FMC is registered in over sixty countries as an insecticide/miticide/termiticide. The product demonstrates a unique spectrum of activity,

light, heat and soil stability and low vapour pressure with low skin irritation, all of which favour use of Bifenthrin in wood protection and preservation.

### Characteristics of Bifenthrin Technical Grade:

Common Name:	Bifenthrin
Chemical Name (IUPAC):	(2-methyl[1,1-biphenyl]-3-yl)-methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl cyclopropanecarboxylate
Chemical Family:	Synthetic Pyrethroid
Empirical Formula:	$C_{23}H_{22}ClF_3O_2$
Chemical Structure:	



CAS registry number:	82657-04-03
Molecular Weight:	422.88
Color:	Off white to pale tan
Specific Gravity:	1.21 at 25° C
Melting Point:	57-64° C
Flash Point:	165° C (closed Cup)
Decomposition Point:	Exothermic decomposition at greater than 170° C
Vapour Pressure:	0.024 mPa at 25° C
Solubility in Water:	Insoluble, < 0.1 ppb at 25° C
Solubility in Solvents:	<u>Soluble</u> : In most organic solvents; <u>Slightly soluble</u> in heptane, methanol
Corrosive Action:	None

F. M. C. India Pvt. Ltd. sponsored a project on evaluation of bifenthrin against wood destroying insect- powder post beetles for protection of wood and wood based panels at IIRTI, Bangalore. The project was initiated in April 2002 at IIRTI campus in Bangalore. The objective of the study is to evaluate the efficacy of Bifenthrin in controlling powder post beetles in wood and wood based panels. The study report for 36 month duration is given as under.

The trials were conducted as per the following schedule of treatment with Bifenthrin 2.5EC formulation, which was made available for testing by the sponsorer:

1. Treatment of solid timber by brushing and dipping.
2. Treatment of veneers prior to making of plywood.
3. Treatment of plywood after plywood making.
4. Treatment by glue line poisoning of plywood.

## **MATERIAL AND METHODS**

### **(a) Concentration of the chemical used:-**

Bifenthrin 2.5 EC was diluted with water at 4 levels for evaluation against borer viz. 0.025%, 0.05%, 0.10%, and 0.20%. These concentrations were used to treat solid timber, veneers and plywood either by dipping or brush coating. For glue line poisoning, phenol formaldehyde resin was mixed separately with Bifenthrin at four concentrations viz. 2.5gm a.i/m<sup>3</sup>, 5gm a.i/m<sup>3</sup>, 10gm a.i/m<sup>3</sup> and 20gm a.i/m<sup>3</sup>. Untreated solid wood and plywood served as control.

### **(b) Treatment of solid wood.**

To study the toxicity of the chemical against borers, the most non-durable timbers such as Rubber wood (*Hevea brasiliensis*) was selected. The sample size of solid wood for borer test was 10 x 4 x 0.1 cms.

- i) Dipping the solid wood samples: Solid timbers of the sizes mentioned above were separately given one-minute dip in all the four concentration mentioned. The numbers of sample maintained were 50 for each concentration for borer tests.
- ii) Brush coating the Solid timber samples: Solid timber of the sizes mentioned above were separately given a brush coating with different dilutions of Bifenthrin.

### **(c) Veneer treatment:-**

Veneers of Rubber wood of the size 30 x 30 and 0.16cm were selected. They were given one-minute dip in different concentrations of Bifenthrin mentioned above and dried. Plywood was made with these treated veneers using phenol formaldehyde resin with 8% coconut shell flour as filler as per IS:848. Three-ply plywoods were made employing rubber and Makai veneers following normal

process parameters of plywood production. Number of samples maintained were 50 for each level Loading of Bifenthrin and the sample size was 10 x 4 x 0.48cm, which were exposed for powder post beetle attack.

**(d) Plywood treatment:-**

Untreated Rubber wood veneers were used to make 3-ply plywood and given a dip treatment immediately when it came out of the hot press in above four concentrations of Bifenthrin solutions. The number of samples was 50 for each level of concentration of Bifenthrin. The size of the sample was 10 x 4 x 0.48cm which were used for powder post beetle attack.

**(e) Glue line poisoning of plywood:-**

Glue line treatment of preservative chemical is a simple and cost effective method of treating plywood to enhance its service life. The glue line is also a relatively safe location for the preservative. It involves adding requisite quantity of preservative chemical in glue mix at the time of application of glue to the veneers, which gets diffused into the veneers during the hot pressing. The following three studies were carried out to evaluate the suitability of Bifenthrin as glue line preservative.

- i. **Evaluation of compatibility of phenol formaldehyde resin (PF resin) with Bifenthrin:** 100gm-phenol formaldehyde resin with 8 gm of coconut shell floor( as a filler) was mixed with four levels of Bifenthrin, the concentrations mentioned above, separately in a beaker. Observations were made every 30 minutes to see whether the consistency of the resin was maintained. Studies made revealed that a pot life of 7-8 hrs was obtained for all the four levels of the concentrations of Bifenthrin used for the study with PF resin.
- ii. **Evaluation of toxicity to borers:** Phenol formaldehyde resin was mixed separately with Bifenthrin at four concentrations namely- 2.5gm a.i/m<sup>3</sup>, 5gm a.i/m<sup>3</sup>, 10gm a.i/m<sup>3</sup> and 20gm a.i/m<sup>3</sup>. Plywood boards of 3-ply were made using Rubber veneers of size 30 x 30 x 0.16cm. The glue line poisoned plywood boards were tested for the toxicity against borers. The number of plywood samples used for toxicity study was 50 for each loading of Bifenthrin. The size of the plywood samples for testing was 10 x 4 x 0.48cm.
- iii. **Evaluation of strength of plywood:** Makai (*Shorea assamica*) veneers used for making glue line poisoned plywood with Bifenthrin 2.5EC at four levels of concentration were used for

testing the bond strength (glue shear values) as per IS:303-1989 (Table V).

For each type of treatment, 50 untreated samples were kept as control.

## OBSERVATIONS

The treated and untreated control samples were properly labeled and exposed to powder post beetles by keeping them in the laboratory under normal room temperature in trays and tubs having adequate powder post beetle infested material. The culture of powder post beetle was maintained in the laboratory by rearing them on dry tapioca chips. Six monthly observations were made covering a total exposure period of 36 months, which was considered adequate for practical purposes. Observations about presence of borer attack on the samples were made using the following criteria:

- i) Larval activity was assessed from the production of frass from the surface and edge of exposed plywood samples & hardwood and presence of emergence flight holes.
- ii) Presence of even a single hole on the sample was considered to be attacked.

### Solid timber :

Treated (either by dipping or brush-coating) rubber solid wood exposed to borer attack for a period of 36 months revealed that none of the samples were attacked while the untreated samples were attacked in six months (Table I-A & Table I-B).

Table I-A

### Rubber wood exposed for powder post beetle attack (Dipping)

Concentration of Bifenthrin	6 months exposure	12 months exposure	18 months exposure	24 months exposure	30 months exposure	36 months exposure
0.025%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.05%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.10%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.20%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
Untreated control	Attacked	Attacked	Attacked	Attacked	Attacked	Attacked

**Table I-B**

**Rubber wood exposed for powder post beetle attack (Brushing)**

<b>Concentration of Bifenthrin</b>	<b>6 months exposure</b>	<b>12 months exposure</b>	<b>18 months exposure</b>	<b>24 months exposure</b>	<b>30 months exposure</b>	<b>36 months exposure</b>
0.025%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.05%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.10%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.20%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
Untreated control	Attacked	Attacked	Attacked	Attacked	Attacked	Attacked

**Plywood(Veneer Treated) exposed for borer attack:**

Rubber veneers treated with four levels of Bifenthrin made with PF bonded plywood boards were exposed to powder post beetle attack for a period 36 months. Observations made at six-month interval revealed that none of the treated boards were attacked by borer. However, control boards were heavily infested by powder post beetle (Table II).

**Table II**

**Veneer treated plywood exposed for powder post beetle attack**

<b>Concentration of Bifenthrin</b>	<b>6 months exposure</b>	<b>12 months exposure</b>	<b>18 months exposure</b>	<b>24 months exposure</b>	<b>30 months exposure</b>	<b>36 months exposure</b>
0.025%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.05%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.10%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.20%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
Untreated control	Attacked	Attacked	Attacked	Attacked	Attacked	Attacked



**Plywood treated after manufacture exposed for borer attack:**

Untreated plywood coming out of hot press was dipped for a minute in four concentrations of Bifenthrin solution as mentioned earlier. These treated plywoods were exposed to borers for 36 months. Observations made at six-month interval revealed that none of the treated samples were attacked. However control samples were heavily infested by borers (Table III).

**Table III**

**Plywood given a dip treatment exposed for borers attack**

<b>Concentration of Bifenthrin</b>	<b>6 months exposure</b>	<b>12 months exposure</b>	<b>18 months exposure</b>	<b>24 months exposure</b>	<b>30 months exposure</b>	<b>36 months exposure</b>
0.025%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.05%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.10%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
0.20%	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
Untreated control	Attacked	Attacked	Attacked	Attacked	Attacked	Attacked

**Glueline poisoning of plywood**

Observations made on glueline-poisoned plywood exposed for borer attack revealed that the first concentration (2.5gm a.i/m<sup>3</sup>) was infested by borers after 30 months exposure. The remaining three concentrations are not attacked even after 36 months duration of exposure (Table IV). Samples kept as control were heavily infested by borers in six months.

**Table IV**

**Glue line poisoned plywood exposed for powder post beetle attack**

<b>Loading of Bifenthrin</b>	<b>6 months exposure</b>	<b>12 months exposure</b>	<b>18 months exposure</b>	<b>24 months exposure</b>	<b>30 months exposure</b>	<b>36 months exposure</b>
2.5gm/m <sup>3</sup>	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Attacked
5gm/m <sup>3</sup>	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
10gm/m <sup>3</sup>	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
20gm/m <sup>3</sup>	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked	Not attacked
Untreated control	Attacked	Attacked	Attacked	Attacked	Attacked	Attacked

**Glue Adhesion Strength**

Results of glue adhesion strength test (Table V) suggest that addition of Bifenthrin to PF resin does not have any adverse effect. Bond strength of plywood made using PF resin mixed with Bifenthrin in the entire range of doses i.e. 2.5gm a.i/m<sup>3</sup> to 20gm a.i/m<sup>3</sup> was found to conform to IS: 303-1989.

**Table V**

**Effect of Bifenthrin 2.5EC on Glue Adhesion Strength**

<b>Loading of Bifenthrin</b>	<b>Average of 6 samples</b>			
	<i>Dry</i>		<i>Wet</i>	
	<b>Failing load, Kg</b>	<b>Wood failure, %</b>	<b>Failing load, Kg</b>	<b>Wood failure, %</b>
2.5gm a.i/m <sup>3</sup>	170	60	135	90
5gm a.i/m <sup>3</sup>	150	90w	130	80
10gm a.i/m <sup>3</sup>	160	80	110	90
20gm a.i/m <sup>3</sup>	140	75	140	80
Untreated control	160	80	140	90

## CONCLUSION

The results obtained for 36 months exposure to powder post beetle attack of all solid as well as panel material indicate a high toxicity of Bifenthrin in extremely low concentrations for protection of wood and wood based panels. However the lowest concentration i.e., 2.5 gm a.i/m<sup>3</sup> used as a glue line poison made in three ply plywood has not protected plywood against powder post beetle attack after 30 months. The other three concentrations, namely, 5gm.a.i/m<sup>3</sup>, 10gm.a.i/m<sup>3</sup>, 20gm.a.i/m<sup>3</sup> have protected plywood upto 36 months of exposure to powder post beetle attack.

These results combined with the favorable physical and chemical properties, such as chemical stability, vapour pressure and compatibility with resin indicate that Bifenthrin is suitable as an effective long term protectant against powder post beetle attack on wood and plywood at 10gm.a.i/m<sup>3</sup> concentration.