

## Foraging and Chemical Control of Subterranean Termites in a Farm Building at Faisalabad, Pakistan

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### Abstract

A study was conducted to investigate the direction of foraging of the termites towards a farm building (Entomological Research Laboratories, ERL) and efficacy of soil barrier inside this farm building at Post Graduate Research Station, Faisalabad, Pakistan. Foraging of the termites was determined by installing equally spaced PVC pipes with corrugated cardboard in them around building. Soil barrier of the most efficacious insecticide from bioassay test was created around a pit (0.48 m, 0.32 m width and 0.4 m deep) inside ERL. Chlorpyrifos and alpha cypermethrin proved the most effective against termites with  $LT_{50}$  of 3 hours each at a concentration of 1200 ppm. Foraging of termites from mulberry plantation was highest than from fallow field side towards the building. Soil barrier could prevent penetration of the insecticide mixed soil for only up to 15 days when 0.33% damage of wood pieces was observed. Application of soil barrier in an outdoor setting under local conditions against the termites is discussed.

**Key words:** Termites, soil barrier, chlorpyrifos, alpha cypermethrin, farm building

### Introduction

Termites of the families Kalotermitidae, Hodotermitidae and Rhinotermitidae invade wooden houses and wood works in the buildings. These activities of termites cause colossal losses to structures in many parts of the world. Family Termitidae is the largest and economically the most important of the fungus growing termites which also create considerable problems in agriculture and forestry (Grace and Yates, 1999; Wong and Cheok, 2001; Cox, 2004; Peterson et al., 2006) and in housings as well (Kumar and Thakur, 2010).

Genera *Odontotermes* and *Microtermes* of family Termitidae have been reported as pest of agricultural crops in Punjab, Pakistan (Ahmed et al., 2004, 2005, 2006, 2007, 2008 a, b). These termites' species can

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also infest wooden materials inside the buildings near agricultural fields (Ahmed et al., 2008).

The buildings and materials inside them are saved from the ravages of the termites by chemical barrier which is applied either as pre- and/or post-construction treatments. Wood is an integral part of materials in building or housing construction, thus termites play havoc to them if not properly and timely protected. Insecticides applied for the protection of building and materials belong to repellent or non repellent insecticides (Wong and Cheok, 2001; Nunes et al., 2004; Sukartana et al., 2009; Peterson, 2010; El-Sherif et al., 2010).

Many insecticides belonging to different groups have been tried in the field in Pakistan but without strict scientific basis and evaluation under a given set of soil type, termite species involved and related agro-ecosystem (Ahmed and Riaz, 2004; Ahmed et al., 2006; Ahmed and Farhan, 2006). Plant chemicals and microbial insecticides were also used and their success against the termites was highly variable (Ahmed et al., 2005; Ahmed et al., 2008 a,b, 2009).

With growing importance of urban pest control in Pakistan, anti-termite campaign has also encroached into rural housing and farm building as well. Introduction of new formulations has also necessitated evaluating their efficacy in the field and laboratory as well. Keeping this in view, the present studies were carried out to determine termites' foraging to the farm building and protection of wood material with newly marketed insecticides in Punjab, Pakistan.

### Materials and Methods

#### Studies on Incidence of termites around farm building:

The termites' density was determined from the three sides linking to the agricultural fields around Entomological Research Laboratories (ERL), Post Graduate Agriculture Research Station (PARS), Jhang Road, Faisalabad. PVC pipes of 60 cm length and 10 cm diameter were buried in soil. East side having eight pipes faced mulberry field whereas water course was on western side. Southern side was paved and adjacent to a road, so it was difficult to lay pipes on these two sides. Northern side faced a fallow field (Fig 1). A roll of corrugated cardboard (100 gm

was inserted in each PVC pipe which served as food for termites. The number of termites foraging on these rolls was observed at weekly intervals during March 2009 to February 2010 and difference in termites' density was determined by t test at  $p < 0.05$ . Foraging termites was correlated with environmental condition as well by Pearson correlation (Minitab 11).

### Bioassay

**Termites' collection:** Termites were collected from the agricultural fields around ERL at PARS, Jhang Road Faisalabad. 3<sup>rd</sup> instar workers and soldiers (as determined by size) were collected within 3 days of the beginning of the experiments. Termite traps consisted of (PVC) polyvinyl chloride pipes buried in the ground with the top 2 cm above soil. A roll of moistened, corrugated cardboard was placed inside a pipe and the pipes were capped and then covered with soil. Traps were checked weekly and re-baited. Trapped termites in cardboards were placed in the zipped plastic bags, brought to the laboratory and were provided fresh, moistened cardboard in plastic jars, kept at 26<sup>o</sup>C until ready to use. Termites collected from the traps at PARS were used at the time of assay in the laboratory within a fortnight.

**Preparation of soil for bioassay:** Soil used in this study was collected from a turf plot on ERL at PARS, Jhang Road Faisalabad. Soil analysis (Soil Chemistry Section Laboratories, AARI Faisalabad) classified it as sandy clay loam. The soil had a pH of 7.5, cation exchange capacity of 2.01 ds m<sup>-1</sup>, and an organic matter content of 0.62%. In previous year the plot was fallowed and received only natural rainfall. The plot had not been recently exposed to any fertilizer and/or insecticides. Soil was collected in the late afternoon, when topsoil moisture content was least and if it had not rained during the previous 24 hours. The top 7.5 cm of soil, beginning at the root zone, was collected from the turf plot by using a cup corer (10 cm in diameter), returned to the laboratory, and immediately sterilized by placing it in oven for two hours at 100<sup>o</sup>C.

**Determination of chemical's toxicity:** Toxicity tests were done in Petri dishes of 8 cm diameter with 10g sifted soil, and strips of sugarcane having dimension 1.5 × 6 cm. Soil before use was oven dried at 100<sup>o</sup>C for 2 hours and then enough water was added to equilibrate field water holding capacity. Serial concentrations of Torque (chlorpyrifos 48 EC), Mirage (imidacloprid 5EC), Bouncer (bifenthrin+cypermethrin 305 EC) and Guardian (alphacypermethrin 10 SC) (supplied by Ali Akbar Group, Lahore, Pakistan) in water were added to the soil and thoroughly mixed. Sugarcane strips were not treated. Control treatment in this case was soil mixed

with water alone. 100 workers and 10 soldiers of the termites were released in the Petri dishes having treated and control soils. These dishes were placed in an incubator running at 28±2<sup>o</sup>C and 80±5% R.H. Termites were examined after every 2 hours up to 12 hours, and later, at an interval of 12 hours until all workers and soldiers died. LT<sub>50</sub> from three replications in CRD was calculated by Kaplan Meiyer Survival Test.

**Prevention of above floor material from the termites:** Three concrete below soil pits of 0.48 m, 0.32 m width and 0.4 m deep were built inside ERL building. Floor was cemented. 15 cm soil below floor and around pits was mixed with LT<sub>50</sub> concentration of most efficacious insecticide to observe access of termites to the material above floor. Wood pieces were kept on the floor in each pit. These wood pieces were checked fortnightly for six months because almost 90% woods in control treatment were destroyed by this time. Soil in control was not treated with insecticide. Wood pieces were divided into 25 cm grid to determine extent of damage. Also number of days these woods were accessed by the termites was recorded. The difference between treated and control wood pieces was determined by t test at  $p < 0.05$ .

### Results

Laboratory bioassay of chlorpyrifos, alpha cypermethrin, bifenthrin + cypermethrin and imidacloprid showed that chlorpyrifos and alpha cypermethrin were the most toxic at their high dose (1200 ppm) with LT<sub>50</sub> of 3 hours in each case. LT<sub>50</sub>s, however, increased with decrease in concentrations (Table 1).

Foraging of termites from mulberry plantation and fallow field towards farm building is given in Table 2. Termites' density in March and April 2009 was highest in pipes facing fallow field with difference between two sides was statistically non significant. Following these months, foraging was high in pipe facing mulberry plantation and difference with density in pipes facing fallow field was statistically significant ( $P < 0.05$ ). The overall difference between termites' density in pipes facing mulberry (421.75) and fallow fields (272.75) was statistically significant ( $p = 0.02$ ).

Correlation with environmental factors showed that average temperature was negatively related with termites' density. Relative humidity and rainfall had low correlation value with termites' density. R<sup>2</sup> values revealed that, though not very important but, these factors may play a role in regulation of termites' density (Table 3).

**Table 1** LT<sub>50</sub> values of four insecticides against termites in laboratory bioassay

Conc.	Chlorpyrifos	Alpha cypermethrin	Bifenthrin + cypermethrin	Imidacloprid
	LT <sub>50</sub> (hours)			
1200 ppm	3.00 (3.32; 5.51)	3 (1.72; 9.52)	6 (1.07; 9.51)	6 (1.34; 18.07)
600 ppm	9 (2.51; 20.54)	23 (0.79; 27.65)	18 (0.89; 11.040)	13 (0.88; 10.04)
300 ppm	30 (3.31; 16.39)	38 (1.24; 7.13)	49 (0.78; 14.49)	38 (3.03; 8.72)
150 ppm	39 (3.31; 8.72)	41 (3.48; 37.21)	54 (3.65; 28.98)	50 (3.13; 8.72)
Control	117 (6.64; 16.25)	97 (6.04; 64.77)	102 (6.09; 3.46)	99 (6.17; 45.84)

Conc. = concentrations, Parenthesis represents slope and  $\chi^2$  values, respectively.

**Table 2** Termites density towards farm building form mulberry and fallow fields' sides during March, 2009 to February 2010

Time Scale	Fields around building		Statistics		
	Mulberry	Fallow	F	P value	t value
March 2009	751.42±143.25	776.16±170.2	1.99	0.163	-0.09
April	872.28±113.51	952.68±138.97	1.96	0.16	-0.37
May	814.44±92.19	649.47±95.21	0.56	0.45	1.08
June	278.13±66.31	93.09±18.56	36.37	0.000	3.51
July	36.15±8.98	6.29±2.09	49.361	0.000	4.36
August	71.81±21.02	23.46±7.96	8.33	0.005	2.62
September	544.68±57.49	320.19±36.52	0.003	0.96	3.39
October	879.53±58.54	474.07±62.65	7.37	0.008	4.06
November	751.06±68.47	96.68±19.34	38.28	0.000	11.98
December	69.53±16.05	7.96±2.98	44.27	0.000	5.22
January 2010	20.75±7.95	3.40±1.47	17.72	0.000	2.97
February	117.16±24.92	50.91±14.86	2.68	0.105	2.40
Seasonal average	421.57±21.51	272.75±25.43	4.92	0.027	4.15

**Table 3** Correlation co-efficient and R squared value of termites' density and environmental factors

	Correlation coefficient			R <sup>2</sup> value
	Temp.	R.H.	R.F.	
Mulberry field	-0.74	0.39	0.19	0.176197
Fallow field	-0.78	0.39	0.19	0.265924

Temp. - Temperature, RH - relative humidity. RF – rainfall

**Table 4** Percent damage of buried wood in pits by termites against chlorpyrifos 48 EC at ERL, PARS, Jhang Road Faisalabad

Time	Fortnight	Mean (%) damage	Level of significance
April 15, 2009	1	0.33	E
April 30, 2009	2	1.00	E
May 15, 2009	3	4.67	DE
May 30, 2009	4	5.67	DE
June 15, 2009	5	6.00	DE
June 30, 2009	6	7.33	DE
July 15, 2009	7	11.00	DE
July 30, 2009	8	15.33	CDE
August 15, 2009	9	24.00	BCD
August 30, 2009	10	33.33	BC
September 15, 2009	11	40.33	AB
September 30, 2009	12	55.00	A
<b>Treatments</b>	<b>Slope ± S.E</b>		<b>Grade</b>
C <sub>1</sub> (1200 ppm)	3.58±5.69		C
C <sub>2</sub> (600 ppm)	14.67±5.69		B
C <sub>3</sub> (Control)	32.75 ±5.69		A

Road														
Water channel														
Mulberry field	Road	Pipe row # 1	Yard	Yard	Lawn						Yard	Yard	Water channel	
			Yard	Yard										
			Building		B	U	I	L	D	I	N	G		Building
			Building											Building
			Building		B	U	I	L	D	I	N	G		Building
			Building											Building
Crop field	Pipe row # 2													
	Fallow field						Fallow field							

**Fig 1 Map of Entomological Research Laboratories at Post Graduate Research Station, Jhang Road, Faisalabad**

Table 4 shows the percent damage of the wood inside pits by the termites protected by chlorpyrifos 48 EC having 1200 ppm, 600 ppm concentrations along with a control treatment. Damage was significantly less in 1200 ppm concentration followed by 600 ppm concentration, and damage was extreme in control condition having slope values 3.58, 14.67 and 32.75 respectively. Similarly percent damage of wood was increased at each fortnight. The mean values of percent damage from first fortnight to last fortnight ranged between 0.33-55.0%, respectively.

**Discussion**

Table 1 has indicated that chlorpyrifos and alpha cypermethrin has been the most effective termiticides. The effectiveness of chlorpyrifos has also been proved in agriculture fields of diverse soil types and termite species (Ahmed et al., 2004, 2006, 2008). Cypermethrin treated structure and soil barrier was effective in prevention of building from termites (Ripa et al., 2007). Imidacloprid and combination of bifenthrin + cypermethrin were not less than other tested insecticides. Imidacloprid has been found effective in various formulation and application types (Ahmed et al., 2005; Peterson, 2010).

It has been observed that the food availability such as wooden structures, tree bark, leaf litter, crop residue and weed heaps promotes the activity of termites being good food and habitat for termites. It was also noted that, big objects lying on hedges of the agriculture field i.e., big boulders, manure heaps, huge wooden logs, opaque tree bark and tree stumps provide habitat for termites to construct galleries and number of tubes in ground which sometimes extend towards the agriculture fields to accessing the food sources where they encounter with roots of crops, which they start infesting. Plant cover of the crop increases the ground shade and reduces the water evaporation rate thus increasing the humidity and moisture of the soil which is the main factor that provide the appropriate habitat for termites’ activity (Pearce, 1999; Cornelius and Osbrink, 2010; Kumar

and Pardeshi, 2011). The direction of foraging from mulberry plantation towards building was indicative of some of above mentioned factors, though temperature had negative relation with termites’ foraging, more than relative humidity and rainfall. These results conform with earlier report that relative humidity, soil temperature and total population of termites were found positive but non significantly correlated while atmospheric temperature had negative but non significant impact on population of termites (Sattar et al., 2008). The penetration of barrier by the termites around pits was observed. Termites were able to penetrate this barrier in a fortnight, though damage was less than 1 %. This contrast to the results obtained by Mulrooney et al. (2006) who reported that at all sampling times, termiticide being highest in top 2.5 cm of soil and dissipated up to 50% in the 0–2.5-cm depth was 9, 6, and 2 months for bifenthrin, chlorpyrifos, and imidacloprid, respectively. Our results have shown that one should be careful while treating out door soil with chlorpyrifos for termites’ control.

**References**

Ahmed S, and MA Riaz, 2004. Some studies on population dynamics and chemical control of subterranean termites in sugarcane. *Pakistan Entomologist*, 26: 11-16.

Ahmed S, and M Farhan, 2006. Laboratory evaluation of chlorpyrifos, bifenthrin, imidacloprid, thiamethoxam and flufenoxuron against *Microtermes obesi* (Isoptera: Termitidae). *Pakistan Entomologist*, 28: 45-50.

Ahmed, S, A Naseer and S Fiaz, 2005 Comparative efficacy of botanicals and insecticides on termites in Sugarcane at Faisalabad. *Pakistan Entomologist*, 27: 23-25.

Ahmed S, MR Ashraf and MA Hussain, 2008a. Pathogenicity of a local isolate of *Metarhizium Anisopliae* against *Coptotermes heimi* (Was.) (Isoptera:

- Rhinotermitidae) in the Laboratory. Pakistan Entomologist, 30: 43-50.
- Ahmed S, MR Ashraf, MA Hussain and MA Riaz, 2008b. Pathogenicity of Isolates of *Metarhizium Anisopliae* from Murree (Pakistan) against *Coptotermes heimi* (Wasmann) (Isoptera: Rhinotermitidae) in the laboratory. Pakistan Entomologist, 30: 119-125.
- Ahmed S, MR Ashraf, MA Hussain and MA. Riaz, 2009. Pathogenicity of isolates of *Metarhizium anisopliae* from Gujranwala (Pakistan) against *Coptotermes heimi* (Wasmann) (Isoptera: Rhinotermitidae). International Journal of Agriculture and Biology, 11: 707-711.
- Ahmed S, RR Khan and MA Riaz, 2007. Some studies on field performance of plant extracts against termites (*Odontotermes guptai* and *Microtermes obesi*) in sugarcane at Faisalabad. International Journal of Agriculture and Biology, 9: 398-400.
- Ahmed S, T Mustafa, MA Riaz and A Hussain, 2006. Efficacy of insecticides on subterranean termites in sugarcane. International Journal of Agriculture and Biology, 8: 508-510.
- Ahmed S, W Akbar and MA Riaz, 2004. Effect of crop rotation and intercropping on subterranean termites in wheat at Faisalabad. International Journal of Agriculture and Biology, 26: 25-30.
- Ahmed S, MA Ejaz, MA Riaz and A Hussain, 2008. Some studies on natural resistance of different trees and prevention of infestation by termites through use of industrial effluents at Karor, Layyah, Pakistan. 39<sup>th</sup> Ann. Meet. Istanbul, Turkey, 25-29 May 2008, IRG Secretariat, Stockholm, Sweden.
- Cornelius ML, and WL Osbrink, 2010. Effect of soil type and moisture availability on the foraging behavior of the Formosan subterranean termite (Isoptera: Rhinotermitidae). Journal of Economic Entomology, 103: 799-807.
- Cox C, 2004. Protecting your home from subterranean termite damage. Journal of Pesticide Reform, 24: 6-7.
- El-Sherif SI, MH Belal, HM Rashad and NA Abd El-Latif, 2010. Movement of three Termiticides in a Sandy Loam Soil and their Biological Activity on the Workers of the Subterranean Termite *Anacanthotermes ochraceus* Burm. (Isoptera: Hodotermitidae). Research Journal of Agricultural Sciences, 1: 177-183.
- Grace JK, and JR Yates, 1999. Termite resistant construction and building materials. In: Wm. H Robinson, F Rettich and GW Rambo (eds.). Proceed. 3<sup>rd</sup> Intern. Conf. urban Pests, 19 - 22 July, Prague, Czech Republic.
- Kumar D, and M Pardeshi, 2011. Biodiversity of termites in agro-ecosystem and relation between their niche breadth and pest status. Journal of Entomology, 8: 250-258.
- Kumar S, and RK Thakur, 2010. A check list of termites (Insecta: Isoptera) from Haryana Agricultural University campus, Hisar, Haryana. Journal of Experimental Zoology India, 13: 523-526.
- Mulrooney JE, MK Davis, TL Wagner and RL Ingram, 2005. Persistence and efficacy of Termiticides used in pre construction treatments to soil in Mississippi. Journal of Economic Entomology, 99: 469-475
- Nunes L, T Nobre, B Gigante and AM Silva, 2004. Toxicity of pine resin derivatives to subterranean termites (Isoptera: Rhinotermitidae). Management Environmental Quality International Journal, 15: 521-528.
- Pearce MJ, 1999. Termites: Biology and Pest Management. CAB Intern., London, pp 172.
- Peterson C, 2010. Considerations of soil-applied insecticides for termite control. Outlooks on Pest Management, 21: 89-93.
- Peterson C, TL Wagner, JE Mulrooney and TG Shelton, 2006. Subterranean termites - their prevention and control in buildings. Home and Garden Bulletin, 64: 38.
- Ripa R, P Luppichini, NY Su and MK Rust, 2007. Field evaluation of potential control strategies against the invasive eastern subterranean termite (Isoptera: Rhinotermitidae) in Chile. Journal of Economic Entomology, 100: 1391-1399.
- Sattar A, Z Salihah and A Farid, 2008. Screening of chemical compounds for slow acting toxicant characteristics against subterranean termites. Suranaree Journal of Science and Technology, 16: 63-78
- Sukartana P, G Sumarni and S Broadbent, 2009. Evaluation of chlorfluazuron in controlling the subterranean termite *Coptotermes curvignathus* (Isoptera: Rhinotermitidae) in Indonesia. Journal of Tropical Forest Science, 21: 13-18.
- Wong AHH and KS Cheok, 2001. Observations of termite-fungus interactions of potential significance to wood biodeterioration and protection. Timber Technology Bulletin, 24: 1-8.