academicJournals

Vol. 8(5), pp. 274-282, May 2014
DOI: 10.5897/AJEST2014.1690
Article Number: 902350245093
ISSN 1996-0794

http://www.academicjournals.org/AJEST

African Journal of Environmental Science and Technology

Full Length Research Paper

The comparative insecticidal and residual efficacy of sniper and alpha cypermethrin in the control of *Blattella germanica* (L.) (Dictyoptera: Blattellidae) infestation

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Received 3 March, 2014; Accepted 29 April, 2014

Blattella germanica **(German cockroach) is an urban insect pest in Nigeria due to an increase in strains that are resistant to the commonly used insecticides. The purpose of this study was to determine which of the insecticides used by pest control professionals are still effective. The insecticidal efficacies of dichlorvos (organophosphate-called sniper©) and alpha cypermethrin (a pyrethroid called alpha action ©) were determined in laboratory bioassays against *B. germanica*. Efficacy and response were affected by application rate of insecticide and exposure period. Insecticides mixed with diesel were more effective than those mixed with water. Insects exposed to the insecticides in closed chambers gave higher mortalities than insects in open chambers. *B. germanica* was more susceptible to dichlorvos than to alphacypermethrin in both open and closed chambers. Mortality of *B. germanica* increased with increase in concentration of the insecticide used. Sniper mixed in diesel was fastest acting insecticide against *B. germanica* where 100% mortality was observed 5 min post exposure in closed and opened chambers. Both insecticides gave 100% mortality of all insects exposed within 4 h of the exposure period. Sniper mixed with diesel had the LT_{95} of 10 min while sniper mixed in water was 17 and 23 min, respectively in closed and opened chambers. The LT_{95} of alphacypermethrin (5% (v/v)) mixed with diesel and water in closed chambers were 10 and 125 min, respectively. The residual effect of sniper and alphacypermethrin was less than one week.**

Key words: Resistance, commercial insecticide, susceptibility.

INTRODUCTION

German cockroaches live in close association with people. They are tropical in origin but in the temperate zone most species live in parts of house and other building where warmth, moisture and food are adequate. They usually live in groups and are mostly active at night. In the daytime they hide in cracks and crevices in walls, door frames, and furniture, and in secure places in bath-rooms, cupboards, steam tunnels, animal houses, base-ment, television, radio and other electronic devices, drains and sewer systems. If the light is turned on in an infested kitchen at night the cockroaches will run from dishes, utensil, working surface and the floor toward shelters (Rivault et al., 1993).

German cockroaches eat all food used for human

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consumption. They however prefer starchy and sugary materials. They sip milk and nibble at cheese, meats, pastry, grain product, sugar and sweet chocolate. They also feed on cardboard, book binding, ceiling boards containing starch, the sized inner lining of shoe sole, their own cast skin, dead and crippled cockroaches, fresh and dried blood, excrement, sputum, fingernails and toenails of babies and sleeping or sick persons (Rauh et al., 2002). More importantly, roaches are sometimes implicated as disease vectors, as carriers of intestinal diseases, such as diarrhea, dysentery, typhoid fever and cholera (Appel and Tucker, 1986; Gradcolas, 1996).

The females unlike most other cockroaches carry ootheca that protrude from their abdomen until the eggs are ready to hatch or may hatch from ootheca while female still carries it (often in rear cases). The ootheca is then dropped in a secluded location, where the nymphs emerge within 24 h. A female may produce four to eight cases during her lifetime, each containing 30 to 48 eggs. Eggs hatch in about one month and nymph develop in 1 to 4 months. Adult females live for about six to seven months and males live slightly less. The German cockroach produce more eggs and has more generation per year (three to four) than other cockroaches thus troublesome infestation can develop from a few individuals (Rust et al., 1995).

Chemical control is still the main approach for urban pest control (Castle et al., 1999; Rozendaal, 1997; Marrs, 1993; Lee and Yap, 2003; Tidwell et al., 1994). The use of insecticides is seen as the most effective tool in cockroach control program (WHO, 1996; Chavasse and Yap, 1997; Lee and Yap, 2003; Tidwell et al., 1994). The major insecticides used against cock-roaches in Nigerian households include pyrethroids (alpha cypermethrin) and organophosphates (dichlorvos).

Resistance has been reported amongst cockroaches to various groups of insecticides such as organophos-phates, carbamates and synthetic pyrethroids, when applied directly, as residual spray and or in topical application (Diaz et al., 1994; WHO, 1996, Wei et al., 2001). With the increase in the number of German cockroach resistance to insecticides lately, there is a need to re-evaluate/ re-ascertain the insecticides that are being used so as to know those that have become less effective or the efficacious ones, in order to sustain the control of this deleterious organism.

This study therefore seeks to investigate the comparative insecticidal and residual efficacies of sniper and alpha cypermethrin against *B. germanica* in laboratory during fumigation (closed) or disinfestation (opened) exercises.

MATERIALS AND METHODS

All the experiments were carried out at the laboratory of the Department of Zoology, University of Lagos, Nigeria. Temperature and relative humidity measurements were recorded daily using the Thermo-Hygro Analog Yenaco.

Insect collection

A number of German cockroaches identified at insectary of the department, were collected from some old cupboards in some hostels in New Hall Area of the University of Lagos. The cupboards have been locked for over four months. Several male and female nymphs and adults, including female carrying ootheca were found in the cupboards.

Insect culture

These insects were carefully removed, kept in vials and taken to the Zoological laboratory and transferred to another plastic vial measuring 25 cm in length and 17 cm in width. A wire gauze and net were used to cover the plastic vials. The cover and body of the vials were strapped together using rubber band to prevent escape or cross infestation of the cockroaches. The cockroaches were fed with bread, and the slices of bread were changed three times a week. The drinking water placed in each container was also renewed weekly. The culture was kept in the laboratory for over six months, until the roaches in each vial were more than hundred. Each vial contains nymphs, adult males and females.

Insecticides used

The insecticides used were alpha cypermethrin and dichlorvos called sniper by SaroAgroSciences

Experimental design

Four experimental groups (two groups and two formulations) were included in the design. The first two groups contained filter paper treated with diesel formulation of sniper and alpha cypermethrin while the other two groups contained filter paper treated with water formulation of sniper and alpha cypermethrin. Each group was exposed to closed environment (fumigation) and opened environment (disinfestation). There were two controls (treatment with water and diesel), that were each run parallel to the treatments. The controls consisted of filter papers treated with water and diesel for both closed and opened environments

Toxicity test

All life stages of German cockroach except the first, second nymphal stages and the gravid females were used for the toxicity tests. Sniper and alpha cypermethrin insecticide formulation were used in accordance to the instruction on the labels. Four concentrations 2.5% (v/v) and 5% (v/v) of water; and 2.5% (v/v) 2.5% (v/v) and 5% (v/v) of diesel were used. Each formulation was sprayed on filter paper to run off. Excess liquid was drained off. Thereafter ten (10) German cockroaches were confined into each jar.

The upper surfaces of the jar were lightly greased with petroleum jelly to prevent escape of the insects. Control jars had only water sprayed on the filter paper. Each treatment was replicated three times. Cockroaches' knockdown or mortality was recorded at 5, 10, 15, 20, 30 min to the 4^{th} h after spraying. The number of cockroaches dead and alive was counted and noted. The cockroaches were removed from the jar and kept in the freezer for 30 min and thereafter discarded. The jars containing treated and untreated filter papers were kept aside on laboratory bench and used in subsequent experiments.

Table 1. Cockroach mortality upon exposure to water (control) in filter paper in open and closed chambers.

Percentage mortality (%)	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
	Open	0	0	0	0	0	0	0	0	0	0
	Closed	0	0	0	0	0	0	0	0	0	0

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 2. Cockroach mortality upon exposure to diesel (control) soaked in filter paper in open and closed chambers.

Percentage mortality (%)	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
	Open	0	0	0	0	10	13	13	27	27	37
	Closed	0	0	0	10	10	20	20	27	43	43

Number of insects per replicate was 10 and each experiment was replicated three times.

Quantal response

On assumption of death, the German cockroach is pricked with the strands of hair from a camel hair brush to ascertain death. Responses of cockroaches were noted and the parameters considered include time of knock down and mortality rate per minute

Residual effect of the insecitides

The jars used in the experiments above containing treated filter paper were used for the residual test on weekly bases for two weeks, 10 cockroaches were confined to each jar and mortality and or knockdown noted as in toxicity test above.

Statistical analysis

Statistical analysis of the results was also done after the results have been ascertained and its corresponding mean and standard deviation were recorded against time. This was done using the equations:

Mean, $\bar{x}$= $\Sigma F\mathrm{X} / \Sigma F$

Standard deviation= $\sqrt{\Sigma(\mathrm{x}-\bar{x})}/n-1$

The lethal time value (LT_{50}) and the regression slope for each treatment were obtained using probit analysis (SPSS 2000). Mean percentage of insect mortality value was subjected to arcsine transformation followed by comparison of mean using LSD test.

RESULTS

Mortality of *B. germanica* exposed to diesel and water

No insects died throughout the period of the experiment when exposed to water in both the closed and opened chambers (Table 1). No mortality was recorded in the insects exposed to diesel until after 20 and 30 min in closed (Io) and opened (Ic) chambers respectively with the highest mortality (43%) recorded in closed (I_o) chambers (Table 2).

Mortality in Insects exposed to sniper and alphacypermethrin mixed with water

Mortality of *B, germanica* increased with increase in concentration of the insecticide used. It was higher in closed than in opened chambers and higher in insecticide mixed with diesel than in water. Mortality of *B. germanica* was recorded from 5 min in the insects exposed to both 2.5% (v/v) and 5% (v/v) of aqueous sniper in both opened (Io) and closed (Ic) chambers. All insects placed in aqueous sniper (5% (v/v)) died within 20 min while 100% mortality was recorded in all concentration used in the closed and opened chambers within one hour (Table 3). On the other hand, no mortality was recorded until after 20 min (6 and 33%) in *B. germanica* exposed to 2.5% (v/v) and 5% (v/v) of aqueous alpha cypermethrin respectively. 100% mortality was recorded after 4 h of exposure in both open (Io) and closed (Ic) chambers (Table 4).

Mortality in insects exposed to sniper and alphacypermethrin mixed with diesel

100% mortality was recorded in less than 5 min in the insects exposed to sniper mixed with diesel in both concentrations (2.5% (v/v) and 5% (v/v)) used and in both open (Io) and closed (Ic) chambers (Table 5) On the

Table 3. Cockroach mortality upon exposure to sniper (mixed with water) in filter paper in an open(Lo) and closed (Lc) chambers.

	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
Percentage mortality (%)	2.5% (v/v) L_O (I)	27	27	50	70	93	100	-	-	-	-
	2.5% (v/v) L_C (II)	13	27	33	37	73	86	100	-	-	-
	5% (v/v) L_O (I)	40	70	76	96	100					
	5% (v/v) L_C (II)	56	66	96	100	-	-	-	-	-	-

Number of insects per replicate was 10 and Each experiment was replicated three times.

Table 4. Cockroach mortality upon exposure to alpha cypermethrin (mixed with water) in filter paper in an open(Lo) and closed (Lc) chambers.

	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
Percentage mortality (%)	2.5% (v/v)L_O (I)	0	0	0	6	6	16	53	90	96	100
	2.5% (v/v)L_C (II)	0	0	0	33	33	40	70	60	60	67
	5% (v/v)L_O (I)	0	0	0	26	33	33	56	83	93	100
	5% (v/v)L_C (II)	0	0	0	33	40	43	63	90	90	100

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 5. Cockroach mortality upon exposure to sniper(mixed with Diesel) in filter paper in an open(Lo) and closed (Lc) chambers.

	Treatment	Time									
		2 min	5 min	8 min	10 min	20 min	30 min	45 min	1 h	2 h	3 h
Percentage mortality (%)	2.5% (v/v)L_O (I)	100	-	-	-	-	-	-	-	-	-
	2.5% (v/v)L_C (II)	100	-	-	-	-	-	-	-	-	-
	5% (v/v)L_O (I)	100	-	-	-	-	-	-	-	-	-
	5% (v/v)L_C (II)	100	-	-	-	-	-	-	-	-	-

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 6. Cockroach mortality upon exposure to alpha cypermethrin (mixed with diesel) in filter paper in an open (Lo) and closed (Lc) chambers.

	Treatment	Time									
		2 min	5 min	10 min	15 min	30 min	45 min	1 h	2 h	3 h	4 h
Percentage mortality (%)	2.5% (v/v)L_O (I)	56	100	-	-	-	-	-	-	-	-
	2.5% (v/v)L_C (II)	46	93	100	-	-	-	-	-	-	-
	5% (v/v)L_O (I)	40	93	100	-	-	-	-	-	-	-
	5% (v/v)L_C (II)	46	100	-	-	-	-	-	-	-	-

Number of insects per replicate was 10 and each experiment was replicated three times.

other hand, 100% mortality was recorded after 10 min in insects exposed to Alpha cypermethrin mixed with diesel in both open and closed chambers (Table 6).

Residual effect of sniper and alpha cypermethrin on *B germanica* at *one week after treatment*

At one week after treatment 5% (v/v) of sniper mixed with water gave 10 and 50% mortality of *B. germanica* at 15 min and 4 h respectively of exposure in the closed chambers (Table 7) while sniper diluted with diesel gave 26 and 46% mortality respectively in closed and opened chambers under the same conditions (Table 8). On the other hand under same concentrations, 0 and 23% mortality respectively of *B. germanica* was recorded for Alphacypermethrin mixed in water (Table 9) and 16 and 40% mortality recorded for Alphacypermethrin mixed in

Table 7. Residual effect of sniper (mixed with water) in filter paper on cockroach morality in an open(Lo) and closed (Lc) chambers (after one week).

Percentage mortality (%)	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
	2.5% (v/v)L_O (I)	0	0	0	23	23	30	33	33	37	37
	2.5% (v/v)L_C (II)	0	0	23	26	26	33	40	40	46	46
	5% (v/v)L_O (I)	0	0	3	6	36	43	43	43	50	50
	5% (v/v)L_C (II)	0	0	10	13	26	33	40	40	50	50

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 8. Residual effect of sniper (mixed with diesel) in filter paper on cockroach morality in an open (Lo) and closed (Lc) chambers (after one week).

Percentage mortality (%)	Treatment	Time									
		2 min	5 min	10 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
	2.5% (v/v)L_O (I)	0	10	16	16	20	23	26	26	26	26
	2.5% (v/v)L_C (II)	0	13	16	16	16	30	36	36	36	36
	5% (v/v)L_O (I)	0	16	23	23	26	33	43	43	43	43
	5% (v/v)L_C (II)	0	20	26	26	30	36	46	46	46	46

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 9. Residual effect of alpha cypermethrin (mixed with water in filter paper) on cockroach morality in an open (Lo) and closed (Lc) chambers (after one week).

Percentage mortality (%)	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
	2.5% (v/v)L_O (I)	0	0	0	0	0	13	13	16	20	20
	2.5% (v/v)L_C (II)	0	0	0	0	0	13	16	16	20	20
	5% (v/v)L_O (I)	0	0	0	0	0	3	10	16	16	16
	5% (v/v)L_C (II)	0	0	0	0	0	20	20	23	23	23

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 10. Residual effect of alpha cypermethrin (mixed with diesel in filter paper) on cockroach morality in an open (Lo) and closed (Lc) chambers (After one week).

Percentage mortality (%)	Treatment	Time									
		2 min	5 min	10 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
	2.5% (v/v)L_O (I)	0	0	0	6	10	10	16	26	26	26
	2.5% (v/v)L_C (II)	0	0	0	13	13	13	23	30	30	30
	5% (v/v)L_O (I)	0	0	0	6	10	23	23	33	33	33
	5% (v/v)L_C (II)	0	0	0	16	16	26	26	40	40	40

Number of insects per replicate was 10 and Each experiment was replicated three times.

diesel (Table 10).

Residual effect of sniper and alpha cypermethrin on *B germanica* at *two weeks after treatment*

No mortality was recorded at two weeks of treatment until after 3 and 4 h in *B. germanica* exposed to sniper mixed with diesel and water respectively and the highest mortality of 16 and 10% were recorded after 4 h with 5% (v/v) sniper in closed chambers (Tables 11 and 12). Same trend of 3 and 4 h after exposure was found in *B. germanica* exposed to alphacypermethrin mixed with diesel and water. Highest mortality of 20% was recorded

Table 11. Residual Effect of sniper (mixed with water in filter paper) on cockroach morality in an open(Lo) and closed (Lc) chambers (After two weeks).

	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
Percentage mortality (%)	7.5ML/300ML $_O$ (I)	0	0	0	0	0	0	0	0	0	3
	7.5ML/30OML$_C$ (II)	0	0	0	0	0	0	0	0	0	3
	5% (v/v)L$_O$ (I)	0	0	0	0	0	0	0	0	0	3
	5% (v/v)L$_C$ (II)	0	0	0	0	0	0	0	0	0	10

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 12. Residual effect of sniper (mixed with diesel in filter paper) on cockroach morality in an open(Lo) and closed (Lc) chambers (after two weeks).

	Treatment	Time									
		2 min	5 min	10 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
Percentage mortality (%)	2.5% (v/v)L $_O$ (I)	0	0	0	0	0	0	0	0	6	6
	2.5% (v/v)L$_C$ (II)	0	0	0	0	0	0	0	0	10	10
	5% (v/v)L$_O$ (I)	0	0	0	0	0	0	0	0	13	13
	5% (v/v)L$_C$ (II)	0	0	0	0	0	0	0	0	16	16

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 13. Residual effect of alpha cypermethrin (mixed with water in filter paper) on cockroach morality in an open (Lo) and closed (Lc) chambers (after two weeks).

	Treatment	Time									
		5 min	10 min	15 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
Percentage mortality (%)	2.5% (v/v)L $_O$ (I)	0	0	0	0	0	0	0	0	0	0
	2.5% (v/v)L$_C$ (II)	0	0	0	0	0	0	0	0	0	3
	5% (v/v)L$_O$ (I)	0	0	0	0	0	0	0	0	0	3
	5% (v/v)L$_C$ (II)	0	0	0	0	0	0	0	0	0	6

Number of insects per replicate was 10 and each experiment was replicated three times.

Table 14. Residual effect of alpha cypermethrin (mixed with diesel in filter paper) on cockroach morality in an open(Lo) and closed (Lc) Chambers (After two week).

	Treatment	Time									
		2 min	5 min	10 min	20 min	30 min	45 min	1 h	2 h	3 h	4 h
Percentage mortality (%)	2.5% (v/v)L $_O$ (I)	0	0	0	0	0	0	0	0	6	6
	2.5% (v/v)L$_C$ (II)	0	0	0	0	0	0	0	0	13	13
	5% (v/v)L$_O$ (I)	0	0	0	0	0	0	0	0	16	16
	5% (v/v)L$_C$ (II)	0	0	0	0	0	0	0	0	20	20

Number of insects per replicate was 10 and each experiment was replicated three times.

after 4 h in 5% (v/v) alphacypermethrin in closed chambers (Tables 13 and 14).

Lethal time of sniper to *B. germanica*

Table 15 shows the LT_5, LT_{50} and LT_{95} of 2.5% (v/v) and 5% (v/v) of sniper mixed in diesel and water. LT decreases with increase in the concentration of sniper. The LT_5 and LT_{50} could not be calculated because 95% mortality of *B. germanica* was recorded within 10 min of the experiment. Sniper mixed with diesel had the LT_{95} of 10 min in both closed and opened chambers while with sniper mixed in water was 17 and 23 min respectively in closed and opened chambers.

Table 15. Lethal time of sniper to mortality of *B. germanica.*

Lethal time (min)	Aqueous sniper				Sniper and diesel			
	2.5% (v/v)		5% (v/v)		2.5% (v/v)		5% (v/v)	
	I_O	I_C	I_O	I_C	I_O	I_C	I_O	I_C
LT_5 (min)	8	6	2	2	-	-	-	-
LT_{50} (min	**12**	**18**	**7**	**5**	**-**	**-**	**-**	**-**
LT_{95} (min)	45	72	23	17	10	10	10	10

Number of insects per replicate was 10 and each experiment was replicated three times

Table 16. Lethal time of alpha cypermethrin to mortality of *B. germanica.*

Lethal time	Aqueous alpha-cypermethrine				Alpha-cypermethrine mixed with diesel			
	2.5% (v/v)		5% (v/v)		2.5% (v/v)		5% (v/v)	
	I_O	I_C	I_O	I_C	I_O	I_C	I_O	I_C
LT_5(minutes)	25	12	13	11	2	-	3	-
LT_{50}(minutes)	62	40	44	30	5	-	6	-
LT_{95}(minutes)	183	175	161	124	10	10	10	10

Number of insects per replicate was 10 and each experiment was replicated three times

Lethal time of alphacypermetrin to *B. germanica*

Table 16 shows the LT_5, LT_{50} and LT_{95} of 2.5% (v/v) and 5% (v/v) of alpha cypermethrin mixed in diesel and water. LT also decreases as concentration of alphacypermethrin increases. The LT_5 and LT_{50} is unknown for alpha-cypermethrin and diesel solution in both 2.5% (v/v) and 15 ml/300 ml in closed (Ic) chambers because 95 mortality was recorded within 10 min. The LT_{95} of 5% (v/v) of Alphacypermethrin mixed with diesel and water closed chambers were 10 and 125 min respectively (Table 16).

Percentage mortality after four hours of exposure

At the onset of the experiment, both insecticides gave 100% mortality of all insects exposed within 4 h of the exposure period. However, the efficacy decreased with increase in residual time that by the second week after treatment, 17 and 20% mortality of *B. germanica* were recorded in sniper and alphacypermethrin respectively mixed in diesel in the closed chambers (Table 17).

DISCUSSION

For effective pest control of the German cockroach, closed (fumigation environment) and mixing the insecticide with diesel rather than water is being suggested. This is because *B. germanica* mortality was higher and time of death faster in closed chambers than in open chambers. Moreover, mixing each of the two insecticides with diesel gave better results than mixing with water.

The study revealed the effectiveness of two groups of insecticides, sniper (organophosphate) and alpha-cypermethrin (Pyrethroid) in the control of German cockroaches. Label-recommended doses of sniper and alphacypermethrin (5% v/v), were effective by having 100% mortality after four hours of exposure to *B. germanica*.

However, the 100% mortality recorded in 2 min in the insects exposed to sniper (Table 5) mixed with diesel in both concentrations used (2.5% (v/v) and 5% (v/v)) and in both open (Io) and closed(Ic) chambers suggest sniper to be more effective in controlling *B. germanica* than alphacypermethrin that had 100% mortality in 10 min under the same conditions (Table 6). Lots of studies have shown that cockroaches show high level of resistance to pyrethroid compared to organophosphates (Wei et al., 2001; Cochran, 1995).

This is not the case in this situation as both insecticides were able to control *B. germanica* in less than 10 min when mixed in diesel and less than 20 min and 4 h when sniper and alphacypermethrin respectively were mixed with water. This experiment conforms with that by Agrawal et al., (2005) who found that propoxur (an organophosphate) was more effective in controlling the German cockroach, *B. Germanica,* than deltametrin (a pyrethroid).

This study also showed that efficacy and time of response were affected by time of application of insecticide and time of exposure of insects after treatment. The insecticides (sniper and alpha- cypermethrin) were more

Table 17. Percentage mortality of *B. germanica* after four hours of exposure.

Parameter	Period	2.5% (v/v)		5% (v/v)	
		I_O	I_C	I_O	I_C
Diesel	Control	36	43		
Water	Control	0	0		
Sniper/water	Initial	100	100	100	100
	One week after treatment	37	47	50	50
	Two weeks after treatment	3	3	3	10
Sniper/diesel	Initial	100	100	100	100
	One week after treatment	37	40	43	53
	Two weeks after treatment	7	10	13	17
Alpha cypermethrine/water	Initial	100	100	100	100
	One week after treatment	20	20	13	23
	Two weeks after treatment	0	3	3	7
Alpha cypermathrine/diesel	Initial	100	100	100	100
	One week after treatment	27	30	33	40
	Two weeks after treatment	7	13	17	20

Number of insects per replicate was 10 and each experiment was replicated three times

effective when the insects were exposed immediately after application of insecticides as compared to when they were exposed one and two weeks after application. Thus the residual effect of sniper and alphacypermethrin can be said to be less than one week.

B. germanica collected from several places at one geographical location, University of Lagos, Nigeria with a total area of 8194.93 m^2 (consisting of both wet and dry land) showed high susceptibility to sniper and alpha-cypermethrin. There is a need for more research to be carried out to ascertain its susceptibility on these insecticides in other geographical locations in Lagos State, Nigeria.

Conclusion

From this study, closed chambers (fumigation) are more effective than open (disinfestation) exercise. In a situation where fumigation exercise is to take place, an environment that is well enclosed should be ensured as much as possible so as to have an effective and thorough pest control exercise. Sniper and alphacypermethrin were found to be effective in the control of *B. germanica*. Sniper however, was more effective than alpha cypermethrin. Four hours of no- entry after pest control exercise is recommended for fumigation exercise using sniper. However, an additional hour may be added if alphacypermethrin mixed with water is used. Diesel was found to increase the efficacy and can be a preferred choice over water in fumigation (closed) and disinfestation (opened) exercises. However caution should be exercised in the use of diesel as diluents due to its volatile nature and resultant toxic effect on the environment.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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