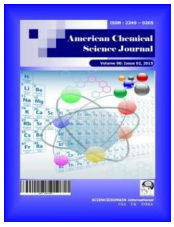

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Comparative Efficacy of Varied Concentrations Fipronyl in the Laboratory Management of Termites

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Authors' contributions

This work was carried out in collaboration between all authors. Author RG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NCO, JJK, FMW and RWN managed the analyses of the study. Authors RG and JJK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Fipronyl are chemical formulations of phenyl pyrazole insecticide acting on the chloride channel of nervous system of insects to hinder chloride metabolism of γ- amino butyric acid of insect's nervous system resulting in excess neuronal stimulation followed by death. It has good control against subterranean termites attacking buildings. The efficacy of Fipronyl 200 g/l against field -collected eastern subterranean termite was carried out to assess the efficacy of Fipronyl at the rate of 200 g/l in controlling termites when compared with fipronil 25g/l in laboratory since Fipronil 25 g/l was the experimental standard. The experiment was laid out in a Randomised Block Design carried out in the laboratory with five treatments and six replicates.Both termicides were tested at Fipronyl 200 g/l concentrations (2 ml/l, 4 ml/l and 6 ml/l) and fipronil 25 g/l under concentration of (10 ml/l) by treating *Eucalyptus grandis* and *Gravillea robusta* wood blocks. The research was carried out at the Forest Products Research Centre of the Kenya Forestry Research Institute. The mode of wood blocks treatment was by dip diffusion. This study showed that 2 ml/, 4 ml/l and 6 ml/l levels of

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concentrations for Fipronyl or fipronil 25 g/l (10 ml/l) have equal impact on termites since there was no significant difference in weight loss in the treated timbers, compared with untreated blocks that had weight loss. Therefore, Fipronyl are effective termicides at the rates of 2 ml/l, 4 m/l and 6 ml/l. Fipronil 25 g/l are effective termicides at the rate of 10 ml/l. Further exposure time of wood samples to termites is advisable to give a clear evaluation on the efficacy of Fipronil 25 g/l and Fipronyl 200 g/l commercial formulations at various treatment concentrations on treated timber.

Keywords: Comparative; efficacy; concentrations; fipronyl; management; termites.

1. INTRODUCTION

Most parts of Kenyan regions have warm climatic conditions with quite variable patterns of rainfall. Summer temperatures are generally warm with cool winter temperatures. All these conditions are ideal for the existence of termites. Termites are one of the most economically important pests, with a widespread global distribution [1]. Economic loss due to termites has been estimated at 11 billion dollar per year increase as the standard of living improves [2-3]. They cause significant economic damage to wooden structures in buildings in several areas. When seasonal variations were studied for different species of termites, it was observed that *Heterotermes indicola* and *Microtermes spp* were more persistent [4]. In Kenya significant damage is caused by the termite species *Macrotemes nataensis*. Insecticide application is an effective strategy for termite control [5]. Fipronyl have a delayed action that allows the contaminated termites to maintain normal behaviour for an extended period so as to transfer its lethal effects activity on termite colonies beyond the immediate zone of treated soil [6-7]. Fipronil usage has a greater impact on termite populations than Organochlorines cyclodienes and pyrethroids and can provide 100% control for more than 10 years [8]. In other studies [9], worked on Partial post construction treatments with the use of fipronil which is slow-acting and is non- repellent insecticides. The objectives of this research were to evaluate the efficacy of Fipronil 25 g/l and Fipronyl 200 g/l with the later having three treatment concentrations on treated timber against subterranean termites; and to assess the magnitude of timber attack by subterranean termites under different treatment regimes.

2. MATERIALS AND METHODS

2.1 Description of Study Site

The research was carried out at the Forest Products Research Centre of the Kenya Forestry Research Institute.

2.2 Experimental Design

The experiment was carried out in May 2015. The experiment was laid out in a Randomised group design carried out in the laboratory with five treatments and six replicates. Testing was carried out using Fipronyl at the mass concentration of 200 g/l and fipronil 25 g/l with the latter being the experimental standard. The Protocols for Assessment of Wood Preservatives; A production of the Australian Wood Preservation Committee (AWPC) (2007 revision) was used. This was a Wood preservation experiment with the main aim of treating timber commonly used in the construction and furniture industry in Kenya. The test species used were *Eucalyptus grandis* and *Grevillea robusta.* The treatments using Fipronyl at 200 g/l mass concentrations were carried out at three concentrations (2 ml/l, 4 ml/l and 6 ml/l) and fipronil 25 g/l mass concentration was carried out at 10 ml/l concentrations.

2.3 Study Sample

The test chemical, Fipronyl 200 g/l was tested at three concentrations – 2 ml/l, 4 ml/l and 6 ml/l. Fipronyl 200 g/l were tested against an approved and registered chemical known as Fipronil 25 g/l that is used at concentrations of 10 ml/l. A total of 60 wood samples were used in the study.

2.4 Laboratory Experimentation (Protocol)

Wood samples of *Eucalyptus grandis* and *Grevillea robusta* were sawn into 1 cm cubes. The cubes were labeled by giving each code number, weighed and recorded. The numbers of wood blocks were 60 cubes with 30 cubes for each species. The wood samples were dried in an oven set at 161℃ in oven for 24 hours. Their weights were recorded. The samples were immersed for four days in Fipronyl 200 g/l at concentrations of 2 ml/l, 4 ml/l and 6 ml/l, fipronil 25 g/l at a concentration of 10 ml/l.

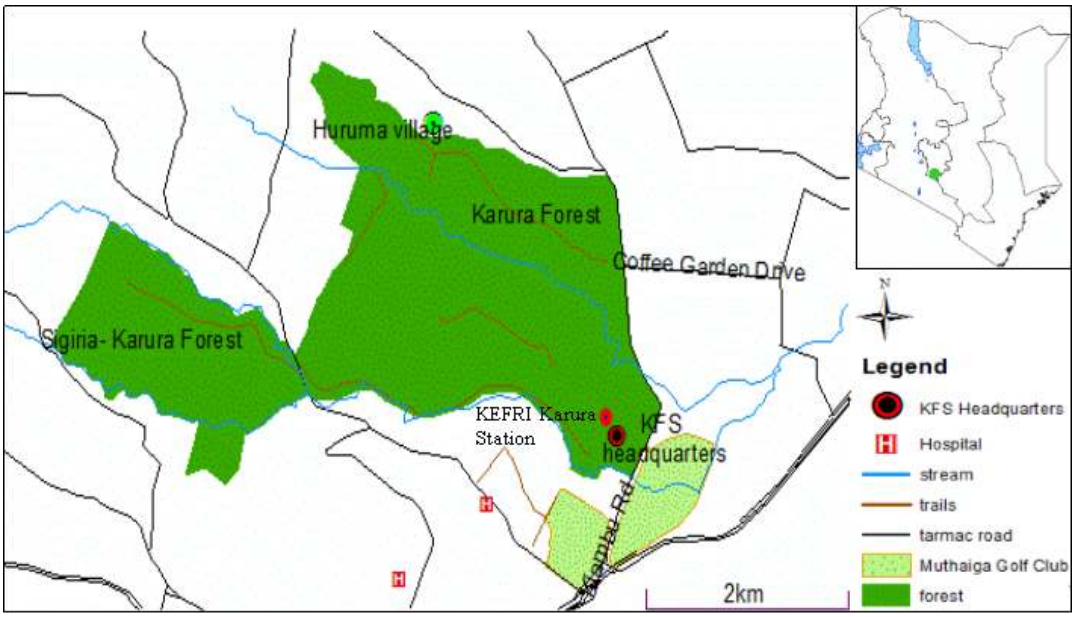

Fig. 1. Location of KEFRI-Karura forest
Map modified from Goggle Earthpro (Author, 2015)

Sand was collected, washed and then sterilized in an oven for 24 hours at 161°C. This was put in 27 clear plastic test bottles of 300 ml capacity, each 1/3 full. Thirty millimetres of distilled water was sprinkled on to the sand till it was wet and kept aside for two hours. Then two wood samples of the treated and untreated blocks were put into the sand in each and subterranean termites of the species nataensis from a single colony comprising of 360 females and 40 males were introduced. This was according to a procedure adapted from AWPA E1-97 standard (standard method laboratory for evaluation to determine resistance to subterranean termites, 1997).The test bottles was then kept in an incubator at temperatures between 25-28℃. For each concentration six wood samples, were exposed to termites. The wood blocks were inspected weekly for visual rating and after four weeks for weight loss techniques in the laboratory test as per the Protocols for Assessment of Wood Preservatives (AWPC) (2007 revision). During each inspection, the blocks were removed, cleaned by scrapping soil or sand off the blocks surface and intensity of termite attack assessed. The attack was rated visually and on weight loss basis.

2.5 Data Analysis

Data analysis was performed using STATA version 13 special Edition. Categorical variables were summarized as frequencies and its corresponding percentages, while weight loss, the only continuous variable of interest, was positively skewed because of some weighted outlier, therefore it was summarized as median and it's corresponding inter quartile range (IQR). Two-way ANOVA was the only statistical technique which was used to find out if there was any difference in weight loss given that different concentration of treatments were applied using different modes of application under laboratory test. Results were presented in form of tables and graphs.

3. RESULTS

3.1 Magnitude of Termites Attack on Treated and Untreated Timbers

There were a total of 60 wood blocks whose data analysis represented 100% evaluation in experimental trial. The number of wood blocks in the control group were 12 (20%) were not equal to that of intervention 48 (80%). Data on weight loss by treatment captured during laboratory experiments for both overall and group summary statistics like median, minimum, maximum and inter quartile range (IQR) were presented in Table 1. In the laboratory experiment, the median weight loss for Eucalyptus was 0 (IQR: 0-0) grams and its minimum and maximum weight loss was 0 grams and 0.2 grams respectively, while the median weight loss 0 (IQR: 0-0) grams for *Gravillea robusta* and its minimum and

maximum weight loss was 0 grams and 0.5 grams respectively. Majority of the wood blocks in the laboratory test treated with either fipronil 25 g/l or Fipronyl 200 g/l did not have their weights changed after exposure to termites, this represented 48%. This showed that the treatment was so highly effective that it suppressed the termites from finding the foods and for those termites which probed to eat the timber were completely killed by both Fipronyl mass concentrations of 200 g/l and fipronil 25 g/l.

The control wood samples had weight loss of approximately 0.2 grams represented 6 (10%), control wood blocks which lost their weight approximately to 0.3 grams represented 3 (5%), those wood blocks which lost weights approximately to 0.1 grams represented 2 (3%) and other control wood blocks 1 (2%) lost approximately to 0.5 grams, (Fig. 2). The median weight loss for controls and interaction wood blocks were different. Furthermore, the shape of distribution was assessed and was not similar. Also the treated samples and the control samples had different inter quartile ranges, (IQR: 0-0 grams) and (IQR: 0.2-0.3 grams) respectively.

Table 1. Findings of weight loss stratified by treatment and control group as compared with its overall

Outcome variable	Experiment type	Grouping factor	Freq. (%)	Min	Max	IQR	Median
Weight loss	laboratory	Control	12 (20%)	0.1	0.5	0.2 - 0.3	0.2
		Treated	48 (80%)	0	0	0-0	0
		overall	60 (100%)	0	0.5	0-0	0

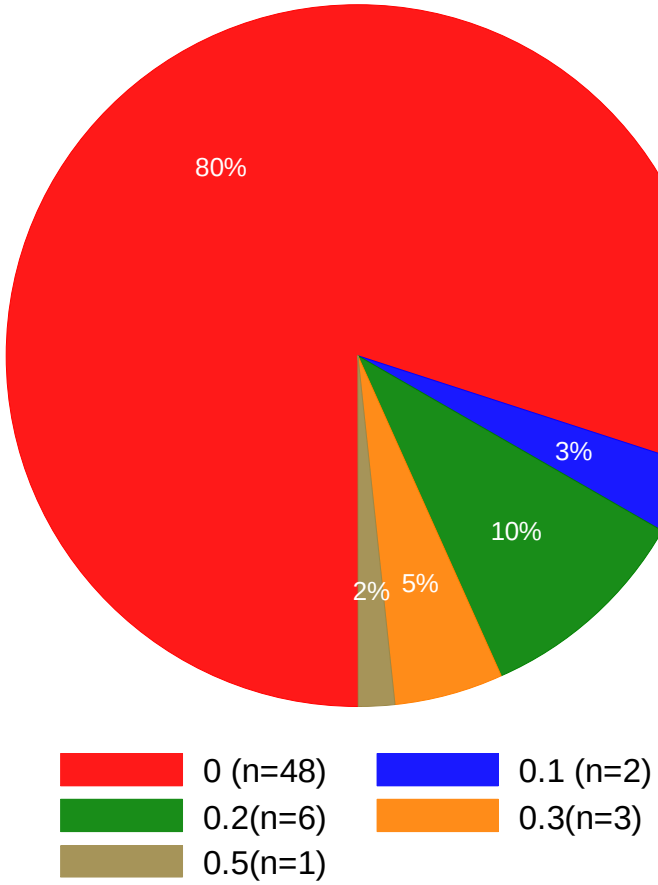

Fig. 2. Distribution of timbers by weight loss
(n= numbers of pieces, decimal units are weights)

Different concentration of treatments applied to wood samples was coded as T1, T2, T3, and T4 and the only control allotment was coded as T5 in experiment. All wood samples that were subjected to different concentration of treatment and showed no change in their weight were in total 48 (80%), while wood samples that were untreated (control T5) and were attacked by the termites showed different weight loss of (0.1, 0.2, 0.3, 0.5) grams and were in total 12 (20%), (Fig. 3). The difference in weight loss between control and the treated wood blocks indicated that there was a significant difference, P- value (0) with adjusted R-squared value of 39.2% for the explanatory variable, Table 2 shows how effective the treatment (fipronyl 200 g/l and fipronil 25 g/l) were in preventing termites from destroying the wood blocks.

Among the Eucalyptus wood blocks in the laboratory experiment, 6 (50%) wood blocks for each species were allotted or subjected to different treatment concentrations thus labelled T1, T2, T3, or T4 and the remaining 12 timbers from each species (Eucalyptus and Grevillea timbers) were also under control (T5) in two plastic bottles (Table 2).

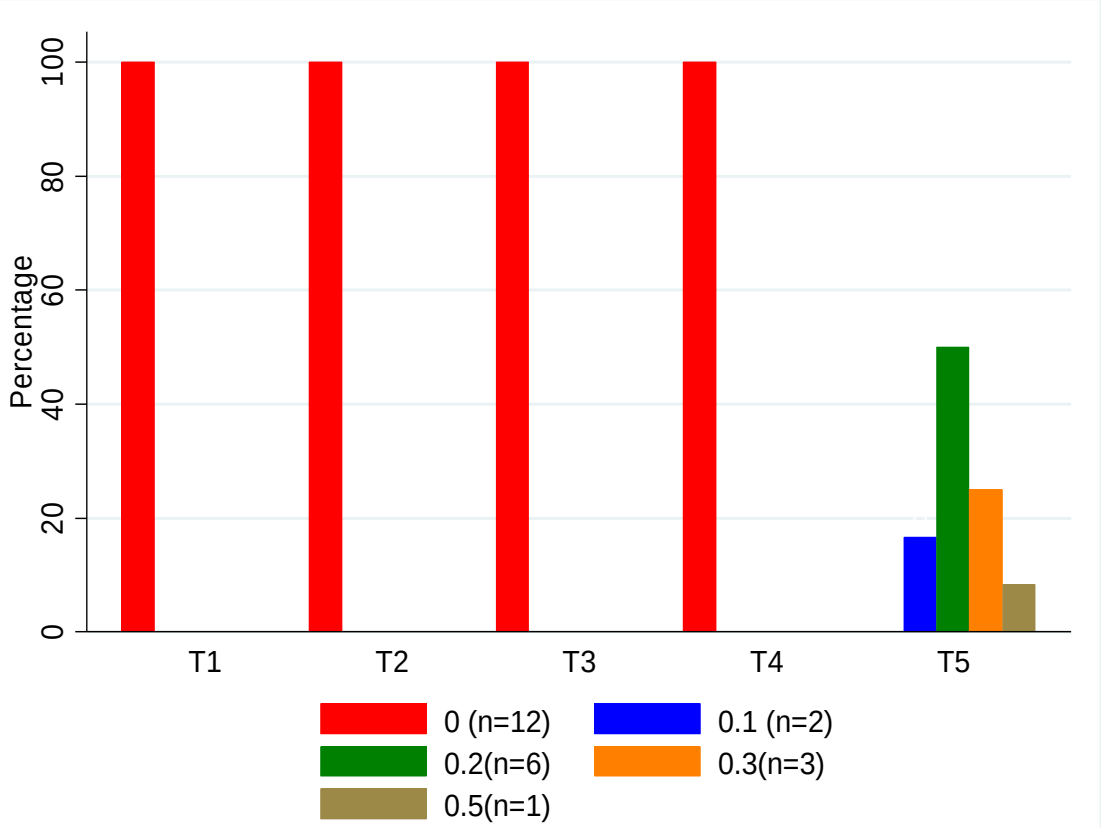

Fig. 3. Distribution of weight loss by treatment under laboratory experimentation

Table 2. Distribution of timbers by species and treatments applied under laboratory experimental test

		Treatment					
	Timber species	**T1**	**T2**	**T3**	**T4**	**T5**	**Total**
Laboratory experiment	EU	6 (50%)	6 (50%)	6 (50%)	6 (50%)	6 (50%)	30 (50%)
	GR	6 (50%)	6 (50%)	6 (50%)	6 (50%)	6 (50%)	30 (50%)

T1-Standard recommended dosage T2- Higher dosage T3- Lower dosage T4-Termidor and T5- Control. EU-Eucalyptus grandis and GR- Grevillea robusta

4. DISCUSSION

There was no significant difference ($p < 0.05$) in termite attack on wood blocks treated with different levels of concentration of either Fipronyl 200 g/l or fipronil 25 g/l, the standard product. This study found out that those different levels of concentrations of 2, 4 and 6 ml for Fipronyl or 10 ml for fipronil 25 g/l have equal impact on termites since there was no difference in weight loss in the treated woodblocks. The untreated wood blocks had a weight loss of varying values, of 0.2 to 0.5 gm. These findings showed that all levels of concentrations for the termiticides were equally effective when applied on timber. These findings are consistent with those of [10] who discovered that termite bait products account for approximately one third of the market share according to a 2002 survey. Although the availability of fipronil 25 g/l termiticides still remains a challenge in many developing countries like in Kenya, fipronyl 200 g/l as an alternative could still be used for termites control with fairly accurate results in areas where fipronil 25 g/l is not readily available or have environmental effects. A problem where concerns have been voiced about its environmental and human health effects was found out in the study by [11] where a highly persistent Organochlorines insecticides, in a product which was used to control termites. Although the termites were within a restricted environment of clear plastic test bottles in the incubator with woodblocks treated with either Fipronyl 200 g/l or fipronil 25 g/l, it showed same results where all the termites died for the treated wood blocks. Only one termite exposed to untreated timber of *Eucalyptus grandis* and three termites exposed to untreated timber of *Grevillea robusta* survived for 28 days. Termite galleries were evident after 28 days on untreated blocks. This study analyses the quality of samples based on the two types of treatments (Fipronyl 200 g/l and fipronil 25 g/l) used during the study unlike [12] whose demonstration was mainly based on treated soil. From the results of this study, it is clear that there is sufficient support for significant difference in termites attack between untreated and treated timbers with termiticides basing on visual and weight loss rating of termite's attack, p-value (0). The study found that the difference was from untreated timbers which lost their weights after exposure to termites. Therefore Fipronyl 200 g/l is highly effective against a variety of termites. It disagrees with [13] who found that fipronil 25 g/l did not meet the criteria for liquid termiticides baits. Result from this study shows that Fipronyl 200 g/l treatment was effective just as fipronil 25 g/l treatment on timbers. This is consistent with studies by [14-16] who showed that too high Fipronyl concentrations may kill termites faster than expected while at lower concentration may not supply a sufficient dose for contaminated termites to transfer a lethal dose to unexposed termites.

5. CONCLUSIONS

Termite galleries were evident after 28 days on untreated blocks in laboratory test which showed that they were attacked. Termites generally did not get in touch with treated wood block samples. Therefore, Fipronyl 200 g/l is an effective termicides used at concentration rates of 2, 4 and 6 ml/l and fipronil 25 g/l (10 ml) too which was used as the experimental standard. Significant difference in termites attack between untreated and treated wood block samples with termiticides can be based on visual and weight loss where treated wood block samples were ranked as sound indicating that it was not attacked and untreated wood block samples were ranked slight, moderate, trace and severe to give clear indication of magnitude of attack.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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