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Effects of Certain Insecticides against the Subterranean Termite, *Psammotermes hypostoma* Desneux (Isoptera: Rhinotermitidae), Using a Controlled Cardboard-Dip Bioassay

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Abstract

The purpose of the current study was to determine the toxicity of three compounds to *Psammotermes hypostoma* Desneux, a subterranean termite (Isoptera: Rhinotermitidae): chlorpyrifos, imidacloprid, and lambada cyanothrin. In the agricultural and rural districts of the Sohag governorate in Egypt, *P. hypostoma* termites are regarded as some of the deadiest termites. The cardboard dip bioassay method is being used in a lab setting. In comparison to imidacloprid and lambada, the results demonstrated that chlorpyrifos gave control of the termites' population after 3, 12, and 24 hours of application on setts. Following three hours, the highest values for LC50 and LC90 were 37.74 and 837.34 ppm for chlorpyrifos, whereas the lowest values were 166.11 and 7685.44 ppm for lambada. The mortality rose as the duration was extended; after24 hours, the chlorpyrifos LC50 and LC90 were 7.92 and 97.74 ppm, respectively. After 90 days of treatment, subterranean termites, *P. hypostoma*, dramatically reduced the percentage of infested trees treated with chlorpyrifos and imidacloprid; lambada showed the lowest reduction percentage. Furthermore, imidacloprid's effectiveness and sideeffects continued for up to 105 days following treatment, while chlorpyrifos's lasted for up to 120 days. According to the study's findings, out of all the insecticides tested, chlorpyrifos was the most effective pesticide.

Key words: termites, insecticides, controlled, Bioassay.

INTRODUCTION

Olive trees, palm tree trunks, and wood trees can all be harmed by subterranean termites. They may also target certain field crops,such as sugarcane,cotton, and wheat.Additionally When termites target peanuts,The termite, *Psammotermes hypostoma* Desneux, damages buildings, furniture, country grain storage, records, and almost anything composed of cellulose, according to Ahmed et al. (2011), El Haemesy (1976), and Badawi et al. (1986) (Rizk et al, 1982; Abdel Galil, 1986; and Bohibeh, 2010). Subterranean termites severely damaged many homes and structures for the previous 20 years in many different parts of Egypt, including Quna, Sohage, Luxor, Aswan, Sinai, Alexandria, Cairo, Port-Said, Damanhur, New Valley, Assiut, and so on (Ahmed and El-sebay 2008 ; Ahmed and Mohany, 2008; El-Bassiouny and El-Rahman 2011; Ahmed et al., 2014 or 2015 Ghesini and Marini, 2017). But in the USA, underground termites seriously damage a home (Su, 1994).Mud tunnels dug by subterranean termites on trees connect to the colony and facilitate termites' migration.into olive trees and other trees to reach the cellulose substance found in date palms (Badawi et al., 1985); moreover (Helal and El Sebay, 1994), termite management requires the use of chemicals, such as insecticides (Akbar et al 2018 and 2021; Lewis 2003 and Iqbal, and Saeed (2013) 2013). This study sought to determine the effectiveness of certain insecticides on termite workers in both laboratory and field settings.

MATERIALS AND METHODS

Toxicological study

Study Site

The fieldwork-was carried out at Al-awther Farm, which follows the faculty of agriculture at Sohag University. This farm was built 20 years ago and is approximately 20 acres. There are lots of crops, such as orange trees, lemons, mangoes, and a place for cattle. It caused a severe injury to the tree's termites.

Collecting termite workers

In April 2023, a field strain of *P. hypostoma*, the subterranean termite species, was collected from the AL-Kawthar farm, which is affiliated with the Faculty of Agriculture in Sohag Governorate. The El-Sebay trap (El-Sebay, 1991) was utilized to capture termite-infested cardboard rolls. The rolls were then transported to the Plant Protection Department's laboratory at the Faculty of Agriculture, Sohag University, using polythene bags. After removing the termites from the cardboard rolls with a small brush, they were placed in Petri dishes (9 cm diameter) containing moistened corrugated cardboard as a source of cellulose and moisture for the bioassay.

Insecticides

Commercial formulations of chlorpyrifos (Westbane 48% EC), imidacloprid (Imidachem 35% SC), and lambdacyhalothrin (Carilot Al-Nasr Gold 5% EC) were used for the bioassay and field experiments (Table 1).

Research facility Bioassay

The viability of bug sprays against *P. hypostoma*, an underground termite, was evaluated within the field utilizing the cardboard dip-bioassay procedure. The results are given in partitioned reports. The discoveries of research facility tests conducted to discover the concentration are detailed here. These pesticides that must be utilized in arrange to annihilate 50% (LC50) and 90% (LC90) of underground *P. hypostoma* specialist termites. Five areas of focus of each insecticide's aqueous solution (10, 20, 100, 500, and 1000 ppm) were employed. Five-by-five-centimeter cardboards were dipped in each pesticide concentration for ten seconds, allowed to dry in a lab setting for roughly 30 minutes, and then put inside plastic cans with lids. Fifty termite workers in good health (same dimensions and form), these plastic cans were filled with three duplicates of the same termite colony, which were then kept for twenty-four hours at 25 ±2°C, 40 + 5 RH%, control. With (cardboard was dipped in a distilled water solution. Three repetitions of the toxicity experiment were conducted for each concentration. Termite mortality was noted following 3, 6, 12, and 24-hour-long therapy. If a termite worker could not coordinate, it was deemed dead. Forward motion, Abbott's formula was used to adjust the results (Abbott, 1925). The insecticides' slope values and median lethal concentrations (LC_{50})

were ascertained. Abbott's formula was used to adjust the results (Abbott, 1925). The insecticides' slope values and median lethal concentrations (LC_{50}) were ascertained. Probit regression analysis with SAS (2003) software (Version 16.0 for parts per million (ppm)) and presented as Windows (SAS 2003) (Finney, 1971) [(LC_{50} of the most toxic tested compound/LC_{50} of the tested] is the toxicity index. polymer) 100] (Sun, 1950).

Field Treatments

The field experiments were conducted in the El-Kawthar farm affiliated with the Faculty of Agriculture at Sohag University, Egypt, in April 2023, to assess the infestation of subterranean termite, *P*. *hypostoma* in the affected trees. Before the start of the experiment, the area was surveyed using exploratory traps (cardboard fish traps) placed in a chessboard pattern with a distance of 1 meter between each trap. This pre-experiment survey aimed to confirm the presence of termite infestation and locate underground colonies. The survey revealed a high infestation level of underground termites in the area.

Field Trials

Experimental Design and Termite Inspection: The most effective method of control involved digging a 30 cm wide and 30 cm deep trench around the trees. Each insecticide was applied at a concentration of 20 cm/4 L, with ten replicates (10 meters) for each treatment, including the control. Ten corrugated board traps (El-Sebay, 1991) were placed at intervals of ten meters, serving as bait traps. The corrugated cardboard was rolled into a 10 cm high and 7 cm diameter roll, moistened with water, and sealed with a plastic sheet. The cardboard rolls were buried 30 centimeters below the soil surface in the trenches. The traps' plastic covers were numbered for identification and placed at the same level as the soil surface. These traps attracted subterranean termites to the soil surface by providing moisture and cellulose material as a food source. The treatment started in April 2023, and inspections were conducted at 15, 30, 60, 90, 105, and 120-day intervals. The percentage reduction of infestation was calculated using Abbott's equation (1925).

Reduction (%) =

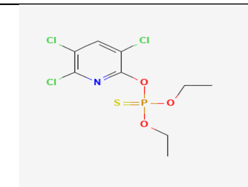
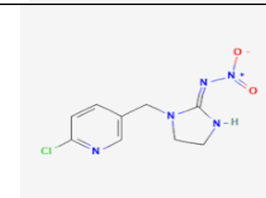
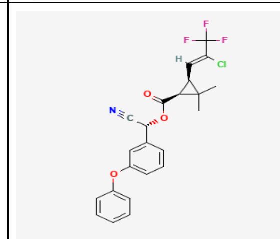
$$\frac{\text{Total No of traps} - \text{No.of infected traps}}{\text{Total No.of traps}} \times 100\ \%$$

RESULTS AND DISCUSSION

The findings are presented in Table 2 and Figs. 1, 2, 3, and 4 illustrate the toxicity of imidacloprid and lambda cyhalothrin compared to chlorpyrifos against *P*. *hypostoma* using the cardboard-dip bioassay at 3, 6, 12, and 24 hours. Based on the LC50 values obtained at these time intervals, chlorpyrifos was found to be the most toxic insecticide (37.74, 19.99, 13.48, and 7.92 ppm), followed by imidacloprid (82.23, 42.30, 24.94, and 14.30 ppm), and lambda-cyhalothrin was the least toxic (166.11, 125.90, 75.82, and 20.11 ppm).

Similarly, the LC90 values at 3, 6, 12, and 24 hours were determined for the tested insecticides. Chlorpyrifos exhibited LC90 values of 837.34, 360.33, 160.98, and 97.74 ppm, while imidacloprid showed LC90 values of 2951.46, 1296.87, 899.85, and 193.73 ppm. lambda-cyhalothrin had the highest LC90 values among the tested insecticides, measuring 7685.44, 3825.94, 3452.70, and 342.39 ppm.These results indicate that chlorpyrifos demonstrated the highest potency against the subterranean termite, *P*. *hypostoma*, consistent with the findings of previous studies by Abd-Ella (2020) and El-Zoghby *et al*. (2022). Furthermore, Ahmed et al. (2014) investigated the toxicity of chlorpyrifos (48% EC) and imidacloprid (20% SL) against *P*. *hypostoma* using the cardboard-dip bioassay at 3, 6, 12, and 24 hours. Their results showed that chlorpyrifos had an LC50 value of 28.29 ppm at 3 hours and 0.36 ppm at 24 hours, while imidacloprid had an LC50 value of 50.95 ppm at 3 hours and 0.82 ppm at 24 hours. These findings confirm the high toxicity of chlorpyrifos compared to the other tested pesticides.Furthermore, the homogeneity response of *Psammotermes hypostoma* to the pesticides was assessed. Chlorpyrifos displayed the highest homogeneity response (slope 0.952), followed by imidacloprid (slope 0.824).

Table (1): Bug sprays utilized against the underground termite, *P. hypostoma*

No.	Common name	Group	Chemical structure- Molecular weight	Mode of action	Chemical	
					Name	Structure
1	Chlorpyrifos	Organophosphates	$C_9H_{11}Cl_3NO_3PS$ 350.6	Affects the nervous system by inhibiting the breakdown of acetylcholine (ACh), a neurotransmitter	diethoxy-sulfanylidene-(3,5,6-trichloropyridin-2-yl)oxy-λ5-phosphane	
2	Imidacloprid	Neonicotinoids	$C_9H_{10}ClN_5O_2$ 255.66	Acts on several types of post-synaptic nicotinic acetylcholine receptors in the nervous system.	E)-1-(6-chloro-3-pyridylmethyl)-N-nitroimidazolidin-2- ylideneamine	
3	Lambda Cyhalothrin	Pyrethroids	$C_23H_{19}ClF_3NO_3$ 449.8	Sodium channel modulators (3)	[(R)-cyano-(3-phenoxyphenyl)methyl] (1S,3S)-3-[(Z)-2-chloro-3,3,3-trifluoroprop-1-enyl]-2,2-dimethylcyclopropane-1-carboxylate	

On the other hand, lambda lambda-cyhalothrin exhibited the lowest homogeneity response (slope 0.77) at 3 hours. These values changed to 1.174, 1.132, and 1.041, respectively, at 24 hours. Information spoken in Figure 5 shows that all bug sprays caused a noteworthy lessening in termites after 15, 30, and 60 days after treatment (DAT) came to 100% of underground termites. After 60 days of treatment, chlorpyrifos (48), imidacloprid (35% SC), and lambada cyanothrin (5 % EC) recorded 100% lessening. Though Lambada Cyhalothrin (5 % EC) recorded 80% of lessening, chlorpyrifos,and imidacloprid recorded a100% of decrease after 90 days of treatment. Though chlorpyrifos recorded a 100% decrease, imidacloprid recorded a 90% diminishment and lambada Cyhalothrin recorded a 70% decrease after 105 days of treatment. Besides, after 120 days of treatment, chlorpyrifos recorded a100% decrease, whereas imidacloprid recorded an 80% lessening and lambada Cyhalothrin recorded 60% lessening, individually. These comes about demonstrated that chlorpyrifos and imidacloprid enlisted an ltogether tall percent lessening of the plagued harming trees by underground termite, *P. hypostoma*, for 120 days. Whereas, Lambada Cyhalothrin recorded the least lessening rate compared with other bug sprays. Thus, the current ponder may well be suggested to utilize chlorpyrifos to control harmed trees with the underground termite's administrator in Egypt. Chlorpyrifos is additionally a reference bug spray and is more often than not included in bioassays and field medicines for comparison with another planning termiticide(Scheffrahn *et al* 1997;Ahmed *et al*., 2014;Ahmed and Qasim ,2011; Manzoor and Pervez, 2014). Chlorpyrifos could be a repellent termiticide that anticipates termites' development within the soil and in this way, limits get to nourishment, which causes mortality (Ahmed *et al*., 2015; Ahmed *et al*., 2017).

Table (2): Poisonous quality of tried bug sprays, against *pasmmotermes hypostoma*, utilizing cardboard-dip bioassay after 3, 6, 12, and 24 h presentation:

Insecticides	LC50	Confidence limits of LC_{50}		Slope	Toxicity index	X^2	LC_{90}
		Lower	Upper				
After 3h							
Chlorpyrifos	37.74 a	26.76	51.12	0.952	100	1	837.34
Imidacloprid	82.23 b	58.35	114.63	0.824	45.895	2.179	2951.46
Lambada Cyhalothrin	166.11 c	116.86	244.05	0.77	22.718	4.402	7685.44
After 6h							
Chlorpyrifos	19.99 a	13.63	27.40	1.02	100	1	360.33
Imidacloprid	42.30 b	29.21	58.61	0.862	47.244	2.117	1296.87
Lambada Cyhalothrin	125.90 c	91.55	175.09	0.864	15.874	6.3	3825.94
After 12h							
Chlorpyrifos	13.48 a	9.23	18.24	1.19	100	1	160.98
Imidacloprid	24.94 a	15.89	35.93	0.823	54.077	1.849	899.85
Lambada Cyhalothrin	75.82 b	52.46	107.66	0.773	17.784	5.623	3452.70
After 24h							
Chlorpyrifos	7.92 a	4.77	11.39	1.174	100	1	97.74
Imidacloprid	14.30 ab	9.69	19.51	1.132	55.393	1.805	193.73
Lambada Cyhalothrin	20.11 bc	13.84	27.41	1.041	39.38	2.539	342.39

χ^2 = Chi-square, Harmfulness file was calculated with regard to the foremost compelling compound LC50
LC50 values in same column with diverse letters are essentially distinctive (95% FL did not cover based of certainty limits values)

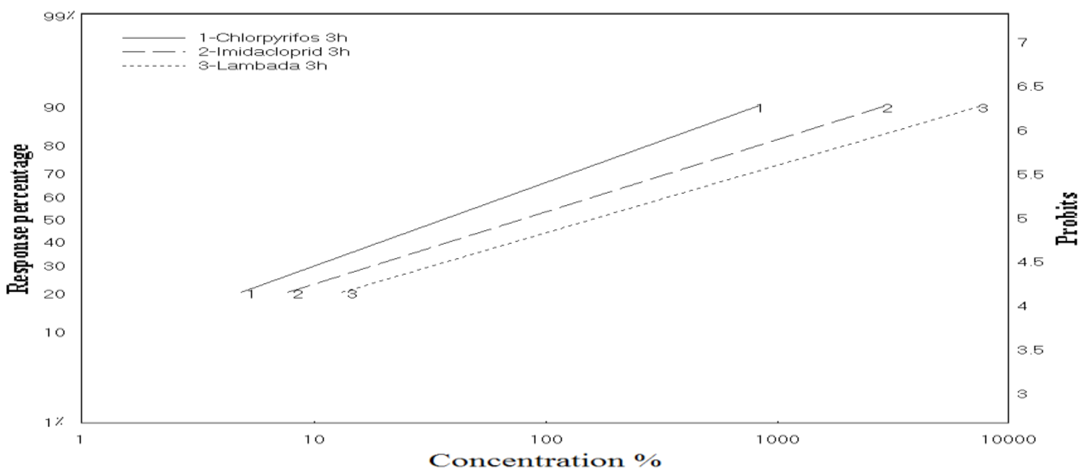


Figure (1): Harmfulness lines of tried bug sprays compare to chloropyrifos against *P. hypostoma* after 3 h.

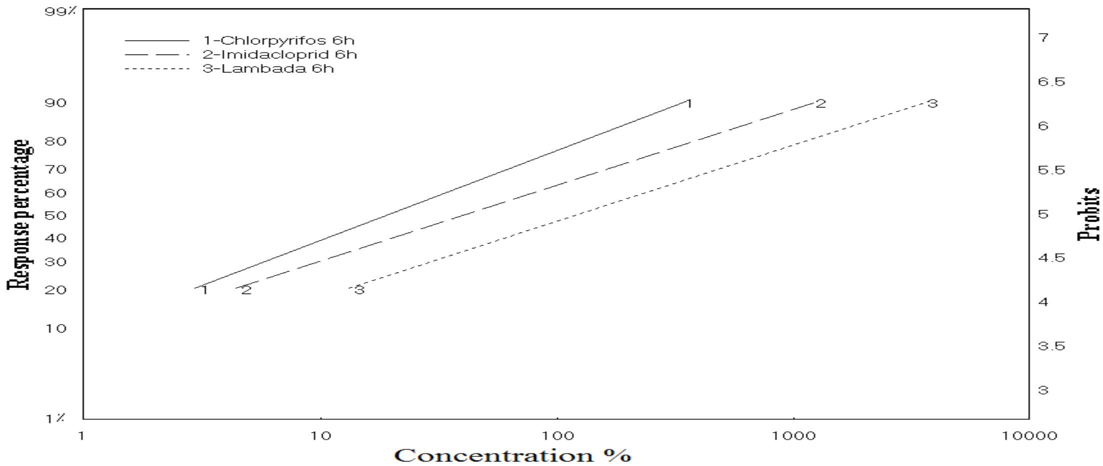


Figure (2): Harmfulness lines of tried bug sprays compare to chloropyrifos against *P. hypostoma* after 6 h

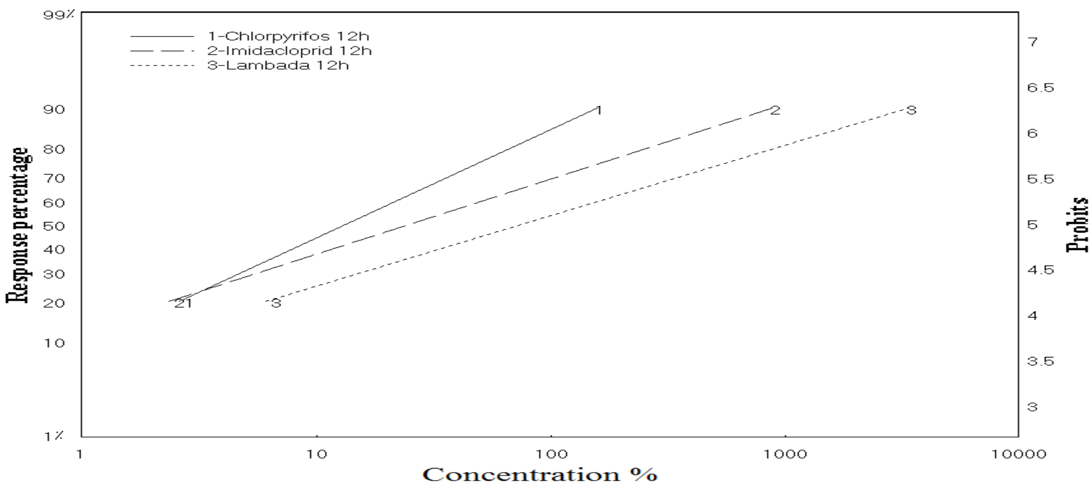


Figure (3): Harmfulness lines of tried bug sprays compare to chloropyrifos against *P. hypostoma* after 12h.

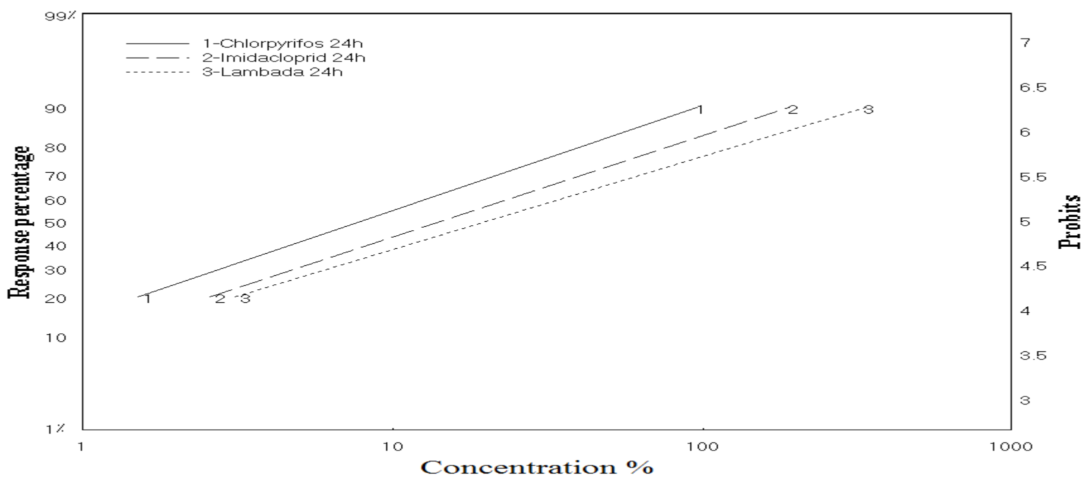


Figure (4) Harmfulness lines of tried bug sprays compare to chloropyrifos against *P. hypostoma* after 24 h.

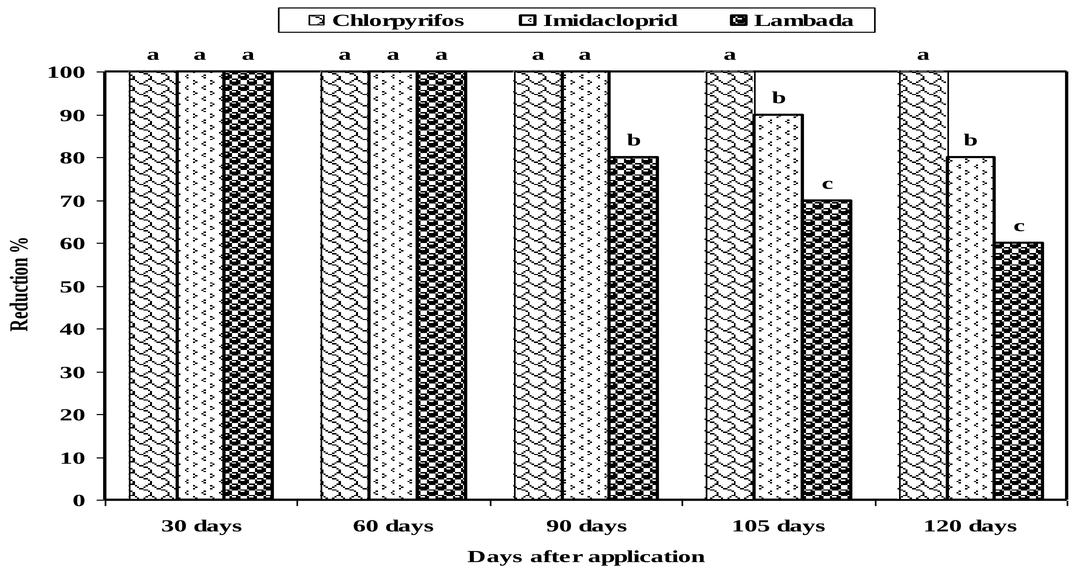


Figure (5) Reduction percentage of insecticides against *P. hypostoma* after 30, 60, 90, 105 and 120 days after treatment under field condition.

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