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Original Research Article

Efficacy of Biomax and Fiprokill against *Heterotermes indicola* (Wasmann)

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Abstract

Termites cause profound economic losses worldwide. *Heterotermes indicola* causes tremendous damages to wood work in the buildings and forest trees. Different types of insecticides have been used to control this subterranean termite. In the present study, efficacy of Biomax (Chlorpyrifos) and Fiprokill (Fipronil) against *Heterotermes indicola* (Wasmann) was studied. Toxicities and repellencies of these chemicals were compared at same concentrations. Mortality during 8 hours exposure for Biomax at different concentrations 480, 240, 120, 60, 30, 15, 7.5 and 3.75 ppm was 93.3%, 80%, 73.3%, 63.3%, 56.6%, 50%, 45.6% and 43.3%, respectively. Fiprokill at the same concentration (480, 240, 120, 60, 30, 15, 7.5 and 3.75 ppm) caused 66.6%, 56.6%, 50%, 43.3%, 33.3%, 30%, 26.6% and 20% mortality, respectively. Biomax was found to be more toxic as compared to Fiprokill. LC_{50} values for *H. indicola* exposed to soil treated with Biomax and Fiprokill were 5.735 and 221.676 ppm, whereas LC_{90} values for *H. indicola* exposed to soil treated with Biomax and Fiprokill were 359.290 and 813.722 ppm, respectively. Biomax was repellent at 480, 240, 120 and 60 ppm while Fiprokill was found non-repellent at all the concentrations used.

Keywords: Toxicity, *H. indicola*, Repellency, LC_{50}, LC_{90}

Introduction

Termites are the most important eusocial insect pests of human structure, causing significant damages by feeding on all types of cellulose containing materials (Hickey, 2006; Ahmed and French, 2008; Khan et al., 2015). They cause significant damage to plants, agricultural crops like rice, barley, sugarcane, millet and household materials (Sattar et al., 2014; Aihetasham et al., 2015). Termites have also been frequently considered as the decomposers of different lignocellulosic materials (Lenz, M. et al., 2011). Lingocellulose waste degrading capability of termites attributes them a central place in carbon cycle (Brune, 2014; Manzoor et al., 2015).

Different methods such as baiting system, wood treatment, physical barriers and biological control agents have been used for termite control, but the most effective and extensively used method is the chemical control. Chemicals including imidacloprid, silafluofen, chloropyrifos, cypermethrin, spinosad, bifenthrin and fipronil were found effective in controlling different species of termites (Manzoor et al., 2014). The chemicals are differed in their functions, Biomax (Chlorpyrifos) belongs to organophosphorus insecticides, acaracide and miticide. It acts on the nervous system of insects inhibiting acetylcholinesterase (npIc.orst.edu/factsheets/chlorpgen.html). On contrast, Fiprokill (Fipnonil), a slow acting toxicant, belongs to chemical family of phenypyrazole. It is a widely used insecticide, and a strong disrupter of insect central nervous. It inhibits GABA- gated and glutamate-gated chloride channels chloride (GluCI), causing toxicity of central nervous system (npic.orst.edu/factsheets/fipronil.html).

Now a days, non-repelllent insecticides are preferred over repellent insecticides as these chemicals mainly depend on foraging of termites in treated areas to attain maximum lethal contact, in addition, they cause delayed mortality and trophallaxis (Su and Scheffrahn, 2000; Thorne and Breisch, 2001; Misbah-ul-Haq et al., 2016).Fifty species of termites have been described from Pakistan. Among these, 11 species have been observed destroying wooden structure of buildings (Akhtar, 1983; Aihetasham et al., 2015). Amongst subterranean termites, *Heterotermes indicola* (Wasmann) is a serious pest known to urban and rural areas (Aihetasham et al., 2015). It has ability to damage standing trees by hollowing them out from the inside, without producing any external signs of injury (Balachander et al., 2013; Misbah-ul-Haq et al., 2016).As maximum damage to wood in Pakistan is caused by subterranean termites therefore it is necessary to investigate different methods for their control. Present study involve efficacy of two insecticides, Biomax (Chlorpyrifos) and Fiprokill (Fipronil) against *Heterotermes indicola*.

Materials and Methods

Collection of termites

Termites (*Heterotermes indicola)* were collected by hand picking using fine forceps and camel hair brush from infested old trees of *Populus euramericana* from botanical garden, University of the Punjab, New Campus, Lahore. Termites were kept in Laboratory at 26±2ºC and 80% relative humidity. Active and healthy, termites workers were selected for experiment. They were placed in Petri-plates (70mm x 10mm) having moist filter paper (soaked in distilled water) for further experiments.

Soil for Bioassay

The soil was collected from garden of the Department of Zoology, University of the Punjab, New Campus, Lahore, Pakistan. The collected soil samples were with sandy and loam texture and pesticide contamination free as there had been no known chemical application. After sieving soil with the help of thin net, oven dried for 24 hours at 70ºC.

Insecticides

Two insecticides Biomax (chlorpyriphos) 48% and Fiprokill (Slow acting) 25 TC were selected for the experiments because of their repute as an effective pesticide against different crops pest. To compare their effectiveness on *Heterotermes indicola*, a particular amount of Biomax was dissolved in distilled water. Stock solution of Biomax (480 ppm) was prepared with eight different concentrations i.e., 480, 240, 120, 60, 30, 15, 7.5 and 3.75 ppm.Similarly, a particular amount of Fiprokill was also dissolved in distilled water. Stock solution of fiprokill (480 ppm) was prepared with eight different concentrations i.e., 480, 240, 120, 60, 30, 15, 7.5 and 3.75 ppm. For control, soil was treated only with distilled water.

Toxicity test

Procedure used by Smith (1979) was adopted for soil toxicity. Bottom of each petri plate was evenly covered with 10 grams of weighted oven dried soil. The procedure involved the application of Eight different dilutions 480, 240, 120, 60, 30, 15, 7.5 and 3.75ppm (6ml each) of Biomax were applied to soil samples. Similarly, these eight different dilutions of Fiprokill were used for treatment of soil. These Petri-plates were sterilized at 70ºC for 24 hours prior to the experiment. In each petri plate ten termites were released. Three replicates of each concentration of insecticides were used with control. Mortality data of termites was observed after every half hour up to eight hours.

Repellency test

Similarly, for repellency test, procedure of Smith (1979) was adopted using the same. In this regard, Twenty-seven Petri-plates were washed and then oven dried at 70ºC for 24 hours. Ten grams of oven dried soil was weighted in Petri-plates and with the help of glass slide the soil was evenly divided in two halves so that one half of the bottom of each petri plate was covered with 5 gm of treated soil and the other half with 5 gm of untreated soil. Ten termites were released in the centre of each petri plate to record their orientation on untreated soil. Three replicates of each concentration were used. For minimizing effect of light, plates were completely covered with black cloth, providing natural environment and maintaining room temperature at 25-26ºC and 80% RH. After 15 minutes intervals, the numbers of termites were recorded on untreated soil to take 5 observations. A treatment concentration at which 21 or more out of 30 termites i.e. the aggregate of three replicates of termites found on untreated soil was considered as repellent at all five observation time.

Calculation of LC_{50} and LC_{90} values and Statistical analysis

Data collected for LC_{50} and LC_{90} of Biomax and Fiprokill for *H. indicola* after 8 hours exposure was statistically analyzed by Probit analysis using MINITAB version 17.0 software. Probability plots for Response of *H. indicola* to each chemical were plotted and determined.

Results and Discussion

For *H. indicola*, the percentage mortality in soil treated with Biomax, after 8 hours was 93.3%, 80%, 73.3%, 63.3%, 56.6%, 50%, 46.6% and 43.3% in 480, 240, 120, 60, 30, 15, 7.5 and 3.75 ppm respectively, whereas, at the same concentrations, the percentage mortality in soil treated with Fiprokill, after 8 hours was 66.6%, 56.6%, 50%, 43.3%, 33.3%, 30%, 26.6% and 20% respectively (Figure. 1)

LC_{50} of Biomax and Fiprokill for *H. indicola* was 5.735 ppm and 221.676 ppm, respectively (Table. 1). It was noticed that at higher LC_{50} insecticide required greater time to kill a population. SimilarlyLC_{90} of Biomax and Fiprokill for *H. indicola* was 359.290 and 813.722 ppm, respectively (Table. 1). Probability plots for response of *H. indicola* to Biomax and Fiprokill at eight different concentrations (Fig.2-3).

Table 1. LC_{50} and LC_{90} values ofInsecticides (Biomax and Fiprokill) against *H. indicola*

Serial No.	Insecticides	LC_{50}(ppm)	LC_{90}(ppm)
1	Biomax	5.735	359.290
2	Fiprokill	221.676	813.722

Soil toxicity test showed that mortality increased with increase in concentration of Insecticide. The comparison of toxicity of Biomax and Fiprokill showed that Biomax was found to be more toxic as compared to Fiprokill.

Our results are in confirmation with Ahmed and Farhan (2006) who studied the effectiveness of chlorpyrifos, imidacloprid, bifenthrin and thiamethoxam against *Microtermesobesi* and found chlorpyrifos as the most effective in controlling termites. Organophosphates such as chlorpyrifos, degrades quickly, whereas chloronicotinyls and pyrethroid degrade slowly (Baker and Bellamy, 2006). Rao *et al*. (2005) studied the effect of chlorpyrifos and monocrotophos on the locomotorbehaviour (velocity) and acetylcholinesterase activity of *Odontotermes obesus* at intervals of 4, 8, 12, 16, 20 and 24 h and found LC_{50} values for chlorpyrifos and monocrotophos as 0.046 and 0.148 µg cm^{-2}, respectively. After 24 h termites showed 97 and 88% reduction in locomotorbehaviour.

Results showed that chlorpyrifos was 3.22-fold more toxic than monocrotophos. Sheikh (2015) also evaluated the efficacy of Tenekil (poly chlorinated petroleum hydrocarbon), Terminus (chlorpyrifos) and Termidor (fipronil) on *M. obesi*. Their LC_{50} values were 114.55, 3.15, 7.816 and ppm, respectively in 8h exposure.The results showed that terminus caused maximum mortality (93.3%) at higher doses i.e.,500 ppm after 8 hour exposure.

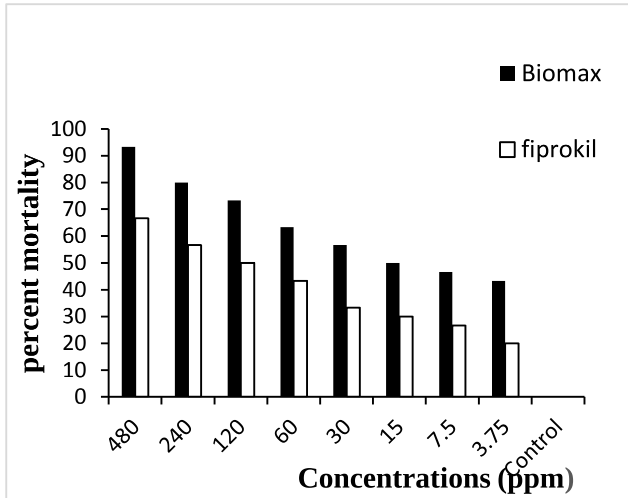

Fig. 1. A comparison of Mortality (%) of *H. indicola* exposed to eight different concentrations ofBiomax and Fiprokill

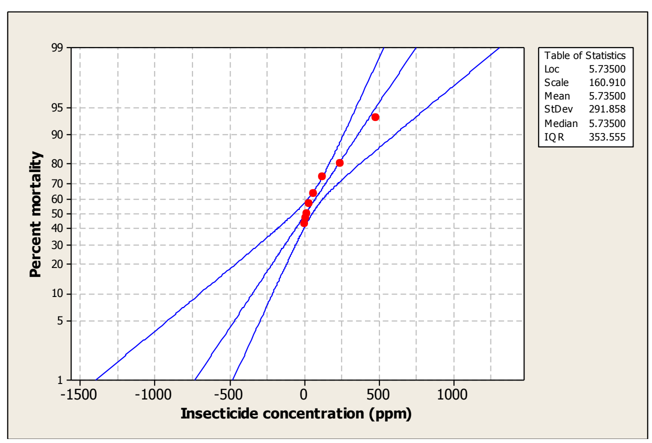

Fig. 2: Probability Plot for Response of *H. indicola* to Biomax at different concentrations

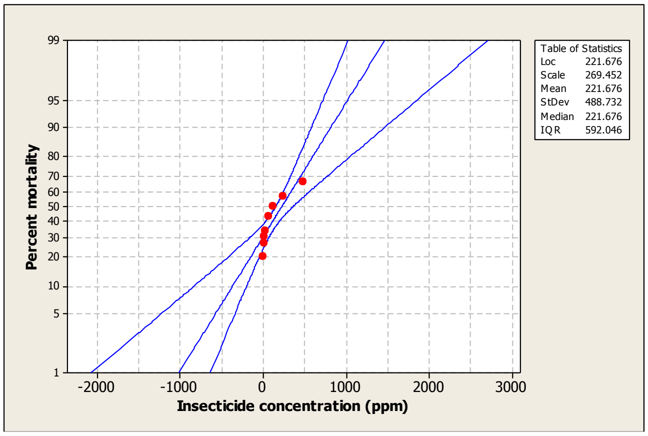

Fig. 3: Probability Plot for Response of *H. indicola* to Fiprokill at different concentrations

Our findings are also in accordance with Ahmed *et al*. (2006) who reported toxicity of chlorpyrifos, imidacloprid and monomehypo against termites on sugarcane. After 15, 45, 60, and 75 days of application on setts chlorpyrifos gave significant control of termites population and reduced the number of termites as compared to imidacloprid and monomehypo. Iqbal *et al*. (2013) also evaluated toxicity of six new chemical insecticides (Chlorfenapyr, spinosad, thiamethoxam, fipronil and imidacloprid) against *Microtermes mycophagus* D. LC_{50} values for *M. mycophagus* D. exposed to soil treated with these insecticides were alculated and found in ranges of 3.72-5.88 ppm and 2.80-3.45 ppm, for chlorfenapyr and fipronil, respectively. Manzoor *et al*. (2012) also explained toxicity and repellency of four insecticides cadusafos, chlorfenapyr, imidacloprid, bifenthrin and fipronil at different concentrations against *Heterotermes indicola*.
Their LC_{50} values for *H. indicola* were 346.75, 75.86, 14.45, 1.05, 0.46 for imidacloprid, chlorfenapyr, fipronil, bifenthrin and cadusafos, respectively. Their results confirmed that cadusafos (organophosphates) was more toxic with LC_{50} significantly lower in 8h treatment.
The results regarding the repellency of Biomax and Fiprokill also showed that Biomax became repellent at higher doses i.e, 480, 240, 120, and 60 ppm, whereas, Fiprokill was non-repellent at all concentrations (Figure 4). This proved that Fiprokill (fipronil) is a slow acting and non-repellent toxicant with delayed moratlity as compared to Biomax (chlorpyrifos) which caused quick contact mortality and its repellency effects hence it can be used for long term control programme. Similar results were obtained by Hu (2005) who studied the effect of fipronil and indoxacarb against two subterranean termites i.e., *C. formosanus* (Shiraki) and *R. flavipes* (Kollar) as both were toxic, non-repellent and had delayed mode of activity.

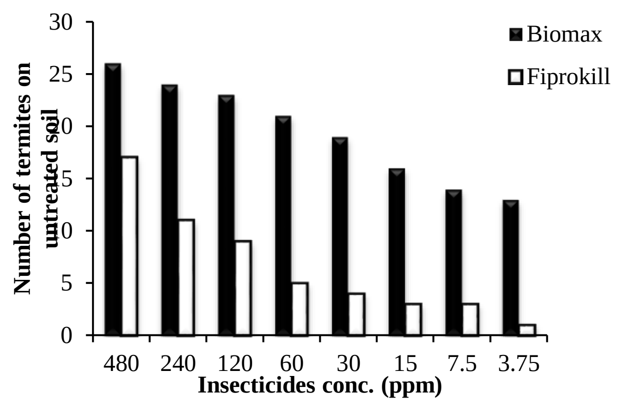

Fig. 4: A comparison of Repellent effect of Biomax and Fiprokill to *H. indicola* at different concentrations

Conclusion

Both insecticides were toxic to *H. indicola* however Biomax with LC_{50} 5.735 ppm and LC_{90} 221.676 was found to be more toxic as compared to Fiprokill with LC_{50} 359.290ppm and LC_{90} 813.722 against *H. indicola*. Fiprokill was non repellent at all concentrations as compared to Biomax. Therefore Fiprokill being slow acting toxicant and non-repellent termiticide is the best solution for effective and long term termite control

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