

Efficacy of Biflex and Fipronil in controlling subterranean termites (Isoptera:Rhinotermitidae) in different soils types in Pakistan.

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Abstract

The present study was conducted to test the efficacy of Biflex (Bifenthrin) and Fipronil (Phenyl pyrazole) termiticides against a common termite species *H. indicola* (wasmann) in the laboratory. Soil was collected from different areas and after analysis divided into sandy clay loamy soil (SCL) and sandy loamy soil (SL). Laboratory bioassays were conducted to determine mortality and LT50 values in treated soil after 30,60, 90, 120 and 365 days. Regarding soil type, both termiticides had greater efficacy in sandy clay loamy soil (SCL) compared to sandy loamy soil(SL). Comparison of termiticides revealed that Biflex was more persistence in both soils compared to Fipronil. Termiticides showed maximum efficacy in sandy loam soil compared to sandy clay loam soil. Concentration and time both are inversely related to each other relative to efficacy.

Introduction

Subterranean termites are mostly distributed in warm and humid climatic conditions found in tropical and subtropical countries. They are called as subterranean termites because they live in the soil habitat. These termites form tunnels of soil that can be several meters long and are used to forage and locate food and moisture resources such as wooden pieces and other cellulose containing food materials near water. Colonies of subterranean termites consist of immature individuals having soft and delicate bodies sensitive to desiccation and heat. These termites are responsible for damage to timber in agricultural and urban areas (Whitford, 1991).

Throughout the world, Fipronil, Imidacloprid and Bifenthrin are popular termiticides used for termite control. Most of the synthetic insecticides kill the target insects by directing effecting four specific targets sitessuch as hormone action, respiration, cuticle formation and the nervous system. The majority of synthetic insecticides act as neurotoxins (Narahgashi *et al.*, 1998).

Pakistan has warm climatic conditions with quite variable patterns of rainfall. Summer temperature is generally extremely high with severe winter temperature. All these conditions are ideal for the existence of termites. Termites cause significant economic damage to wooden structures in urban areas of Pakistan thus termites are of public interest. A survey study was carried out to investigate and identify the termites species that cause severe damage in houses, indigenous buildings and construction materials in Pakistan. Eleven out of the 53 termite species described in Pakistan are a significant threat to timber-in-service. During the survey it was determined that *Odontotermes obesus*, *O. guptai*, *O. gurdasurensis*, *O. horai*, *Heterotermes indicola*, *Microtermes obesi*, *M. mycophagus*, *Eremotermes paradoxalis*, *Coptotermes heimi*, *Microcerotermes championi* and *Eramotermes paradoxalis* are economic species causing infestation to residential wooden structures. *O. obesus* was abundant in grounds and lawns of houses and the next important termite species collected from trees and soil was *Coptotermes heimi*. When seasonal variations were studied for different the species of termites, it was observed that *H. indicola* and *Microtermes* were more persistent (Manzoor and Mir, 2010). Keeping in view the significance of damage caused by termites in Pakistan, The present study was carried out to test the efficacy of two commonly used termiticides Biflex and Fipronil in controlling *Heterotermes indicola* - a common subterranean termites (Isoptera:Rhinotermitidae) in various soils in Pakistan.

Materials and Methods

This study was carried out in the Entomology Research Laboratory, Lahore College for Women University, Lahore in 2012. Termiticides representing two chemical classes were selected as follow: Fipronil (Phenyl pyrazole) 2.5% EC (Termidor from BASF). And Biflex (Pyrethroid) 2.5% EC (FMC Corporation, Pakistan).

For collecting termites, traps were fixed after surveying the entire premises of Lahore College for Women University, Lahore. Places with dung, debris and signs of termite's infestation were considered to be appropriate. At the selected places, about 0.5 feet of the soil was dug to make a porthole. Tissue paper rolls soaked with sugar cane juice were placed inside the porthole then covered with the soil. After 6-7 days, the traps were checked for collection of termites. Traps were colonized with substantial numbers of termites, collected by placing in a plastic box and taken to the Entomology laboratory. All stones, debris and pebbles as well as dead termites were removed. Only active and healthy termites were used for the experiment. Active termites were kept in the plastic box with moist filter paper as a source of food and humidity. Termites were kept in constant darkness till bioassays were conducted.

Soil and Soil analysis

In March 2012 soil was collected from different residential areas of Lahore such as Eden tower, Valencia town, Gulberg, DHA, Wapda town, Bahria town, Johar town, Iqbal town, Ravi, Model town. Soil was cleaned through sieving (a fine 2mm mesh screen) in order to remove lumps, straws and stones. After screening, the soils consisted of fine particles. After that this soil was autoclaved and oven dried to destroy all types of fungus spores and other contamination. Autoclaved soil was kept in glass jars and covered with foil paper as a lid.

Soil contact bioassay

Laboratory Bioassays were carried out to determine the mortality and LT_{50} values of each termiticide. The test arena consisted of washed and autoclaved Petri plates. Soil of single type was used in each plate. Air dried Sandy clay loam (SCL) and Sandy loam (SL) soils were treated with 5ppm of each insecticide. Soil for the controls was treated with only distilled water. After treatment soil was air dried under a fume hood for about 8h to remove excess moisture. 5 grams of each treated soil type and concentration was weight into a petri plate provisioned with a piece of moist filter paper. Moist filter paper acted as food source. Control units containing not-treated soil were assembled in the similar manner. All plates were acclimated for 24h in complete darkness. After acclimatization, 25 termites (workers) were added to each unit and mortality assessed for about 30 days. Three replicates were conducted for each soil type. The same procedure was repeated for 60, 90, 150, 365 days post-treatment soil. Mean mortality and lethal time (LT) were calculated.

Results and Discussion

Table 1 shows the mortality (mean \pm SEM) of termites at different time intervals post treatments up to 12 (30, 60, 90, 120, 150 and 365 days) months duration. From results it was revealed that mean mortality of termites in Biflex treated SCL soil was 25.00 \pm 0.00, 24.667 \pm 0.33, 22.333 \pm 0.33, 17.667 \pm 0.33, 16.667 \pm 0.33, and 15.667 \pm 0.33 at 30, 60, 90, 120, 150 and 365 days treatment, respectively. Similarly mean mortality of termites in Biflex treated SL soil was 25.00 \pm 0.00, 25.00 \pm 0.00, 24.333 \pm 0.67, 22.000 \pm 1.15, 18.33 \pm 0.33 and 18.33 \pm 0.33 at 30, 60, 90, 120, 150 and 365 days treatment, respectively. From ANOVA analysis it was revealed that there were significant differences in the mean mortality at 12 month intervals as $P < 0.05$, $df = 47$.

Like Biflex, Fipronil bioavailability was also measured in post-treatment soil bioassay. From the results, it was revealed that mean mortality of termites in Fipronil treated SCL soil was 20.00 \pm 0.577, 17.00 \pm 0.577, 14.00 \pm 0.33, 10.00 \pm 0.00, 8.00 \pm 0.33 and 7.00 \pm 0.00 at 30, 60, 90, 120, 150 and 365 days treatment, respectively. Similarly mean mortality of termites in Fipronil treated SL soil was 20.33 \pm 0.882,

16.00±0.577, 15.00±0.33, 12.00±0.577, 8.33±0.577 and 8.33±0.577 at 30, 60, 90, 120, 150 and 365 days treatment, respectively. From statistical analysis it was revealed that there was significant difference in the mean mortality at 12 month intervals as $P < 0.05$, $df = 47$. In both soils, mean mortality rate decreased as time increased indicating a decrease in termiticide concentration with time.

Table 2 shows lethal time of Biflex and Fipronil at different time intervals in SCL and SL soils. Bioavailability values of the termiticides were determined in post-treatment at the highest concentration (5ppm) of both termiticides. LT_{50} values were determined at 30, 60, 90, 120, 150 and 365 days time intervals. From calculated LT_{50} values it was revealed that lethal time increased as time intervals increased. Indicated termiticide efficacy decreased as time increased. By comparison of termiticides it was revealed that Biflex was more persistence in both soils compared to Fipronil. Termiticides showed maximum efficacy in sandy loam soil compared to sandy clay loam soil. Concentration and time both are inversely related to each other.

In Pakistan before this study, no evidence of persistency and bioavailability was available, but throughout the world research supports our study: Smith and Rust (1990) investigated the effect of pyrethroids i.e. Bifenthrin, Cypermethrin, Permethrin, Chlorpyrifos and Chlordane on subterranean termites in loamy soil. In their direct exposure studies Bifenthrin had the greatest activity compared with other insecticides and highest mortality rate was observed in Bifenthrin treated soil. It was also revealed that pyrethroids i.e. Bifenthrin, Cypermethrin and Permethrin have highest efficacy compared to Chlordane and Chlorpyrifos. Saran and Kamble (2008) conducted a study over 6 months to estimate the bioavailability and degradation of Imidacloprid, Fipronil and Bifenthrin against the *Reticuliterme flavipes* (Kollar) (Isoptera: Rhinotermitidae) in loamy soil from Nebraska, USA. The degradation rate was estimated by a half-life model. It was concluded that termiticide degradation was concentration dependent as degradation of the rate lowest was quicker than the highest label rate. Laboratory bioassays were conducted at 8, 3, 65, 90, 135, 160 and 180 days for the assessment of termiticide bioavailability. The results revealed that bioavailability reduced as treated soil aged. An inverse relationship was observed between LT_{90} and concentration. Lower LT_{90} values were observed in the soil treated with the highest concentration of termiticide. Among all termiticides Bifenthrin showed the highest efficacy then Fipronil followed by Imidacloprid.

Similarly, Spomer *et al.* (2009) investigated both low and high concentrations of particular pesticides used to eliminate insect st pests. However environmental fate and bioavailability of termiticides in particular soils is an important consideration when deciding whether low or high label application rates are appropriate for a particular type of soil.

Wiltz (2010) evaluated the effects of soil properties on termiticides performance against Formosan subterranean termite (Isoptera: Rhinotermitidae). The pH of the fluid can affect the sorption considerably because it can affect the solubility of the compound. It was studied that soil pH and soil clay also have strong effects on the mortality and bioavailability of the Bifenthrin, Fipronil and Chlorfenapyr against subterranean termite. A high mortality rate was observed at 0.06% Bifenthrin at low pH as well as in a low clay soil. Mortality was higher in low pH (97-100%) compared to medium pH (84-100%) soils. Among all termiticides, Bifenthrin had strong effects as the highest mortality was observed at 0.06% Bifenthrin, 0.125% Chlorfenapyr, and 0.125% Fipronil at low pH. Saran and Kamble (2008) also studied the application of Fipronil termiticide ranging from 0.06-0.125% and reported an increased in bioavailability with decreasing adsorption coefficient and increased termiticide concentration .

Conclusions

During the present study, it was concluded that both soil termiticides Biflex and Fipronil have toxic effects against *H. indicola*. Bioavailability and degradation of the termiticides tested is directly related to the concentration used. In laboratory soil contact bioassays, mean percentage mortality was more obvious in Biflex compared to Fipronil. From these results it was observed that Biflex was more bioavailable compared to Fipronil.

Table 1: Mean±SEM percent mortality of *H. indicola* (Wasmann) in response to different concentrations of Biflex (Bifenthrin) and Fipronil (Phenyl pyrazole) in sandy clay loam and sandy loam soil at 5ppm concentration at different time intervals (Post treatment).

^aMeans followed by similar letters within columns are indicate not-significantly different ($P > 0.05$, $df = 47$) by ANOVA test. Each mean ± SE is based on 75 termites (3 replicates /25 termites per replicate)

Termiticide	Soil	Time intervals days	Mean±SEM	Difference in mortality between concentrations by ANOVA test
Biflex (Bifenthrin)	Sandy clay loam soil (SCL)	30	25.00 ^a ±0.00	P<0.0001, df= 47
		60	24.667 ^b ±0.33	
		90	22.333 ^c ±0.33	
		120	17.667 ^d ±0.33	
		150	16.667 ^e ±0.33	
		365	15.667 ^f ±0.33	
	Sandy loam soil (SL)	30	25.00 ^a ±0.00	P<0.0001, df= 47
		60	25.00 ^b ±0.00	
		90	24.333 ^c ±0.67	
		120	22.000 ^d ±1.15	
		150	18.33 ^e ±0.33	
		365	18.33 ^f ±0.33	
Fiprinil	Sandy clay loam soil (SCL)	30	20.00 ^a ±0.577	P<0.0001, df= 47
		60	17.00 ^b ±0.577	
		90	14.00 ^c ±0.33	
		120	10.00 ^d ±0.00	
		150	8.00 ^e ±0.33	
		365	7.00 ^f ±0.00	
	Sandy Loam soil (SL)	30	20.33 ^a ±0.882	P<0.0001, df= 47
		60	16.00 ^b ±0.577	
		90	15.00 ^c ±0.33	
		120	12.00 ^d ±0.577	
		150	8.33 ^e ±0.577	
		365	8.333 ^f ±0.577	

Table 2: Lethal time (LT₅₀) in days of Biflex (Bifenthrin) and Fipronil (Phenyl pyrazole) to *H. indicola* (Wasmann) in sandy clay loam soil and sandy loam soil at 5ppm concentration at different time intervals (Post treatment).

Termiticide	Soil type	Treatment time (Days)	n	Lethal Time LT ₅₀ Days
Biflex	SCL	30	25	3.2
	SCL	60	25	3.7
	SCL	90	25	4.5
	SCL	120	25	5.0
	SCL	150	25	7.0
	SCL	365	25	7.5
Fipronil	SCL	30	25	3.7
	SCL	60	25	6.0
	SCL	90	25	7.3
	SCL	120	25	8.2
	SCL	150	25	8.5
	SCL	365	25	11.2
Biflex	SL	30	25	3.0
	SL	60	25	3.5
	SL	90	25	3.7
	SL	120	25	4.0
	SL	150	25	5.0
	SL	365	25	7.0
Fipronil	SL	30	25	3.3
	SL	60	25	5.4
	SL	90	25	7.0
	SL	120	25	8.5
	SL	150	25	11.11
	SL	365	25	13.11

SCL= Sandy clay loam soil SL= Sandy loam soil

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