Iranian J. Publ. Health, 1998, Vol. 27, Nos. 1-2

A DEVICE FOR DETECTION OF THE RESIDUAL ACTIVITY OF BETA-CYFLUTHRIN (RESPONSAR 12.5% SC) AS A NEW PYRETHROID ON DIFFERENT SURFACES AGAINST *BLATTELLA GERMANICA* (ORTHOPTERA: BLATTELLIDAE)

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Key words: *Beta-cyfluthrin, German cockroach, Iran.*

Abstract

This study was designed to evaluate the efficacy of beta-cyfluthrin (Responsar 12.5% SC), against a standard susceptible strain of German cockroach, *Blattella germanica*, using three different dosages, at three different exposure times, on two types of surface, parous (mosaic) and non parous (glassed ceramic of tiles).

Comparison of the results indicated that, beta-cyfluthrin at 12.5 a.i.mg/m^2, has negligent residual activity on both mosaic and glazed ceramic tiles from one to two weeks. However at 25 a.i. mg/m^2, (middle dosage) on mosaic it had a residual activity for about four weeks, whereas on glazed ceramic tiles the residual activity increased to seven, seven and nine weeks when the cockroaches were exposed for 10, 15 and 20 minutes respectively. Whilst beta cyfluthrin at 37.5 a.i. mg/m^2 (highest dosage), had the longest residual activity on mosaic, it was active for six, seven and nine weeks, while on glazed ceramic tiles the residual activity increased slightly to seven, nine and nine weeks when the nymphae were exposed for 10, 15 and 20 minutes respectively. These results of the bio-assay test indicate that 12.5 a.i.mg/m^2 is too low for any residual spraying. Application of Beta-cyfluthrin at a target dosage rate of 25 and 37.5 a.i. mg/m^2 showed longer residual deposit effect than the earlier one. Hence these dosages could be recommended for light and heavy infested areas respectively.

This study is also recommending a simple device for measuring the residual activity of insecticides against German cockroach either in laboratory or in the field conditions.

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Introduction

The German cockroach, *Blattella germanica* (L.), is the most common household pest in the world. The main groups of pesticides available for its control are the organophosphorus, carbamate, and pyrethroid compounds. Repeated application for German cockroach control has resulted in the development of moderate to high levels of resistance to a number of insecticides. Reported to date are chlorpyrifos (9), bendiocarb (14) and five pyrethroids in different wild strains (3). Additionally, cross-resistance to a number of insecticides has also been reported in a number of wild strains (4,8,10,11).

Most of control methods continue to rely primarily upon residual treatment of the infested areas. The length of effective residual life, depends upon several factors, among which are: (a) the persistent nature of the active ingredient in the face of physical environmental factors such as temperature, moisture or humidity, air currents and light; (b) the formulation applied; (c) The type of substrate; and (d) the biological factors, such as cockroach activity patterns (1).

Residual efficacy can be measured by a variety of methods. In a laboratory study, the residual deposits of 42 compounds against *Blattella germanica* applied on 4 types of surfaces were evaluated (7). The residual activity of chlorpyrifos against *B.germanica* was evaluated on a plastic resin lacquer surface in the laboratory (13). The cockroaches were confined to the test surfaces by Petri dish lids, and the LT_{50} value was calculated for different days of exposure to the treated surfaces. Regarding the repellency properties of different pesticides, and biology and ecology of pests, a number of researcher evaluated the residual deposits of insecticides under simulated household conditions, e.g. test chamber (6), choice boxes (2,5) and wall voids (16).

The aims of this study is measuring the residual efficacy of beta-cyfluthrin as a new pyrethrid insecticide using a simple device against German cockroach in the laboratory condition.

Materials and methods

A simple device was used to measure the residual activity of an insecticide on different surfaces in a forced contact testing method, using a test chamber (Fig. 1). The test chamber is made of two pieces of glass; a glass cylinder with an inside diameter of 10 cm and a height of 5 cm, and a covering plate which fits inside the cylinder. In the middle of plate there is a hole (1 cm diameter) to which is fitted a tube of about 10 cm of length. The tube is acting both as a handle, to facilitate the plate mobility inside the cylinder, or as a channel to pass CO_2 gas into the glass cylinder. To ensure that the covering plate will not squeeze the nymphae during exposure time, three pieces of glass (glass spacer) with approximately 0.5 cm high were attached under the covering plate.

In order to measure the deposit effect of insecticide on treated surfaces, the following procedure should be utilized. (a) Place the glass cylinder on the treated surface. (b) Introduce the cockroaches into the glass cylinder. (c) Insert the plate into cylinder. (d) Leave the cockroaches for a measured exposure time. (e) Anaesthetize the cockroaches by passing CO_2 through the tube, and transfer them to a rearing glass jar. (f) Record the mortality after a 24 hour holding period.

According to the above method, the residual activity of beta-cyfluthrin (Responsar 12.5% SC) was determined on mosaic (30 x 30 cm), and glazed ceramic tile (15 x 15 cm) as porous and non-porous substrates respectively. These substrates are commonly used in kitchens, bathrooms, restaurants and food facilities. The surfaces were treated with 10 ml of a known volume of formulation of beta-cyfluthrin in water, by means of a pipet, onto substrate at the rate of 0 (water), 12.5, 25 and 37.5 a.i. mg/m^2. Each mosaic was divided into four equal sectors (15 x 15 cm), suitable for four individual bio-assay tests. Bioassay tests were carried out at three different exposure times (10, 15 and 20 minutes) against 2-4 day old of first nymphae of German cockroach, at weekly intervals for each dosage. The nymphae for bioassay tests were provided from a standard susceptible strain of German cockroach which maintained in our insectary, without any exposure to insecticides for at least 18 years. At each exposure time, about 40 adults representing four individual replicates of 10

adults were tested. At the end of the exposure time, the adults were transferred into a rearing glass jar, and supplied with a water vial, dry dog chow and dry bread, and under a photoperiod of 12:12 (L:D) at 26 ± 2 C and RH of 50 ± 5. Mortality was counted after 24 hours holding time. In this assay the effective residual activity of insecticide was calculated based on the decrease of mortality of German cockroach from 100% to 50-55% during the course of study.

Results and discussion

The efficacy of beta-cyfluthrin was evaluated , against a susceptible strain of German cockroach, using three different parameters, i.e., three dosages (12.5, 25 and 37.5 a.i. mg/m^2) at three different exposure times (10,15,20 minutes), on two surface (mosaic , and glazed ceramic tiles).

Comparisons of the result of bio-assay contact mortality tests indicated that, beta-cyfluthrin at 12.5 a.i. mg/m^2 (the lower dosage, recommended for light infection by manufacturer), has negligible residual activity on both mosaic and glazed ceramic tiles. On the glazed ceramic tiles, the mortality dropped sharply from 100% to about 50% two weeks after spraying, when the nymphae were exposed to mosaic and glazed ceramic tiles for 20 minutes respectively (see table 1).

Beta-cyfluthrin at 25 a.i mg/m^2 (middle dosage), on mosaic, did not showed any remarkable differences in residual activities, when the nymphae were exposed for 10, 15 and 20 minutes, i.e. the mortality gradually decreased from 100% to about 50-70% on week four. In contrast on glazed ceramic tiles, beta-cyfluthrin had a higher residual activity at 10 and 15 and 20 minutes of exposure time, the mortalities decreased from 100% to about 50% after seven, seven and nine weeks of spraying respectively.

Beta-cyfluthrin at 37.5 a.i. mg/m^2 (higher dosage), had the longest residual activity. On both mosaic and tiles, the mortality gradually decreased from 100% to about 50%, after six, seven and nine weeks of spraying, when the nymphae were exposed to insecticide for 10, 15 and 20 minutes respectively.

Comparison of the result of bio-assay tests using three dosages of beta-cyfluthrin at three different exposure times on two surfaces against a susceptible strain of German cockroach, indicated that, 12.5 a.i mg/m^2 is too low for any residual spraying. However the 25 and 37.5 a.i. mg/m^2 dosages, could be the recommended dosages for German cockroach control in light and heavy infested areas respectively. These studies also indicated that 20 minutes exposure time gave more reliable results than the shorter exposure time used. Therefore 20 minutes could be the recommended exposure time for evaluating the residual activity of beta-cyfluthrin in any comparative study on different surfaces (for more details see table).

The effect of substrates on the residual activity of cyfluthrin (20 WP) and fenvalerate (0.5% EC) against adult male German cockroaches was studied by Rust unpubl, 1995. He showed that on glazed ceramic tiles, at LT_{50} level, cyfluthrin (31.2 a.i. mg/m^2) had the residual activity for 84 days, when the cockroaches were exposed for 30 minutes.

World Health Organization has a standard method for determination of residual activity of insecticide on different walling materials using plastic conical chamber for adult of mosquitoes (17,18). There is a lack of any standard method for such study against crawling insect. This study is recommending a simple method for measuring the residual activity of insecticides against German cockroach either in the laboratory or in the field conditions.

Table 1- Residual efficacy of beta-cyfluthrin (12.5% SC) on mosaic (porous) and glazed ceramic tiles (non - porous) against a susceptible strain of *Blattella gemanica.*

Surfaces	Dosages a.i mg/m²	Exposure time (minutes)	% Mortality after 24 hr. holding periods								
			weeks after spraying								
			2	3	4	5	6	7	8	9	10
Mosaic (porous)	25	10	100 (43)	100 (41)	50	20	-	-	-	-	-
		15	100 (41)	100 (42)	55	22	-	-	-	-	-
		20	100 (40)	100 (40)	70	30	-	-	-	-	-
	37.5	10	100 (39)	100 (43)	100 (43)	100 (42)	51.2 (41)	-	-	-	-
		15	100 (42)	100 (40)	100 (42)	100 (40)	80 (40)	30.2 (43)	-	-	-
		20	100 (40)	100 (40)	100 (40)	100 (41)	100 (43)	95.2 (42)	85.7 (42)	50 (40)	-
Glazed ceramic tiles (non porous)	25	10	100 (40)	100 (41)	100 (40)	100 (43)	80.4 (41)	51.2 (43)	-	-	-
		15	100 (41)	100 (40)	100 (41)	100 (40)	85.7 (42)	56.1 (41)	-	-	-
		20	100 (40)	100 (43)	100 (42)	100 (43)	100 (43)	100 (40)	90.2 (41)	71.4 (42)	12.5 (40)
	37.5	10	100 (40)	100 (43)	100 (42)	100 (40)	90 (40)	60 (40)	-	-	-
		15	100 (40)	100 (40)	100 (43)	100 (40)	95.1 (41)	90.5 (42)	80.5 (41)	56.5 (44)	12 (40)
		20	100 (41)	100 (42)	100 (44)	100 (41)	100 (44)	100 (40)	95 (38)	80.7 (43)	40 (40)

The figures in brackets represent the number of cockroaches tested.

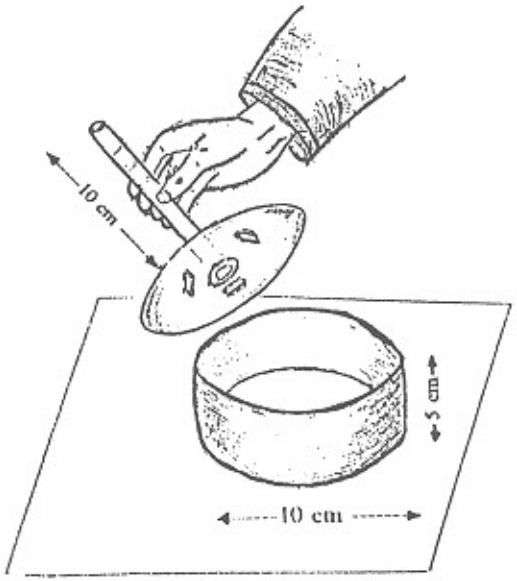

Fig. 1- The bio-assay test chamber for measurment of the residual deposits of beta- cyfluthrin on different surfaces

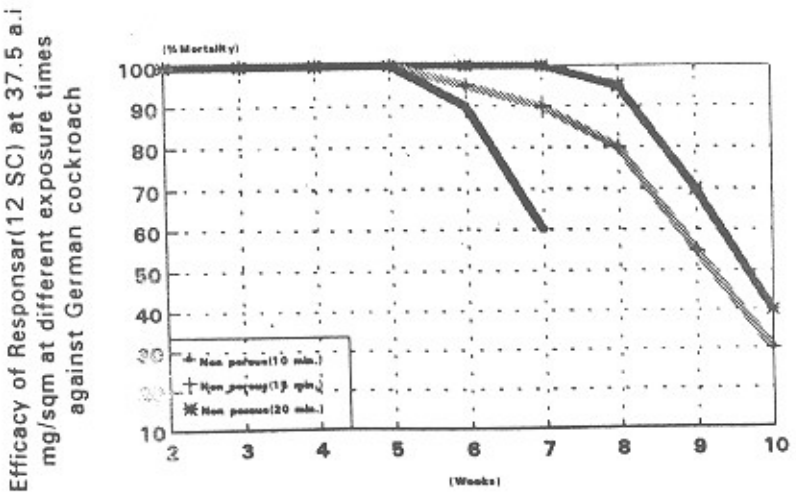

Fig 2- Efficacy of beta-cyfluthrin 12.5%, SC at 37.5 a.i mg/m² at different exposure times against German cockroach

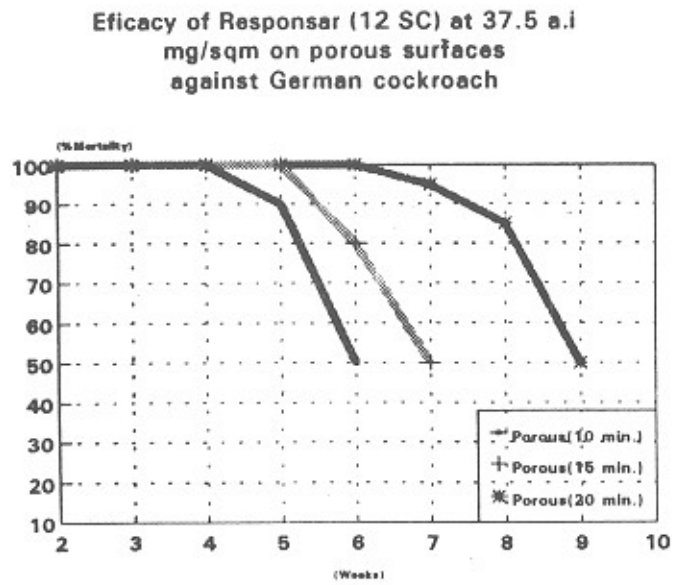

Fig 3- Efficacy of beta-cyfluthrin 12.5% SC at 37.5 a.i mg/m^2, on porous surfaces gainst German cockroach

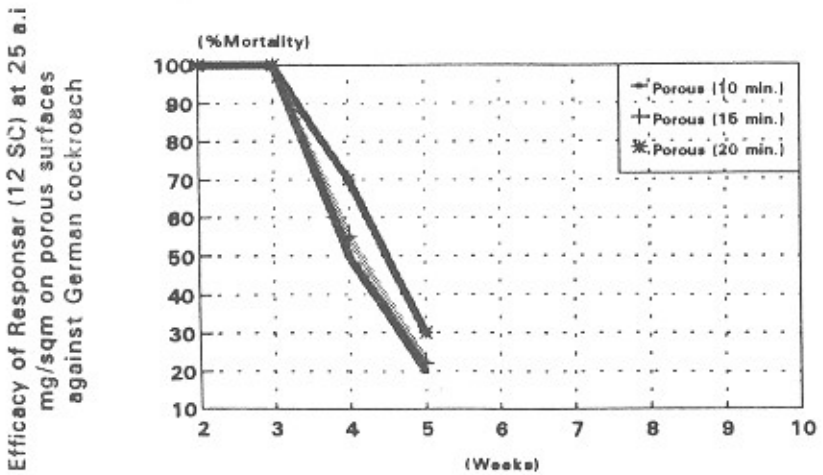

Fig 4- Efficacy of beta-cyfluthrin 12.5% SC at 25 a.i mg/m^2, on porous surfaces against German cockroach

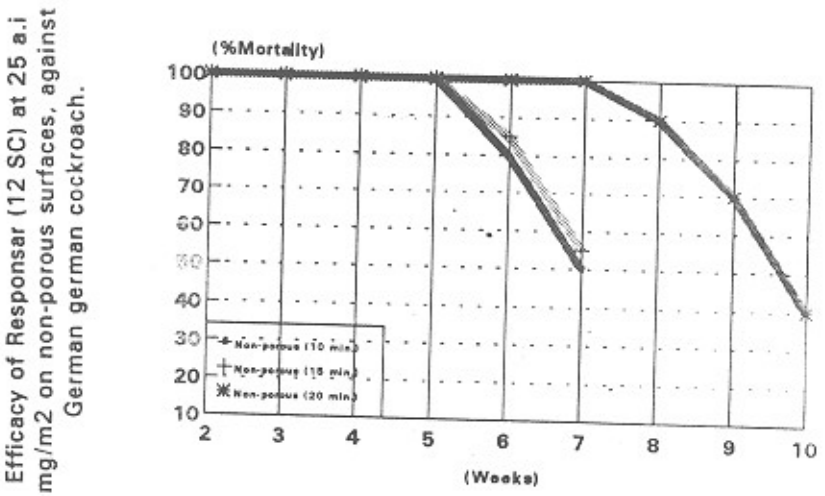

Fig 5- Efficacy of beta-cyfluthrin 12.5% SC at 25 a.i mg/m^2, on non-porous sufaces, against German cockroach.

References

1. Braness, G.A. and Bennett, G.W. (1990): Residual effectiveness of insecticides for control of German cockroaches (*Dictyoptera: Blattellidae*) in food-handling establishments. J. Econ. Entomol. 83, 1907-1911.
2. Burden, G.S and Eastin, J.L. (1960): Laboratory evaluation of cockroach repellents. Pest Contr. 48 (11), 22-24.
3. Cochran, D.G. (1989): Monitoring for insecticide resistance in field - collected strains of the German cockroach (Dictyoptera: Blattellidae). J.Econ. Entomol. 82: 336-341.
4. Collins, W.J. (1973): German cockroach resistance. 1. Resistance to diazinon includes cross-resistance to DDT, pyrethrin, and propoxur in a laboratory colony. J. Econ. Entomol. 66:44-47.
5. Ebeling, W., wanger, R.E and Reierson, D.A. (1966): Influence of repellency on the efficacy of Blatticides. I. Learned modification of behavior of the German cockroach. J. Econ. Entomol. 59, 1374-1388.
6. Flynn, A.D. and Schoof, H.F. (1966a): A simulated-field method of testing residual insecticide deposits against cockroaches. J. Econ. Entomol. 56: 110-113.
7. Flynn, A.D. and Schoof, H.F. (1966b): Evaluation of various toxicant as residues against *Blattella germanica* (L.) J. Econ. Entomol. 56: 1270-1274.

8. Heuvel, M.J Van den, and Cochran, D.G. (1965): Cross resistance to organophosphorus compounds in malathion and diazinon-resistant strains of *Blattella germanica*. Ibid. 58:872-874.

9. Koehler, P.G. and Patterson, S. (1988): Suppression of German cockroach (Orthoptera: Blattellidae) population with cypermethrin, and two chlorpyrifos formulations. J. Econ. Entomol. 81: 845-849.

10. Ladonni, H. (1993): Susceptibility of *Blattella germanica* to different insecticides in different hospital in Tehran-Iran. J. of Ent. Soc. of Iran. Vol. 12 & 13, March, 1993.

11. Ladonni, H. (1997): Susceptibility of different field strains of *Blattella germanica* to four pyrethroids (Orthoptera: Blattelidae). Iranian J. Publ. Health, Vol. 26, Nos. 3-4.

12. Michael K.R., Owens, J.M. and Reierson, D.A. (1995): Understanding and controlling the German cockroach. Oxford University Press, Inc. pp 430.

13. Miller, T.P and Gold, R.E. (1983): Sorption of ^{14}C-labelled chlorpyrifos (killmaster II) by German cockroach (Orthoptera: Blattellidae). J. Econ. Entomol. 76: 1211-1215.

14. Schal, C. (1988): Relation among efficacy of insecticides, resistance levels, and sanitation in the control of German cockroach (Dictyoptera: Blattellidae). J.Econ. Entomol. 81: 536-544.

15. Scott, J.G; D.G. Cochran and B.D. Siegfried. (1990): Insecticide toxicity, synergism and resistance in German cockroach (Dictyoptera: Blattellidae). J. Econ. Entomol. 83: 1698-1703.

16. Wagner, R.E; Ebeling, W; and Clark, W.A. (1964): An electric barrier for confining cockroaches in large rearing or field collecting cans. J. Econ. Entomol. 57, 1007-1009.

17. World Health Organization, (1963): Insecticide resistance and vector control. 13th report of WHO expert committee on insecticide. WHO.Tech.Rep.Ser. 256.

18. World Health Organization, (1996): Report of the WHO informal consultation on the evaluation and testing of insecticides. CTD/WHOPES/IC/96.1