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# Bioefficacy of diflubenzuron against subterranean termite

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*Abstract*

**BACKGROUD & OBJECTIVE:** Subterranian termite is a structure-infesting termite that accounts for a significant proportion of the damage wherever it occurs. One sustainable control strategy that usually helps to reduce the damage of subterranean termite is the use of insecticides which are safe to the environment. Hence, bioefficacy study of diflubenzuron, an environ friendly, chitin synthesis inhibitor was evaluated against subterranean termite. **METHODOLOGY:** It was achieved by testing by testing the three different concentrations of diflubenzuron against subterranean termite as per IS 4873. **RESULTS:** Diflubenzuron was found to be effective against subterranean termite. **CONCLUSION:** From the results of this study, it has been found that diflubenzuron at 1% concentration rate provided excellent control of termite. This is the first report on the use of diflubenzuron in the glue line to control the termite.

***Keywords***: *Diflubenzuron, Subterranean termite, Chitin synthesis inhibitor, Wood preservation.*



## 1. *Introduction*

Termites are the most troublesome pest of wooden structures, causing economic damage annually throughout the world. The most commonly used termiticides in India are CCA, CCB, organophosphorous, organochlorinated and some synthetic pyrethroids. Though these chemical preservatives are excellent in controlling termites but some of these chemicals have been rated as persistent organic pollutants (POP). Several environmentally friendly approaches to heavy metal free wood protection are being investigated worldwide. An attempt has been made in this direction to find out the alternative suitable eco-friendly termiticide.

Diflubenzuron belongs to halogenated benzoylphenylureas (BPUs) which constitute a class of the Insect growth regulator (IGRs) that interfere with insect growth and development by inhibiting chitin synthesis at time of moulting and is effective in controlling immature stages of insects. Chitin synthesis inhibitors (CSI) are chemicals that are toxic only to insects and other arthropods[1]. It is being considered as a "Third generation insecticides" having an effective stomach and contact mode of action. After consuming diflubenzuron the activity of termite to moult will be inhibited. Diflubenzuron is considered to be of very low acute toxicity, with oral $LD_{50}$ in mice and rats of >4500 mg/kg of body weight[2]. Diflubenzuron was not fetotoxic or teratogenic, carcinogenic and did not show significant signs of reproductive toxicity[3].

Diflubenzuron was found to be effective against eastern subterranean termite *Reticulitermes falvipes*[4]. In several studies the effectiveness and the efficiency of baiting system by using Insect Growth Regulator (IGR) in termite baiting was evaluated[5,6,7,8]. IGRs used in baiting system are slow acting chemicals to reduce termite population. So, the effect of IGRs on termite colonies causes a high proportion of pseudergates, worker nymphs or larvae to moult into pre-solider or non-functional inter castes[9,10]. Many slow-acting toxicants have been impregnated into wooden bait blocks and tested against subterranean termite such as Mirex, hydramethylnon, avermectin B, A-9248 (diiodmethyl para-toyl sulfone), sulfluramid, hexaflumuron and diflubenzuron[11,12] evaluated hind gut protozoan in *R. flavipes* and found that they were killed by IGR's and suggested starvation induced mortality, intercaste production, egg production inhibition[13] ecdysis inhibition[14] and feeding inhibition[15]. Therefore, keeping in mind the disadvantages of POPs and advantages of IGR's the bioefficacy of diflubenzuron was evaluated against subterranean termite.

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## 2. *Materials and Methods*

The laboratory and field experiments were conducted during 2009 to 2011 at Indian Plywood Industries Research & Training Institute (IPIRTI), Bangalore, Karnataka, India.

### 2.1 Treatment of Solid wood planks by dipping method

Solid wood of rubber was treated with diflubenzuron (25% WP) by dipping method for half an hour and the concentration used for the treatment were 0.5, 1 and 2% respectively. The samples were of size 15.3 cm x 3.8 cm x 0.625 cm. After getting maximum absorption in 30 minutes the planks were removed and percentage of intake of preservative or the amount of preservative absorbed by the sample was calculated in kg/m$^3$ as per IS 4873[16]. The test planks were conditioned and subjected in the test yard/grave yard to assess the bioefficacy against subterranean termite.

### 2.2 Treatment of plywood by Glue line poisoning (GLP)

Three doses of diflubenzuron viz., 0.5, 1 and 2% of diflubenzuron respectively were mixed with PF resin (conventional) as glue additive. Control samples were also prepared in which insecticide was not added in glue. Laboratory scale plywood was prepared by using rubber wood for three ply construction. The veneers were coated with glue mixed with and without the preservative chemical. After the requisite pre-assembly time, glue-coated veneers were hot pressed at 140±5°C with a pressure of 14Kg/m$^2$ and pressing time of 6-7 minutes.

### 2.3 Field test/ test yard/ grave yard test

Toxicity test was performed according to Indian Standard 4833[17]. Treated and untreated solid wood and plywood samples were randomly installed in test yard. Eighteen replications were made for each treatment with control stakes in rows at the IPIRTI, Bangalore test yard. Termite activity and percentage of damage to the test panels were recorded at the intervals of three months. Observations were made covering a total exposure period of twelve months. Specimens were reinstalled in their respective positions after each inspection. The knife test or sound test was carried out as and when necessary to determine the extent of decay or destruction due to termite attack, till the sample was destroyed. The visual observations and ratings were done according to the Indian Standard 4833[17]. Results of toxicity studies of diflubenzuron on solid wood and plywood against termites are presented in Table I.

## *3. Results and Discussion*

The development of alternative strategies to control termite infestations that avoid pesticide accumulation in soil was an important goal of the present study. The present research work was planned with a view to examine the efficacy of a new biocide viz., diflubenzuron against subterranean termites. The absorption or retention of the preservative in solid wood was recorded and presented in Table I. The maximum absorption of the preservative chemical was found in diflubenzuron at 2 per cent (1.53 kg/m$^3$) followed by 1 (1.17 kg/m$^3$) and 0.5 per cent (0.23 kg/m$^3$) respectively.

Results of the toxicity test of the tested preservative chemical for solid wood and plywood are presented in Table I & Table II respectively. In both case, viz., solid wood and plywood, diflubenzuron at 2% concentration level resulted as the best treatment but was on par with diflubenzuron at 1% concentration. At the end of the test i.e. after twelve months, the treated solid wood samples resisted the attack of 25% of moderate attack in the tested lowest concentration of. 0.5%. Diflubenzuron at 1% concentration showed slight attack (10 %). The untreated control samples were fully destroyed at the end of the study (Figure I). Diflubenzuron at 2 % concentration level was free of attack. In all the treated sample, attack of subterranean termite was not observed for 6 months, whereas, the control samples recorded 60% damage.

In case of GLP treated plywood samples the untreated panels were damaged up to 20% within three months of the exposure, 50% in six months and completely damaged within twelve months of exposure. Whereas, the panels treated with diflubenzuron almost at all concentrations i.e. 0.5,1 and 2% resisted the attack till six months. The lowest studied concentration rate of 0.5 per cent showed moderate attack of 24 %. Diflubenzuron at 1% concentration rate recorded the negligible attack (7%). In case of diflubenzuron at 2% concentration was absolutely free from the damage of termite. (Figure II)

## *4. Discussion*

The development of alternative strategies to control multigenera/multispecies termite infestations that avoid pesticide accumulation in the environment is an important goal. Diflubenzuron is a potent chitin synthesis inhibitor to control wood pests. It has been found to be extremely active against wood destroying termites when applied in preventive or curative way. During the re-evaluation of moult-inhibitors it

**Table I:** Toxicity of preservative treated solid wood against subterranean termite (Field test) * Average of eighteen samples

| Chemical | Concen-tration (%) | Absorp-tion (Kg/m$^3$) | Damage (%)* Months 03 | 06 | 12 |
|---|---|---|---|---|---|
| Difluben-zuron | 0.5 | 0.23 | 0 | 0 | 25 |
| | 1 | 1.17 | 0 | 0 | 10 |
| | 2 | 1.53 | 0 | 0 | 0 |
| Untreated control | | | 0 | 60 | 100 |

was found that diflubenzuron could be an appropriatef replacement for the pyrethroids in wood preservation. IGR's are commonly considered as slow-acting compound. Several novel slow-acting pesticides are being screened for the control of subterranean termites[18,19,20,21]. This is the first report on the use of diflubenzuron in the glue line to control the termite.

The insect cuticle presents a potentially vulnerable and specific target for the disruption of its chemistry, structure and function by insecticides[22]. The amino sugar polysaccharide chitin is a particularly important component of the insect cuticle. If synthesis of chitin is disrupted at crucial times, such as, egg hatch or moult, then the insect will die. Few published data are available on field studies by using diflubenzuron[23]. In the present study, diflubenzuron proved to be an excellent chemical against subterranean termite. The efficacy of diflubenzuron was also studied by Kubota Sh et al.,2006[5] in laboratory which showed the ecdysis inhibition against *Heterotermes indicola* (Wasmann) and *Reticulitermes flavipes* (Kollar). At present preservative treatment is mandatory only in special grades of plywood such as marine, shuttering and those being used in cooling towers. As most of the species used for manufacture of plywood are non-durable, it is desirable to treat the plywood of

**Table II:** Toxicity of preservative treated plywood against subterranean termite (Field test) * Average of eighteen samples

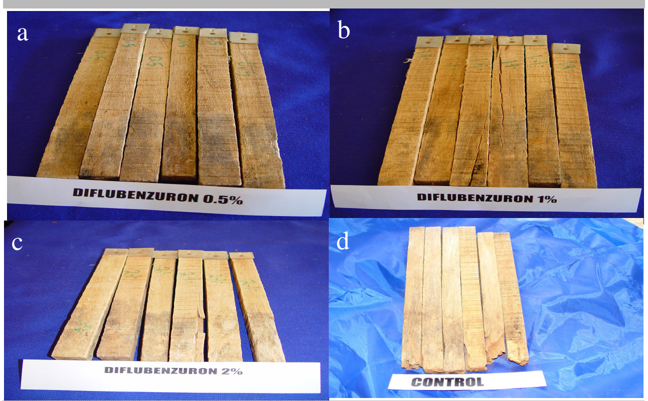
| Chemical | Concentra-tion (%) | Damage (%)* Months 03 | 06 | 12 |
|---|---|---|---|---|
| Diflubenzuron | 0.5 | 0 | 0 | 24 |
| | 1 | 0 | 0 | 7 |
| | 2 | 0 | 0 | 0 |
| Untreated control | | 0 | 50 | 100 |

other grades. Plywood is usually thin and the destructive biological agencies can operate effectively bringing about a rapid failure. Preservation of plywood by treating it with suitable chemical in both exterior and interior application is thus necessary to overcome such risks and to prevent losses due to early failure necessitating frequent replacement.

The common chemicals which are being used as GLP are organo-phosphorous, carbamates and pyrethoids. These chemicals may have undesirable effect on the atmosphere. The metal based preservative viz., boron based and copper sulphate is the most commonly used preservative by dipping method. But metals cannot be broken down in the environment; the disposal of any wood treated with a metal based preservative will be more expensive and difficult in future. Thus use of environmentally acceptable preservative that contain no metals is an essential criteria in wood preservation. Therefore, target specific biocides are needed to develop resistance against bio-degradation of wood. In the present study target specific biocide was tested against subterranean termite. On this background IGR's like diflubenzuron can be an appropriate replacement for the synthetic pyrethroids and organo-phosphorous preservative chemicals.

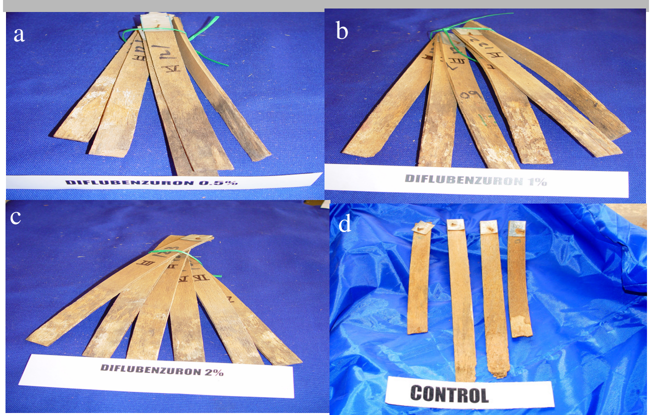
On the basis of results and discussion of present investigation it can be concluded that diflubenzuron at 1% rate recorded negligible loss and hence, can be adopted as the lethal dose to control subterranean termite. Moreover, considering the economy 1% concentration is feasible commercially. The additional benefit from using diflubenzuron is the lack of any adverse effect on environment and human-being. Moreover, it can be considered as an alternative to synthetic pyrethroids and organophosphorous wood preservatives, which in the near future may get phased out in India.

**Figure I: :** Solid wood samples after Twelve months exposure studies in field




**a. Diflubenzuron 0.5% b. Diflubenzuron 1% c. Diflubenzuron 2% &. d. Control (6 months after exposure)**

**Figure II:** Plywood samples after Twelve months exposure studies in field




**a. Diflubenzuron 0.5% b. Diflubenzuron 1% c. Diflubenzuron 2% &. d. Control (6 months after exposure)**

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