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Lethal time response relationships of selected insecticides against field population of worker termites *Odontotermes sp*. (Isoptera: Termitidae)

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Abstract
Bioassay studies were carried out to test the lethal time response of clothianidin, fipronil and bifenthrin under laboratory conditions. Insecticide clothiadin at the concentrations of 0.025, 0.05, 0.075 and 0.1%, fironil and bifenthrin were evaluated at the concentration of 0.075 and 0.05%, respectively. Results revealed that *Odontotermes sp.* worker termites were relatively more susceptible to the insecticides after one month of treatment application. The LT_{50} values for different insecticides increased as the time after the treatment increased. The lowest LT_{50} of 3.69 h was obtained during one month after treatment in bifenthrin @ 0.05% treated soil and highest LT_{50} of 33.19 h was obtained in the clothianidin @ 0.025% during ten months after treatment of soil. In all the subsequent months bifenthrin was found highly toxic to *Odontotermes sp.* worker termites except five and nine months in which clothianidin @ 0.1% recorded the least LT_{50} value of 7.90 and 16.11 h, respectively.

Keywords: Bioassay, LT_{50}, termites and *Odontotermes sp*

1. Introduction
Termites have long been a serious pest of wooden structures, timber products and any other lignocellulose materials. The termites were classified in to three groups based on their habit, nature of damage and moisture requirement. They are dry wood termites (live entirely within dry wood and do not need to access to an external moisture source and soil), damp wood termites (live in old tree stumps, rotting logs and pieces of buried timbers, and can also invade into sound wood in buildings) and sub-terranean termites (build shelter tubes and nest in the soil or on the sides of trees or building constructions and rely principally on soil for moisture).
Insecticides happen to be the major effective weapon under modern agricultural technology against various insect pests to obtain maximum yield and additional returns. For the control of termites, many measures have been recommended, among which use of insecticides found effective over long time. However, termite control appears to be very difficult to achieve in the post chloradane era even with the newest chemicals and technologies (Potter, 1999) [11]. In choladane era, termites and other soil pests were known to be controlled by using insecticdes such as aldrin, BHC, DDT and heptachlor dusts applied to the soil before sowing the crops. They were found to be more effective in controlling termites because of their long persistence (Harris, 1969; Rajagopal *et al*, 1970) [4, 10].
Due to the long-term persistence of these insecticides, it led the increasing public concern on environmental contamination and the risk to human health, particularly in cases of organo chlorides. Many chlorinated hydrocarbon termiticides have now been banned in many developed countries and thus they are almost totally banned in other developing countries in the near future. All countries are now seeking for the safer chemicals or the more effective methods for termite control. New pesticides, methodologies or application such as application of reduced quantity of chemical expecting long term control from the insecticides are seen as new areas. In the study more efforts were put into searching for better termiticide candidates following rising public concerns. Neo-nicotinoid and pyrethroids have been marketed as repellent termiticides after the usage of chlordane was banned in many parts of the world. The major constraint in termites management through these new chemicals appears to be whether are these effective in all situation and on various type of soils. Hu (2005) [6] demonstrated a delayed mode of activity and non-repellency of indoxacarb and fipronil against the two termite species *Reticulitermes flavipes* (Kollar) and *Coptotermes formosonus* Shiraki.

The present study evaluated the efficacy of clothianidin 7.5 CS, fipronil 5 SC and bifenthrin 8 EC on mortality of termites in insecticide treated under modified ground board unit soils from Botanical garden G K V K, UAS. Among the test insecticides, clothianidin is a new novel neo-nicotinoid insecticide possessing a thiazolyl ring. The characteristics of this insecticide include a good systemic action and high insecticidal activity against sucking insect pests such as Hemiptera and Thysanoptera. Clothianidin is even effective for Diptera, Coleoptera and Lepidoptera pests and can be applied by different methods. This insecticide is available in the capsule suspension formulation and was used at different concentration against termites of *Odontotermes sp.* to know the residual toxicity and comparing with the fipronil and bifenthrin.

2. Materials and Methods

The experiment was carried out in the Botanical garden where natural termite activity was noticed. Experimental plot was selected after noticing the termite activity on fallen silver oak leaves and other food material.

2.1 The following were the treatment details

The test chemical clothianidin 7.5 CS was evaluated against termites in four concentrations and were compared with known termiticide *viz.*, fipronil and bifenthrin. The treatments were replicated thrice in randomized complete block design.

The prepared insecticide solution was applied as drenching one sq. ft. area of the soil with 1.5 l of spray solution using a high volume sprayer. Treated area of the soil was covered with the thick polythene sheet to prevent evaporation loss of treated insecticide. Concrete slab was covered above the polythene sheet. The residual toxicity of the insecticides from the treated area was determined up to ten months.

Following were the treatment details

Sl. No.	Insecticide	Trade name	Concentration (%)
1	Clothianidin 7.5 CS	-	0.025
2	Clothianidin 7.5 CS	-	0.05
3	Clothianidin 7.5 CS	-	0.075
4	Clothianidin 7.5 CS	-	0.1
5	Fipronil 5 SC	Regent	0.075
6	Bifenthrin 8 EC	Biflex	0.05
7	Untreated control	-	-

2.2 Residual toxicity test (Petridish method)

The residual toxicity of chemical in the treated soil was determined by collecting 10g of soil sample from each treatment (modified ground board unit) at monthly interval. The soil was brought to the laboratory and was evenly spread separately in petriplates. The active worker and soldier termites of *Odontotermes sp.* were collected from botanical garden, GKVK campus, during morning hours of the day. The collected termites were maintained in a plastic container and these were released to the petriplate immediately at the ratio of 15:1 (workers: soldier) in each of treatments.

The mortality of termites was recorded at 1, 2, 4, 6, 12, 24 and 48 hours after release. Probit analysis for time-mortality response of termites to different insecticides and concentrations was carried out to establish the LT_{50} Values. The experiment was repeated at monthly interval up to ten months. Data were pooled and analyzed by probit analysis (Finney, 1971) [3]. Lethal time to 50% mortality (LT_{50}) was estimated for each insecticide tested. Termite mortality in control was corrected using Abbott's correction formula (Abbott, 1925) [1]. Time mortality responses were subjected to probit analysis as prescribed by Finney (1971) [3]. All the analysis was carried out using SPSS16 statistical programme.

3. Results and Discussion

The LT_{50} values of different insecticides *viz.*, clothianidin, fipronil and bifenthrin on *Odontotermes sp.* in soils from treated unit of modified ground board unit, botanical garden is presented in (table 1). The results clearly indicated that the termites were relatively more susceptible when they were exposed to one month after treatment application. During one month after treatment lowest LT_{50} (3.69 h) was observed in bifenthrin @ 0.05% and highest (7.66 h) was found in clothianidin @ 0.025%. Bifenthrin @ 0.05% showed more toxicity by recording the lowest LT_{50} among the test insecticides up to four months after treatment. The lethal time of second, third and fourth month after treatment was 4.77, 4.63 and 6.19 h, respectively. Earlier, Hoi (2007) [5] evaluated the contact toxicity of six insecticides (bifenthrin, chlorfenapyr, chlorantraniliprole, fipronil, imidacloprid and indoxacarb) against *Coptotermes gestroi* and the results indicated that bifenthrin was the most toxic contact insecticide (table 1).

Median lethal time was lowest in the clothianidin @ 0.1% (7.90 h) and was followed by bifenthrin @ 0.05% (8.86 h), clothianidin @ 0.075% (10.85 h), clothianidin @ 0.05% (11.56 h), fipronil @ 0.075% (12.49 h) and clothianidin @ 0.025% (15.57 h) at five months after the treatment. Bifenthrin applied at 0.05% showed highly toxic effect among the tested insecticides with 10.68 h at six months after treatment. Similarly, Raj and Shripat (2008) [9] have reported LT_{50} value for bifenthrin 120 ppm and fipronil 125 ppm was 17.92 h and 37.31 h, respectively at 180 days after treatment. Bifenthrin @ 0.05% showed significantly lower LT_{50} compared to rest of the evaluated insecticides at six months onwards, except nine months after treatment in which clothianidin@ 0.1% recorded least LT_{50} of 16.11 h which is followed by bifenthrin @ 0.05% (16.12 h).

Lowest LT_{50} values were obtained during one month after treatment compared to the later months in which LT_{50} values were gradually increased at a given concentration for same insecticide. It may be due to the gradual degradation of insecticides by microbes or abiotic factors. The LT_{50} values of clothianidin @ 0.025%, 0.05%, 0.075% and 0.1% was 7.66, 7.23, 5.61 and 4.99 h during one month after treatment, respectively (fig. 1). Whereas LT_{50} values were 33.19, 29.53, 24.00 and 20.53 h in the clothianidin @ 0.025%, 0.05%, 0.075% and 0.1%, respectively at ten months after the application.

Among the neo-nicotinoids and pyrethroid insecticides, pyrethroid insecticide exhibited higher toxicity by recording lower LT_{50} as compared to neo-nicotinoids. The present results were also supported by the earlier findings of Raj and Shripat (2008) [9], where they reported that *Reticulitermes flavipes* termite mortality was fastest for bifenthrin followed by fipronil and imidacloprid. Similar, findings were reported by Manzoor *et al.* (2012) [8] who showed the effectiveness of the chemical in descending order recorded as follow, Biflex>fipronil>chlorphenapyr>imidacloprid>Cadusafos.

There was an inverse relationship between the concentration of the insecticide tested and its lethal time. Similar, results were also obtained by Manzoor *et al.* (2012) [7] where they

reported that type of insecticide and the concentration of the insecticide exhibited the greater influence on the time taken for causing mortality of termites. Further, bifenthrin was found to be more stable compound (Baskaran *et al*. 1999) [2] in the soil as evident by recording the average lowest LT_{50} values up to ten months after treatment application. They were also opined that the effectiveness of the insecticide might be due to the higher persistence of the insecticide in the treated soil and it also depend on the abiotic factors.

4. Conclusion

Based on the findings of the study it can be concluded that bifenthrin 8 EC @ 0.05% showed effective in control of *Odontotermes sp*. termites as it was evident from recording lowest LT_{50} value (19.45 hrs.) at ten months after the treatment application among the tested insecticides. The next best insecticide was clothianidin 7.5 CS @ 0.1% which records the LT_{50} of (20.53 hrs.) at ten months after application of treatment.

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Table 1: LT_{50} values of Clothianidin, Fipronil and Bifenthrin for termites in insecticide treated soil (Petridish method)

Insecticide	Conc. (%)	LT_{50} (hrs.)									
		1 MAT	2 MAT	3 MAT	4 MAT	5 MAT	6 MAT	7 MAT	8 MAT	9 MAT	10 MAT
Clothianidin	0.025	7.66	8.82	9.14	11.46	15.57	16.34	21.30	24.37	28.75	33.19
Clothianidin	0.05	7.23	7.26	8.55	9.13	11.56	16.05	18.44	22.29	26.92	29.53
Clothianidin	0.075	5.61	7.48	7.10	8.96	10.85	13.18	16.74	19.77	21.46	24.00
Clothianidin	0.1	4.99	6.40	7.67	8.10	7.90	12.02	12.08	15.61	16.11	20.53
Fipronil	0.075	6.37	6.77	8.88	10.70	12.49	14.69	16.51	20.82	24.61	31.20
Bifenthrin	0.05	3.69	4.77	4.63	6.19	8.86	10.68	11.77	14.04	16.12	19.45

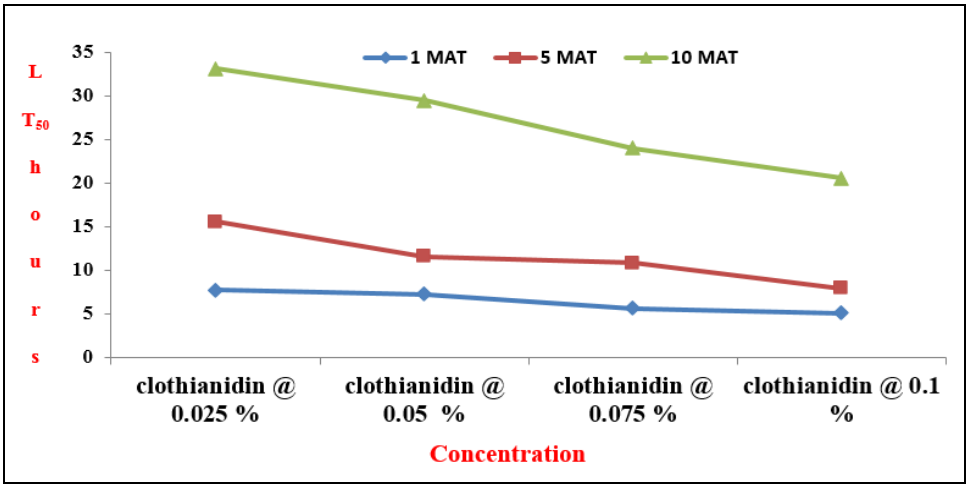

Fig 1: LT_{50} of clothianidin @ various concentrations against worker termites of *Odontotermes sp.*

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